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Disciplinary Literacy: a Case Study on How Secondary Teachers Engage Students in Disciplinary Discourses

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DISCIPLINARY LITERACY: A CASE STUDY ON HOW SECONDARY TEACHERS ENGAGE STUDENTS IN DISCIPLINARY DISCOURSES

by

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ABSTRACT
DISCIPLINARY LITERACY: A CASE STUDY ON HOW SECONDARY TEACHERS ENGAGE STUDENTS IN DISCIPLINARY DISCOURSES

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Secondary teachers are currently pressured to address low adolescent literacy rates by adopting disciplinary literacy approaches. While the pressure mounts, direction on how such approaches may be modified to meet the learning objectives of different subject areas is limited. Each subject area will have different Discourses or ways of speaking, writing, listening and thinking about its field, necessitating different literacy strategies for each subject's curriculum. Successful disciplinary literacy entails learning which strategies and approaches to learning are most effective for student learning for each subject area. In this multi-case study, I observed two high school teachers in Chemistry and Psychology to witness how they modified content area strategies to meet disciplinary literacy demands, and interviewed them about their experiences of this process. Through observations and interviews with the teachers and the curriculum director, a picture emerged of a district that was relaxed in its approach to the challenges of disciplinary literacy reform. Teachers reported that they were not influenced by the district's disciplinary literacy initiative, but had other sources that guided their best practices to get students actively learning during class. Classroom reform was largely left up to individual teachers. The district's lack of a clear purpose in its disciplinary literacy initiative created the feeling among teachers that disciplinary literacy was an administrative fad that would pass in time. Recommendations

include guidelines for improving students' collaborative discourse during group activities and suggestions for literacy coaches working with teachers in multiple departments at the secondary level. The enduring question is raised regarding the role of professional organizations in the identification and dissemination of effective disciplinary literacy strategies.

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Chapter One

Introduction to the Study

Current adolescent literacy rates raise concerns in American secondary schools among educators who aspire to provide equal educational opportunity for all students. On the 2009 National Assessment of Educational Progress (NAEP), only 74% of high school seniors read at or above the basic level (National Center for Education Statistics, 2010). Additionally, only 38% of 17-year-olds scored at or above NAEP's proficient level. This means that one-quarter of the nationally representative sample left high school with below basic reading skills, and over 60% of high school graduates did not exhibit the level of reading skills needed to learn effectively from college texts. While our vision of secondary schooling is to provide students with opportunities for higher levels of learning, reality falls far short.

The previous predominant national paradigm for literacy instruction was intensive phonics and decoding practice in primary grades under the Reading First section of the No Child Left Behind Act (No Child Left Behind, 2001, Title I, Part B, Subpart A). We know now that intensive attention to basic literacy does not improve students' achievement in later grades, with early gains disappearing by eighth grade (Perle, Grigg, & Donahue, 2005). Below basic reading levels, or what has been called a functional level of literacy, limits students' educational and economic prospects (Finn, 2009). Additionally, low literacy levels have been implicated in poor health maintenance (Berkman, et al., 2004) and in higher criminal rates (Beck & Harrison, 2001). Adults with reading levels of basic or below are less likely to vote or be civically involved than are more proficient readers (Kutner, Greenberg, Jin, Boyle, Hsu & Dunleavy, 2007). Although a review of literacy research indicates that we have the potential to educate all children to proficient levels of reading (Allington, 2012), about 8 million adolescents struggle

with the grade-level reading demanded in most high school subjects (Biancarosa & Snow, 2006). Increasingly, national attention is brought to bear on this problem, and secondary teachers are expected to respond.

Several national policy reports indicate that secondary teachers should help students overcome low levels of literacy by implementing cognitive strategy instruction in the classroom (e.g. American College Testing, 2006; Biancarosa & Snow, 2006; International Reading Association, 2006; Lee & Spratley, 2010; National Association of State Boards of Education, 2006; National Governors Association Center for Best Practices & Council of Chief State School Officers (NGACBP & CCSSO), 2010). Cognitive strategy instruction draws students' attention to thinking that proficient readers use to construct meaning from text. Common examples include summarizing, predicting, creating mental images, self-questioning and activating prior knowledge (Dymock & Nicholson, 2010).

But most cognitive strategy instruction has been generalized across subjects and grade levels, originating in work with elementary students (Allington, 2012; Conley, 2008) or with students with special needs (Faggella-Luby, Graner, Deshler, & Drew, 2012). Cognitive strategy instruction that is effective for K-6 schooling may not be appropriate for general secondary classrooms. In secondary classrooms, the cognitive demand of reading increases due to greater text complexity, teachers' expectations that students have mastered basic and intermediate literacy skills, and different styles of literacy based on disciplinary demands (Conley, 2008; Learned, Stockdill, & Moje, 2011; Moje, Overby, & Tysvaer, 2008; Shanahan & Shanahan, 2008). Generic strategies cannot convey the complexity embodied in secondary subjects as entryways into the broader disciplines.

In response to the inadequacy of general cognitive strategy instruction for secondary classrooms, secondary teachers are encouraged to teach disciplinary literacy. Disciplinary literacy has been described as "advanced literacy instruction embedded within content-area classes such as math, science, and social studies" (Shanahan & Shanahan, 2008, p. 40). The move towards disciplinary literacy is becoming stronger as many states adopt the Common Core State Standards (CCSS) and more rigorous testing in reading and math (NGACBP & CCSSO, 2010; US Department of Education, 2012). Language about the need for disciplinary literacy may also be seen in state agency statements about education. For example, the Wisconsin Department of Education website asserts that all teachers should integrate discipline-specific literacy into instructional practice, and gives examples for several subjects (http://dpi.wi.gov/standards/disciplinaryliteracy.html). The importance of including disciplinary literacy in all classrooms to improve student learning has gained traction within the current wave of school reform efforts.

Yet less attention is spent examining how content area teachers recognize which literacy practices function best in their subjects (Learned, Stockdill, & Moje, 2011). Content area teachers do not traditionally consider the reading needs of students (Conley, 2008). Secondary teachers are rarely trained in how to help students learn effectively from text, much less how to teach advanced literacy skills. Training for teacher certification may include one undergraduate class in content area reading, or none, depending on the state (Jetton & Alexander, 2004). As expert readers, teachers are unlikely to use much conscious effort in their own reading, relying instead on automatic skills to construct meaning from text (Afflerbach, 2004; Allington, 2012; Clay, 2002). Especially for teachers years beyond their university training, the idea that they are expert readers in their fields may be new. They may hear about new requirements for

disciplinary literacy without being aware of research about how discipline-specific literacy practices may be integrated into instruction. Darling-Hammond (2010) notes that often teachers are not exposed to recent educational research, which tends to be published in academic journals for researchers and their peers to read. If teachers are not themselves consumers of research, then schools need to plan how to help connect teachers with research about best practices, particularly for disciplinary literacy.

Emerging research indicates how certain strategies may be used in some subjects (e.g. Adams & Pegg, 2012; Johnson & Watson, 2011; Shanahan & Shanahan, 2008), but large gaps remain in our knowledge of veteran teachers using disciplinary literacy in secondary classrooms. In the last couple years, research has flourished on preparing pre-service teachers for disciplinary literacy (e.g. Cook & Dinkins, 2015; Fang, 2014; Hart & Bennett, 2013; Masuda, 2014; Park, 2013). However, to the best of my knowledge, no research has presented in-service teachers' firsthand experiences of adapting cognitive strategies to fit disciplinary literacy instruction. In order to teach students how to use strategies that work well in a discipline, teachers need to consider how they adapt general reading strategies for their subjects.

Problem Statement and Significance of Study

Disciplinary literacy is a set of teaching approaches that address cognitive complexity that varies by subject. Currently, national policy calls for secondary educators to implement disciplinary literacy in English language arts, social studies/history, science and technical subjects to increase levels of adolescent literacy (NGACBP & CCSSO, 2010; Wisconsin Department of Public Instruction, 2012c). Disciplinary literacy means that teachers present

subjects to students as an "apprenticeship" that introduces them to the ways of reading, thinking, speaking and writing that characterize the field (Buehl, 2011; Collins, Brown & Newman, 1989; Gee, 2012; Schoenbach, Greenleaf, & Murphy, 2012). It invites students to *do* science or social studies or literature, instead of having teachers simply transmit knowledge from the end products created by others.

Yet the standards and policy reports neglect *how* disciplinary literacy may be undertaken in secondary instruction. Instructional advice from the Wisconsin state department is emerging, but is not yet offered for all subjects (Wisconsin Department of Public Instruction, 2012c). The answer to what disciplinary literacy exactly is has been left nebulous in policy and practice. There is a lack of fit between what teachers are being pressured to do and practical suggestions for how to undertake this style of teaching. If teachers are pushed to undertake a different way to educate, they must know what they are being asked to do and have guided practice with the new approach (Fisher & Frey, 2008). The familiarity and comfort teachers develop with a method matters because school reform depends in large part on the buy-in of the teaching and administrative staff (Brazer & Peters, 2007).

How can in-service teachers learn and implement disciplinary literacy? While national policy dictates that schools adopt this approach, few studies grapple with how disciplinary literacy approaches impact secondary teachers' instruction (e.g. Adams & Pegg, 2012; Shanahan & Shanahan, 2008). We need research that introduces teachers to disciplinary literacy approaches with guided practice. Based on general literacy strategies' failure to be adopted into secondary instruction (Conley, 2008; Fisher & Ivey, 2005), the research should include teachers' perspectives on how they modify existing strategies to fit their content area and how likely they are to develop this approach as part of their permanent teaching repertoires. The significance of

this study is that it addresses the gap between policy mandates and teacher experience, involving teachers as disciplinary experts adapting cognitive strategies into their classroom instruction and sharing the successes and challenges of this process.

The purpose of this qualitative case study is to understand how secondary content area teachers implement disciplinary literacy to apprentice students into their subject areas and to examine the teachers' experiences of the process. I studied teachers' perspectives on the process of applying disciplinary literacy to make general literacy strategies specific to developing knowledge in different content areas. One of the challenges of this work is helping teachers to become conscious of the disciplinary underpinnings of their subjects, which they may tend to use automatically and unconsciously as they teach. Another challenge is engaging teachers in discussions of how to bridge the distance between the important content knowledge of the disciplines and students' everyday knowledge. The findings include obstacles encountered by some teachers that are likely to play a role in school settings. My findings are useful for those who are interested in how experienced teachers adjust their instructional practices to include disciplinary literacy. This study informs the practices of teachers and professional developers seeking to organize disciplinary literacy tasks to address concerns about low levels of adolescent literacy. It is also offered as advice to literacy specialists who coach secondary teachers on curriculum and instruction.

My research questions are:

- How do secondary teachers engage students in disciplinary Discourses?
- What are teachers' experiences with modifying literacy strategies according to the needs of readers in their discipline?

- How might these modified strategies expand teachers' worldviews about and experiences with the subject area?

The research unfolded differently than I anticipated, requiring shifts in my original research questions. In qualitative research, the reflective process of designing and implementing a study often leads to changing the research questions as we seek to understand the experiences of others (Agee, 2009). My original focus was on disciplinary literacy instruction of students who are diverse by ethnicity or race and who live in urban or suburban locations. However, it was clear during the research phase that the teachers I observed did not differentiate among students in culturally relevant ways. In fact, I rarely witnessed any form of differentiation for students, whether based on race/ethnicity, class, ability, reading levels, or any other reason. The homework and summative assessments were uniform for all students, and classroom discussions rarely included consideration of race/ethnicity or class. Therefore, I revised my research questions to address the general student population and omitted interpretation of data on culturally relevant instruction.

Theoretical Perspective: Discourse Theory

Several authors who suggest disciplinary literacy approaches to classroom instruction cite James Gee's Discourse theory to support how we should teach students to think like mathematicians, scientists, or historians (e.g. Buehl, 2011; Moje, Luke, Davies, & Street, 2009; Shanahan & Shanahan, 2008). Origins of discourse theory as formal study of spoken or written language to learn about one's thinking may be traced to Harris' (1952) thesis, "Discourse analysis." In the course of the last sixty years, discourse theory has been adopted and refined by several academic fields: linguistics, social linguistics, cognitive linguistics, anthropology, philosophy, literary studies, and interdisciplinary areas of cultural studies and social theories

(Yang & Sun, 2010). Social linguist James Gee proposed his own Discourse theory, describing his term "Discourse" as drawing from the ideas of a dozen theorists, including Foucault's discourses, Lave and Wenger's communities of practice, and Wittgenstein's forms of life (Gee, 2011). Gee's theory represents his twenty-year evolution from focusing on isolated language to focusing on language in use shaped by the values of society and cultural context (Gee, 2012). In this section, I discuss Gee and key scholars who influenced his work, tenets of Discourse theory, and how it is appears in policy statements about education.

Gee (2012) describes Discourses as the entirety of human communication in a situation that helps us to identify who we are by what we say and do:

> Discourses are ways of behaving, interacting, valuing, thinking, believing, speaking, and often reading and writing, that are accepted as instantiations of particular identities by specific groups. . . Discourses are ways of being "people like us." They are "ways of being in the world." They are "forms of life." They are socially situated identities. They are, thus, always and everywhere social products of social histories. (p. 3)

It may be noted that Gee capitalizes "Discourse" to distinguish his theory from other theories of language. Gee uses "Discourse" to describe the broad view of human interaction described above, and "discourse" to signify verbal or written language in use.

Discourses may be divided into the primary Discourses in which we are raised and the secondary Discourses that we learn through living and schooling. Advantages tend to accrue to those whose primary Discourses closely approximate the predominant secondary Discourses of schooling, as do the upbringings of many White, middle class Americans (Gee, 2012; Rothstein, 2004). Gee (2012) defines literacy as "mastery of a secondary Discourse" (p. 173). He posits that learning secondary Discourses provides entrance opportunities for those historically closed

out of many professions due to discrimination. The premise that Discourses can be learned regardless of one's initial group membership supports disciplinary literacy in secondary schools. To effectively teach disciplinary literacy, teachers must consciously apprentice students into the language structures and conventions that represent their subjects, and provide opportunities for students to practice the Discourse.

Gee's Discourse theory arises from New Literacy Studies in critical theory, and may guide content area teachers in implementing disciplinary literacy (Alvermann, Phelps & Gillis, 2005; Buehl, 2011; Gee, 2012). New Literacy Studies (NLS) is an overarching term for critical literacy theory that challenges the traditional view of literacy as a decontextualized cognitive skill of comprehending the printed word (Gee, 2012). NLS challenges the dominant cognitive model of literacy from cognitive psychology that situates reading as a solitary activity typified by the "normal" adult experience (Handsfield & Jiménez, 2009; Street, 2005).

In the 1980s and 1990s, a group of interdisciplinary scholars including James Gee, Shirley Brice Heath, Brian Street, Courtney Cazden and others began to question what literacy was, who benefits from being literate, and what cultural practices are embedded in our views of literacy in classrooms and society (Alvermann, Phelps, & Gillis, 2005). Rather than accept the decontextualized view of reading, NLS scholars characterized the dominant paradigm as an attempt to impose Western ideals of individualism and rationality on other cultures (Street, 2005). Gee describes NLS as contributing to the collapse of the traditional dichotomy of illiterate, "savage" people and literate, "civilized" societies by deconstructing literacy practices in anthropology and linguistics. NLS scholars assert that literacy is not only cognitive, but includes sociocultural practices closely connected "to power, to social identity, and to ideologies, often in the service of privileging certain types of literacy and certain types of people" (Gee,

2012, p. 63). While most people can read and communicate effectively, how reading and communication styles are valued by society will differ across location, class, ethnicity, gender, and time with "different effects in different social settings and none apart from such settings" (p. 63). Gee argues that literacy itself does not lead to success; rather it is knowledge, habits, and dispositions learned through literacy matching society's expectations that are related to success.

In linguistics, Gee explores the "Havelock-Goody-Ong line of work" (2012, p. 70). This line of reasoning moves examinations of literacy practices away from the "primitive" – "civilized" dichotomy to a concrete – abstract thinking dichotomy, and finally to recognition that groups with strong oral language traditions value different linguistic patterns than do groups with strong "essayist prose style" traditions (p. 79). Rather, we recognize that all language exists on continuums. Writing usually contains more complex forms of expression than oral language, with complex grammar, complicated syntactical devices, and detachment between writer and audience. However, there are also stylized, complex and detached forms of oral language, such as epic poems or college lectures. Likewise, writing may be personal and contain simple or fragmented ideas reliant on reader familiarity with topics, such as in letters, emails or text messages. Based on these lines of reasoning, we should treat instances of literacy as socially situated, where meaning can only be fully understood when context is considered (Gee, 2012; Street 2005).

An influential NLS scholar is cultural anthropologist Brian Street. Street (2005) asserts that literacy is traditionally viewed within the "autonomous model" which assumes that literacy will lead to economic opportunities through enhanced cognitive abilities, irrespective of context or one's background. This view attributes power to literacy itself, apart from culture and history, supporting a purely cognitive approach to literacy instruction. It disguises the cultural

interpretations and ideological assumptions of knowledge on which literacy is founded and presents its particular view as value neutral. Street suggests that literacy may be better understood through an "ideological model" in which literacy leads to economic opportunity for members of dominant classes or races, as dictated by a society's political history, economic conditions, social structures and local ideologies. The ideological model guides teachers to be more aware of how social literacies influence how people interact, including how teachers socialize students into a field. Adopting the ideological model of literacy also creates opportunities to engage adolescents in classroom discussions about relationships between power and literacy in modern society (Ladson-Billings, 2009; Schoenbach, Greenleaf, & Murphy, 2012).

Gee introduces Ronald and Suzanne Scollon as NLS scholars who "realize that what is at issue in the use of language is different ways of knowing and different ways of making sense of the human experience" (2012, p. 77). In their study of Athabaskan Indian society, the Scollons (1981) found that the group valued writing that was contextualized and left themes implied for the audience to understand based on shared cultural meanings. Successfully understanding the implied themes was a marker of cultural membership. The cultural group valued forms of writing that were almost exactly the opposite of the prose taught in school. The decontextualized nature of essayist prose made little sense to Athabaskan children in European-based school settings. Adopting school practices constituted a choice between membership in the tribe or in the dominant society. In this case, literacy practices reflected cherished social identities, and adopting dominant ways of thinking precipitated a crisis of identity.

Through this overview of the New Literacy Studies, we see several of the tenets of Discourse theory. Literacy is a socially situated practice that reflects our identities. It may be

understood along continuums of expression in written and oral forms, which are more to less formal and detached from speaker to audience. How literacy is valued depends on one's position within specific social circumstances and memberships in society. Likewise, definitions of literacy differ among groups. Some forms of literacy are valued more highly than others depending on the power structures in which they are embedded. Therefore, literacy is argued to be a contextualized, multifaceted form of self-identification embedded in ideological social structures.

In education, we can recognize Discourse theory in policy statements about how educators should approach their subjects. Literacy is presented as more than reading words from the page, but as the key to understanding a discipline. According to the Wisconsin Department of Public Instruction website:

> Each discipline has its own specific vocabulary, text types, and ways of communicating. . . Students who are literate in a particular discipline are able to successfully read, write, and speak about that discipline and can listen to and think critically as others communicate in that community (2012c).

The Common Core State Standards (CCSS) direct K-12 teachers to include classroom examination of otherwise-implicit features of literacy in one's subject (NGACBP & CCSSO, 2010, p. 3). But the CCSS does not explain what these features are. From literacy research, we see that these implicit literacy features include appropriate forms of evidence and argumentation; common text structures; the types of problems the discipline addresses and how they are solved; the types of questions that experts ask themselves and others; and specific ways that vocabulary frames meanings (Collins, Brown, & Newman, 1989; Dymock & Nicholson, 2010; Ivey & Fisher, 2006; Lee, 2007). Through explicit instruction in these and other literacy strategies,

students will ideally be able to transfer classroom learning to similar real life problems. A problem with this approach is that few teachers feel adequately trained in identifying the essential knowledge of their disciplines to explicitly teach it to students (Alvermann, Phelps & Gillis, 2006; Lee, 2007; Mac Mahon, 2014; Tomlinson, 2004).

Gee suggests that the literacy identity of scientist, mathematician, historian, etc., may be wielded by anyone as a conceptual tool for navigating interactions in the academic group. If students can learn to wield disciplinary literacy as a tool, they may be able to successfully navigate the worlds of science, math, history and other academic disciplines and gradually move from apprenticeship to full inclusion within that group. Teachers help students to develop expertise in each discipline by identifying the types of literacy that are privileged, and explicitly including instruction in those types of literacy into content area instruction. Now, we turn to examining the literacy practices emerging from research that help teachers conceptualize and recreate the secondary Discourses of their disciplines.

Chapter Two

Literature Review: Disciplinary Literacy

The purpose of my study is to understand teachers' perspectives of implementing disciplinary literacy in secondary classrooms, and to share their challenges and successes. Therefore, we need to understand disciplinary literacy. Disciplinary literacy incorporates teaching approaches that address cognitive complexity that varies by subject, by identifying the types of literacy challenges each subject presents to learners. "Most students need explicit teaching of sophisticated genres, specialized language conventions, disciplinary norms of precisions and accuracy, and high-level interpretative processes" (Shanahan & Shanahan, 2008, p. 43). The Common Core State Standards for Literacy require secondary educators to implement disciplinary literacy in English language arts, social studies/history, science and technical subjects (NGACBP & CCSSO, 2010; Wisconsin Department of Public Instruction, 2012c).

Disciplinary literacy means that teachers present subjects to students as an "apprenticeship" that introduces them to the ways of reading, thinking, speaking and writing that characterize their field (Braunger, Donahue, Evans, & Galguera, 2005; Buehl, 2011; Collins, Brown & Newman, 1989; Gee, 2012; McConachie & Petrosky, 2010; Pearson, Moje, & Greenleaf, 2010; Schoenbach, Greenleaf, & Murphy, 2012). An apprenticeship model de-emphasizes decontextualized, didactic approaches in favor of observation, coaching, reducing scaffolding as appropriate, successive approximation of mature practices, and student reflection on their own problem-solving approaches (Collins, Brown & Newman, 1989). The approach invites students to actively participate in science, math or social studies thinking, instead of listening to teachers transmitting knowledge as the end products of others' thoughts.

Disciplinary literacy may be challenging to adopt. Teachers must overcome what Herber (1978, p. 22) classically called "assumptive teaching," the assumption that secondary students no longer need literacy instruction because they should know how to read and write in the desired ways. Teachers must simultaneously recognize both expert and novice understanding, in order to bring the latter up to the performance level of the former (Dewey, 1990/1902). Teachers need to learn how to bridge this gap for students. Sometimes teachers who have high content knowledge are prone to an "expert blind spot" of assuming that students understand concepts at the same level of complexity that expert learners do (Nathan & Petrosino, 2003) and teach accordingly. As expert learners, these teachers have logically reorganized their own learning, and may attempt to teach students the entirety of the new conceptual structure, rather than following a developmental sequence from simple to complex ideas. This implies the need for teachers to reflect on how novices and experts conceptualize learning in their field differently, on a continuum of ideas from simple to complex, and to reflect on common misconceptions novices may hold. As indicated by Dew and Teague (2015), successful disciplinary literacy requires deliberate selection of which strategies to use and how to include them into lessons at the right times.

To this point, I have discussed disciplinary literacy as a singular idea that applies to all classroom teachers and incorporates ways of thinking and knowing in diverse fields. At this point, it seems helpful to move from a generalized view to surveying how literacy differs by field. Emerging studies of disciplinary literacy show patterns for how we may expect literacy to differ among classrooms for several subjects. I limit the scope of the current examination to two content areas, but in actuality, all teachers could explore how literacy functions in their

respective disciplines. My goal here is not to provide a comprehensive examination, but to begin a conversation about what it means to be literate in a field.

Science Literacy

In science, literacy is shaped by inquiry and documentation of evidence that leads from hypotheses to conclusions (Pearson, Moje & Greenfield, 2010). Scientists need to understand the findings of others as well as know how to express their own discoveries in writing that follows the conventions of the field. Therefore, "hands-on" inquiry still requires reading as a secondary form of investigation. For example, science teachers may engage the class in textbook analysis of how reading physics is different than reading in other fields (Schoenbach, Greenleaf, & Murphy, 2012). Schoenbach, et al., also share the experience of a science teacher who has students perform the experiment first, and then read the textbook to learn about what they had observed, giving students a concrete purpose for reading. They share a third example of a science teacher who required a random member of a laboratory group to explain the experiment before they can begin, requiring all members to read and understand directions, which students tended to skim or skip entirely. As examples of developmentally appropriate instruction, sometimes short-term reading goals connected to grades bring immediate meaning to schoolwork for adolescents better than when we espouse abstract principles of the intrinsic value of learning (Lee, 2007).

Under a disciplinary literacy perspective, an ideal science classroom involves students in active engagement in reading, writing, speaking and listening to science (Pearson, Moje & Greenfield, 2010). Even vocabulary learning is active engagement. Ideally, students learn new words within a conceptual network of ideas, and in the context of repeated exposures to the same words during reading, inquiry and discussions (Cervetti, Barber, Dorph, Pearson, &

Goldschmidt, 2012). Learning science terms through conceptual networks draws on the interrelatedness of word knowledge to facilitate student learning (Nagy & Scott, 2000). Some researchers indicate morphology and word origins, especially Latin and Greek, are keys to understanding science vocabulary (Baumann & Graves, 2010; Shanahan, 2009).

Shanahan (2009) reports that subfields of science differ from one another in how knowledge is presented. Disciplines of study spring from different epistemological traditions in how they approach, represent, and critique knowledge. Specialized vocabulary can cause difficulties for novice readers. For example, biology texts focus more on classification systems indicated through Latin and Greek roots for terminology, while physics and chemistry texts include more mathematical notations. We see the same ideas echoed in the state and national standards for scientific literacy (NGACBP & CCSSO, 2010; Wisconsin Department of Public Instruction, 2012a). In addition to containing dense terminology (Buehl, 2011), science reading includes procedural knowledge, integration of information in prose, visual representations like charts and graphs, and symbolic notations such as formulas or alphanumeric representations of elements and compounds (NGACBP & CCSSO, 2010, p. 62). Science textbooks assume readers possess a great deal of prior knowledge and are often written above the grade level for which they are intended (Allington, 2012; Buehl, 2011). Even this brief overview of scientific literacy indicates some of the challenges science teachers face in apprenticing students into the discipline.

Social Studies Literacy

Social studies incorporate several sub-disciplines, each with different forms of literacy. For example, political science texts focus on systems of government and hierarchies within them, while histories offer a chronological flow of events (Shanahan, 2009). Expert readers in social

studies learn how to judge the credibility of sources and understand that texts are positioned within the writer's perspective as influenced by background, history, context, and other personal factors (Buehl, 2011; NGACBP & CCSSO, 2010; Shanahan & Shanahan, 2008; Wineburg, 1991). For history in school, an important movement of the last fifteen years or more has been the reading of primary sources, rather than secondary accounts in textbooks, increasing the difficulty of assigned texts (Carpenter, Earhart & Achugar, 2014). Readers of history encounter a barrage of historical references to people, places, titles, events, and systems of ideas, many of which authors assume are familiar to readers (Buehl, 2011). Unlike science vocabulary, unfamiliar social studies terms may only be encountered once or twice in a text (Hynd, Holschuh, & Hubard, 2004). This makes it harder for students to pick up the meaning of vocabulary incidentally through repeated exposures and multiple sets of context clues.

Social studies texts contain several different text structures. A common text structure is cause and effect, particularly in history. Students may miss historical references offered as causes, inhibiting their understanding of effects (Piercy & Piercy, 2011). Similar to science, the form of text is multimodal in social studies, with literacy encompassing text, visual data representations like maps, timelines, charts, and graphs, and political cartoons that incorporate sophisticated literary devices like satire and hyperbole (Buehl, 2011; Hynd, Holschuh, & Hubard, 2004). Each form of social studies literacy requires a different way of thinking through the text.

In a classic account, Wineburg (1991) studied the differences among groups of historians and high school students reading the same historical accounts. As the historians read, they processed text by evaluating the source of the information, placing the text's argument within a particular time period and context, and corroborating evidence across sources. The complexity

of constructing a view of history influenced how the historians inferred subtexts within the readings. In contrast, the high school students tended to miss subtexts and overlook the importance of context, focusing instead on finding "right" answers and determining whether authors were on the right or wrong side of issues. They viewed each text as relating a singular truth about how history unfolded. The high school students treated each reading separately, rarely looking for similarities, contradictions, or themes across accounts. Their reading was nowhere near as involved as that of the historians. It also represented a far simpler view of what it means to read history than is found in current literacy standards.

The Common Core State Standards (CCSS) represent a challenging perspective on how students should read for social studies and history, requiring that students learn how to corroborate evidence between primary and secondary sources, analyze how text reveals an author's point of view, and analyze conflicting accounts of the same event (NGACBP & CCSSO, 2010, p. 62). Within disciplinary literacy, each of these represents a skill set to be explicitly taught to students. Teachers have an excellent opportunity to help students understand how historians construct narratives through introducing students to several primary accounts of the same event and having small groups debate essential questions about historical decisions (Ravi, 2010). An additional challenge in reading social studies texts lies in students' understanding of how historical and current events touch our individual lives (Piercy & Piercy, 2011).

Successful social studies teachers bridge between times and people long past to the current lives of their students. Yet additional bridges must be built across the divide between the expert features of disciplinary literacy and the everyday reality of students' lives, which influences how they comprehend, what they read outside of school, and how they approach

learning in school. In order to teach our students, we must implement ways to help those who struggle to grasp our subject areas. We turn now to a review of cognitive strategies that may help struggling readers.

Engaging Students Who Struggle with Reading in Disciplinary Literacy

In this section of the literature review, I focus on instructional strategies that help students who struggle with reading to develop effective secondary Discourses. Struggling readers are not a uniform group. Students have unique personalities, histories, goals and quirks that influence their motivation to grapple with the challenges of reading in each subject (Reed, Schallert, Beth, & Woodruff, 2004). Students may be recognized as strong learners in one subject, but be labeled as struggling in another (Buehl, 2011; Gee, 2012). Readers' willingness to struggle through difficult texts may be influenced by their interest in the topic, their motivation to read, their self-identification as a good or poor reader, and the efficacy of the processing strategies that they use (Fox, 2009). Learning disabilities may relate to reading difficulties, and constitutes an entire field of research under exceptional education (Klenk & Kibby, 2000). In light of the variety of struggling readers, I focus on how content area teachers can simultaneously help a range of students who struggle during instruction.

Teachers may help students who struggle with reading by getting to know their students well as learners. They should understand that each classroom consists of students who read and learn at a range of levels, not a standardized group (Allington, 2012; Tomlinson, 2004). Instead, teachers need to recognize that gender, culture, learning exceptionalities, regional location and past experiences shape students as learners. Any intervention program to improve reading should not only be validated by research, but also grounded in rich knowledge of the local context in which it is used (Underwood & Pearson, 2004). A teacher can also learn about his/her

students through initial diagnostics to determine readiness, and regular formative assessments to adjust instruction according to student learning (Fisher & Frey, 2007; Pham, 2012). They may use pre-assessments, interest and reading inventories, and questionnaires about preferred learning styles that students complete (Allington, 2012; Tomlinson, 2004). Also, teachers can promote healthy learning environments by encouraging students to view learning as growth, rather than accepting the view that learning reflects fixed intelligence that cannot be changed (Dweck & Leggett, 1988; Tomlinson, 2004). Teachers may learn about students and their reading histories by consulting the student, parents/ guardians, previous teachers, counselors, special education teachers, and reliable others who have worked with a child.

There are three ways that teachers can differentiate instructional practices to help struggling readers: by content, process, and product (Tomlinson, 1999). As Underwood and Pearson point out, one of the most commonsense ways to improve students' reading and writing is to engage them in wide reading and writing-to-learn activities (2004). Differentiating content means moving away from a single textbook and incorporating multiple sources at different reading levels into units, including digital sources of information (Allington, 2002; Alvermann & Rush, 2004; Buehl, 2011). Students may learn relevant information out of trade books, young adult literature, magazines, newspapers, websites, songs, films, and videos. By giving choices about what they read, we invite engagement from a wider range of students (Johnston, 2012; Moje, et al., 2004). When we manage student choice according to disciplinary features, we can use texts that students understand independently to teach disciplinary literacy (Allington, 2012).

Teachers may differentiate the process of classroom instruction. Some differentiation strategies for process do not overly disrupt normal classroom routines or place extra workload burdens on the teacher (Tomlinson, 2004). Teachers may support students' cognitive and

metacognitive development by using think-alouds or close reading to display their own thinking processes for students (Davey, 1983; Schoenbach, Greenleaf, & Murphy, 2012; Tomlinson, 2004). Similar to Collin, et al.'s (1989) "abstracted replay," teachers may use "revoicing" to restate students' points, which gives students a chance to own or disown the position, uses teachers' inferences to acknowledge students' implied reasoning, and provides immediate scaffolding for students who struggle with English (O'Connor & Michaels, 1993).

There are others ways that teachers may differentiate the process of learning without major changes to instruction. Teachers may engage students in discussions of how social, cognitive and affective factors influence how well they learn on a given day, as well as initiating discussion about inequality and power in society and its relationship to literacy (Ladson-Billings, 2009; Schoenbach, Greenleaf, & Murphy, 2012). Some writing may be assigned as ungraded, formative assessment, and some may be graded as summative assessment (Fisher & Frey, 2007). Teachers may teach students to use graphic organizers to visualize relationships among ideas, or directly teach text structures and textual markers signifying the structure (Dymock & Nicholson, 2010; Schoenbach, Greenleaf, & Murphy, 2012). Teachers may explicitly teach students how to take notes using techniques like split-page notes (Fisher & Frey, 2012), structured note-taking (Smith & Tompkins, 1988), or PowerNotes (Santa, 1988, cited in Buehl, 2009). They may adapt any of several questioning strategies to engage students in classroom discussions (e.g., McKeown, Beck, & Blake, 2009; Pressley, Symons, McDaniel, Snyder, & Turnure, 1988; Raphael, 1982). Especially when they know students well enough to predict their levels of familiarity with an upcoming topic, teachers may frontload instruction to build academic knowledge before students read (Beers, 2003; Buehl, 2011).

Other ways to differentiate process involve greater changes in classroom routines, especially away from whole-group, lecture formations (Tomlinson, 2004). Teachers may include whole group, small group, and independent work in each unit to encourage all students to discuss and verbally process information with their peers (Fisher & Frey, 2008). Small group work can be especially powerful for students who are reluctant to speak in whole-group settings, perhaps because they are shy or uncertain of their academic English (Baecher, Artigliere, Patterson, & Spatzer, 2012). This may also be true for any student who has not yet mastered the Discourse of the subject area. Teachers can organize student groups by the strategy of reciprocal teaching, and assign students rotating responsibilities of questioning, clarifying, summarizing and making predictions about the text (Palincsar & Brown, 1984). They may use a jigsaw format that makes individual students responsible for information that their group needs to complete an assignment (Aronson, 1978, as cited in Fisher & Frey, 2012).

For productive group work, teachers change group membership to reflect student skills and the task, provide scaffolding as needed, and provide groups with a meaningful task that is challenging but possible for the group to perform with minimal teacher scaffolding (Fisher, Frey, & Everlove, 2009). Group work should be thoughtfully designed by the teacher to incorporate principles of positive interdependence, face-to-face interaction, individual and group accountability, interpersonal and small group skills, and group processing (Johnson & Johnson, 1975, as cited in Fisher, Frey, & Everlove, 2009). Carefully designing and incorporating group work into instruction to differentiate process can be challenging, but rewarding in the sense that more students get to contribute and share their understanding of what they are learning. If Discourse theory includes listening to students speak about their learning, then students need to learn how to communicate ideas to peers and teachers.

Teacher may also differentiate by product, meaning that students have choices in how they demonstrate their learning (Tomlinson, 1999). For example, in a unit on European, Asian, or African countries, students may choose a region to study based on their cultural heritage or personal interest, rather than all students studying the same country at the same time (Allington, 2002). Students may get choices about the order in which to complete assignments related to their learning styles, like writing an essay or a poem, drawing a picture or map, making a chart, and giving a performance within the same unit. The format for writing assignments can range from informal, such as composing text messages, email messages, or personal letters, up to the formal five-paragraph essay. Using research like Gardner's (2004/1983) multiple intelligences theory can help teachers to generate a range of assignments that encourage students to produce creative yet rigorous work. Choices for how to differentiate product are only limited by the teacher's willingness to research and create new ways for students to demonstrate their learning.

This brief overview of reading strategies helps to illuminate an unresolved issue with content area teachers using reading strategies to engage adolescents in disciplinary Discourses. The issue is not that secondary teachers do not know enough strategies. There are literally hundreds of strategies available. Many compendiums of reading strategies have been compiled (e.g., Beers, 2003, 2000; Buehl, 2009; Fisher, Brozo, Frey & Ivey, 2007; Fisher & Frey, 2012; Miller, 2003; Robb, 2000; Tovani, 2000). For over twenty years, professional development sessions have introduced secondary teachers to reading strategies (Conley, 2008; Fisher & Ivey, 2005; Gritter, 2010; Ryder & Graves, 2003). Yet these have rarely been transferred into instructional routines in content area classrooms. Teachers may know about the strategies, but be skeptical that they will help students learn content area material (Conley, 2008; Draper, 2008; Learned, Stockdill, & Moje, 2011; Shanahan & Shanahan, 2008; Tomlinson, 2004). The field of

education has not transitioned from offering generic strategies to teachers to making the strategies appealing for opening opportunities for student learning in the context of specific subjects.

When secondary teachers are introduced to generic literacy strategies in professional learning opportunities, they generally do not see the relevance of them for their classrooms (Conley, 2008; Draper, 2008; Learned, Stockdill, & Moje, 2011; Shanahan & Shanahan, 2008). Depending on how strategy instruction is presented to teachers, it may seem too radical a departure from normal instruction, or conversely, too similar to how they already teach (O'Brien, Stewart, & Moje, 1995). Sometimes teachers have too little training to use strategies effectively (Almerico, 2011). Sometimes cognitive strategy instruction is imposed upon teachers who feel as if their expertise in content knowledge and pedagogical skills are being slighted (Draper, 2008; Fisher & Ivey, 2005). Sometimes teachers ignore professional development in reading due to assumptions that all middle and high school students are already proficient enough to learn from textbooks (Alvermann, Phelps, & Gillis, 2005; Herber, 1978). Also, some teachers are unlikely to use strategies that reflect constructivist ideals of education if their pedagogical philosophies reflect a more didactic view of teaching (Draper, 2002).

Furthermore, secondary teachers will not use literacy strategies if they see them as interfering with content learning (Conley, 2008; Fisher & Ivey, 2005). When teachers do not think that strategies help students learn content, they drop them from instruction, despite any mandates. Many teacher educators who teach the use of content strategies in secondary classrooms recommend involving pre- and in-service teachers in reflection and discussion about how, when, and why they use strategies in teaching their discipline (e.g. Almerico, 2011; Alvermann, Phelps, & Gillis, 2005; Buehl, 2011; Draper, 2008; Gritter, 2010; O'Brien, Stewart,

& Moje, 1995; Shanahan & Shanahan, 2008). Fisher & Ivey (2005) suggest that the goal should be to help content area teachers see that the goal of including literacy is to capitalize on the learning students do through reading and writing, not to teach them how to read and write. How a teacher capitalizes on reading and writing will differ by subject. Gritter suggests that undergraduate content area literacy classes provide "a contact zone in which pre-service teachers consider and reconsider how disciplinary epistemology maps onto effective content area literacy instruction" (2010, p. 147). It is the subject area's epistemology, or system for constructing and recognizing knowledge, that determines which strategies to teach and model.

This literature review reveals the need for my proposed research: working with individual teachers, reflecting on the disciplinary knowledge they want students to gain, and making connections between these goals and literacy instruction that encourages all students to participate in disciplinary Discourses. As experts in the epistemology of their disciplines, teachers decide which strategies complement the thinking of their field and facilitate student learning. Including teachers in integrating specific strategy instruction into their content area classes honors their professional knowledge about their subjects, pedagogy, and the students with whom they work.

Chapter Three

Methodology

My research centers on gathering information about the individual perspectives of teachers who are trying to implement disciplinary literacy in a suburban Midwestern high school. With so many strategies and different ways to conceptualize disciplinary literacy, depending largely on subject area, there could be countless ways that a secondary teacher may successfully implement disciplinary literacy. Therefore a multi-case study seemed a logical methodology to employ. Case studies are employed when a researcher wishes to understand a phenomenon of study within its natural environment, which may include contexts of historical, physical, cultural, social, economic, political, ethical, and aesthetic backgrounds (Stake, 2005). The motivation behind selecting case study as a research design is to present and examine a bounded system in its full complexity (Creswell, 2007), and to "optimize understanding of the case" (Stake, 2005, p. 443). Researchers conduct case studies to illuminate both the process and the products of inquiry (Creswell, 2007; Stake, 2005; Yin, 2009). A multi-case study allowed me to observe the teachers' efforts at disciplinary literacy and the students' responses without imposing my own ideas about how instruction should unfold. By focusing on two teachers' classrooms, I was able to compare the successes and challenges in these professionals' approaches to disciplinary literacy.

"Place your best intellect into the thick of what is going on" (Stake, 2005, p. 449). Case study analysis is reflective work on the local, foreshadowing, and consequential meanings embedded in the issues around which inquiry is structured (Yin, 2009). The researcher engrosses him/herself in the data and deliberates about what common and uncommon meanings are

revealed. As the researcher immerses him/herself in the meanings of the data, new categories of codes are revealed, or previous codes are collapsed together.

Case studies may be undertaken due to intrinsic interest in a case, or as an instrumental attempt to provide insight into an issue or to generalize across cases (Creswell, 2007). In an intrinsic case study, the researcher chooses a particular case for its unusual characteristics. In an instrumental case study, the researcher attempts to generalize from the particular case to general experiences of similar cases. Cases are selected more for the "opportunity to learn" that they provide than for producing a representative sample of a population (Stake, 2005, p. 451). Researchers dedicate their analysis to developing an understanding of what is important about the case within the world of the participants in order to share this understanding with the audience. The conceptual structure of case studies is thematic, and the researcher includes data in the final report to illustrate emerging themes.

Trustworthiness of Qualitative Analysis

One of the challenges of qualitative inquiry is to present one's findings in ways that mirror validity and reliability of positivist science, while still honoring a constructivist, interpretive paradigm of naturalistic research (Creswell, 2007; Lincoln & Guba, 1986). Naturalistic research occurs in real life settings, and is conducted by a person who admittedly is influenced by values, experiences and social contexts. As mentioned above, case studies are by nature reflective work in which one's observations are recorded through the filters inherent in one's consciousness. As the analysis unfolds, new ideas are folded back into the coding process, changing original conceptions of what is happening and why, and refining initial ideas. The important findings are not patterns within the data themselves, but "plausible inferences" one draws from the patterns (Lincoln & Guba, 1986, p. 17). How, then, can a researcher offer

readers assurance of the credibility of what is reported, when readers never witness the phenomena and are informed that events have been interpreted through the researcher's point of view?

Several analysts have offered suggestions for how qualitative researchers may legitimize their findings (Creswell & Miller, 2000). One of the most famous approaches was suggested by naturalist researchers Lincoln & Guba (1985). Rather than grapple with questions of validity and reliability, a poor fit for most qualitative research, they focus on the trustworthiness of the story that the researcher relays to the audience. They suggest four criteria for determining trustworthiness: credibility, transferability, dependability, and confirmability. In the pages that follow, I use these criteria to introduce my claims for the trustworthiness of my research, combining the last two due to their closely linked natures.

Credibility. Credibility describes how the researcher presents the findings in ways that the reader may find reflect an accurate social construction of reality. It represents the confidence that the reader may have in the findings and recommendations being made. There are many possible approaches to establishing credibility in case study research (Creswell & Miller, 2000). In this study, I present my claim for credibility through reflexivity, prolonged engagement in the field, triangulation of sources, and member-checking.

Reflexivity. In all qualitative research, the researcher is regarded as an instrument of study (Creswell, 2012; Patton, 2002). As such, the researcher should document his or her role as part of the research report. Understanding the person behind the research helps the readers to decide for themselves whether or not the account given is trustworthy. Qualitative researchers report on their guiding paradigm, consisting of ontological, epistemological, and axiological assumptions (Creswell, 2007; Guba & Lincoln, 2005; Mustafa, 2011). The researcher situates

him/herself in the findings by sharing any preconceptions, competing interests, or biases that may influence perception. Reflexivity, or self-awareness, is an integral element of the work because of the many decisions and value judgments made by qualitative researchers in their choices of what to study and how (Creswell, 2007). The researcher describes him/herself in light of the study as part of reflecting about one's subjectivity about the research.

The theoretical paradigm that frames this case study is a sociocultural perspective of the construction of reality (Case, 1996; Vygotsky, 1978), specific to how literacy shapes society and one's success within it, described above as Discourse theory within New Literacy Studies (Alvermann, Phelps, & Gillis, 2005; Gee, 2012; Street, 2005). My ontological assumption is that reality is a societal creation between learner and material to be learned through the medium of language. Epistemology refers to how one conceives of knowledge as existing or being constructed within that reality (Guba & Lincoln, 2005; Mustafa, 2011). According to Vygotsky (1978), knowledge is constructed in sociocultural contexts in which language is both a socially constructed tool for learning and a resource to be developed. The boundary between learner and what is to be learned is permeable, with each slightly changing the other during the interaction process (Miller, 1993). As a psychological tool that influences how one thinks, language is closely tied to the social and historical circumstances in which an individual lives. Social constructivism links the historically individualistic tasks of learning to the social environment that guides what and how people learn. Knowledge that is relevant in one culture may not be relevant or useful in another (Gee, 2012; Street, 2005).

Rather than accepting an autonomous model in which certain forms of literacy have intrinsic value regardless of context, I believe that literacy exists as an ideological construct within networks of social and cultural traditions of learning that privilege some forms of literacy

above others (Gee, 2012; Street, 2005). The ways that language is valued are determined to a large extent by the social context, and this will differ across societies, time, and places (Gee, 2012). Disciplinary literacy explicitly presents to students the idea that certain forms of literacy are more valued within disciplinary traditions of inquiry than are others. These are Discourses of power, which allow students to learn how to successfully communicate in that field, eventually earning the mantel of expert. While certain Discourses are acknowledged to be privileged ways of interacting in a field, they are not conflated with being the only way to communicate in other circumstances, and are not proposed to replace primary Discourses associated with family and community life (Gee, 2012; Lee, 2007).

My axiological basis for research, or value system, reflects my conviction that schools should serve students' interests first. While teachers deserve respect and acknowledgement as professionals, I believe that decisions about schooling should be based on what will help each student succeed to the best of his or her abilities during the time they share with us and beyond. From my professional experience, I believe that well-designed disciplinary literacy approaches may open fields of study to students who otherwise might have been barred from learning due to lacking knowledge of intrinsic conventions and privileged language structures. From my work as a teacher of students who have not been successful in school, I believe that improving how teachers structure learning may help struggling students to recognize the value of the knowledge and skills we offer, and may convince them that success in schooling really is in their best interests.

Since the interviewer serves as an instrument of study him or herself (Creswell, 2011), let me quickly share an important change in my career, which impacted how I analyzed my data. I started this research in the role of a graduate student on an academic fellowship, with a part-time

job as an adjunct instructor at my university. This opportunity gave me the freedom to be able to spend three full school days a week in other teachers' classrooms. It also positioned me as an instructor to pre-service teachers, who were eager to learn from my teaching experience. This positioned me as an academic, an outsider at the high school, and an instructor in education, with strong opinions about how disciplinary literacy should be implemented.

But after I had collected my data and started transcribing it, I accepted a full-time position as a reading specialist and literacy coach in a different high school than my research site, one with a strong disciplinary literacy vision. As I analyzed my findings, I had finished my second year in the new position. My coaching work reflects many of the ideas of my dissertation. In my position as a coach, I work with high school teachers in thirteen different departments, helping them to solidify the disciplinary literacy goals of each department. I also work with individual teachers to coach them on various instructional strategies to get reluctant high school students to interact with classroom texts. One of the valuable lessons I took away from my dissertation research was the need to listen to what teachers are already doing well, and build upon it. My shift from wanting to tell teachers what to do to closely observing and learning what they are already doing well, has served me in the new position. It has helped me to better understand the types of literacy valued by each discipline, and provided me with a more humble disposition toward the current work of the teachers.

The shift in jobs also shifted how I thought about my role as a researcher. When I first wrote my proposal, I viewed myself as a literacy expert who would make suggestions about how the teachers should adjust their instructional practices, to increase the amount and quality of reading and thinking students engage in during class. Then I would observe these adjustments and evaluate their success enabling students to speak knowledgeably about the discipline. But I

discovered that my observed teachers, while very polite, were not going to change practices based upon my suggestions. Each one said that he would be willing to do so, but overall, my suggestions were disregarded. From this experience, and my current job experience, I have realized more fully the commitment, effort and time required by secondary teachers to modify their instruction to meet expectations of high-quality disciplinary literacy. This is not a new idea, (i.e. Loucks-Horsley, Stile, Mundry, Love & Hewson, 2010). Yet it resonates more deeply for me now, since I personally encountered resistance to changing curricula from teachers, despite seemingly solid backing of extensive research on best literacy practices. I have relearned that the process of change needs to be long-term, embedded in the department member's professional development, and needs to belong to the teachers themselves, before they are willing to undertake such significant revision to their existing curricula.

Prolonged engagement. Research findings are more credible when one has spent a respectable length of time in the field of study (Creswell & Miller, 2000). There is no set duration for how long the engagement must be, but the researcher should stay long enough to build trust and rapport with participants, find the gatekeepers who allow access, and have the opportunity to hear multiple perspectives from participants. I had worked or volunteered in the high school in various capacities for three years before beginning my research.

In addition to gathering data at the high school during that semester, my interest in disciplinary literacy stems from approximately seventeen years in education working as a high school English teacher, a researcher during graduate school, and a high school reading specialist. Most of my teaching has been in alternative schools with students who were suspended or expelled from traditional public schools. My dissertation represents almost two decades of

working in and reflecting on secondary schooling with students who struggle in school. I plan on remaining in education in some capacity throughout my career.

Triangulation of data sources. Researchers may enhance the credibility of their claims by offering multiple data points or events that offer corroborating evidence of a claim (Creswell & Miller, 2000). The multiple data points may be across participants, theories, or methods such as observations, interviews, and documents. As examined in more detail below under "Data collection," my research triangulated among interviews with the curriculum coordinator and two teachers; over one hundred hours of observations in two classrooms, and content analysis of text books and of student work.

Member checking. Member checking is a process in which the researcher shares the data, interpretations and claims with participants, and asks for feedback. Lincoln and Guba describe member checking as "the most crucial technique for establishing credibility" (1985, p. 314). Member checking shows that the researcher values the participants' perspectives of events, and respects their rights to verify how they are represented.

It was very important to me that I represented the teachers and their work fairly, both to honor their commitment of opening their classroom doors to me, and to increase the credibility I would have with my intended audience of other teachers and educators. Throughout the study, I informally checked with the teachers about what I thought I had witnessed in the classroom, or ideas that I had transcribed from interviews. These were usually quick conversations before or after classes, or questions added to interviews. After I wrote my initial findings chapter, I shared each teacher's section with him electronically, and asked for feedback on any necessary changes or corrections. The teachers and curriculum coordinator all replied that they were happy with the ways that I had represented them, their classrooms and their school.

Transferability. Similar to positivist science's external validity, transferability is the extent to which the research findings will be applicable in settings other than the study site (Malterud, 2001). One difference in qualitative research is that the reader must be convinced of the finding's applicability through recognizing similarities between the research site or events and their own situation. The phenomenon under study is presented through thick descriptions that allow the reader to actively draw his or her own conclusions about the issue, event, or individual (Lincoln & Guba, 1985). I support my claim to the transferability of my findings to other secondary classrooms by including rich descriptions of the students and teachers, the research site and the classroom activities taking place. Whenever possible, I used the language of participants themselves to add verisimilitude to my claims, and to let them speak directly about their activities, planning, student learning and goals.

Dependability and Confirmability

According to Lincoln and Guba (1985), dependability and confirmability are related evaluative criteria for qualitative research. Dependability is similar to reliability in positivist research, concerning whether a study would be replicable by others. Confirmability, also referred to as neutrality (Schwandt, 2007), indicates the degree to which findings are shaped by respondents and not by the researcher's biases or preconceptions. Lincoln and Guba (1985) suggest that qualitative researchers may offer their claim to confirmability and dependability through inclusion of an audit trail of the entire research process. Such a trail may include granting readers or reviewers access to raw data, notes, data reduction, analysis, journals and memoes by the researcher, and information about any instruments that were developed. The audit trail offers a transparent description of the research steps taken from start to reporting of findings. Dependability and confirmability may also be established through triangulation and

reflexivity, both addressed above under "Credibility." To create an audit trail, I included lengthier transcripts as appendices, inviting readers to evaluate my coding process and resulting inferences, as recommended by Hammer & Berland (2014).

Another part of creating a claim to reliability, or dependability, in case studies is keeping all documents and study materials tightly organized (Yin, 2009). All files generated during the study are kept on my computer and backed up on a flash drive and external hard drive in my home office. Any identifying information about individual teachers or students has been removed from digital sources. All data collected from audiotaping during classes was erased after it was transcribed and proofread, no longer than two months after it was recorded.

To further support my claim of dependability and confirmability of my findings, in the remainder of the Methodology chapter, I give detailed descriptions of the participants and sampling procedures, the site of study, my process for securing access and permissions, the approach to data analysis I followed, the coding schemes I developed, and the procedures of each phase of my research.

Participants

For the case study, I sought access to teachers working with adolescents in science and social studies who were trying to adapt their instructional practices according to disciplinary literacy. I decided upon participants from two different subjects in order to compare and contrast advanced literacy practices across disciplines. High school teachers tend to be more specialized in their subject areas than elementary or middle school teachers are (Buehl, 2011). This seems to indicate that high school teachers may consider themselves to be content experts, and may be comfortable discussing the epistemological bases of their subjects in relationship to instruction. Originally, the study included a mathematics teacher as well, but the data from his classroom

indicated a strongly teacher-driven approach to instruction that did not fit my parameters for disciplinary literacy, so I omitted his data from the final report.

The teachers who helped me conduct my case study were colleagues whom I have worked beside, trained in two professional development sessions, or previously interviewed, who were willing to try approaches that get students actively engaged with reading text during instruction. Following a professional development session I conducted in November 2011, several teachers indicated interest in improving how students read in their subject areas. Some of the feedback I received was that teachers would be willing to use disciplinary literacy approaches if they were shown how.

Sampling. Participants needed to be willing to regularly discuss their perceptions of domain and concept knowledge, students and their learning, modifications to adapt literacy strategies to reveal domain and concept knowledge, and their impressions of the entire process. My primary sampling strategy was a purposive sample using a snowball method as necessary to find interested participants (Creswell, 2012). I discussed my study with the high school principal at my research site and asked permission to conduct research. I asked him to forward an email message to all the high school teachers, asking for volunteers and indicating his approval of the study (see Appendix A).

To choose participants, I visualized levels of disciplinary literacy on a spectrum from none at all, with the teacher expressing no interest in using literacy strategies, to teachers adjusting instruction to include some strategies but seeing room to improve, to advanced teachers comfortably incorporating disciplinary literacy strategies into all or most areas of instruction. For my study, I was looking for teachers who were adjusting instruction to include some literacy strategies already, but who acknowledged that there were ways that they would like to improve

their uses of reading and writing strategies during instruction. This allowed me to focus my study on areas of growth teachers experience in their use of literacy strategies, and their impressions of the process. Information about teachers' levels of disciplinary literacy was obtained through initial interviews.

Over my three years in the district, I had had eight teachers who agreed that they would be interested in participating in my dissertation research. But no one responded to the principal's email. I called and double-checked that he had forwarded it. Then I began contacting teachers directly. They were polite but definite in refusing to participate. Most felt simply too busy to participate in research. One science teacher suggested that I try one of the middle schools instead. Finally, I asked two teachers with whom I had worked during summer school. They agreed to work with me. By luck, this convenience sample included one Psychology teacher and one Chemistry teacher. In our initial interviews, they each expressed interest in adapting their classroom instruction according to disciplinary literacy and had some ideas of how they already incorporated it. This placed both into the middle of my proposed spectrum for disciplinary literacy instruction.

Site of Study

The research site was a Midwestern suburban high school in which over three years, I had worked as a long-term and short-term substitute, summer school teacher, volunteer, and occasional professional developer on literacy across the content areas. I chose this research site because the teachers were faced with increasing pressure to incorporate disciplinary literacy, but no systematic professional development had been implemented to address this need. Teachers received one-day workshops on general literacy strategies in the fall and spring, and two-day workshops on literacy in the summer. From my own experience as a presenter, these workshops

were given by different experts who were not informed of previous workshop topics. The high school employed a reading teacher, but she worked only with struggling students, not as a literacy coach for teachers. So there was no in-house support for teachers exploring and modifying literacy strategies.

Like many other American schools, this predominantly White, middle class school is growing increasingly diverse across ethnicity and class (Keaton, 2012; WISEdash, 2014). The high school population of 2,004 students during the 2012-2013 school year was 73% White, a percentage that has decreased by 12% over the last ten years. The ethnicities of the remaining student population were 12% Hispanic, 6.5% Black, 5.6% Asian, 1.3% American Indian, and 1% two or more ethnicities. Twenty-four percent of the population qualified as economically disadvantaged, a number that has more than doubled from 9.2% in 2002. Ninety-six percent of the students were classified as English language proficient, with the remainder split among 1.6% of students speaking Spanish, 0.4% speaking Hmong, and 1.9% speaking other home languages (WISEdash, 2014). The school was located in a middle-class public district that had accepted transfer students from an adjacent large urban district when I was a long-term sub. I learned during my research phase that the transfer program had been ended two years before.

The WISEdash database does not provide information on staff demographics, but anecdotally from my experience, most of the staff fit the typical American teacher pattern of being White and middle-class (Keaton, 2012). The new principal was the only African American educator in the building. He was just promoted at the beginning of the 2012-2013 school year from vice principal for the 12th grade class. He had worked in the district for over ten years as a teacher and as an administrator.

Access and Permissions

Over three years, I had regular access to the high school as a teacher, substitute, volunteer, and professional developer. I had some uncertainty about getting administrative permission, since the principal with whom I had been working retired at the end of the 2011-2012 school year. But the new principal had originally hired me for summer school, and we had a good relationship. I spoke with him about my research design, and he approved the study, forwarding my introductory email to teachers. He recommended several teachers to contact about participating, and during the study we spoke occasionally about how the research was going.

I have an Institutional Review Board (IRB) application approved, with a more recent revision also improved. The study includes examples of student work within "commonly accepted educational settings," (IRB, New Study Form, p. 2), which was still classified as "Exempt." I specified in the participant recruitment email that all student work I received must be anonymous. To participate, the teachers signed the consent forms that were included in the IRB process. The classroom observations were audiotaped, which meant that students' parents had to provide written consent or choose to opt out for their children. Students who were eighteen years old were able to sign their own consent forms. Out of 85 consent forms returned, I received one who opted out of the study. In the transcriptions of this student's class, whenever he spoke during discussions, I recorded only that he had spoken, not what he said. Working with the university's IRB director, I revised the university permission slip to include more information about the study's purpose and participants' rights to be excluded if they wish (please see Appendix H). When students didn't have permissions returned, I omitted their contributions

from transcriptions in whole group discussions, and didn't audiotape the small groups in which they worked.

Initial Organizational Framework for Coding

For my study, the primary units of analysis were disciplinary literacy strategies included during instruction that invited students into the subject Discourse. As noted in the literature review, there were hundreds of possible strategies I might see. I did not know which specific strategies I might observe in practice, indicating the need for an inductive process for selecting codes. Part of the nature of qualitative research is that it unfolds and increases its complexity as the research concepts develop (Creswell, 2007). Through my observations of the teachers and considering their answers and reflections from interviews, my coding scheme shifted many times.

To code my observations, I first used two main organizational schemes: how learners work with information (Weinstein & Mayer, 1986) and different stages of instruction in which they are present (Fisher & Frey, 2008). These distinctions are noted on the initial observation protocol (please see Appendix E). These two concepts helped me to understand myriad happenings in a bustling high school classroom.

Literacy strategies may be classified by how learners work with the information from the text as rehearsal, elaboration, or organization (Weinstein & Mayer, 1986; see Table 1). Rehearsal strategies involve using the information verbatim, as it is found in the text. Examples of rehearsal strategies include note-taking of presented facts, highlighting, underlining, recital, memorization, and summary. Elaborating involves more in-depth processing than rehearsal, in which readers interact with information from the text. Many common literacy strategies are forms of elaboration: paraphrasing, clarifying understanding, making connections, questioning,

determining important ideas, and creating mental images (Dymock & Nicholson, 2010). Readers elaborate when they begin with the information from the text, but transform it in some way through their own understanding. A third way of classifying literacy strategies is organizing, in which readers group individual concepts or facts differently than how the author does, or across readings. Examples of organizing strategies include outlining, PowerNotes, use of text frames with different text structures, and graphic organizers (Buehl, 2011).

Table 1. Organization of Literacy Strategies

Codes for Literacy Strategies	**Description**
Rehearsal	Reader records information exactly as found in the text
Elaboration	Reader interacts with and adds to information from the text
Organization	Reader reorganizes information across or between texts

The second way that I organized my observations was by dividing the instructional period into different phases of instruction: focus lessons, guided instruction, collaborations, and independent tasks (Fisher & Frey, 2008; Pearson & Gallagher, 1983; see Table 2). Fisher and Frey expanded upon Pearson and Gallagher's original concept to describe Gradual Release of Responsibility (GRR) as an iterative process.

The focus lesson is when the teacher lectures, shows video clips, or in some other way presents information to students as an expert. The teacher is the center of attention and students are usually passive during focus lessons, although may use rehearsal or organizational strategies to take notes of the lecture information. If students had been taught to use a particular note-taking strategy, and were held responsible for its use, the focus lesson became part of my observations. But a non-example during a focus lesson would be if the teacher directs students to take notes during lecture, with no guidance or expectations of how, and no student

accountability to follow through. If, for example, the teacher were to require notes without guidance of how, but then hold students accountable for having notes, developing a structured note-taking strategy would represent a potential area for growth in the teacher's instruction.

The next stage of instruction was guided instruction, in which the teacher provides scaffolding to students in a whole group, small group, or one-on-one format. The identifying feature of guided instruction is interaction between teacher and students. The teacher may pull specific students aside into temporary groups to clarify a concept or skill with which all group members are struggling, or may move between collaborative groups, helping to clarify directions for the group task. He/She may move around the room answering individual students' questions. The guided instruction stage yielded observational data when the teacher questioned, prompted and cued students toward finding the right answer or understanding a procedure, without directly giving the answer him/herself except as a last resort (Frey & Fisher, 2011).

The collaboration stage often occurs simultaneously with guided instruction, as the rest of the class works in small groups or partners on an assigned task while the teacher scaffolds for some students. Collaboration provided observational data when students discussed how they pulled information from the text among themselves and especially when they used the Discourse of the subject to discuss it. Student talk was often linked to student writing, as they discussed answers while recording them and/ or reporting them out to the whole class. A non-example during collaboration was when groups worked silently to complete a task.

The last stage in the GRR model is independent practice. This may occur during the school day or as homework. Students may work independently while the teacher is offering one-on-one guided instruction for others. This stage is important for instruction, but rarely provided observational data. It was the source for student work that demonstrated understanding and use

of literacy strategies, after homework was submitted. If a teacher assisted a student during independent practice, it then became an example of guided instruction, as described above. A non-example during independent practice would be times in which students worked quietly without asking questions or talking and I did not collect student samples, offering no way of observing their cognitive processes to determine if they were using disciplinary Discourse.

Table 2. Codes and Roles in Phases of Instruction

Codes for Phase of Instruction	**Description**	**Teacher's role**	**Student's role**
Focus lesson	Modeling, Demonstrating, and Direct instruction by teacher	Central, acts as expert on content knowledge	Peripheral, acts as audience
Guided instruction	Scaffolding and Instruction targeted to student needs	Central, acts as expert on pedagogy and content knowledge	Increasing, acts as problem-solver
Collaboration	Students practice new knowledge or skill in small groups	Peripheral, acts as guide as needed	Central, acts in collaboration to practice new skills with small audience
Independent tasks	Students apply new learning on their own	Uninvolved until assessment	Central, learning to act as expert

Emerging Units of Analysis

As noted during the Literature Review, there are many possible ways for teachers to implement disciplinary literacy. I originally envisioned active reading strategies that help students to comprehend disciplinary texts. My time in the classroom quickly showed me that I had to expand my units of primary analysis, because there was little reading occurring during class. Instead, I needed to consider the full range of literacy strategies being demonstrated to help student engage with the knowledge and skills of the subject area. As my classroom observations proceeded, I included writing strategies when they required that students worked

with information from the class, rather than personal reflections or other background knowledge. I noted examples of students using language and terms they learned in class. Specifically, I watched for examples of reading, speaking and writing by students related directly to the work of experts in each field. This made coding tricky, to create categories to capture these divergent yet legitimate approaches to teaching students to think, read, write and act like experts in two different fields. Leaving coding open to how two teachers had interpreted disciplinary literacy generated many codes.

My list of possible codes expanded during the process of coding. I started with the seven described above, derived from my literature review. Then I added many in the first weeks of observing classrooms, as I witnessed how each teacher worked to introduce students to the Discourse of their field. Many of my fieldwork memoes were notes on codes to include. Some codes I combined during the coding process. For example, I realized that "teacher scaffolding" and "guided instruction" were synonymous, and combined them. Many examples of students "speaking" Chemistry or Psychology could be grouped under a general "Discourse practices" code. Other codes I dropped all together. For example, while "technology" might have been differentiation of product or process, I never saw it used for either. Nor was it explicitly connected to software or programs used by experts in the field, therefore not part of disciplinary literacy. Likewise, several codes that I had anticipated for culturally relevant practices ended up with no examples, and so were dropped as well.

As part of subsequent waves of data analysis, I created several codes to capture instances of disciplinary literacy in each classroom, when the teacher described a form of reading or writing by its use by professional psychologists or chemists. These were generated from the teacher interviews, when I asked teachers how they implemented disciplinary literacy, and

during the observations, when I saw how the classrooms operated. I also included a series of codes that overlap disciplinary literacy, which classified teacher statements about the purpose of learning as preparation for college learning, for career after college, or for career without college (see Table 3).

Table 3. Disciplinary Literacy Codes

Codes for Disciplinary Literacy	**Description**
Background knowledge built through reading	Reference to knowledge students needed to gain from outside reading, usually during application in class
Chemistry literacy practice	Explicit reference to reading, writing, thinking or speaking like a chemist
Connections to real life	Teacher or student refers to how learning reflects knowledge needed outside of school
Differentiation by content	Teacher individualized the level of reading complexity for students, while teaching the same content materials
Differentiation by process	Teacher individualized the manner by which students learn the materials
Differentiation by product	Teacher individualized the manner in which knowledge or mastery may be demonstrated by students
Discussion of how and why strategies were used	Explicit statements during instruction on how and why students should use disciplinary literacy strategies
District's disciplinary literacy initiative	Reference to the district writing initiative
Multiple sources of content knowledge	Assigned readings that supplemented the textbook
Obstacles or Constraints	Teacher statements about something that prevented them from teaching in particular ways
Preparation for career after college	Teacher statements that linked current learning to careers requiring college
Preparation for career without college	Teacher statements that linked current learning to careers not requiring college
Preparation for college learning	Teacher statements that linked current learning to advanced learning in college
Psychology literacy practice	Explicit reference to reading, writing, thinking or speaking like a psychologist
Questioning	Instances when students asked or were guided to ask on-topic questions
Technical writing	Writing according to stated norms and conventions of a field
Think-alouds	Instances when the teacher shared thought processes and struggled with a particular text in front of a class

Adding the original seven codes for organizing the disciplinary literacy strategies to the seventeen codes generated through my observations of disciplinary literacy in the classroom, I eventually arrived at twenty-four codes. After working through my data several ways and considering the patterns that emerged, I clustered my codes into three categories which displayed the disciplinary literacy work of the Chemistry and Psychology teachers at this school. The categories were the explicit Discourse practices arranged by the teacher; the strategies that the teacher employed to teach Discourse practices; and the context in which the teaching took place (see Table 4). In the case of Collaboration, I clustered it into both practices and strategies, since it represented a phase of instruction as well as a culmination in student learning due to teacher planning.

Table 4. Clustering of Codes into Categories

Categories	**Clustering of Codes**	
Explicit Discourse practices	Chemistry literacy practice Collaboration Connections to real life Discussion of how & why strategies used Focus lesson Guided instruction Independent tasks	Preparation for career with college Preparation for career without college Preparation for college Psychological literacy practice Questioning Technical writing
Strategies to teach Discourses	Background knowledge built through reading Collaboration Differentiation by content Differentiation by process Differentiation by product	Elaboration Multiple sources of content knowledge Organization Rehearsal Think-alouds
Context of teaching	District disciplinary literacy initiative Obstacles or Constraints	

After much iterative reflection and analysis, I was able to uncover three key findings from this study:

Finding one: In a school with a laissez faire approach to classroom reform, most changes in instruction relied on the individual teacher's judgment of best practices. This contributed to the feeling among teachers that disciplinary literacy was an administrative fad that would pass in time.

Finding two: While goal-oriented collaboration was a key feature in both subjects, each teacher left the learning of interpersonal skills by students to chance, leading to different levels of effective Discourse within student groups.

Finding three: Instructional coaches at the secondary level will need to know their teachers well to be able to make suggestions of relevant classroom strategies. Sometimes, the best service a coach could offer was as a sounding board as the teacher talked through obstacles and found solutions him/herself. This was particularly important in a subject for which there was only one teacher, and therefore limited in-building collaboration possibilities.

I examine each of these findings at length in the Discussion chapter below.

Research Procedures

Each research question is linked to specific units of analysis that were collected and analyzed as described below (see Table 5). The research process proceeded through the following phases.

Table 5. Research Process

Research questions	Units of Analysis	Data Collection	Data Analysis
How do secondary teachers engage students in disciplinary Discourses?	Reading, writing or speaking strategies used during instruction Differentiation strategies of small group work	Classroom observations; Field notes Teacher interviews	Buehl (2011, 2009) Fisher & Frey (2008) Dymock & Nicholson (2010) Shanahan & Shanahan (2008) Lee (2007) NGACBP & CCSSO (2010)
What are teachers' experiences with modifying literacy strategies according to the needs of readers in their discipline?	Rationales for reading and writing strategies Concerns about use Planned and implemented modifications	Teacher interviews Teacher reflections Classroom observations; Field notes	Buehl (2011, 2009) Shanahan & Shanahan (2008) Fisher & Frey (2012) Frey & Fisher (2011)
How might these modified strategies expand teachers' worldviews about and experiences with the subject area?	Changes between original and modified reading and writing strategies Student outcomes as seen in homework or class interactions	Teacher interviews Teacher reflections on modifications Classroom observations; Field notes Examples of student work	Buehl (2011, 2009) Dymock & Nicholson (2010) Shanahan & Shanahan (2008) Adams & Pegg (2012)

Phases of Research. A table outlining the phases of research may be found in Appendix B. There were eight phases of research: access, initial interviews, preliminary analysis of initial interviews, refinement of initial observation and interview protocols, data collection, data analysis, member-checking, and writing results. Gaining access and permissions have been described above. It is noteworthy that the process of gaining access helped me to make the transition into a new role in the school, from occasional employee and volunteer to researcher.

Protocols for initial interviews for science and social studies may be found in Appendices C, and D. The initial interviews served four possible functions. First, they could have narrowed

down the field of possible participants by allowing me to characterize each teacher on a spectrum of how interested and willing they were to incorporate disciplinary literacy practices into classroom instruction. The second purpose was to learn the teacher's perspective as a content area expert about the epistemological basis of their discipline and how teachers guide students to become comfortable using it. Thirdly, the initial interviews were used to refine the initial observation protocol, a copy of which may be seen in Appendix E. Lastly, the initial interviews allowed me to design the subsequent interviews, which extended ideas about reading and/or writing strategies brought up by the teachers, or probed their existing knowledge about strategies they would like to use in instruction.

Data Collection. The phase of data collection began immediately after the initial interviews, and lasted throughout the spring semester, over four months. Originally I was ambitious about how involved I would ask teachers to be. I had planned to ask them to provide or allow the following forms of data to be collected: ten individual interviews, occurring twice a month; between three to five hours of observations each week; textbook or classroom passages for readability analysis; content analysis of student work; and five teacher reflections, following every other interview. This proved to be unrealistic in terms of the time and effort the teachers were able to contribute. They were each willing to let me observe two classes each, more than I had originally planned, three times per week. I was allowed to collect passages from textbooks or assignments for reading samples at will. Each teacher provided several examples of student work with the names obscured, examples described as either high or low quality, for content analysis. But they had little time for interviews or reflections. The Psychology and Chemistry teacher had time for three interviews each, less than once per month. Neither of the teachers was willing to write reflections, though each of them verbally reflected before and after classes and

during the interviews. To be realistic and respect my participants' time, I had to cut back on the variety of data sources I examined, and omitted written reflections altogether.

The first data source was the individual interviews, lasting between twenty-five and sixty minutes each, with the teachers and one with the district's curriculum coordinator. This yielded over six hours of data about the teachers' impressions of disciplinary literacy, their attempts to incorporate it into their classrooms, and the district's disciplinary literacy initiative. Building from the initial interview and observations, later interview protocols included questions about epistemological traditions in the disciplines: appropriate forms of evidence and argumentation; common text structures; the types of problems the discipline addresses and how they are solved; the types of questions that experts ask; and groups of students who struggle with the subject. Through the interview protocol, I sought to examine how teachers adapt literacy strategies to help students experience the work of their fields. At the end of each interview, participants were notified of the next topic and asked to come to the next interview prepared to discuss it.

The second data source was observations in classrooms, as many times per week as I was able due to my own employment obligations. This ended up being six hours per class per week for four months, for a total of approximately one hundred observation hours. I asked teachers to provide lesson plans for observation days at least one day in advance, but this did not always happen. Having lesson plans would have aided my knowing which literacy strategies teachers intended to include; however, I was still able to recognize their use when the teachers did not supply lesson plans. The observation protocol shifted as I built on my ongoing data collection between the beginning, middle and end phases of the research (Creswell, 2007).

A third source of data comes from text analyses of available textbooks, worksheets, and assignments related to the class. To conduct these, I inputted random selections of the text into

an online site that analyzes reading levels according to several common reading formulas (http://www.readabilityformulas.com/). Although this is only an estimate, even an estimated reading level can yield important information predicting whether students at a particular grade will struggle to read it (Allington, 2012). The reading analysis results were reflected in the subsequent interview protocol questions and conversations with the teachers about the readability of the text compared to students' grade level. These analyses generated new questions to ask the teachers. For example, how closely matched were students and texts for readability? If the match was poor, what literacy strategies did the teacher use to scaffold instruction and provide students with materials they could read (Allington, 2012; Buehl, 2011)?

For the fourth data source, I requested copies of student work from each teacher. Before student work was given to me, I asked the teachers to remove any identifying information to protect student privacy. For each teacher, I asked for samples of student work that reflected literacy strategies that promoted disciplinary literacy. The frequency with which I asked for student work was based on the types of literacy strategies each teacher implemented.

I had planned for a fifth data source, the teacher reflections. But the teachers were not willing to write reflections, citing time constraints. The original guide for the reflections may be seen in Appendix F: "Think about your recent use of (specific literacy strategy). How did it work to teach students how to think like a (historian, mathematician, or scientist)? Did it work equally well for all students, or did some struggle? If so, who? How could you modify (specific literacy strategy) to help all students learn to think like an insider in your field?" Instead, I included these questions in subsequent interviews and in the ongoing informal conversations I had with each teacher before, during or after their classes.

Data Analysis. As data was collected, I transcribed all interviews and observations myself, creating a Word document for each. I transcribed the interviews within a week of recording, to maximize my memory of the events and allow for additional memoing and field notes (Creswell, 2007). I audio-recorded classes when I observed. My initial observations were typed on my laptop while I was observing, and then cross-checked against the recording, when I added the teacher's and students' verbatim contributions. I also captured my thoughts and memoes about my questions and comparisons in a field journal on my laptop after observations and interviews. I transferred all of these documents into ATLASti 6.2.18 to code them and analyze the data for larger themes (Creswell, 2007) related to specific disciplinary Discourses and teachers' perspectives of literacy strategies in their content area classrooms. As I collected data and coded the transcripts, initial findings were cycled back into the research to adjust the questions I asked and what I was focused on during observations or suggestions I made for classroom instruction (Creswell, 2012). As I coded, I made memoes of codes to add, expand or combine, and notes about possible meanings being revealed. I used ATLASti to add descriptions of each code in the software as a reminder. In addition to software, I filled many notebooks with ideas about what I saw in the classrooms and what it might mean. Gradually, the data analysis helped me refine my coding down to the four main themes that represent my findings.

My next step was to perform member-checking with my participants. As part of the validation process described above, I brought this information back to participants for each to check that I had accurately represented their words and actions. Over email, the teachers and curriculum director verified that they accepted the premise of my claims. With member-checking complete, I began the final writing and revising of my findings.

Potential Issues and Concerns

Creswell suggests considering any ethical issues that may arise during or as a result of collecting data (2012, p. 205). It seems like there may be some concerns of disruptions to the classes. I had some of the students in my own classes, and I sometimes got questions about why I was there that had the potential to pull students' attention away from the teacher. This was not an issue during the study. When students tried to ask me questions or talk to me during class, I redirected them back to the lesson, and answered their questions at the end of class. After a few days of observations, most students ignored me during class.

In the informed consent procedure, teachers and students were made aware that their participation was voluntary, and withdrawing would not negatively affect their work place or schooling. Throughout the research process, I worked to minimize any feelings teachers may have had of being coerced into continuing participation, by checking how they felt about participating. In the initial email conversations, asking teachers for participation, I adjusted the number of interviews and deleted the need for reflections based on their stated concerns about the level of commitment needed. At interviews and observations, I asked if I was asking too much of them, and if there was anything I could change to help them remain comfortable with the demands of the study. My attitude toward the teachers is that they are experts in their content areas who can teach me about the norms of reading, writing, and being a practitioner in their fields. Our relationship was built upon respect among professionals. My experience with the high school teachers was great throughout the study, and we were able to communicate beforehand when they needed me to shift the date of observations or interviews due to testing or assemblies. We were able to shift observation dates freely, and I still gathered about forty-five hours more than originally planned. There were no problems with meeting the teachers for

interviews when we arranged them. In the IRB submission, I described the study as including no known risks to participants.

Limitations

There are some limitations to this research study. As a qualitative researcher, I was increasingly aware of how much my own philosophy of education influenced what I expected to see in secondary classrooms. As described above, I was aware from the outset that I would interpret events through my own subjectivity, requiring ongoing conversations with my participants to ensure that I represented their classes and ideas as loyally as possible.

Yet it was not until I was almost done with this process that I realized how deeply my beliefs in the effectiveness of standards colored my expectations for "good" disciplinary literacy. As an educator who has studied educational history and policy, I welcomed the adoption of the Common Core standards. In hindsight, I was overeager in my assumptions that the school district in which I conducted my research would be actively implementing the standards during the 2012-2013 school year, only two years after the standards were adopted. As Lewis (2003) notes, educational policy will often suffer from a lag time between legislation being passed and the reforms being implemented. This lag time may be increased in education, as compared to economy policy, because of the many interest groups who may oppose a given reform as well as the complex nature of educational institutions. In contrast, a national survey of school superintendents indicated that only 37% of 211 school districts surveyed were prepared to implement the Common Core during the 2013-2014 school year, with the majority of school districts setting their readiness dates much later (Rentner & Kober, 2014). Despite my overzealous expectations that my participants would be implementing the Common Core

standards at an early date, I documented many powerful examples of disciplinary literacy happening in the classrooms.

In this case study dissertation, I gathered information that generalizes to teachers' practice and professional developers' approaches to implementing disciplinary literacy in secondary classrooms across the curriculum. We are in an interesting era of American education, in which the demands made on teachers and students are increasing, yet the support and retraining needed to meet those demands are uncommon. As noted in *Education Week*, implementation may prove the downfall of disciplinary literacy if schools don't know how to teach in the recommended ways (Gewertz, 2012). This project contributes teacher perspectives on how school districts may implement ongoing, site-based reform that involves teachers in all steps of the process as informed, respected participants in an initiative aimed at improving adolescent literacy rates through disciplinary literacy.

Chapter Four

Findings

The purpose of my research was to gather teachers' perspectives of implementing disciplinary literacy to apprentice students into learning how to wield the Discourse of the subject area like an expert does. In order to gather data about the experiences of secondary content area teachers implementing disciplinary literacy practices, I spent a great deal of time in the high school from January 2013 to May 2013. The high school served about 2000 students, set in a middle-class suburb south of a large urban area. Despite its size, the high school's atmosphere was generally welcoming. The people were friendly and courteous; as a substitute teacher and visitor, I was often asked by students in the hall if I knew where I was going and if I needed help finding my way. As an outsider, I always felt comfortable and safe at the school.

As part of a district, the high school's administration answered to the central office for direction in curriculum and instruction. After I spoke with the assistant superintendent about my research on disciplinary literacy, she recommended that I interview the district's curriculum coordinator at the central offices, and arranged a meeting for me at the end of April. She mentioned that the district had been undertaking a disciplinary literacy initiative the whole school year. To frame my findings within the larger context of the district initiative, I begin by presenting the results of that interview. From there, I present my classroom findings organized by subject area for Chemistry and Psychology. All names have been changed to protect the privacy of respondents.

District Disciplinary Literacy Initiative

My interview with the curriculum coordinator occurred in April 2013, near the end of my data collection in the high school. Regardless, it seems fitting to begin with that interview because we discussed the disciplinary literacy initiative that was supposed to drive professional development all year.

The curriculum coordinator, Mr. Zachary Graham, reported that he had been serving in this role at the district level for five years. As curriculum coordinator, Mr. Graham reported that his primary responsibilities were financial responsibilities, standardized testing, and professional development for teachers. His professional goal was to improve instruction for the students: "I think my goal is to spend the most amount of time I can to push people beyond their comfort level, to really think about improving instruction and making sure that students understand and increase achievement."

Mr. Graham had indicated that the district was not using the Common Core standards as guidelines for curriculum and instruction. Instead, they were focused on promoting good teaching strategies, which seemed a vague description of what the district wanted teachers to do. When I asked him for an example of how the district tried to change teachers' instructional practices, Mr. Graham brought up disciplinary literacy:

> And then really looking at, what's the point of any curricular discipline? And so we have done a number of in-services this year, talking more about disciplinary literacy. Just cuz it's an easy concept that the average teacher can integrate into their classroom without too much effort. It's a slight shift, but it doesn't really impede that much upon what they're currently doing in the classroom. But if they make the little shift, it can have great impact.

We see in this statement that Mr. Graham described disciplinary literacy as a small shift. It seems to be simply having teachers recognize what the purpose of learning their subject area was and sharing the purpose with the students. He described the types of initiatives that he preferred:

> So I try to pick things that can have a huge impact without necessarily completely changing somebody's world, and things that you can provide a little bit of knowledge about and get people to kinda start rolling on their own, and they can really kinda improve upon that and find more information about it.

His hope was that a couple hours of in-service would propel teachers to find more out on the topic on their own, and that occasional reminders of what they had learned would keep the initiative fresh in everyone's mind. From this description, it seemed that the district followed a laissez-faire approach to monitoring how teachers implemented what they learned during professional development sessions.

It seemed as if Mr. Graham hadn't yet explained what disciplinary literacy meant. I asked him how he thought the teachers would describe it.

> Well, I would hope they would describe it as a way of getting to what the purpose of their content is. That they would look at it as knowing how to read and write as that professional in that profession. So we've said that multiple times to them. That it's really, how do you think as a mathematician, how do you think. That has been the way that we've discussed it and I think it's accessible to a lot of people.

In this second description of disciplinary literacy, Mr. Graham goes beyond just teachers knowing what the purpose of their subject is. They are expected to analyze how professionals in their subjects read, write and think. Mr. Graham's second answer seems aligned with the current

state department's description of disciplinary literacy as the reading, writing and thinking needed to perform the Discourse of a field. It also complicates professional development, because now the definition has been broadened so far that it becomes unclear what instructional practices, if any, lie outside of it.

I asked next what approaches the school district has taken to encourage teachers to re-evaluate how they engage students in reading, writing and speaking about their subject areas. Mr. Graham described a general in-service presentation on what disciplinary literacy is, and then a specific goal of improving text-dependent writing across the curriculum. "And I think that the high school's improvement goals all year have been to increase the amount of writing in each class." This was the first I had heard of this initiative, when I had already observed over one hundred hours in classrooms. Mr. Graham described instructional changes at the high school in terms of improving the types of questions teachers asked students each week, getting more in-depth. I was very surprised to hear about a weekly writing assignment in the high school classrooms, and decided to ask about it in the next teacher interviews.

I mentioned to Mr. Graham my surprise that the disciplinary literacy initiative was increasing writing in the high school classes. From further probing, I learned that the teachers were supposed to ask questions somewhere in their instruction once a week that required written response from students, and then the questions and responses were submitted to the administrators. The level of questions posed to students was related to the ACT suite, either long or short response text items. Mr. Graham believed that the writing part of the disciplinary literacy initiative was happening in the high school classrooms, although it might be hard to observe: "So depending on the discipline, there might be more written response in some areas

and more ACT simple questions in others, and maybe that would be more difficult to see as well."

Mr. Graham's specific interest in instructional practices lay in teacher questioning. As a doctoral student himself, Mr. Graham viewed instruction through a lens of how depth of knowledge could scaffold inquiry during instruction. His area of study was

> the oral questions in the classroom setting, how you engage students to get to a level of complex questioning. . . I think too many teachers feel like they have to cover content. That they can't stop and ask good questions. Which if they really realized, if you just asked the complex questions, and you took some time to dialogue about it, you're probably going to get at a better level of understanding than if you just try to cover the content.

He contrasted dialogue and in-depth classroom questioning with focusing on standards as a "little product" that distracted from the process of learning. In this excerpt, we can interpret the need for dialogue as engaging students in Discourse, but at no point in our interview did we address how to support students in speaking the language of a subject area.

Next I asked specifically about reading, and whether the disciplinary literacy initiative was attempting to get more textbook reading in the classroom. Mr. Graham answered that their reading initiative focused on close reading, whether it was from a textbook or from another source. Teachers were encouraged to photocopy pages from the textbook and teach kids to annotate it. When I replied that I hadn't seen this happening either, he admitted,

> No, I'm not surprised about that. That's the hardest part of the shift. I think that that's a long-term process for people to internalize how they can make those

> changes. And I think the only way that's going to happen is at the building level and that consistent approach. I think there have been a number of classrooms that have really changed the way things are done, and a number of classrooms that have probably done very little.

This comment got me thinking about how change occurs in high schools when the state and national education departments are trying to leverage it from afar. Mr. Graham was having difficulty affecting change, just from the distance of the district office. This theme led me to add a question about future policy changes to the final teacher interviews and led me to consider the importance of building leadership in reforms.

I was hoping to get information about how teachers encourage students to communicate with each other about their learning. I asked Mr. Graham if the district offered any training on collaboration in the classroom. He answered that there had been only a couple of workshops, and then he changed topics to how to get teachers to change their instructional practices. He described the majority of the high school teachers as very traditional, and that changing instruction was an area where administration would have to "continue to push and challenge… but it will be a very long and slow process." Instead, he admitted that it was "a lot easier to change practice when you force change." Some ways that instructional changes may be forced were by buying new resources and requiring their use, or changing from a traditional schedule to block scheduling. He had doubts about getting teachers to improve instruction otherwise:

> But I would say human beings as a general rule, will not change unless they are forced to change by outside forces. Except on probably rare occasions, when somebody just decides, "This just isn't working for me. I need to drastically do

something different." And, you know, there are some people who are able to pull that off, and a lot of people who never get to that point.

Then Mr. Graham returned to the idea that many high school teachers were focused on content, at a time when the learning process was emphasized as more important:

> And in the end, the content of their course really isn't very important. It's the process of working with that content. It's the critical dialogue in the content. It's the thinking about that content and how you access the content… it's too easy to get caught up in: I need to cover this, and I need to talk about this, and I need to do this.

While the content may be important to some, he asserted that most students would probably not use it in their lifetimes:

> And so we have to recognize that for a very small percentage of the students sitting in front of us, are they actually going to use our content. [Most students] are going to use our life skills and our thinking skills and our analyses and engagement in dialogue and argument and that kind of thing.

While Mr. Graham spoke about pushing teachers to improve instruction, there wasn't much pressure to make changes yet. The district had no plans to make the drastic changes he described, such as changing the curriculum or switching to block scheduling. Administration in the district had been talking on and off about how teachers needed to change the process of teaching for years. But Mr. Graham predicted that when the Smarter Balanced Assessments finally were implemented, then teachers would understand the need for change:

> But until there's assessment on it, why change? Because right now, our scores are okay. Not great, but okay. And so, there isn't necessarily the fire underneath the feet to make massive changes.

Mr. Graham wanted teachers to make big changes in the teaching process that would improve instruction for all students. In his research, he was guiding individual teachers to improve the quality of instructional questions. But from our interview, he did not seem overly controlling in his approach to professional development. Instead, he was attempting to create a framework for change, introducing ideas that teachers would need to be familiar with in the near future, and encouraging them to make incremental changes in how they presented their content to students. Rather than prescribe specific ways to teach, Mr. Graham recognized that teachers with different instructional styles could get good results for students: "But a really good teacher who is consistent, who uses a consistent approach and gets to higher level thinking, whether you're sitting in desks in rows or you're sitting in small groups, I think probably has similar good outcomes." However, he also pointed out benefits of improving teaching styles for "some mediocre teachers and the students who are in those classes." It was unclear how the district administration distinguished between really good and mediocre teachers to determine who could benefit from improving their instructional approaches.

Instead of trying to mandate changes from the district level, Mr. Graham predicted that most of the changes would come from the building level. During the next school year, for the first time building administrators would be responsible for designing their own professional development, on topics they deemed most important, with the intention that these themes would be interwoven throughout the school year during in-services, faculty meetings, and professional learning communities. Building administrators would also be responsible for deciding what

types of instructional practices would be reflected in the teacher evaluations. He saw this approach as theoretically a good idea, but was concerned about the amount of time required to plan in-services. He estimated that the five members of the central office staff put about two hundred hours into planning a full-day in-service for the buildings. A lot of time was dedicated to meeting the diverse needs of the different roles and professions in a building, from teachers for every subject, to the therapists, psychologists, counselors, and more. It would be a gigantic undertaking for one person to take on by him/herself, while still managing a building.

The district made this change, "because the school report card is school-based. Our belief is that the principals need to have a high level of influence on the training that is specific to their building." While Mr. Graham agreed that it was important for the principals to have control over the professional direction of their buildings, it seemed like the principals didn't understand the magnitude of the task. He would support them as well as he could with ideas and data, but he couldn't design individual in-services for nine different buildings. "I think, theoretically, it is exactly where we need to go. In reality, I'm skeptical, but hopeful."

From this interview, a picture of the district context emerges in which teachers were notified about policy changes concerning standards and standardized assessments. Through professional development, the teachers learned general ideas about how to change instruction, such as discussing the purpose of their content with students as part of learning. They were encouraged to include literacy strategies such as close reading, academic vocabulary study, questions to guide discussion and writing-to-learn activities.

But for the most part, the high school teachers were left to decide for themselves what the Discourse of their discipline was, and how to introduce students to it. They were left to study the standards and assessments on their own, if at all. Since there was no alternative vision for what

students should learn and be able to do, the desired changes in instruction remained vague. Paradoxically, during the same interview Mr. Graham described the disciplinary literacy changes they would like to see teachers make as minimal and easy to implement, and as a challenging, major shift in thinking about instruction. Overall, it was not clear from our interview exactly what types of changes the district was asking high school teachers to make. With this context in mind, we now step into the first of the high school classrooms in which I observed, the Chemistry classroom of Mr. Jared Hayes.

As a reminder for the reader, I organized my observations of class activities and routines according to Fisher and Frey's (2008) expansion of Pearson and Gallagher's (1983) Gradual Release of Responsibility (GRR) framework. While it is described in detail in the preceding chapter, it may be helpful to review the main GRR phases through which instruction ideally proceeds: focus lessons, guided instruction, collaboration, and independent practice. Teachers use focus lessons briefly at the beginning of a unit or lesson; this is the time in which they impart expert knowledge about a topic. Next the lesson may proceed to guided instruction, during which students practice the new concepts or skills with teacher scaffolding as needed. Guided instruction may occur one-on-one or as the teacher corrects misunderstandings common to a large or small group. The third GRR phase is collaboration, in which students work together to practice and refine their learning. The second and third phases often occur simultaneously. Finally, students are able to move into the last phase of independent practice, which includes working on their own during projects, papers and assessments. While these phases may proceed in order, the process is often recursive over the course of a unit or lesson, or some phases may be omitted entirely (Buehl, 2011).

I would also like to remind the reader of the organizational scheme I introduced for understanding literacy strategies: rehearsal, organization and elaboration (Weinstein & Mayer, 1986). Students use rehearsal strategies when they use information in its original form. When readers interact with information to reword and change information, it is described as elaboration. Finally, readers may classify information from one or more sources in ways that represent their own logical reordering, which is described as organizational strategies. In addition to these two coding systems, I used seventeen additional disciplinary literacy codes related to specific Discourses by subject, instructional strategies in use, or post-secondary goals mentioned by the teachers (please see Tables 1, 2, and 3 above).

As I transcribed and coded my data, the enormity of my data set was daunting. There were over three hundred typed pages of observations, reflections, and interviews. Each classroom presented a different view of disciplinary literacy, influenced by the subject area, the individual teacher's personality and experience, and the goals of the school district. In order to create continuity between the two classrooms, I organized my findings according to major aspects shared by all classrooms: introduction of the teacher, including statements about educational philosophy; demographics of the classes; a glimpse of literacy strategies in the classroom, including how the district's disciplinary literacy initiative influenced instruction; and the types of constraints on instruction experienced by each teacher. Using this organizational framework, I was able to sift through the many codes I had generated and group different aspects of instruction for closer consideration. As always, writing served as an exercise in deep introspection about what I had observed.

Chemistry

"The way that the lab is structured, they have the unknown, and they have to go back and do the lab itself, and they have to come talk to me, and they have to tell me what they think is in their test tube. If they come up to me and say, "I think I have mercury," but they really have mercury and silver, often times I know what they did wrong. But I don't really offer a lot of help. Because I sorta treat this lab less like a 'Let's get the right answer,' and more of a real-world or even as a problem-solving situation: 'What did I do wrong?'. . . It is a problem-solving lab. It's been designed to force them to think on their own." -- Mr. Jared Hayes, Chemistry teacher

"Crap. This chemistry will be the death of me!" – Rhonda, Chemistry student

When I wrote my proposal, I talked with a Biology teacher about helping me with my research. I had worked with her as a substitute Special Education co-teacher and observed her style of getting the kids actively involved. She had some interesting projects and approaches to teaching that seemed to indicate a strong disciplinary literacy perspective. Unfortunately, when it came time for me to begin my research, she felt too busy to participate. This left me scrambling to find another Science teacher. Luckily for me, Mr. Jared Hayes was generous enough to share his classroom and time.

Introducing Mr. Hayes. I was not well acquainted with Mr. Jared Hayes before this research. Mr. Hayes taught Chemistry during summer school the first two years that I taught it, and worked as an interim administrator during my third year of summer school. That was the only personal contact I had with him before this project, but when I emailed him, asking for help, he agreed. Mr. Jared Hayes was a Caucasian man in his early thirties who had taught high

school Chemistry for six years in this district, and for four years in a different district before that. He was also a track coach, and spent his evenings at meets and practices during the second half of the spring semester. Listening to him in class and during interviews, it was apparent that his two daughters in elementary school were extremely important to him, and he spent a great deal of time with them. He made time to interview with me during or after school on three occasions: January 31, March 13, and May 17, 2013.

From working with Mr. Hayes during the summer and observing him during the research, a certain seriousness in his personality became clear. Whether it was interviewing with me, answering questions about the labs, classes and students, or teaching his class, he always got to the point as quickly as possible. In fact, his interviews were the briefest, while still yielding plenty of content. This seriousness seemed to shape his interactions with students and his philosophy of education.

Mr. Hayes mentioned that his favorite part of teaching Chemistry was "the part where the kids realize that they have to think for themselves. One of the things that I've spent a lot of time doing in terms of changing the curriculum from when I got here was, I've changed it from being a spoon-fed, testing thing to the kids having to learn material and then use the material to answer questions instead of regurgitating." This was apparent in several of the labs that I observed, which required students to apply content knowledge gained from reading and lectures to problem-solving situations, and in the guided reading assignments for the required textbook chapters. Mr. Hayes often referred to the belief that his job was to get students thinking in ways that would transfer to other classes and college.

In our second interview, I asked Mr. Hayes about his relationship with students. In class, he often gave them feedback about their maturity levels and the need for individuals to take more

responsibility. I wanted his perspective, because when I wrote down his words, they lost his teasing tone. I told him that in my transcriptions he often seemed grouchier than he had in class. How would he describe his interactions and relationships with students? "I would like to say that I'm fair and honest, but I try to model what I want them to be in terms of a young adult. And so I am very honest with them about their progress, both personally and academically." The kids responded warmly to his teasing, even when it was directed at them. Students teased Mr. Hayes back or made comments like when Sakina told a new girl, "Mr. Hayes always says he doesn't care, but in his heart, he does care." On the question about his interaction with kids, Mr. Hayes elaborated,

> One of the guys that used to teach here, he basically said if a child makes it through four years of high school and hasn't once been made to feel like they're stupid, then he's not done his job. And so he said, "I don't want a kid to leave this building and go to college thinking that they know everything and then get lit up by a professor." So he took it upon himself to be brutally honest with many of these kids. And most of the kids completely respected him for it. So there are times when I am, when I speak that way to kids, because I think it's a very important thing for a young adult to go through.

In addition to explaining his interactions with the kids, this statement gives us a preview of how Mr. Hayes viewed his class as important preparation for college learning.

In speaking about his classroom instruction, Mr. Hayes espoused disciplinary literacy ideas of teaching students how to think like a professional in his field. Technical reading and lab report writing were important components of his classes. He mentioned that one of the changes in science education was that the Next Generation Science Standards (NGSS) focused on

engineering as the type of professional thinking students should learn. He had always followed the National Science Teacher's model, and focused on teaching students how to think and problem-solve like chemists do:

> We've incorporated some lab activity that is very much like what an actual chemist might do. And that's one of them where the kids really struggle a lot, because it requires a lot of concrete thinking, it requires trouble-shooting. And designing a flow chart that they don't have and then working their way through that.

Mr. Hayes and a colleague with whom he collaborated, Mr. Wright, focused the first semester curriculum on teaching students the background chemistry knowledge they would need in order to be successful in applying that knowledge during the second semester, which I observed. While there were aspects of engineering in the labs, he hadn't yet made them explicit to students like the NGSS recommended.

Extending the idea of disciplinary literacy to helping students learn the Discourse of a subject area, I asked Mr. Hayes if he could think of an example of when he introduced students to chemistry Discourse.

> There are a few labs, like I said, especially in the second semester, where we give them very little direction, and force the students to come up with the experiment themselves, force the students to come up with the answer, and we don't tell them anything until they're done. When they hand in the lab, we tell them if they're right or wrong. And so, there's a lot of struggle that the kids have to go through, they have to be able to make connections between first semester and what we've just taught and what they're trying to do in lab. And so the, some of the brightest

> kids, who want to know the answer, get really frustrated. And I find that some of the kids who are not necessarily good students, but they're good thinkers, get through it very quickly. . . Whereas the kids who are very book-smart, and know only what the textbook says, struggle a lot. So my challenge is to get those book-smart kids not to shut down, and some do.

In this excerpt, Mr. Hayes described the active problem-solving lab that is presented in detail below, in which students have to fight their way through a real problem like a chemist may have to do in his or her work. It is interesting that in Mr. Hayes' perspective, this type of disciplinary literacy activity challenged the kids who would traditionally be considered very good in school, the "book-smart" kids. Some other students who may struggle with traditional school activities, abstract and unconnected to real life, understood the hands-on activity and worked through it quickly. This gives up a glimpse into the power of disciplinary literacy, to reach students at different levels of ability and aptitude, and provide or challenge them with alternative avenues to learn the content we teach.

While I was observing the problem-solving lab, Mr. Hayes also told me that his department had changed the curriculum to give the students seven extra days to be able to complete the difficult labs. One of the challenges Mr. Hayes encountered with disciplinary literacy was finding time for active learning that engaged students. As an observer, it was clear to me that Mr. Hayes took the challenge of keeping students engaged to heart. During labs, he circled the room the entire time, checking with students to see that they were making progress, and cuing or questioning them when they were stuck. He was in constant interaction with students every time I observed, even while he was giving lectures. When I transcribed the

conversations of groups at their lab tables, every transcription included at least one moment of scaffolding by the teacher, even if it was only his voice in the background offering advice to everyone. But in order to make time to interact with students in such an intense manner, other content had to be trimmed from the curriculum.

Continuing the first interview, I asked Mr. Hayes what kind of professional writing his students would learn how to do. Technical writing was one of the main emphases of the Chemistry department for the second semester:

> Many of the labs that we do second semester, they have to produce some type of written document. My job, I always tell the students, is to prepare you for whatever the next level of science class is. So if they go off to take Physics, if they go off to take AP Chem, if they go off to take AP Bio, those three teachers are going to expect that you can write a proper lab report. Will they be able to produce a paper, based on that? Not necessarily, but that would be the next level, that maybe they don't get in high school, but that they should be able to produce written technical writing, at least from a lab report standpoint. . . There are some kids who can have a conversation with me and they can put it out there and explain [a concept], but they can't write it. So I feel that we're getting better at challenging the kids to write and to practice more.

When we examine the labs below, we will see the guided instruction Mr. Hayes incorporated to help students learn specifics of how to write a lab report properly.

In our interviews, Mr. Hayes also mentioned some of the general reading strategies that he taught students how to use: highlighting, circling important ideas, asking questions, and looking up words they don't know. He regularly modeled doing this himself in front of the class,

and told them that these were strategies he used. To help expand their vocabularies, he intentionally used difficult vocabulary when he talked to them, and then checked to see if they understood what he had said. He explained:

> When vocabulary terms come up, I do my best to try to dissect them, I do my best to take the time to try to do it. But much of the vocabulary, especially second semester, is something we've already taught first semester. So again, like I said, I try to dissect it for them, I don't know that everybody does.

There were times that I observed his embedded work with vocabulary, such as when he linked the term "amphoteric" to "amphibian" in Biology. Amphibians live in a dual environment, just like amphoteric substances act like acids sometimes and bases at other times, of which water is a prime example. They knew the term amphibian from earlier Science classes, so Mr. Hayes built on this knowledge. Another vocabulary example was the difference in how the word "conjugate" is used to describe ions in Chemistry versus in language classes. He knew that many of his students were taking Spanish, and pointed out that conjugating was different in Science than in learning languages. Conjugating languages means changing the verb, while conjugating in Chemistry means that ions are related to one another.

Likewise, there were days when he explicitly told the students to pull out highlighters and mark the important information on their lab sheets, so that they wouldn't misread the directions and mess up an experiment. There were several examples of how he incorporated reading strategies in his lectures and guided instruction. Despite this extra help, Mr. Hayes felt that kids who weren't invested in the class didn't really read deeply. "I feel like a lot of students say, 'Aaa' [dismissive sound] and they'll just move on and just kinda run through, just to get [the reading] done."

Mr. Hayes had an interesting philosophy of teaching Chemistry in high school. When I asked him if using active and reading-based methods changed how he thought about high school chemistry, he responded that high school teachers aren't really teaching Chemistry:

> You're just teaching some skills that will make a kid successful in some future science classes. And we call it Chemistry. . . That's sorta my philosophy. My job is to prepare kids for the next level of science class. If I was really teaching Chemistry, we wouldn't call it Chemistry and cover the eleven units that we cover. We'd call it Chemistry and we'd cover maybe two units. Because when they go to college, if they take Organic Chemistry, that's a whole year and not two weeks. If they take Inorganic Chemistry, that's a whole semester, not three weeks. So we're just teaching skills. Can you be successful at the next level?

He returned to this idea when I asked him about how his training in science education during college compared to his own learning in high school:

> Well, the difference is the true understanding of the content of that particular semester that you're in. Like for example, with biochemistry, it's the true linking of the biology and the DNA and the chemical reactions that go on inside of a living entity and then not only understanding the living part, but also understanding the chemistry that goes along with it. So there were times when I would be reading the textbook or listening to the teacher and I would go, "Oh, that makes sense now! Why my body does this." Whereas, [the kids] might say that your body creates energy through the ATP of the Creb cycle or through cellular respiration but. They might say, "This is how it's done," and memorize some stuff, but most kids don't make that leap until they've spent some real time

> with the chemistry and the biology that goes along with it. And so, when you're on the next level, and you're really, truly learning that particular concept for that particular semester, if you really learn it, suddenly it's like, "Oh, that makes sense!" Whereas for a high school kid, I'm just learning a bunch of stuff.

We can see that Mr. Hayes viewed his time with the students as the beginning of their science education, as preparation for more advanced high school and college science classes. He knew that he was helping students to build a foundation for future learning. He returned once more to this idea when he talked about his job in light of his philosophy:

> I sorta look at my job as a science teacher, it is not my job to teach them everything. When they go to college, if they are going to go into science, that is when that is their place to learn that. It is my job to prepare them to be successful at that if they want to be. So I teach them the lab skills, how to do a lab report. I teach them how to communicate, hopefully, through writing. I teach them how to do the math. And I teach them hopefully how to study for a science class. Those are the things I'm teaching. I'm not teaching Chemistry.

Mr. Hayes was working within the National Science Teacher model, and was studying the Next Generation Science Standards with the intention to apply them. He agreed with the basic premises of disciplinary literacy, that students should learn the skill sets that they would need to apply in future professional or educational settings. He was very clear that his job was to teach students beginning scientist skills, which corresponds to the idea of apprenticing students into the Discourse of a subject area, and allowing them space to make mistakes and grow.

Demographics of Chemistry classes. Mr. Hayes' classes were a mixture of students who took Chemistry to fulfill the three Science classes required for graduation, and students who

took Chemistry as a prerequisite to advanced Science classes. The former group was mainly juniors and the latter group was mainly sophomores. He estimated that only about twenty percent of his students were interested in going into science as a career choice. I observed Mr. Hayes' third hour and seventh hour classes two or three times per week from January through May 2013.

The demographic mixture of Mr. Hayes' classes was fairly homogeneous. Third hour had twenty-five students, with fifteen girls and ten boys. Twenty-two of the students appeared to be Caucasian. One boy appeared to be Latino, and occasionally spoke Spanish during group work, but the primary language he spoke was English. There were two girls who appeared to be Middle Eastern. In the recordings of their group work, the girls talked about speaking Arabic to their Caucasian lab partner, and used Arabic briefly to count during lab procedures, to swear when the lab was going poorly, or to speak to each other, but the primary language they used in class was English. I never heard the girls mention from which country or ethnicity they originated.

Seventh hour was also very homogeneous. There were twenty-five students with sixteen girls and nine boys. Twenty-three of the students appeared to be Caucasian. One boy appeared to be Asian Indian and spoke with a slight accent in the group recordings. Another boy may have been Latino based upon his last name and appearance, but he didn't return a permission slip, so was not recorded. In both classes, there were no students receiving services for English language learning, Special Education, or Title I services related to economic disadvantage, per Mr. Hayes.

During the first interview, I asked Mr. Hayes whether there were some students who struggled in his class more than others and why he thought they struggled. He replied,

> For my class, the biggest issue is the kids get bogged down. Because this is the first class where it's not just vocabulary or content, it's math as well. So kids tend to struggle who struggle with the math, then lose sight of the theory, and they're struggling with both of those things then. Versus a kid who is very strong in math, or above average in math, only has to focus on the theory. And so, the kids who really struggle are low in both the math, and as a result of that, they're low on the theory.

In Mr. Hayes' perspective, it was a student's weak math background that caused him or her to have difficulties in Chemistry. He also expressed this in class one day, after a girl asked about her wrong quiz answer on basic computation:

> Now the problem you brought up. And I don't mean to pick on you and your math skills, but I'm going to today. My frustration, my actual frustration in life in general, is that a lot of people say, "Oh, I got an A in Algebra," and then they don't know how to do algebra. So I force them to think about it. What it really means is not that you don't know how to do algebra. What it really means is more along the lines of the fact that you don't know how to transfer your knowledge of algebra in your head to another setting. And that's this class.

For Mr. Hayes, his Chemistry class was a setting in which students would apply what they had learned, not just in Algebra, but from classes that taught them to compute, reason logically, and articulate their reasoning concisely in writing, as they learned the conventions of science. As we saw above, he explicitly told students that one of his expectations was that they would transfer what they had learned in previous math classes and use that knowledge in Chemistry. His emphasis on technical writing required students to stretch their learning, to combine their base

knowledge, new Chemistry knowledge, and writing skills to express their learning in ways appropriate to chemists.

Class routines. Mr. Hayes' class had a semi-regular routine. His units included all of the GRR phases, but never proceeded through all on a given day. Many classes were devoted solely to collaboration and guided instruction in labs, or focus lessons in the form of lectures, or independent practice in the form of tests. In a pattern common to many of the high school classrooms, Mr. Hayes' class often started with a check-in time for homework. Mr. Hayes walked around the classroom with a clipboard, making note of who had the homework completed and who didn't. Mr. Hayes had a different policy on homework than other teachers I observed. Students received no credit or points for the daily work, which was considered practice. However, if they wanted to retake a test or quiz, they needed to have all of the corresponding homework finished. As Mr. Hayes showed me from his records, most of the students completed the homework, about four-fifths on average in each class. While Mr. Hayes walked around checking homework, he spoke with individual students about their answers or personal lives, using the time for a blend of formative assessment and building rapport.

There were a few days that were pure lecture, an example of a focus lesson that lasted the whole class. When they were going to have a lecture day, Mr. Hayes posted a Powerpoint presentation of his notes on Edmodo.com the night before. Students had the opportunity to print out the notes and bring them to class, to be able to add more from the lecture as he went through it. Some students didn't print the notes, but took their own notes during the lecture. Many students sat without any notes out and just listened to the lecture. In keeping with his belief that students need to become self-responsible, Mr. Hayes recommended taking notes, but did not force students to do so. Students' notes were never reviewed or graded by the teacher, and were

entirely an independent task. Those students who added to the Powerpoint were practicing rehearsal and/or elaboration strategies to help them learn the materials better. Those who took their own notes were practicing rehearsal and possibly organization strategies, if they rearranged Mr. Hayes' notes for better understanding.

Collaboration in the lab groups was a huge component of the class. There was at least one lab each month, sometimes more than one, and they generally took at least a week of class. The main problem-solving lab took over two weeks, and some students had to finish during or after class while everyone else went on to the next unit. Students had chosen their own lab groups, and could join or leave groups at will. Some students worked alone on one or more labs. On days when the students were going into labs, the class would start with Mr. Hayes reminding them of important concepts and procedures with which they were struggling. For example, he might take five to ten minutes in a focus lesson about how to calculate the acidity of a solution using titration, or to describe the purpose of a lab before they began. He reminded them of safety requirements like how to dispose of chemicals properly, how to use the equipment, and always to wear goggles. Then the class started working, and he circulated among groups to check in and help as needed, offering guided instruction. When they had been in the lab groups for a few days already, the focus lesson was very brief, and students got to work almost immediately.

Mr. Hayes also posted each day to Edmodo, reviewing what they had discussed, and the specific page numbers from the text that explained the material further. Worksheets, articles and review sheets were always available online. The Edmodo site made it easy to review what happened each day in Chemistry. Mr. Hayes even posted on days that he was absent, letting students know what they were responsible for, no matter how the substitute might teach the lesson. The Edmodo site provided opportunities for independent practice outside of class.

Literacy strategies in the Chemistry classroom. For the Chemistry class, Mr. Hayes focused his disciplinary literacy reform on improving student writing on technical lab reports. Many hours of my observations revealed how he organized student learning toward this goal. But before we examine the writing element in detail, there were examples of how he tried to improve on students' Chemistry reading as well. One example that he shared during an interview was how he had worked for years to revise the guided reading assignments from the Chemistry textbook.

Mr. Hayes mentioned how students didn't necessarily have to do the reading in order to learn during the labs, although the reading was necessary to do well on the quizzes and tests. Two Chemistry teachers were working hard to get students to read the textbook more closely. At the beginning of the first semester, they assigned a book guide worksheet, which introduced students to the different parts of the Chemistry textbook: chapter introductions, objectives, and review sections; real life application sidebars in each chapter; review problems for each major concept; the glossary at the back; and the index. They had also rewritten the existing guided reading assignments:

> We do have some reading guides that we give them out of the textbook that are more thought-provoking than just skimming and looking for the answers. . . That is one of the things we have been trying to do, in trying to make the readings, the guided readings a little bit more substantial. . . We just changed this worksheet. **Pulled the worksheet out of his desk.** So the first questions were the same, the properties of acids and bases. The next question was similar, What are some of the common uses of industrial acids? And then that was kinda it. There wasn't much more. What we added to it was, Identify what an Arrhenius acid and base

> is. Then we asked them to identify why an acid is a strong acid versus a weak acid. So there was a little bit more thought, interpretation there. And then one of the questions we asked them is, "Why is ammonia considered a weak base?" Well, ammonia's considered a weak base because, and what they had to do, was they had to read this section about what ammonia is, **showing pages of the textbook** but then they also had to go all the way to the end of the section and tie those things together. So we're working on trying to create better reading questions. When I first got here, all of the guided readings that were available were very read-and-fill-in-the-blank. And so we're trying to get better at creating things that force them to do some thinking. And so I can always tell when we didn't change one yet, because then the kids won't whine about it. And then I can tell when we did change one, and they say, "This was really hard!" And then I know I'm doing a good job.

To Mr. Hayes, a Chemistry teacher did a good job when he or she challenged students to think deeply about a problem related to the subject, determine multiple solutions, and articulate those solutions and the logic behind them in the concise manner required in scientific writing. There was a lot of required reading in the class, which was the foundational knowledge that students applied and practiced during labs, and demonstrated mastery of during quizzes and tests.

The readability formula website I had planned to use proved to be almost useless in Chemistry. Worksheets that seemed incredibly complex to me were scored at an elementary school reading level. For example, readabilityformulas.com gave a fourth grade composite rating to the following review worksheet:

> 1. Convert each of the following word equations into a balanced chemical equation.

a. Solid aluminum reacts with aqueous copper (II) fluoride to produce aluminum fluoride solution and solid copper.
b. A solution of sodium chloride and a solution of silver nitrate react to form silver chloride precipitate.

2. Indicate the reaction type in order to predict the products. Complete and balance each of the following chemical equations. If no reaction, indicate with NR. TYPE OF REACTION
   a. $Ba(NO_3)_2$ (aq) + NaOH (aq) →
   b. Al + O_2 →
   c. I_2 + NaBr →
   d. C_3H_6 + O_2 →
   e. Pb + $AgNO_3$ → [NOTE: Pb is +2]
   f. C_8H_{16} + O_2 →
   g. $CuCl_2$ →
   h. Li_2SO_4 (aq) + $Pb(NO_3)_2$ (aq) →

   For the following problems, write a balanced equation in order to calculate the desired unknown.
3. When 0.250 moles of iron react with lead (II) chromate, how many moles of each product are formed? Assume you will make iron (III) chromate.
4. How many grams of silver would be produced in a single replacement reaction if 1.50 mol of copper were placed in a solution of silver nitrate? Assume copper will obtain a +2 charge.
5. Iron reacts with sulfuric acid to form iron (III) sulfate and hydrogen gas. If 12.0 g of iron reacts, how many grams of iron (III) sulfate would be produced?
6. How many moles of nitrogen gas are produced when 36.0 g of NH_4NO_3 decompose in the following reaction? Balanced equation: $2NH_4NO_3$ → 2 N_2 + O_2 + 4 H_2O
7. CO (g) + 2 H_2 (g) → CH_3OH (l)
   a. If 10 g CO react with 2 g H_2, which is the limiting reactant?
   b. How many grams of excess reactant remain unreacted?
8. The Haber process was developed during WWI to produce ammonia gas (NH_3) from nitrogen gas and hydrogen gas according to the equation below. If 7.00g of nitrogen gas reacts with excess hydrogen gas, how many grams of ammonia could be made?
   a. Balanced equation: N_2 (g) + 3 H_2 (g) → 2 NH_3 (g)
   b. In the question above, if the actual yield was 6.00g of NH_3, what was the % yield for the reaction?

I was shocked when the readability results came back at fourth grade complexity. As I looked over the worksheet, I reflected on what must have happened. I believe that the readability formula interpreted the variables as simply letters, and ignored the symbols, subscripts and abbreviations. In Chemistry, letters may stand in as variables, but mostly letters represent

elements from the periodic table, and have a much deeper, content-specific meaning than the readability formula could decipher. We particularly see this when we try to balance equations, and therefore need to know what ionic charge each element has, and how to calculate using the implied charges. In essence, the readability formula missed the mathematics/ science content and procedural knowledge that makes reading Chemistry texts challenging, simply reporting how hard it was to read the words and literal letters, rendering it useless for discussing text complexity on any passage written in the symbolic notations of Chemistry.

In addition to giving student practice writing lab reports, Mr. Hayes had short response questions on his exams. If we think about Mr. Hayes' idea that students who struggle with Math tended to struggle in Chemistry, adding so much writing could also overwhelm students who have a hard time getting their ideas down on paper. But Mr. Hayes had carefully structured his writing prompts so that the students were scaffolded in revealing their acquired knowledge in writing, as we see in the following excerpt.

In late March, I asked and received permission to include two examples of a Chemistry test in my research. Mr. Hayes gave me anonymous examples of a student's test with a high score and one with a low score. The test was entitled "Acid Base Test Short Answer and Essay," and it consisted of four questions: three short answer and one essay. It was the summative activity for a unit on titration, a method for calculating the concentration of a solution. Students had just performed a lab that showed them how to perform titrations. To understand the students' responses, we need to look closely at the third short answer problem and then the essay prompt:

> 3. A student completes a titration of an acid with an unknown concentration. The student pipettes 10.00mL of the acid into an erlynmeyer flask and then titrates it using 0.25 M LiOH. The student starts with 3.68 mL of base and stops at 19.25 mL. Calculate the concentration of the acid. (3 pts)

4. Using the following terms, explain the idea of an acid/base titration on a molecular level. (Explain what the student was doing in problem #3 ***on the molecular level.***) Draw pictures if it helps.
acid neutralization base salt water moles$_{acid}$
end point indicator hyrdonium ions hydroxide ions
pH=7 moles$_{base}$
Circle the terms in your answer. ½ point for the correct use of each term. (6 pts)

From my perspective as a visitor who didn't read the textbook or attend class daily, these directions were baffling. But the students had been working with these terms for weeks, and had done the experiment described in problem three. While some still struggled, many of them were able to answer the prompt.

As a literacy educator, it was clear to me that Mr. Hayes had incorporated considerable scaffolding into the essay prompt. He had included the terms that they should use in their description and prompted them to use visualization as a strategy. He explained what they should do twice, once generally and the second time specifically in reference to problem three. It was clear that students earned the points by using the terms correctly. He also linked the essay and problem three directly to the lab they had just completed. This was a chance for students to take their firsthand experience in class, recognize the Chemistry procedure they performed, and transform their ideas about it into writing. We can see how successful some students were when we read the example of the anonymous student who scored 6/6 points. To simplify typing, I have underlined the circled terms. All parentheticals are presented verbatim:

> When you perform a titration, you are neutralizing an <u>acid</u> and a <u>base.</u> When combined, bases and acids make <u>salt</u> and <u>water</u>. Because water self ionizes, you are left with <u>hydronium ions</u> and <u>hydroxide ions.</u>
>
> To do a titration, you need 3 things: 1 substance with a known volume and 1 with a known concentration and volume. You can figure out the first's concentration

with the $M_AV_A=M_BV_B$ formula. A neutralization can only occur when $moles_{acid}$ = $moles_{base}$ because they require even amounts to produce the hydronium and hydroxide ions. (See reaction below.) To find out when you are at the end point, when $mole_A$ = $mole_B$, you can use an indicator. Indicators turn colors when in contact of an acid or base. We used phenophthylate, (or something similar to that word) which turned pink when in contact with a base. To figure out when the neutralization is complete, slowly add the base and wait until the liquid turns a light pink. This shows the pH=7 and the acid and base have canceled each other out.

Ex. $KOH + HCl \rightarrow H_2O + KCl$

If the moles don't equal each other, this reaction cannot occur throughout and it will not completely ionize.

This student used all of the terms given and his or her own experience in lab to articulate in detail how a titration is performed. He or she even took the risk of adding the technical term for the indicator used in the lab, despite being uncertain of the spelling. Mr. Hayes indicated that this was a good risk by drawing a smiley face in the margin next to the student's attempt. This was a solid example of a student who had internalized Chemistry Discourse to describe this experiment.

To create a contrast, let us look at the student example that scored only 2/6 points:

The student was calculating the concentration of the acid, a strong acid and a strong base the dissociate in water, it results in strong base strong acid neutralization reaction. The titration requires the boret to dispense the strong acid. Once it is contained it will change color marking the end point.

This student only used four of the twelve given terms, and seemed to have difficulty expressing him or herself in grammatically correct writing. Yet even in this example of a low-scoring test, we see the student trying to incorporate some of the language of Chemistry. He or she used the term "dissociate" to describe the behavior of acids and bases, and used "boret" as a synonym for the erlynmeyer flask cited in problem three. While I was not familiar with the word "boret" in relation to Chemistry, I heard Mr. Hayes refer to the flask as such several times in class. The second sentence gave additional information about the procedure of the lab without scoring any points, yet showed some understanding of what he or she had done. Without talking to the individual student, we don't know why he or she didn't try to use more of the words in the writing, which was indicated as the way to earn a higher score. Yet we can see that even the struggling students were internalizing some of the Discourse of Chemistry through the active learning of the labs, and demonstrating their learning through writing.

For some of the kids, Mr. Hayes' class could be tough. Students had to be very active learners. They had to be able to read their Chemistry textbook, write about what they had done on exams and in lab reports, and accurately speak about Chemistry to each other and the teacher. Mr. Hayes and his collaborating teacher, Mr. Wright, had the reputation of making them work harder than did the third Chemistry teacher, Mr. Jackson, who didn't make students problem-solve and figure out answers themselves. One month into the semester, a group of sophomore girls agreed to let me record as they studied for a stoichiometry test from their review packets. While studying, they talked about the different Chemistry teachers as well as how to solve and explain the problems.

> Becky said, "I got that wrong. I put a 6. It's supposed to be a 9. This test is going to be so hard. I'm really worried!"

"Is his tests hard? Did you have him before?" asked Alicia.

Mary responded, "They're kinda hard," as Becky said, "The writing. I mean, like. He does two parts. Same day. One multiple choice, and one doing the problems. He does. I think that the problems part is like easier than the multiple choice." Mary agreed.

Alicia explained that a test for the third Chemistry teacher, Mr. Jackson, "was all multiple choice. It was do the work and then pick the answer."

"Really?" asked Becky. "Oh no. For the writing, you have to write the answer yourself."

Alicia said, "Really?"

Mary added, "If you show your work and stuff, sometimes he'll give you some credit. I think it's easy."

Becky chimed in, "Yeah, the multiple choice is hard, because you have to like think about, about the history behind it, and why we're doing it. And I don't know why we're doing it." The girls laughed. "I don't know."

Becky said, "He says on the tests, you have to take what you've learned, and not just spit it back out. You have to apply it and stuff. And that's hard."

Alicia asked, "Why? What does stoichiometry mean? What are you doing, when you do it?"

Becky agreed, "They're weird, but they're just hard to answer."

Alicia volunteered, "Well, like Joe talks about Mr. Jackson, he seems like he's easier than Mr. Hayes. Y'know, he already gives the balanced equations. That's what I hear. . . He doesn't make us balance it."

Mary said, “Okay, I don’t get how Mr. Hayes and Mr. Wright are in sync, but Mr. Jackson is in his own world.”

Alicia responded, “Yeah, Mr. Jackson never does the same thing as Hayes and Wright, but he always said last semester, ‘I’m just making it easier on you guys. They’re not, they’re making it harder on you.’”

Mary said, “That’s what I heard.”

Becky started, “But I mean, if Jackson is the AP Chem teacher. . .”

“Yeah,” interjected Alicia.

“Then I’ll be like prepared now, cuz this is harder,” finished Becky.

In this comparison of teachers, we see that the sophomore girls, who are the advanced students in the class, appreciate having to think through and understand the Chemistry. While the work is harder in the present, Becky pointed out that it would make further Chemistry learning make more sense. As the conversation continued, Mary pointed out that she needed the advanced Chemistry, either in high school or college, to help her in her goal of studying medicine.

During the conversation, a fourth girl, Rhonda, was muttering to herself, working through problems on the review sheet. Every couple minutes, the recorder picked up her voice in the background: “Oh, this is decomp. . . How many moles not grams, how many moles . . . So it’d just be .50 times 3 divided by 2, .73. Okay. .375 moles. . .That’s 4.5. One mole, that’d be 2. Each is 12, so need to multiply this by 6. Plus 4 is 10.”

In a gap in the three other girls’ conversation, Rhonda asked, “How many grams of silver are produced? I hate it when you figure it out, and then the oxygen’s like an odd number, so you have to double everything!”

"I know!" responded Mary.

Rhonda talked on, "Then to balance this, for number 4, so it would be. **Pause**. Grams of sulfur. **Pause.** Copper. Yes, yes. I'm pretty confident that's the answer. But maybe it's not."

Rhonda continued talking herself through problems as the other girls chatted, "Where's Ag on the periodic table? Ah, it's 2."

"Combustion!"

"And that will make CF **pause**. . . single replacement."

There was a long pause, then Rhonda announced, "Okay, I don't get it. Crap, chemistry will be the death of me!" She tried to work through the problem a few more times on her own, before finally calling Mr. Hayes over for help.

"Yes, ladies?" Mr. Hayes asked.

Rhonda said, "I have a question for number 4. How do you know that you have to convert copper?"

Mr. Hayes checked, "Number 4?"

"Yeah, like I don't get it," said Rhonda.

"What do you mean, convert copper?" the teacher clarified.

Rhonda replied, "Like on the thing." She pointed at her copy of the orange "cheat sheet" for the class, a reference guide with the periodic table, names and formulas of common polyatomic ions, solubility rules, and ways to identify five types of reactions.

Mr. Hayes said, "Yeah, but I'm telling you, 'How many grams of silver will be produced in the single replacement reaction of copper in a solution of silver nitrate?' So I'm telling you that it's a single replacement reaction, right?"

Rhonda agreed, “Yeah, I did that.”

Mr. Hayes continued, “So, but the issue is that it says. Oh, I gave you one point. I guess I don’t understand your question.”

“Well,” Rhonda began, and then stopped.

After a brief silence, Mr. Hayes asked, “What did you want to do? How about that?”

When Rhonda still didn’t respond, he tried again, “Before you looked at this,” indicating the cheat sheet, “what did you want to do?”

Rhonda told him, “I didn’t know which, like if you added copper to silver nitrate or to silver. You know what I’m saying?”

“Yeah, I got it,” he reassured her. “The reason why I chose copper to convert to silver, and not silver nitrate, is because I gave myself the value of 1.5 moles of copper.”

Rhonda replied, “Oh.”

Mr. Hayes continued, “So this pretty much is my given. So that’s what I have to start with. Does that make sense?”

The remainder of the girls’ conversation after Mr. Hayes left their group is available for interested readers to view, in which they talked through some study skills they used, such as reading the textbook and YouTubing how to do the equations (please see Appendix H.) This was an example of a group that was incorporating the language of Chemistry, and they were working hard to learn through a variety of strategies: referring back to the book, homework and reference guides; using outside sources like YouTube; asking each other; voicing their thoughts aloud; talking to each other about the problem-solving; and asking the teacher when they were

stuck. When Mr. Hayes came to help, he used instructional strategies of answering Rhonda's questions with questions of his own, clarifying where she was confused, cuing her to use her cheat sheet as a resource, and directly re-explaining as necessary for her understanding. He was very good at pausing to take stock of whether he understood what she was asking, to be able to help her when she couldn't articulate what she didn't understand. Even though this was just an in-class study group, it was an excellent example of the type of active learning expected of students under disciplinary literacy, and the active teaching it requires.

Using disciplinary literacy as our lens on secondary literacy gives us a broad definition of literacy strategies, including reading, writing, speaking and thinking like an expert in a field does. For Chemistry, Mr. Hayes' literacy focus was on the technical writing found in lab reports, a skill needed by chemists, engineers, and anyone continuing in science classes or as a career. Mr. Hayes and his colleague had honed in on the skills students needed to be able to produce concise writing that was acceptable in the Discourse of science, as Mr. Hayes described in an interview:

> We talk to the students about being very pointed in their arguments. If they are going to write a conclusion, they need to make a statement. They can't say, "I think." They have to be very specific. They have to make a statement and then they have to have supporting data. In my class, that data has to come from their lab observations, from the lab calculations, or it has to come from a combination of the two. So when a kid says, "The answer, the conclusion of this lab is *da-da-da-da-duh-da-duh*," if they haven't supported it with data from the lab, then their conclusion is useless. Over the course of the year, we train them by the first lab that we give them. I basically draw a red X through almost everything that they

do, and force them to do it again. But I kinda use the strategy, where I tear everything apart and then hand it back to them and give them an opportunity to fix them.

He mentioned that the first assignment requiring lab reports was one of the most time-consuming batches of homework for him to correct, with one hundred and twelve students needing feedback. It took him over a week of nonstop, focused correcting to get through them all and get the papers back to students in a timely manner. But he made the effort so that students would understand his expectations for technical science writing.

In addition to including specific, supported statements in their conclusions, Mr. Hayes' students learned how to make observations that were as precise as possible. They needed to write detailed observations, and then apply their chemistry knowledge to explain what they saw during labs using proper terminology. He addressed the need to use specific language during the focus lesson of several classes. For example, in the beginning of a class in early February, Mr. Hayes described how he wanted them to write up the results for a reaction lab they had finished the day before. He had posted the answers to the lab questions to his Edmodo website, and explained that he was not grading based on the right answers, but on how they wrote about the process of getting those answers. Specifically he was looking at how they described the reactions, using technical terms for the states of matter and the elements. As a class, they were going over the answers and responses they had written:

Mainly, I'm looking at your ability to communicate to me what you did in the lab that supported what you predicted for your products to be. What does that mean? In reaction #8, with hydrogen peroxide and potassium iodine, when I wandered around the classroom while you were doing your labs, I noticed some students

had a one-word description of their observations of what they saw happen, like "Yellow," "Bubbles," or "Flares." If you're looking at your lab – hint, get your lab sheets out. **Waited for students to pull out lab sheets.** If you're looking at your labs, you write a short response that makes sense to you when you are looking. Example, it turned yellow and produced bubbles. What happened to the flame?. . . You have to write down words that help me to understand what you observed, that supported that particular reaction.

For the reaction, he explained that the students should have written the expression that he then wrote on the board:

$$H_2O_2 \underset{(aq)}{\overset{KI}{\rightarrow}} H_2O_{(l)} + O_{2(g)}$$

He clarified that the aq stood for aqueous, l for liquid, and g for gas, then continued:

That's what your reaction should have looked like, yes? But your observations need to support what you observed. If I'm telling you that the splint got brighter, you should write something that says, "The presence of oxygen was confirmed because the splint got brighter," or something along those lines. Do you see the difference between this and just one word, "Flares"? You need to communicate to me exactly what happened. What you saw and why the reaction happened. How you knew the products that you wrote down are there.

By writing the equation, and demanding a written description of the same reaction, Mr. Hayes taught the class to navigate between two different forms of Chemistry Discourse, the symbolic notation and precise words that described it. As he explained to the class:

Basically, what I'm trying to get you to do is take the observations that you made, and I'm pretty sure you guys made good observations, but now make them

> something that you guys can communicate with. Because simply writing down what you saw is only half the battle. The other half of the battle is being able to communicate.

Mr. Hayes' work at improving student writing and learning infused his conversation with students on a regular basis. Three weeks into the spring semester, when students in third hour got back a quiz that they didn't do well on, he reminded them that he had told them what they needed to do:

> Very few people in any of my classes have done the things I've asked you to do: done all the homework, redone the review, and then have a conversation with me about what you did to prepare for this. No one in here has done all that, not all of it. Only about 5 people in all my classes have done that. You need all of that done before you can retake the test.

With that, Mr. Hayes walked around the classroom, handing back the quiz. Sierra asked from the back row, "So we're supposed to redo the review?"

"Yeah," the teacher replied, still passing back papers.

"As in do it again?" Sierra asked. Mr. Hayes nodded as he continued moving through the room.

"What's the point of redoing the review if you've already done it?" continued Sierra in a whining tone. "My mom is going to be so mad. She told me explicitly to get help after school for the retake tomorrow. And now he's not going to be here."

Mr. Hayes finished passing out papers and moved back to the front of the room. "I have a staff meeting tonight, and I get in trouble if I don't go. And for the record, you did have over a week to come and get help." He continued reviewing the answers and addressing students'

questions about the homework problems. "On a test, not the quiz today, you will get points for doing this, doing this, and doing this correctly," he said, pointing to different parts of an equation.

> It's not that you're doing this for me. This is what it is. That's how it's solved. It's the correct way to do things. . . The way this worksheet is set up, it's to get you to see that there's a solid that's formed as part of each of these equations, and an aqueous that's formed as part. It doesn't matter what order your products are.

As he reviewed the parts of the equation before the test retake, Mr. Hayes pointed out the parts of the equation that had to be present, not because it was something that he wanted, but because it was part of the conventions of how chemistry operates. As I observed, I witnessed many examples in which Mr. Hayes redirected students back to the main goal of improving how they communicated scientifically in writing.

While students worked independently on reading and preparing for labs, Mr. Hayes walked around the room, offering guided instruction on how to improve their technical writing, and consequently their learning. In one example, Elizabeth had her hand up from the back seat, two rows away from where I sat. Mr. Hayes went to talk with her about the points she was missing on the last lab, telling her that if she was missing the title on the data table, she could just redo the data table and add the title.

"I wrote 'Data table' on it," she protested.

"'Data table' is very vague," Mr. Hayes countered. "What data are you collecting?"

"Mass," Elizabeth replied.

"Mass of what though?" the teacher prompted. "What are you trying to accomplish here? That's what you need to think about. Look over the lab, figure it out."

In this example, he was explicit about what work students had to do, and then left it up to the students to get it done and figure out where they needed help. When students had questions, like Elizabeth, he answered the question but did not back down on the task he set before her. Mr. Hayes regularly offered just the amount of scaffolding he thought students needed, and then gave them time and space to see if they could figure it out on their own. Sometimes, the level of scaffolding was not sufficient, and then he moved back to offer further assistance.

During my semester of observing Mr. Hayes, I watched the classes work through six different labs. To illustrate some challenges of disciplinary literacy, I've chosen examples from the two labs that the students struggled with most, problem-solving labs that made them figure out what was happening with limited support from the teacher. They had to rely on their reading from the textbook, outside research, their lab partners, and the directions. Mr. Hayes rarely offered direct help, instead redirecting their efforts with questions and cues. In the lab groups, students discussed how to record their observations to meet Mr. Hayes' expectations for specific, concise technical writing. Out of hours of taping lab groups during class, I selected an example from each lab to represent students using the Discourse of Chemistry, or struggling to do so. All of these students had turned in signed permission slips to participate in the research. The first group was in seventh hour and worked through the lab entitled Identifying Unknown Solutions Lab, which Mr. Hayes described as the problem-solving lab during our interviews. To help frame the group work, I also included a student's final Unknown Solutions Lab report to demonstrate the independent writing phase of the problem-solving lab. The second group was in third hour and worked through the lab entitled Qualitative Analysis and Flow Chart Development Lab. To aid the reader's understanding of the students' responsibilities, I included

part of the focus lesson leading into the second lab and selections from four students' struggles on the independent part of it.

Identifying Unknown Solutions Lab. Mr. Hayes began the lab with a focus lesson on the day before they started, passing out the lab sheets and reviewing the directions with the classes. In the Identifying Unknown Solutions Lab, students had to work from formulas they had written to deduce which mysterious solution was in each of nine vials set up by the teacher. The lab directions began:

> **Purpose:** In this lab, you will be given a set of bottles labeled "A" through "I." You are to use your knowledge of double replacement reactions and the formation of precipitates along with observations in lab to deductively identify each solution.

Interested readers may view the entire lab directions in Appendix I.

For the first step, students had thirty-six formula equations to write out as homework for the next day. They needed to write out the formula equations for all of the possible reactions that they might see, and to record the ionic and net ionic equations on the lines below. After the lab, I asked Mr. Hayes for an anonymous high quality student example, which he provided. I share that here to give the reader a visual representation of the cognitive work students were required to do before beginning the physical lab work. Students started with only the written description of each compound, and had to supply the charges and balance the equation in three different ways for each combination. We can see an example of all three equations from the student's lab report. For the combination of silver nitrate and calcium chloride, the student had written:

$$2AgNo_{3(aq)} + CaCl_{2(aq)} \rightarrow 2AgCl_{(s)} + Ca(NO_3)_{2(aq)}$$

$$2\overset{+1}{A}g + 2\overset{-1}{N}O_3 + \overset{+2}{C}a + \overset{-1}{C}l \rightarrow 2\overset{+1}{A}g\overset{-1}{C}l_{(s)} + \overset{+1}{C}a + \overset{-1}{N}O_3$$

$$2\overset{+1}{Ag} + \overset{-1}{Cl} \rightarrow \overset{+1}{Ag}\overset{-1}{Cl}_{(s)}$$

In the second equation, the student showed that the spectator ions of nitrate (NO_3) and calcium (Ca) were removed from the ionic reaction by crossing them out in the equation, as Mr. Hayes had directed. The third equation showed what was left when the spectator ions were omitted. In total, the student had three full pages of reactions written. In this example we can see that part of the work of writing the formulas included figuring out which symbols went with the written descriptions of the solutions, what charge each ion in the solution would carry, and what state of matter each would be in, before and after the reaction. All this was in addition to the computation of balancing the equations, making this assignment a sophisticated example of chemistry literacy.

After he passed out the lab sheets, Mr. Hayes described the procedures students should follow:

> In the lab, your job will be to figure out what is in the nine bottles. Most of them are going to look the same. You'll take the first one on the list and combine it one at a time with all the others. Your job is to make very, very specific, good observations about what happens when you put, when you mix those two solutions together in each of those wells. Does that make sense so far? Good observations are not "precipitate forms." That's not a good observation.

Mr. Hayes went down the list of solutions, telling them each combination they would make and observe, reminding them that they only had to mix each combination once. "Every time you make a solution, you have to use your knowledge of double replacements and precipitates to figure out what's happening." He pointed out that the water and gas produced would be difficult to see. He reminded them that they would have to make good observations of

how A reacted with B, then with C, all the way through I. Students would use their observations to figure out which compound was in each bottle.

Some students complained that writing out the equations was too much work. The teacher pointed out that they only had to write each combination once, but this didn't seem to mollify them. Mr. Hayes elaborated:

> When you turn in your lab report, you need to turn in all thirty-six reactions. I don't want you to just turn in the words. I want the symbols. I want the formula reactions. Your homework for tomorrow is to have the formula equations for all thirty-six. If you don't have those done when you walk in tomorrow, you won't be able to start the lab.

Mr. Hayes explained explicitly what form their chemistry writing must take. As we can see in the rest of the directions in Appendix I, he had modeled each step of the required writing, and even provided sentence frames to help students understand his expectations. In the class, he read through the whole lab directions and answered students' questions about it. For example, Kevin asked, "Is this in a paragraph or bulleted?"

Mr. Hayes answered:

> Not paragraphs. I want numbers. Step 1, I did this. Step 2… In the analysis section, you are going to tell me how you knew that bottle A was (blank). Just telling me what it is isn't good enough. You need to support that statement. Don't say, "I think," "I guess." Say bottle A is (blank), and here's how I know this. For the last one, the process of elimination makes sense. See how your analysis is worth 8 points, but your conclusion is only worth 2 points?

Mr. Hayes read the bullet point describing how they would write the conclusion, then the last bullet point, describing the pre-writing of the thirty-six formulas. As he was describing how they had to write the formulas, Mike interrupted to ask, "Do you need to balance them?"

"Absolutely," the teacher told him. Then he continued, "The only part that does not need to be typed is the double replacement formulas."

Sierra asked, "What happens if we guess one of the solutions wrong?"

"That's where the points in the analysis fit in," Mr. Hayes responded.

This section of transcript shows how carefully structured Mr. Hayes' problem-solving lab was, and the amount of teacher planning required to scaffold students into active learning in the lab. By taking time in class to analyze the directions, Mr. Hayes modeled close reading of a technical document, while also making his expectations for the pre-lab work explicit. He interacted with the students about any questions or confusions they might have and addressed each concern individually. While this all took up precious class time, it was necessary to give the students the foundation for the collaborative and independent work that they were about to embark upon.

If we analyze this lab unit through the Gradual Release of Responsibility model, we see that Mr. Hayes began with the focus lesson, then jumped to independent review from the last units on writing and balancing equations. The quality of their review work would support or detract from how well their labs worked. The next day the unit would cycle back into collaborative work, with guided instruction as Mr. Hayes made his rounds around the room to check for student understanding. Eventually, they would progress into independent work, as students demonstrated their learning through individual lab reports and on related test questions.

The next day, after the bell rang, Mr. Hayes reminded students that if they didn't have the thirty-six reactions written out, they wouldn't be able to start lab. "I'll tell you this much: if you did them correctly, you should have come up with 19 no reactions." In his quick homework check, he walked around with his clipboard, checking that the work was done and correct. Often he pointed out the same error on different students' sheets, prompting them to check rule #7, offering individual guided instruction as needed. Rule 7 was a reference to the solubility rules on the orange cheat sheet, where #7 read:

> Treat all acids as soluble with two special exceptions below:
>
> H_2CO_3 decomposes into CO_2 and H_2O
>
> H_2SO_3 decomposes into SO_2 and H_2O

He told students if they had too many "no reactions" or not enough. As he walked around, students seemed focused, pouring over their reactions, making corrections and discussing with classmates what they did wrong. Many students had their orange sheets out and were looking back and forth from the reference sheet to their homework. It seems like most students understood that they wouldn't be able to do the lab well if they hadn't completed the homework correctly.

When he finished, Mr. Hayes gave some last instructions about how to proceed in the lab, including making note of which number tray they each had and reminding them to clean their equipment thoroughly to avoid cross-contamination. He reminded them of the importance of recording detailed observations:

> Do not, do not, do not create a reaction, say there's a precipitate, and that's your only observation. Make very specific observations about the precipitates that form. Use texture, color, descriptive adjectives, compare it to something you're

familiar with. Don't just write, "Precipitate forms." Be very specific about what you see. Okay. Goggles, go into lab please.

Mr. Hayes originally had set up the problem-solving lab with a lot of scaffolding for students. They were going to start the lab with a traditional method of doing chemistry like a series of recipes, following step-by-step directions. Then they would use their recorded observations from the series of steps to figure out the problem-solving step. But Mr. Hayes realized that this was too much scaffolding, if he wanted students to struggle and successfully problem-solve. As he explained in class, real life problems like those encountered in the workplace require more independent and creative problem-solving than his lab procedure originally required. This was his students' chance to grapple with the problem of figuring out which element was in which test tube.

During this lab, I recorded a group that offered an example of how students talked to each other during the experiment. The recorded group consisted of five boys, with one who did most of the talking. That was Daniel, a Caucasian boy who represented a unique frustration for Mr. Hayes and other teachers. Daniel was intensely interested in Science and pretty good at it. As we see below, he was amazing at fulfilling the expectation that students should use vivid descriptions to capture the results of the experiments, but was not skilled at working with a group. He was an A student to whom other students turned for help. When I asked him about his future, he planned to go to college to study Physics. But Daniel had a tendency to interrupt the teacher and stall classes with off-topic questions and comments. Mr. Hayes mentioned that another teacher observed that Daniel didn't seem to understand the social conventions of letting the teacher teach and waiting to ask off-topic questions until the end of class. It seemed that while Daniel had internalized the Discourse of science, he either didn't understand or didn't

accept the Discourse of schooling. In the below example of Daniel, we see how a student may internalize and demonstrate the Discourse of Chemistry, but perhaps at the expense of productive group work for his peers. That is, Daniel did most of the work himself in this example, and therefore experienced the learning, while most of his group sat by idly.

While Daniel did most of the talking, the recorder caught occasional contributions from Kapil, the Asian Indian boy in the class, and three Caucasian boys, Ed, Thomas and Austin. I'd like to draw the reader's attention particularly to Kapil's contributions, in which he actively tried to engage the other students in collaboration, in contrast to Daniel's tendency to do all the work himself. When group members had questions or needed clarifications, it was Kapil who answered them. While Daniel demonstrated the Discourse of an individual scientist at work, Kapil represented the Discourse of a scientist working with a team.

"We'll do A first," Daniel declared.

"A-B," said Ed.

"What's our lab called again?" asked Austin. "What's our tray?" The reader may remember that clarification is one of the strategies under elaboration. In these questions, Austin was clarifying the basic details needed to label their results appropriately.

"Group 6," answered Kapil as Daniel squeezed drops into the well plate.

After a minute of watching the well plate, Kapil asked, "Do you guys think this is a precipitate?" A couple of boys answered, "Yeah," and "It's like a light blue." Notice that Kapil tried to draw the whole group into thinking about the experiment, working as a facilitator of everyone's learning.

Ed says, "It's blue."

"Light blue," agreed Daniel. The boys agreed on light blue. Daniel continued, "Light blue precipitate forms. And it's like. I'm trying to think of a word for this. Jelly in a way. Er no. To the bottom, right. It's on the bottom. It's, it's."

"Heavier," offered Austin.

"Not heavier," corrected Daniel, disregarding Austin's contribution. "It's like cloudy and like, bubbly."

Kapil added, "Yeah, it's kinda bubbly."

"Cloudy and you can see parts. Parts look kind dry. Not dry, but there's a word for it," Daniel puzzled through the description.

Thomas supplied the word, "Particles," while Ed observed, "Looks like jelly."

"Yeah, there's a fancy way, I know what you mean," Thomas mused.

"Yeah, grainy," said Kapil. "Cuz there's particles there."

"It's like grainy," agreed Daniel. At this point of the experiment, all five boys were participating. But Daniel only acknowledged Kapil's observations, even when Kapil expanded on Thomas' comment about particles. He continued, "Now let's do A-C. Is there anything else we can say?"

"Not really," said Austin. "It didn't really do anything else."

"This is C," announced Daniel as he mixed A and C. "Oh wait, bubbles formed. That means CO_2 formed. Bubbles formed, on the bottom, possible gas. We can't guarantee anything, but when we do it and we see that, then we'll know what's what. Is that all we're writing?"

"Bubbles formed, possibly showing a gas of CO_2," said Kapil slowly as he wrote down the observation. Daniel mixed the next test tube, and was the only one to comment on its lack of reaction.

"Now it's E," directed Daniel. "Immediately turns cloudy white. Cloudy. Yeah, there is a precipitate. Precipitate forms, milkish."

"Yeah, milkish," said Kapil. "Let's just move it around."

"Milkish and it's kinda grainy again," observed Daniel.

"Milkish," repeated Thomas. This was the only comment from the three other boys during the last two combinations. By this point, they had begun to withdraw and talk amongst themselves, letting Daniel and Kapil do the work.

"So there's only seventeen reactions," said Daniel.

"What do you mean?" asked Kapil.

"There's nineteen no reactions," explained Daniel. He had subtracted the nineteen no reactions from the total thirty-six combinations they needed to make.

"Yes, yes, you're right," agreed Kapil. "Precipitate formed similar to milk and."

"Yeah, that's what I put," interrupted Daniel. "Cuz it's usually grains. You look at the edges. More than just putting 'precipitate forms.' What else are we going to put?" Here, Daniel indirectly reminded his group that they needed to be more descriptive than simply recording that a precipitate formed.

Ed answered, "We said, 'White.' We said the shapes. I mean, I'm not going to touch it, not going to taste it!" Notice that Ed extended the sensory descriptions of the lab to include taste and touch. Even though he was not as active in the lab as Daniel and Kapil, his contributions still showed that he was using Chemistry Discourse as described by his teacher.

"This is A-E," said Austin, writing in his chart. "Precipitate forms. Is there anything in there?" Here Austin shared that he had written "precipitate forms," despite multiple warnings by Mr. Hayes and Daniel's comment that the phrase would not give enough information for the lab.

In this instance, Austin showed that he had yet not grasped the manner in which scientists speak and describe their work in writing.

"Yeah, precipitate forms, white precipitate forms," said Kapil, elaborating on Austin's truncated answer.

Daniel mixed the next test tubes. "It's not as yellowish as the former one. It's more of a pure white. Pure white, yeah, pure white. But put like, kinda yellow, on A-D, kinda similar to. Slightly yellow, like milk. Yeah, because there's definitely a difference in the color."

"Isn't niacin like green?" asked Thomas. This was an interesting statement by Thomas, which went unacknowledged by his group. The class hadn't learned the colors of elements. If he thought that niacin was green, it could have been that he had seen someone take it in pill form or had looked it up. We can speculate that he may have combined his out-of-school knowledge with his class work, drawing on life experience to elaborate on the problem-solving lab, although we can't know without more information.

But by this point of the experiment, Daniel had fallen into a monologue. Looking at test tube A-E, he thought out loud:

> Stays about the same. The first one seems more watery to me. This one's whiskey-er. More grains form on the bottom. The first one's watery-er. This is solid at the bottom. Sediment formed in the A-E. Okay. And then the liquid's kinda like, see-through-ish white. Okay. They're all like. I'm trying to make them words.

Going on to A-F, Daniel said, "It's more like, darker white on the bottom than as it goes up. Yeah. If you guys want to do this, you can. I'm just doing it because." Here Daniel acknowledged that he was no longer working with the group, and was simply working through

the experiment alone in their company. By this point, we have seen that Daniel disregarded over half of the contributions made by his group. Each of his four group members had made several comments about the lab. He listened to Kapil twice, to Ed once and to Austin once, acknowledging only four of thirteen comments made or questions asked. Daniel ignored all four of Thomas' contributions completely. At this point, it was no surprise that most of the group had pulled back and allowed Daniel to work by himself.

Ed said, "You can do it."

"Just wanted to make sure," replied Daniel.

"You look like you're having fun," said Austin.

Daniel agreed, "I enjoy putting stuff in other stuff. No reaction. Stayed the same." The other boys repeated as they noted the observation in their charts: "No reaction," "Clear, no reaction," and "Clear solution, clear liquid."

"When we make the table, it'll be obvious what's going on," declared Daniel. "Clear solution, stays the same, means no reaction."

"A-G," began Daniel, but Austin interrupted. "Wait, how do we make. I don't get this."

"What do you mean?" asked Kapil.

"How do you know which one it is?" asked Austin.

Kapil explained, "No, we haven't done any of the others to know. We're going to compare these observations to other observations to figure it out." Again, it was Kapil who offered clarifications to a peer's question about the lab work, modeling excellent collaborative skills as related to scientific inquiry. His acknowledgement of Austin's questions was more likely to keep Austin involved than Daniel's tendency to take over all the work himself.

"Oh, gotcha," said Austin.

Daniel mixed the next two combinations, commenting on the second one, "Okay, A-H. Looks like bluish white. Yeah, bluish white, whiskey precipitate forms."

"Bluish. How do you spell 'bluish'?" asked Thomas. Again he was ignored.

"Would you say cloudy?" asked Daniel.

"Yeah," answered Kapil.

"So what'd you put? Whiskey, that's what I was using," said Daniel. "Cuz it's more like jello, or jelly. Jelly-ish, I don't know."

"Did you put jelly-ish?" asked Kapil.

"Yeah," said Daniel. "Looks like soap. Soapish. You guys are getting this, right?" he asked the two boys who hadn't spoken for a while. They agreed that they were.

"A-I," said Daniel. "Whoa. It's like way more cloudy. It's like very dissipated, you know what I mean? It's like, okay, white. White precipitate forms. But it's more like scattered. Yeah. Scattered and like crystal clumps."

"Is it crystally? Scattered and what?" asked Ed.

"I wrote, 'Crystal clumps,'" clarified Daniel.

"Crystal clumps?" asked Thomas.

"I don't know if it is, I'm just using it like. This is the way I'll figure it out when we do the next one." At this point, the group had finished the A bottle combinations, ran out of class time, and began to clean up.

In this last exchange, Daniel started to engage Ed and Thomas in a discussion that could help them to understand the lab, like Kapil had done throughout the group project. He explained that his choice of words, "Crystal clumps," for the description would help him to figure out which solutions they were observing in future steps of the lab. Instances like this, in which

group members explain ideas to each other, represent a stronger collaborative learning phase within disciplinary literacy than the previous examples of Daniel deciding on descriptions alone and his group members copying them. But notice that Daniel still expected to do the problem-solving alone, with "I'll figure it out" in the next step, instead of "we will."

In this group example, we saw several examples of the students thinking through how to describe their reactions in ways that would help them problem-solve the lab like a chemist would. At the beginning of the lab, all five boys talked about how to describe the reactions they saw based on sensory descriptions of the precipitates, connections to outside-of-school knowledge, and clarifying questions. It was clear that Daniel and Kapil were thinking through the challenge of describing the reactions well enough to help them identify the mysterious solutions. Daniel reminded group members a few times that they needed a good description of precipitates to help them solve the lab. The two leaders had a clear purpose for the lab in mind the entire time they were working.

Of the other three boys, Ed occasionally problem-solved with Daniel and Kapil. He seemed to get drawn into the lab work for a while, and then dropped out again. Thomas and Austin weren't very engaged in the work, especially after Daniel ignored most contributions they made. Even with Kapil answering their questions and addressing their comments, we saw Ed, Thomas and Austin slowly withdraw from the group project.

We can see some results of the disintegration of effective group work when Austin wrote "Precipitate forms" for A-E, after both Mr. Hayes and Daniel said that they needed to write more than that. He announced his answer, and no one in the group corrected him except Kapil, who suggested adding "white." After students handed in their individual lab reports and got corrections back from Mr. Hayes, I heard Austin and Thomas trying to figure out what the right

answers should have been. It was a day that Daniel was absent, and Austin admitted that he had just copied what Daniel had.

In this group example, we see that even in groups where some members actively practice disciplinary literacy, other students may shirk the chore of learning and focus on getting right answers as easily as possible. Conversely, a student who is advanced in the Discourse of Chemistry but weak in social skills may steer the group project into being independent work while group members copy, cheating the other students out of the opportunity to learn. This implies the need to examine how group work is organized within disciplinary literacy, preferably in ways that hold both individuals and the whole group accountable (e.g., see Fisher, Frey, & Everlove, 2009). It seems that if we wish students to use the Discourse of their field, especially speaking to one another, we need to include instruction on how to speak Science (or English, History, etc.) effectively.

In class the next day, Mr. Hayes spent some time on guided instruction, prompting students to think through their observations, and encouraging them to use outside resources, such as Internet sources, to help them determine the identity of some of the bottles. Near the end of the class, I recorded a conversation with Mr. Hayes about the lab. I asked him to clarify how the students could figure out which bottle was which.

"With this lab, I'm amazed," I said. "How do they know when it's a bluish, whiskey-ish, soapy-ish observation?" I asked, thinking of Daniel's group. He smiled and explained,

> So what they did is, when they get the lab, they mixed the things together and they had to write their own observations. So when they wrote their observations, I told them they had to be as specific as they possibly could. If they needed to compare it to something in their real-world life, by all means, go ahead.

His voice dropped and he continued quietly,

> Some of the brighter kids [sic] would just have to write "precipitate" or "no precipitate" and call it a day. But most of these kids need to know. They need to have something more, yeah, concrete I guess. . .But it gets tricky because there are instances where there is more than one set that has three no-reactions. So that's where it gets a little bit tricky. They need to use some deductive reasoning skills to figure that out.

This explanation helped me quite a bit, to understand that students didn't necessarily know which no-reaction combination each formula represented. Mr. Hayes explained that in the past, the Chemistry department had offered advanced students the opportunity to figure out exactly that, through reference to the department's Handbook of Chemistry and Physics. But the activity had been too challenging for most of the advanced students and was not used in regular classes.

It was interesting in this discussion that Mr. Hayes volunteered information indirectly about how he would scaffold the assignment for advanced students, if they were not adequately challenged by the original lab. He never used the terms "differentiation" or "scaffolding," but those were the concepts he described.

At that moment, a student came up with her written analysis, asking the teacher to read it. Mr. Hayes did, and told her, "That's what I'm talking about. That's the smart writing that I think you're capable of."

When the student returned to her desk, I asked, "She brought up something else?"

He said:

She wrote the right answer, but I know she's capable of writing more than what she wrote. Not that it doesn't mean that another child in this class wouldn't have written the exact same thing, and I would have accepted it. Yes. But she's a sophomore, so she's a tenth grader, so she's supposed to be advanced for her grade.

I was surprised at this, because during one of our interviews, Mr. Hayes questioned whether or not differentiation was fair to students who did the regular work. "So you do some differentiation of the product that you're accepting?" I asked.

He showed me the rubric for the experiment, explaining:

What they write doesn't really matter to me. As long as it's coherent, and complete sentences and some formal writing. But like in her case, she's a really bright kid. And I don't want her to turn in garbage. Now, a kid who's struggling in this class, if they turned in what she turned in the first time, that's be great. They'd get the full eight points if they had them all right. But if a kid who is mediocre at best, or is in the middle of the pack, I might, if they came and showed it to me, I might say, "Hey, this is what you should have written." Like, a kid who's just been struggling the whole entire year, but they got the concept down. So there's a lot of grey area in those eight points. Will I take off, like if she would have turned it in the way that she first wrote it? No, I would have given her the full credit, because she did what I asked her to do. But on the other hand, I don't want her to work down. And she wouldn't. She would have been unhappy with that. I think that she would have made revisions eventually. So

there's kids that are going to be taking a science class for the rest of their lives, and she's one of them. That helps, too.

From this interaction with Mr. Hayes, it seemed like he differentiated by the quality of product he would accept from the advanced sophomore students, without calling it that. His differentiation was based on his personal knowledge of what students seemed capable of doing, and his professional goal of acknowledging their learning, while pushing individuals to stretch their abilities. As always, we see that he pushed students based on his expectations of their future college and career prospects.

To study how students moved into the independent phase of the problem-solving lab, we will glance at selections from a student's final lab report, entitled "What's My Identity?" Mr. Hayes had marked 25/25 points on the top of the first page. When I asked for an example, the teacher explained that this example was from a junior female student who struggled but tried very hard in the class. The report was concise, with three pages for the report, and then the three pages of the replacement reaction formulas. In the report, each section not only had a heading, but was printed in a different color, making the sections easy to distinguish from one another. It was well-organized, thoughtful, and reflected the conventions of technical writing that Mr. Hayes had taught the class.

In the purpose statement, it sounded like the student had paraphrased the original purpose statement from the lab directions, and expanded it:

> For the past semester in Chemistry, you have acquired a set of skills on writing chemical equations, predicting the products and many other skills that will help you in this lab. Although, this lab will be testing you on whether or not you can apply these learned skills in a real Chemistry setting. You will be given nine

unknown bottles of chemicals labeled "A" through "I". And through reacting two of the reactants at a time you are asked to find the identity of the unknown chemicals in the bottles.

She had included the disciplinary literacy element of learning that mimics the work of professionals "in a real Chemistry setting." She also had written about applying the practical Chemistry skills they had learned of writing equations and predicting products, and referred to other skills she didn't list.

Her Materials section was limited to the spot plate, bottles of solutions, and a stirring rod. Her Step-by-Step Procedure section consisted of only four steps:

1. Make sure always to put goggles on in lab!
2. Mix two of the solutions at a time in the spot container until you have mixed all the possible solutions together. (hint: there should be 36)
3. Each time you mix two solutions make observations about the chemical reaction
4. Clean up at the end of the lab!

It's interesting to note that in step 2, this student emulated how teachers include hints as written scaffolding. While not technically part of the Discourse of Chemistry, it clearly fits the Discourse of schooling. We can see that there was something that she could have added to improve this section: she didn't have anything about using the observations from mixing the solutions to determine the identities of the bottles. Yet she had followed Mr. Hayes' directions, and had enough steps to indicate that she knew what she had done in the lab and why. Mr. Hayes gave her full credit for every step. As a junior, she may have been one of the struggling students that Mr. Hayes was concerned about in regard to technical writing. He may have

differentiated on the level of writing he allowed from her, in respect to her demonstrated growth in technical writing.

Her next section was the data table, entitled, "Observations Made in Lab." In a chart showing each combination, she had short descriptions of the observed reactions: White, Milky precipitate formed; No reaction; Yellow and Green Precipitate formed; Bubbles – gas forms; Blue and Green Precipitate formed; White, Powdery Precipitate formed. By Mr. Hayes' judgment, she had enough details that she was able to correctly chart out which bottle was which.

Her Analysis section followed the sentence frame given by Mr. Hayes in the directions: "I determined that Bottle A is the _____ because. . ." She had nine bullet points, one per bottle. Selections of these read:

- I determined bottle A to be $BaCl_2$ solution because $BaCl_2$ is the only solution that ended up having 4 no reactions. In lab for the unknown bottle of solution A it made 4 no reactions, therefore making it $BaCl_2$.
- I determined bottle B to be HCl because it first [sic] it had 5 no reactions, but some other solutions had that, so from there I looked to the gas producing reactions. It made a gas with another solution, and was the only one that had 5 no reactions that made a gas. Therefore, telling me that it was HCl.

In her bulleted analyses, the student had two different patterns to her explanations. The first pattern followed the bullet point for bottle A above, when the number of no-reactions matched only one bottle during the lab, and the explanation was two sentences long. The first sentence described what she saw on her written-out replacement reaction formulas. The second sentence confirmed that she observed the same number of no-reactions during lab.

The second pattern was more interesting, as illustrated in the bullet point for bottle B. Sometimes there was more than one possible answer for the number of no-reactions, so the student shared her problem-solving process about other observations she made and conclusions she drew. For bottle B, she observed that gases formed. For bottle D, she noted that it had six no-reactions and also made a gas, which only described NaBr. She noted that bottle F had to be $CuSO_4$ because "$CuSO_4$ is blue and solution F was the blue solution in lab therefore making it $CuSO_4$." While we don't know how she knew $CuSO_4$ was blue from her write-up, it was possible that she did some outside research to figure it out, as suggested by Mr. Hayes. Lastly, there were hints of her thinking process about whether something additional might be needed to explain her answer for bottle G: "I determined bottle G to be $CaCl_2$ because it had 5 no reactions. When I did the lab it was the only one that had 5 no reactions and didn't make anything special like a gas." Here, she added the lack of observation of a gas forming, providing evidence to support her decision-making process.

The student's conclusion was very brief, as per the directions, telling which number tray she had and listing the identities of the nine bottles. In the six pages of her lab report, she demonstrated how Mr. Hayes' students worked through the lab to use the procedures they had learned to first create knowledge, and then to apply their new knowledge deductively to solve a mystery that could be encountered in a real chemistry lab. Through the above examples, we see how Mr. Hayes' students synthesized all of the knowledge and training they had learned and successfully used scientific ways of thinking to problem-solve. Even students who needed more time during class or after school were able to solve the labs eventually and successfully demonstrate the Discourse of chemists in their speech and writing. The Unknown Solutions Lab challenged students to go beyond what they had been told by their teacher or read in their

textbooks, to apply acquired knowledge to a new situation in groups. Some of their success during this lab depended upon their existing skills with collaboration. The next lab built upon their problem-solving experience to challenge students further.

Qualitative Analysis and Development of Flow Chart Lab. The second challenging lab that I share here was the Qualitative Analysis and Development of Flow Chart Lab, which Mr. Hayes referred to as the flow chart lab. To give the reader a sufficient overview of the flowchart lab, I present examples from a focus lesson, collaborative work of one lab group, guided instruction, and the independent work that served as the summative assessment for the unit.

The classes were assigned the flowchart lab immediately after the Unknown Solutions Lab. A big difference in the two labs was that this lab began as a collaborative effort, but ended as an individual responsibility, whereas students worked in groups throughout the Unknown Solutions Lab. For the second lab, students had to develop a flowchart of the reactions they saw when they collaboratively conducted a series of tests on three ions: silver, mercury and lead. Then they were each given an unlabeled vial that might contain one of the ions, a combination of two, or all three. Individual students had to use their flowcharts to go through the lab process and test for each ion. Then they came up to the teacher to tell him which ions were present in their test tubes. When they had guessed right, they were finished with that part of the lab and could work on the individual write-up. If they guessed wrong, they had to go back into lab and retest. Through the Gradual Release of Responsibility model, we see that this lab forced students to take great responsibility for their individual learning and problem-solving.

Mr. Hayes began with a focus lesson about the flowchart lab directions. I share a portion of it here to present how he prepared students by analyzing the directions closely aloud, demonstrating any new procedures or equipment they would be using, and using humor and

cultural data sets (Lee, 2007) from the students' lives to help them to remember and understand the procedures they were expected to perform.

As the teacher passed out the lab directions, the students groaned. "What is this? What is this now?" complained Rebecca. "What, another lab? This is like murder."

Other students complained about doing another lab right away, but Mr. Hayes ignored them and moved to the front of the room. Before he could begin, Stuart asked, "But there's no lab write-up, right?"

Mr. Hayes responded, "False. But this is a different type of lab report. This has got to be typed again. But there's a part that you can group type, and a part that you have to individually type. . . . I tried to make it a little bit easier, in terms of typing everything up." We see that Mr. Hayes balanced the increased individual responsibility of thinking during the lab with decreased requirements for technical writing. This may be viewed as an example of the day-to-day adjustments teachers make as they proceed through units with individual students. He used the previous lab work as a formative assessment to judge how much challenge would be appropriate for the next lab.

Mr. Hayes explained the procedure of the lab, reading the directions to them and clarifying potentially confusing steps. In the purpose section of the directions, students learned that they would "develop a method of separating and identifying the presence of each ion." The background section explained that "the compounds are originally nitrate because ALL nitrates are soluble," repeating one of the solubility rules from the orange cheat sheet. The directions continued,

Determine the properties of the three metal ions by combining them with various solutions. Design a flowchart that would allow us to isolate and identify the presence of individual ions.

Procedure: Do all reactions in **SMALL** test tubes.

Test 1

1. Place **10 drops** of EACH metal nitrate ($AgNO_3$, $Hg_2(NO_3)_2$, and $Pb(NO_3)_2$) into separate test tubes. In a fourth test tube, mix **five drops** of EACH nitrate solution.
2. Add **10 drops** of K_2CrO_4 solution to all four test tubes. ***Observe and record.***
3. *Dump all test tubes into WASTE BEAKER. Clean out the test tubes.*

There were two more tests described under procedures, and then a goal section:

Your Goal: From the data that you collected, you are to use the discrepancies in the behavior of each metal ion to develop a method that would allow you to separate and identify the presence of each metal. Focus on the differences in behavior. You will create a flowchart that you will use to assess the identity of an unknown solution. This solution could contain any combination of the three metallic ions.

There are a few noteworthy disciplinary literacy elements in this selection of the lab directions. First, it was important that Mr. Hayes took the time to read it aloud to the class. That guaranteed that every student present had had the opportunity to hear the directions at least once, even if he or she had difficulty reading or chose not to reread directions independently. We see that the language could be difficult to understand, between the chemical formulas and the discipline-specific vocabulary such as “nitrates,” “ions,” and “discrepancies.” But more

importantly, by examining the first three steps, we can see some of Mr. Hayes' planning on how to help students pick out the important information. He used different font styles, such as bolding, underlining and italics, to pull students' attention to important steps in a complicated procedure. He explicitly indicated the purpose of the experiment with the bolded section entitled "Your Goal." As with much of Mr. Hayes' curriculum, the lab sheet demonstrated a high level of teacher consideration about how to enable students to attain the highest level of independent learning possible.

Mr. Hayes had some additional information for the students about Test one. In the first step, he described the mixture of all three nitrate solutions as "a metallic ionic combo platter."

"What?" asked Michael.

Mr. Hayes explained that combining all of them was like the combo platters that someone might get at a Chinese or Japanese restaurant at the local mall, relating the new Chemistry information to something familiar to students. Without giving the students time to get off-topic, he reviewed what went into each test tube.

As Mr. Hayes demonstrated and explained the lab procedure, he also was reviewing information from one of their most important resources, rule #2 from the orange cheat sheet that explained how elements react with one another. He explicitly explained how this resource would help them to understand the flowchart lab. He continued reviewing what would go into each test tube, then paused at step two of Test one. "Now wait. Look at the color of the potassium chloride. What color is it?"

"Yellow," chorused the students.

Mr. Hayes repeated, "Yellow. Some might say it looks like urine, which it's not. Well, it might be, I don't know."

Brittany, who often didn't pay attention in class, yelled, "You peed in it!"

The teacher teased that he hadn't, that he had peed in the larger container and then poured it in. His inclusion of humor seemed to regain the attention of some students whose attention had drifted away during the long focus lesson. A few students made further comments about the urine color, but Mr. Hayes brought them back on topic.

> So the point is, when you do observations about this, ladies and gentlemen, you have to make sure that you understand the difference between changing this color and an actual precipitate forming. Does that make sense? Because if you do the reaction and something happens, something happens, something happens, but if one of those things is "appears to look this color," then nothing happened. If it's clear and looks this color, **held up the potassium chromate** then nothing happened.

Mr. Hayes went through the set of six directions for Test two, saying that this was where things might get confusing. In both hours, at this point Mr. Hayes told them to get their highlighters out. Most of the students got out their highlighters and started marking the lab directions as he continued explaining. He showed them how to use the centrifuge.

"Wow, that's cool," said Austin.

"Yeah, this is like old CSI stuff, not the new show, the old show," Mr. Hayes agreed. He demonstrated the centrifuge in motion for a few minutes. Later on, I asked him if there was any chance of the students hurting themselves on the equipment, but he assured me that the centrifuge moved too slowly to cause harm, even if a student intentionally stuck a hand in it.

"Now this is the part where you have to pay close attention." He read step three of Test two, which explained that the supernatant, the watery top layer, needed to be poured down the

drain. "Not all four test tubes will dissolve, at least one will completely dissolve. Think about that. In the combo platter tube, will all precipitate dissolve?" he asked. Notice that Mr. Hayes used the now-familiar reference of the "combo platter tube" that he had introduced earlier to encourage students to predict possible reactions they could expect to see during the lab.

"No," replied Deo.

"So you should look for some of it to dissolve, for there to be less than you started with," Mr. Hayes agreed. Since the three tests would take a couple of days to finish, Mr. Hayes got the lab groups started.

Before we move to my observations of the group work, let us review the scaffolding that Mr. Hayes had built into the focus lesson. Well before students entered the classroom, he and his collaborating teacher, Mr. Wright, had written directions that stated a purpose for the lab, introduced new Chemistry terminology, such as "supernatant," and guided the students through the steps of the testing procedure. They made decisions about what was most important for students to do and not do, and guided them by capitalizing, bolding and italicizing important information, while not allowing the lab directions to get too long or complicated. They had chosen the end goal of teaching students how to create and use a specialized form of scientific visualization, a flowchart of causes and effects. Mr. Hayes used this multifaceted lab directions sheet as the basis for the focus lesson, and used humor, local references, demonstration, and direct instruction to preview the lab for students. Armed with this new information, and supported by the resources of their lab sheet directions and orange cheat sheets, the students moved into the next phase of instruction, the collaborative lab groups.

When I rejoined the class two days later, Mr. Hayes began with re-explaining Test three. There must have been some confusion, because Mr. Hayes had looped back in the GRR model to

review some of the procedures in a quick focus lesson. He reviewed that for Test three, they were supposed to set up their four vials like they had for Tests one and two, and then add hydrochloric acid. "After that, you're going to go ahead and you're going to add ammonia water. It says 30 drops of ammonia water, I believe."

Mary raised her hand and said, "It says of NH_3-H_20."

"That's what I just said, ammonia water," Mr. Hayes responded. This exchange implied that Mr. Hayes was comfortable using the symbolic notations or common names of compounds interchangeably, and that students should be able to do the same.

He explained to them that once they had made their ammonia water solution basic, they would decant each of those test tubes into a clean new test tube. "You're going to literally transfer liquid from the first four test tubes into four corresponding test tubes. Not one test tube, as somebody did yesterday. Not in here, somebody else." In this moment of the focus lesson, he pinpointed a common mistake so that they would know to avoid it. When the lab groups had their new test tubes ready, they would add nitric acid to each.

"HNO_3?" clarified Nick. A few minutes before, Mr. Hayes had implied that the common names and symbolic notations in Chemistry were interchangeable. Notice that Nick questioned whether the common name Mr. Hayes gave matched the symbolic notation on the lab sheet. In this way, Nick explored whether he had internalized a chemist's ability to shift effortlessly between common and formula names for substances. In class exchanges like this, students demonstrated an increased ability to switch from reading one type of chemical text to another and an increased Chemistry knowledge base. When Mr. Hayes had finished clarifying the confusing parts of Test three, the groups moved into their lab stations.

Not all of Mr. Hayes' students enjoyed the active learning of Mr. Hayes' Chemistry class. In the following example of collaborative lab work, we see a group that struggled with the Qualitative Analysis and Development of Flow Chart lab. They were uncomfortable and unhappy with the challenge of figuring out the chemistry behind the reactions in the way that a real chemist would. I recorded this as they began Test three. This lab group consisted of three Caucasian girls, Julia, Kristina, and Maren, who were all juniors and taking the class as a terminal Science credit. Julia was in both the Chemistry and Psychology classes that I observed, and seemed to be a pleasant, quiet student.

Julia looked at the directions and announced, "So we're basically doing the same thing as yesterday. But at the end, we're adding ammonia water." We see that the students were now using the phrase "ammonia water" when they saw the symbolic notation "NH_3-H_20" on the directions, even in casual conversation among the lab group members.

Maren said, "Kinda, yeah. It's a little different."

Over the sound of test tubes clattering, Kristina said, "It's right here, it's the Hg." While the students were comfortable with saying "ammonia water" when they saw its symbolic notation, they didn't describe "Hg" as "mercury," or "Pb" as "lead" or "Ag" as "silver." They used the specific common name that Mr. Hayes had demonstrated, but did not transition from symbols to names for other elements. While they were starting to adopt chemical Discourse, statements like this hinted that they had not transferred their new knowledge to different situations, and were still in the apprentice stage of learning.

They discussed the directions, and agreed that they needed to mix the solutions. Maren said, "What we need to do is pour off the water layer. No wait, I get it! I get it now." Maren's statement that she got it seemed to indicate improved understanding of the lab procedures. But

she didn't share that understanding with the rest of her lab group. If we contrast this with the discussion within Kapil's group during the last lab, we see that Maren missed an opportunity to share her learning with her collaborators and to improve everyone's learning.

"Here are the labels," said Kristina as Maren repeated, "I get it now."

They talked amongst themselves, clarifying which test tube was which element, and finding the mercury to begin the mixing.

Kristina said, "Hg. What a blast."

"Better than yesterday, but no. I hate this class," responded Julia.

"Why?" asked Kristina.

Julia explained, "I don't like these kinds of things."

"Yeah," sympathized Kristina.

Julia said, "That's why I don't do sports." Kristina laughed, as Julia continued, "Or math. And then I have that after this, so it's just like, my life is over." Those who work with adolescents may appreciate the dramatics of the age group, in which having two difficult classes in a row seems tantamount to death. Julia did not seem to relish the challenge of classes that made her work through activities, which might explain the links she made between lab work in Chemistry, sports, and math.

Maren said, "I don't understand why we need to mix it."

Kristina replied, "I understand why we put this one. So." Notice that now it was Kristina who affirmed that she understood part of the lab, but did not share that understanding with her group.

Julia asked, "Mix them?"

Maren clarified, "Centrifuge, actually."

Julia said, “Well, yeah, but.” There was a short pause, then she continued, “I wonder if it’s making them mix really good. I mean, isn’t that what it’s doing? Can’t we just put them all in the thing?” Despite Julia’s admitted dislike of the class, she actively considered how and why they used the centrifuge. While she professed to hate the class, she was engaged enough in the lab activity to question its procedures.

Maren agreed, “We put them all in there. Then we add. . .”

Julia interrupted, “Then we like, dumpety-dump-dump, I think.” The girls laughed. Here, Julia clarified the next step in the directions, that they should dump out part of the combination before proceeding. By this point, all three of the girls had referred to the lab sheet directions, showing that they were paying attention to the required procedures, and not simply plowing carelessly through like some students do in Chemistry classes (Schoenbach, Greenleaf, & Murphy, 2012).

Maren said, “Yeah.”

Kristina added, “Then we take the dropper full.”

Julia said, “And then we dump. Then we switch stuff and, I don’t know. It’s just, it’s all so confusing.” Without addressing Julia’s confusion, the girls read the next several steps, mixing the substances, spinning them in the centrifuge, and moving back to their lab table. As they worked through the procedure, they made occasional observations about what happened in the bottles.

Julia noted, “They all look a little bit cloudy. That one’s like misting.”

“Oh, good,” said Kristina. “They’re all turning it blue,” in reference to the litmus paper. Maren said, “So they’re all basic.” Together, Kristina and Maren affirmed that they were on track for what was supposed to happen so far in the lab. They proceeded step-by-step through

the directions, adding thirty drops of hydrochloric acid to each test tube and watching what happened.

"Oh, it's turning black. Okay," observed Maren.

Julia observed, "It made like a cloud." While Julia and Maren commented on the physical appearance of the test tubes, they didn't make the next logical leap, that it was the presence of mercury, silver or lead that caused those reactions. This was the deeper knowledge that they were supposed to learn, as they performed the steps of Test one and created their flow charts. They continued mixing, dumping the extra, and observing the results in the other test tubes.

One combination of substances caused the color of the liquid to change completely. After stirring, Maren said, "There, it turns blue."

Julia said, "Oh my god. This is cool. Look at this. Maybe we need to add more stuff to this." Again, despite her negative stance on the class, Julia took the lead on questioning and considering the lab process. She seemed excited by whatever was "cool." As I coded this selection, I wondered whether Julia legitimately disliked the class, given her involvement in this lab. Perhaps she said that to impress her friends, or reacted to the uncertainty of Mr. Hayes' active approach to learning by rejecting the entire class. Whatever the case may be, at this point of the lab, the girls started to move beyond their focus on the directions, and discussed how to describe the reactions.

"The solution's still clear," said Julia. "It's just the. . ."

"Yeah," interjected Maren. "It seems like it's working with the solid."

Kristina added, "Yeah, and it's only like the outer edges of the solid."

Julia observed, “It looks like it didn’t really touch the middle. Oh, now it’s all white. Yeah, like it didn’t touch it, so it didn’t turn white. But now it’s all white.” Again, the girls focused on recording their observations, but did not discuss the meaning of the colors and chemical changes they saw. They were working at the level of novices following directions rather than chemists thinking through the ramifications of a procedure, until Maren reached the next step.

Maren explained, “That one just turns a little darker, but that’s obviously just because of the mercury now.” From the transcript, before this moment, it was not “obvious” that the girls understood that each reaction indicated the identity of the substance in the test tube. From this statement, we may infer that Maren at least was thinking at a deeper level about what the reactions meant. But as was the norm in this lab group, she did not explain or expand upon how she knew mercury caused the black precipitate, or if she had figured out which reactions indicated silver or lead. We do not know if the rest of the group had also made those connections.

They continued working through the end of Test three, talking about each step as they proceeded. After they tested the last solution with the litmus paper, Maren announced the results.

Maren said, “It’s basic. Or is it like acidic? I don’t know what the term is.”

“Yeah, it’s basic,” answered Julia. “If it turns red litmus paper blue, then it’s basic. Blue to red is acidic.” In this exchange, the girls helped each other to understand part of the procedure. Julia addressed Maren’s question with background knowledge she had gained in class. This was one of the few times the partners asked and answered each other’s questions during this lab. Previously, someone stated that she was confused, or that she understood

something, but there was no interaction between students about what was confusing or had become clear. The lab group finished their last solution, and prepared to clean up.

Kristina asked, "Do you want to look at the thing before I dump it in here?"

"Cloudy," said Julia. "I'll just take yours. I don't really care that much. I'll probably care tomorrow, but I don't care right now." For personal reasons of her own, Julia again indicated her disengagement with the lab. Without speaking with her, we cannot know if her feelings about the active learning in Chemistry were more accurately reflected in her repeated verbal disparagement of the lab, or in her actions and comments during the lab that seemed to indicate interest.

"Okay," answered Kristina, as the group began cleaning up their lab area. When they finished cleaning, they all grabbed pencils and their lab sheets.

Julia said, "Okay, our observations. Let me just stick them down."

Kristina announced her results:

> Okay, ah, I have cloudy. And it's kinda like a whitish cloudy. And then we have cloudy, but kinda like a dark gray, kinda blackish. And then we have a lighter, like a lot lighter gray, but it's not quite gray, it had like a grayish tint. And for the all [combo platter], I have like, it's like a dark white, cloudy. Kinda like a black-white with contrasts.

"Silver," suggested Maren.

"Yeah," agreed Kristina.

"So, like a dingy white?" asked Julia.

"Yeah," said Kristina.

In this outtake, the group was focused on following the procedures of the lab step-by-step and didn't discuss their confusions and points of clarity. Maren read through the lab and seemed to gain understanding about what they were doing, but she never shared her understanding with her group. Likewise, Kristina announced that she understood a confusing step, but didn't explain it for her group members. She just completed the step herself. In both of these moments, group members had answers that everyone needed, but used their insights just to get the lab done, not to increase the learning of other group members. The goal was to get finished, not to learn more deeply.

It seemed like the challenge of keeping the test tubes straight led Julia to feel frustrated. Rather than problem-solve, she expressed her anger at the entire class, and other classes like sports and math. Throughout the lab, this group read the directions one step at a time, and complained about how confused they were. I never heard them read ahead on the lab sheet to see what they would have to write, reread to better understand previous steps, refer to the purpose stated at the top of the sheet, or ask the teacher for help. They also never turned to the textbook or online sources for help, or talked through their confusions with one another. All of these were strategies suggested by the teacher and modeled by other students that could have helped them navigate their confusion.

Yet, despite these difficulties, the girls had moments of understanding, such as when Maren pointed out that the darker part of the combination test tube was "obviously" mercury. This was content knowledge that she had gained through completing Test one, that she didn't have before the experiment. Despite her stated dislike of the class, Julia verbalized the purpose of the centrifuge, to mix the solutions really well. There was even a moment when Julia told the others to check out the reaction because it was "cool," indicating engagement. Without asking

her directly, we don't know if she "didn't care" what was happening in lab because of her dislike of the class, or if something else was going on in her life that she was expressing to her friends. All three girls were learning how to make precise observations and record them in ways consistent with technical science writing, despite their frustrations at the responsibility and work of active learning. With the exception of Maren's statement that one combination was obviously mercury, the girls were missing connections to the purpose of the lab and the reasoning behind combining the elements.

While the students were working, the other chemistry teacher, Mr. Wright, came in to talk with Mr. Hayes about the lab. They were conducting the lab simultaneously, and discussing changes to it for the next time. Mr. Wright advocated for having students draw pictures instead of the flowchart. But Mr. Hayes stated that the kids should be responsible for first creating the flowchart themselves, to process the lab results, before he would give it to them in an easier, visual form the next day. As I listened, I realized that this was another moment of disciplinary literacy, in which chemists would often create and refer to flow charts as a normal part of representing series of reactions, but were less likely to draw pictures of reactions. Mr. Hayes wanted his students to have the experience that was most like real chemistry.

After Mr. Wright left, Mr. Hayes used the rest of the class to teach the students how to create flow charts on MicroSoft Word, and explained why he wanted them to do the flow chart:

> You have to figure out how to do that. Is this a little bit difficult? Yeah. Does it require a bit of thinking? Perhaps. But I'm trying to get you to see that you did a bunch of logical steps. And you need to figure out what to do with those logical steps. Because tomorrow, when you come into class, I'm going to see that you have your data table and your flowchart. You don't have those two things, I'm

not letting you into lab until you do. You are going to get a vial, a test tube tomorrow that has silver in it, mercury in it, lead in it. Or silver and lead, mercury and lead, or lead and silver. And possibly all three of them. You don't know what you're going to get. You have to tell me what's inside.

Before he showed the class how to create a flowchart electronically, Mr. Hayes answered students' questions as a whole group. We can see how he used the following exchange with Jenny about the flowchart to give the whole class guided instruction on how they would use their data from Test one to recognize the tests for each element.

Jenny asked, "You know how you said, 'Write in HCl,' so we don't have to do it again?"

"Correct."

Jenny continued, "But then when we add that ammonia thing, do we like branch it off the HCl, or just under 'Bright yellow'?"

"Well, I wouldn't put it here," said Mr. Hayes, pointing to the "Bright yellow" box on his sample flowchart on the SmartBoard, "because you didn't add ammonia water to bright yellow, right?"

"Yeah" agreed Jenny.

"This right here is a terminal end. This stops. If it did not dissolve, though, after you added hot water, you could assume that what two ions are left in the solution? If it didn't dissolve, what could you assume is left floating around?"

Jenny answered, "Silver."

Mr. Hayes repeated, "Silver. Or?"

"Mercury?" replied Jenny with a questioning tone.

"What was the test for silver?" asked Mr. Hayes. His question was met with silence. "What did you do to identify silver was there?" Still no one answered the question. He rephrased again, "What did you add?" We see another example of how patiently Mr. Hayes reworded questions to get students to arrive at answers, rather than simply giving the answers himself. In the process, he was engaging them in reviewing the outcomes of the first test that they conducted, which they needed to know to complete the lab independently the next day. After another long pause, he asked, "What was the positive test for silver?" Silence still reigned in the room. Mr. Hayes cued, "Look at your data table. Stuart?"

Stuart responded uncertainly, "Um, thirty drops of nitric acid." I noted that the lab sheet stated the chemical formulas for all the solutions, not the terms. Stuart's answer showed his knowledge that HNO_3 is nitric acid. As I have indicated in multiple student responses, this was a pervasive example of acquired Chemistry terminology in Mr. Hayes' classroom.

"Nitric acid was the test for silver," agreed Mr. Hayes. "What was the positive test for mercury?"

There was a pause, as students studied their data tables. This time, students didn't need to be prompted to look at their data tables, and Savannah quickly answered, "Ammonia."

Mr. Hayes amended, "Ammonia water. So after you added the hot water, under the 'Did Not Dissolve' branch, you're going to test for silver or for mercury by adding one of those two things, right? And go from there."

In the preceding example of the girls' lab group, I indicated that there was a difference between focusing on each step and on thinking about the meaning of what they were doing. Mr. Hayes stated this idea in class as he said, "Clearly this lab isn't due tomorrow. You haven't even

done the hard part of the lab yet. You just did a bunch of procedural steps, which isn't hard. Any idiot can follow a recipe, right?"

"Maybe," chimed in Veda.

"Anybody can cook. But can anybody create in the kitchen? There's a difference," continued Mr. Hayes. "You give anybody a recipe, they should be able to follow it. Will they make it perfect? Not necessarily, but it should be edible. But can you create in the kitchen?"

Mr. Hayes tried to help the students see the difference between understanding what was happening in their test tubes, and simply following directions. He used an example all of the students could relate to, cooking either by following directions or by creating something new, based on knowledge and experience. During seventh hour, Mr. Hayes contextualized the recipe comment, that anyone could follow directions to make mac and cheese. "I'm trying to take you beyond the following the recipe part to do the thinking," he explained.

For the final part of the flowchart lab, students needed to test their individual vials and report the contents correctly to Mr. Hayes. As kids guessed which solutions their test tubes contained, Mr. Hayes recorded their answers on his clipboard, and how many guesses it took. They got four points for guessing right the first time, three for the second time, two for the third time, one for the fourth time, and no points for guesses after that. Yet some of them needed to guess more than four times, because they still needed the right solution to write the lab report. Students who had guessed correctly could write their lab reports or use class time to work on review sheets for the next text. Mr. Hayes offered scaffolding on writing the report on the lab sheet directions and during individual guided instruction. (Please see Appendix J for the directions on writing the lab report.)

The directions for the lab report indicated how many points each section was worth, which showed how highly each section was valued. The section with the highest point value, the conclusion, also had the most precise directions. Students could use the directions as a sentence frame for what must be included in their lab reports, and be guaranteed that they would not miss any important sections of information.

In addition to the written directions, Mr. Hayes explained how they should write their conclusions:

> The conclusion is very important. In the conclusion, you have to tell me how you knew which ion or ions you had in solution. And how you knew which ions you did not have in solution. So if you had all three ions in solution, I think that's sufficient, that covers how you figured it out. But if you only had silver, for example, you need to tell me how you knew you did not have the lead and how you knew you did not have mercury, in the conclusion. Does that make sense?

In writing and verbally, Mr. Hayes reviewed the procedures for writing a lab report according to pre-set criteria. Every activity he assigned requiring scientific writing built toward his goal of helping students master writing like a chemist. In these directions, Mr. Hayes made it clear that it was the process of figuring out the identity of the solution that was important to learning, not simply guessing the right answer.

While the final stage of the flowchart lab was technically independent work, Mr. Hayes still offered assistance to students who struggled. In each class, there were students of varying ability and persistence who struggled with the final step. For example, Stuart yelled across the room, "I don't think anything in this lab is supposed to be purple, is it?" Mr. Hayes laughed,

shaking his head as he headed over to help him. Stuart held up a test tube with pinkish-purple fluid in it to show the teacher, who responded, "Only you, Stuart. Only you."

Stuart remixed his test tube and brought it up to the centrifuge. He asked Mr. Hayes to come with him to his lab station, to see if the solution would turn purple again. In a few minutes, Mr. Hayes came back to the front, telling Stuart that he needed to add ammonia water until it turned acidic. As the bell rang, Stuart asked Mr. Hayes what would make the solution turn purple. The teacher rattled off several combinations that could do so, saying that his test tube must have been dirty. Even though Stuart had erred during the lab in not cleaning the test tubes before starting, Mr. Hayes used the moment to teach him what he had done wrong, and addressed his questions about the error seriously, encouraging his curiosity about what may have caused the purple color. Interactions such as that demonstrated to students how mistakes could be learning opportunities, rather than failures to be avoided.

In a brief example of guided instruction during the independent work phase, Andy asked Mr. Hayes if he was done with the lab. Mr. Hayes pointed out that he had guessed his solution correctly, but never had created the flow chart of how he got those results. "So I need to add how I got those?" he asked. The teacher nodded. Again, simply having the right answer didn't satisfy the requirements of the assignment. Proof of the process was equally important, as it is in all science.

During the last lab day in seventh hour, the class was awash in activity, with students working independently, in groups, or with Mr. Hayes. Several students still struggled to guess what was in their vials. In addition to offering guided instruction during the independent learning stage, Mr. Hayes encouraged further collaborative learning as needed. To complete our view of the flow chart lab, I share three examples of students struggling with the independent

work for different reasons. A student named Brittany wanted to guess without performing the experiment. Another student named Jenny had an error somewhere in Test two that prevented her from reaching a valid conclusion. And the third student was Kapil, who was surprisingly reluctant to seek help when he needed it.

Some students seemed to have a hard time believing that guessing would not fulfill the assignment. Brittany came up to the front table and told Mr. Hayes that she was ready to guess what solution she had. When Mr. Hayes told her to go ahead, she guessed silver. The teacher checked his clipboard and shook his head no.

"Darn," said Brittany and laughed, heading back to her lab table. I watched her at her table, talking to her friends without getting her test tube or any equipment ready. Three minutes later, Brittany came up to make another guess. "I have all of them," she hazarded.

"That's not true," answered Mr. Hayes.

"Come on!" cried Brittany dramatically, and went back to her table. After a couple of minutes, Austin and Brittany finally came to the front desk to get their test tubes. "Okay, what am I doing?" asked Austin. Mr. Hayes didn't answer him. It seemed that Austin's question was meant to make the teacher take responsibility for reading the directions to the student. Mr. Hayes' instructional style put as much responsibility for reading and following directions onto the students as possible.

At the back table, Austin performed a series of tests. In a few minutes, Austin jogged back up to the front of the room. "I have silver and mercury," he announced. Mr. Hayes said, "Correct." Austin yelled, "Whoo-hoo!" and danced back to his table. It seemed like once he buckled down to do the work, Austin reached the correct conclusion easily. Perhaps his success influenced Brittany to actually run tests instead of guessing, because she finally began working.

Brittany came up again and waited in line to try again. I couldn't hear what she guessed, but her guess was wrong, and she moved to a side table and asked several other girls for help. If we look at this through the lens of the instructional phases as learning strategies, we see Brittany moving from an independent task into collaboration by seeking peer assistance. Since her independent guesses weren't correct, it seemed like a better approach. Whereas some teachers may discourage group help during independent work, Mr. Hayes encouraged his students to help one another.

At the side table, the three girls were collaborating and verbally problem-solving what Jenny's solution could be. Brittany had to wait for her turn. Jenny announced that she was going to guess that hers was all three. Amanda protested that Jenny's guess wasn't right.

"I'm just going off my flowchart," explained Amanda. "She didn't get a white precipitate. It didn't turn yellow." Amanda's statement showed that she was applying a visual literacy strategy of using her flowchart to evaluate the other girls' results. She used the Discourse of Chemistry that they had learned during Test one, that certain combinations would either create a precipitate or turn the solution yellow. Since these didn't happen, Jenny's vial couldn't contain all three ions. In that moment, Amanda demonstrated mastery of the flowchart element of the unit, and tried to use her new mastery to help others learn.

Regardless, Jenny went up to Mr. Hayes and guessed that her vial contained all three. She was wrong again. When she came back, Marie analyzed Jenny's procedure: "The white precipitate, that means silver. Wait, did you do that color test, where it turns yellow?" The group of girls discussed possible combinations for Brittany, Jenny and Erin. Despite the group's help, Jenny was frustrated and sought Mr. Hayes' advice, heading up to the front desk to wait in line for help.

The front desk was busy with students, including Deo and Finnegan. They had managed to make correct guesses quickly and finish the lab reports. As Mr. Hayes commented in our original interview, some students who weren't necessarily good at most school tasks excelled at the problem-solving labs. It seemed that Deo and Finnegan fit into that category. Unfortunately, they decided to use their free time to annoy students who were still guessing instead of writing their lab reports. They sat at the front table by Mr. Hayes, critiquing the guesses of other students. As Jenny came up to the front table, carrying three test tubes, Deo and Finnegan teased her.

"Black is mercury, brown is silver, and white is lead," Finnegan told her.

Deo looked at the test tubes that Jenny was holding. "Those aren't clean," he said. Although Finnegan and Deo seemed to be trying to annoy Jenny, notice that they were using the Discourse of Chemistry to do so. Finnegan relayed the important results from the flowcharts to her, and Deo reiterated Mr. Hayes' frequent point about the need to clean equipment carefully to avoid contamination. Even the teasing engaged in by these boys reflected their learning during the lab.

When it was her turn, Jenny told Mr. Hayes, "I need some guidance. Maybe prayer. I'm not guessing, I just need some help." She handed Mr. Hayes her test tubes.

Mr. Hayes pointed at a branch of the flow chart and said, "Well, this one will give you some help." Jenny began explaining what she added.

Deo interjected, "If it didn't dissolve, you should have added HCl."

Mr. Hayes told Jenny, "Here's what you should have done. Start with adding HCl. Then add hot water." He asked her to move over by his desk, away from the teasing boys. Then Mr. Hayes explained, "Well, if lead dissolved, if you put it in and it completely dissolved, okay?"

Jenny answered, "If it dissolved, then I would have added K_2CrO_4."

"To what?" checked Mr. Hayes.

Jenny paused for a moment, then said, "The solution."

Mr. Hayes asked, "To the liquid, right?" There were steps in the lab where the students worked with the liquids, and others where they worked with the solids, causing confusion among some lab groups. To help Jenny problem-solve what might have gone wrong, Mr. Hayes drew her attention to common mistakes students had made.

"That's what I did," insisted Jenny.

"Okay, that's what you did here, then?" asked Mr. Hayes.

"Yeah," said Jenny. There was a pause, then she admitted, "I don't know."

"Well, now here's the thing," Mr. Hayes said. He held up one of the test tubes Jenny had brought up. "Is this clear?"

"No. Well, sorta."

Mr. Hayes said, "I can't really see through it. So if it's not clear, that should tell you something. Because when you take the potassium chromate, and you look at it, it is clear, like the Mountain Dew solution, right?"

"Yes," said Jenny.

"This is not that. Do you understand what I'm saying?" prompted Mr. Hayes.

"Yeah, it's not clear," said Jenny.

"So if it's not clear, after you added the K_2CrO_4, that should tell you something," said Mr. Hayes, trying to lead her to figure it out. Jenny was speaking in Chemistry terms, and trying to work through the procedure, but wasn't arriving at the conclusion the flowchart indicated.

"I have no idea what I'm doing," she admitted.

Switching to direct cuing, Mr. Hayes pointed to the first step of her flowchart. "One," he said.

This was enough to help Jenny make the logical leap he was prompting her towards. "I have silver," she stated.

"Agreed," said Mr. Hayes.

"Thank you!" she cried. As she walked away from his desk, she groaned, "Finally!"

Kapil was next to take another guess. "I had eighteen," he said. "Mercury."

Mr. Hayes checked his clipboard, but shook his head no. Without a word, Kapil went back to his lab table. Despite Kapil's strong participation in the lab group for the first problem-solving lab, he did not seek help from Mr. Hayes or other students in the independent problem-solving lab. He didn't even ask Daniel, with whom he had worked well during the last problem-solving lab. If we remember back, Kapil had always answered other students' questions, but rarely asked any of his own, aside from seeking assurances about procedures. This led me to wonder if Kapil was one of the other type of students Mr. Hayes had described in our first interview, book-smart kids who struggled to think their way through the problem-solving labs.

Despite the help of the collaborative group of girls, Brittany gave up and came back up to the teacher's front table. "Yeah, I'm done. I can't do it. I'm screwed," she announced.

Mr. Hayes asked Brittany, "What test tube did you have?"

Brittany said, "Twelve."

"Twelve?" he repeated. "That's lead."

"Just lead? What? How am I wrong?" she asked.

Mr. Hayes said, "I don't know."

"I'm confused, is all," she explained. Even for Brittany, a student who was unable to reach the correct conclusion either by guessing or seeking other students' help, Mr. Hayes provided several steps of guidance: questioning, cuing and prompting her to figure it out on her own. But when these fail, a teacher is still responsible for helping students to come to a correct answer, even if it means informing them of it directly (Frey & Fisher, 2011). While Brittany lost all possible points on the guessing portion, she was now able to use the knowledge provided directly by Mr. Hayes to complete the rest of the lab report.

In the last few minutes of class, Mr. Hayes moved over to Kapil's table to help him. Even though Kapil had not sought help from anyone when he needed it, as a teacher, Mr. Hayes was aware of his struggles, and knew when to offer guided instruction, even during a task that was intended to be independent.

In all of the Chemistry classes, we see a lot going on. We see active problem-solving by the students, and many forms of scaffolding by the teacher, including realizing when to help and when not to. During this last activity, students were largely self-responsible for figuring out how to use their flow charts to problem-solve which solution they had. Yet students weren't abandoned, as we see with the students that Mr. Hayes helped when they were frustrated and unable to get further on their own. He delegated as much responsibility to them as he could, while still helping those who struggled to be successful. Both the reading and the writing in the class were authentic activities that helped students participate in the action of Chemistry like chemists do, but Mr. Hayes acknowledged that sometimes apprentice learners need teacher assistance.

These were only select examples of Chemistry Discourse out of many that I observed during lecture, discussion and labs. Collaboration played a major role in the class, and allowed

students to verbalize their understanding of the Discourse of Chemistry to each other and to the teacher. They had additional opportunities to demonstrate their understanding on summative assessments that required them to reveal their reasoning and provide evidence to support their conclusions. Many of the summative activities were directly related to the lab assignments, allowing students to draw on their learning from all phases of instruction: focus lessons, collaborations, guided instruction and independent learning. We also see how the department's goal of improving students' technical writing infused all of the lab activities. As I arranged a time to meet with Mr. Hayes for our final interview, I wondered how much the district's disciplinary literacy initiative had influenced the Chemistry department's approach to writing, and whether it had changed anything in how Mr. Hayes worked with students on their writing. If we recall details from the interview with Mr. Graham, the disciplinary literacy initiative had translated into including weekly writing prompts in all high school classrooms. I did not remember seeing regular writing in the classes I observed, and was curious about whether the Chemistry teacher was participating in the initiative.

Constraints on teaching. Despite the amount of reading and writing that Mr. Hayes required of his Chemistry students, he could imagine ways that they could do even more, if there weren't certain constraints on his teaching and preparation. I mentioned to Mr. Hayes that I had recently heard about the district's disciplinary literacy writing initiative, and asked him if this was something that he was doing in his Chemistry classes. He agreed that it was, but it was not anything new in his class:

> When we picked those weekly writing assessments, the three of us in the Chemistry department took a look at things that we were already making the kids write. And a lot of times, it's in a lab or in a test situation. So they don't

> necessarily get done separately from what I'm already doing. I'm not giving them a separate one. And I think that some classes are doing that, but I do not see the value of that. What I want kids to do in terms of just writing more in the sciences, is that they're doing it in terms of writing responses to the data that they've collected. Or writing a response to the prompt that I give them as part of a concept on a test. And so this is, I hate to say it, but we've kinda already been doing it. And I don't have time to add an additional one. So all that we've done is we've copied and pasted something that we've already been doing, which we believe is really good, and it has intrinsic value in terms of content and in terms of writing and then we've submitted that.

This explained why I had not noticed any additional writing in the Chemistry classes. The best practices for learning followed by Mr. Hayes and Mr. Wright already included regular writing by students. For all that Mr. Graham had touted the importance of the disciplinary literacy initiative for writing, it was redundant in the Chemistry curriculum.

I asked him how effective he felt the writing initiative was to improve student learning. Mr. Hayes explained that for this year, they had just been asked to decide on the questions that they would ask students, but didn't have to collect or analyze student results yet. He felt that perhaps that would be next year, as the district took "baby steps" to implement the initiative. I double-checked with him, but the administration hadn't asked them to submit any student data or evidence that they were including the writing prompts in their curriculum for that year. Maybe that would be the next step for the following school year, Mr. Hayes mused.

He didn't offer his direct opinion of how well the disciplinary literacy writing initiative would work, but he did foresee issues with implementation:

> Next year, you're going to have to prove that you've done it. And there's going to probably be some form that we're going to have to fill out, or submit something. So I think that's maybe where we're headed, but I don't know how they're going to police that. Because I'm pretty sure nobody down there [at the district office] is going to want to sift through five hundred individual submissions. Because, well, it would be multiples of five hundred, because it would be five hundred times potentially seven. So five hundred times seven hours, which could potentially be, and that's one time a week, so that's three thousand five hundred a week. And so then, you're potentially saying, Okay, so that's going to be, what? Three, six, nine, twelve, fourteen thousand to look at.

He was figuring out responses for one hundred teachers, five days a week, one for each of five or six periods each day. So the fourteen thousand responses would be one week's worth of data from the high school. I pointed out that, due to the budget crisis the school district was in, this would have to be without hiring anyone for the data-crunching. He agreed and continued:

> We got the directive because somebody watched a video or went to a seminar about how some school out East that they forced their kids to write every single day, or something like that, and that improved their ACT scores. And there's probably a lot of data to support that. However, I don't know how they implemented it versus how we implemented it. They [the administration] may have a very clear plan, but they may be taking baby steps.

Since Mr. Hayes and Mr. Wright were already collaborating on how to include authentic writing into the Chemistry curriculum, the writing initiative was just a way to showcase what they already were doing. Likewise, Mr. Hayes mentioned that he felt that the Chemistry

curriculum would align well with the incoming Next Generation science standards, although he needed time to study them closely to be sure.

During our various interviews, Mr. Hayes mentioned two related obstacles to including active, engaging activities in Chemistry: time and space in the curriculum. "When I add anything, I have to take something else out," he explained. Mr. Wright and he had assigned seven extra days to be used for students to finish up the problem-solving labs. That meant seven days that they couldn't lecture, or go more in-depth on specific topics. Even then, some students needed more time, and worked before or after school. As we saw when Mr. Hayes described college chemistry, it would be possible for the teachers to spend exponentially longer on each concept, to really teach students Chemistry, if time weren't a limiting factor.

Mr. Hayes also mentioned that time limited how much feedback he could give students on their writing. After the Identifying Unknown Solutions lab, I had asked him how he helped students when they were having problems articulating what happened in their test tubes:

> And that is my struggle. Because this is a lab that they turn in with about a week to go [in the unit]. And when they turn it in with about a week to go, it literally takes me approximately four to five days to grade it. So for me to hand them back and give them appropriate feedback, I sorta lose that opportunity. And I really haven't come up with a good way to make that better. Really in reality, what I'm happy with at the beginning of that lab, is that they are correctly able to identify the bottles. And I'm happy with some of their arguments. When I read the lab, I get frustrated, because I want them to say the right things. But the reality of the situation is that I just don't have the time to sit down with them individually, or even as a group really, to explain what they could have done better.

He also mentioned that the technical writing skills they were learning would be required in future labs as well.

I asked Mr. Hayes about how he scaffolded the Qualitative Analysis and Flowchart Lab, which students were about to start in his class.

> In that particular lab, I do feel like I'm holding hands a little bit more. Because if they do something wrong as they're going to identify their unknown, the wheels can come off the whole thing. And then they have to start all over. . . What ends up happening there is, a lot of times, the kids will create a flowchart. I'll send them home to create the flowchart, and when they come back, it's incomplete. Or it's discombobulated in some way, shape or form, and we have to shore that back up. So in a perfect world, I'd like to say, "No, this is wrong. Go home and figure out why this is wrong." But because of the time issue, I can't do that. So I usually end up going around and checking each kid's flowchart, saying, "This shouldn't be here. Cross this off. This needs to be down here." So I basically fix it for them. But again, this is probably the first time that a student has been asked to do such a thing that's not very basic. Like you know, sometimes when kids are smaller, they're not told they're creating a flowchart, but they have to create a flowchart based on how you get to school in the morning or something like that. So this is something that's a skill that I don't think they see a lot. They might use one, but they don't make them.

In the above excerpt of individuals working independently on the flowchart lab, we saw an example where "the wheels came off," when Jenny had a cloudy test tube that should have been clear. From Mr. Hayes' explanation above, ideally he may have wanted to send her back to redo

Test Two and discover her error on her own. But due to the need to move on, instead he cued her on where she had an error on her flowchart, helping her reach the right answer. Likewise, he gave Brittany her correct solution when it was clear that she felt defeated by the guessing, rather than make her loop back in the procedure like a real chemist might have to do.

Continuing to discuss the flowchart lab, I asked Mr. Hayes what the students did well in the lab reports:

> When they wrote the lab reports, most kids do a good job at creating the flowchart, and the data table, even though that's something that they haven't had to do before. So they're doing a skill. They're learning a word processing skill that appears to. They appear to be able to do it. They also tend to explain their results a little bit better. And the reason why they tend to explain their results a little bit better, I think, is because they're able to look at the flowchart and say, "Well, here's how I know that I had lead in solution, and here's how I knew that I did not have silver ion in solution. Or mercury ion in solution." Like the flowchart really lays it out for them. It's hard. If they don't explain it well, it ends up coming down to laziness or lack of attention to detail. So the explanation part, I usually get some pretty good conclusions there.

We see how the required flowchart worked as a graphic organizer, which in turn helped students to construct their writing more effectively. From Mr. Hayes' comments, we see that he did not see teaching technical writing itself as a challenge. While he was aware of the time commitment that it took to give every student feedback on what they wrote well and what they needed to work on, that was something that he accepted as part of his responsibility as a Chemistry teacher.

Throughout the time I spent with Mr. Hayes, he focused on what he could teach students that they would need to know for future science classes in high school and college. In fact, when I asked him if teachers in another subject could help teach the students how to write Chemistry reports, he disagreed.

> Not so much, because when we write a lab report, the first few of the year, I'm very. I write red all over it about what I expect. Many, many kids fall into line. The ones that don't are the ones that really aren't all that concerned about taking this class anyway. But the ones that fall into line and figure it out, it's pretty good. And my technical writing is different than writing in an English class, and different than writing in a History class. It has to be very straight to the point and matter-of-fact. One of the things in the beginning of the year, I find myself crossing out and writing a lot of in a comment is, "You can write a lot and say nothing, and that's what you've done here." And that's one of the things that they have to winnow down, because the scientific, technical writing is very straight to the point.

In addition to changing the Chemistry curriculum to really make the students think about what they were doing, we see that Mr. Hayes focused his classes on helping students learn how to write concise technical arguments, and support their conclusions with evidence. This was a huge time commitment for him, not just with the first lab report, but as he gave ongoing feedback and formative assessment on lab reports throughout the semester.

Mr. Hayes also mentioned an obstacle to students reading like chemists do. In our first interview, I asked him what his students were learning about reading like a chemist or engineer does.

> And that's something that we are fully aware that we're lacking. And the struggle is, I can sit down and I can read a journal and I don't have a problem with that. But I know, if I give it to a student, it's above their level. For a lot of different things, not just chemistry-wise, but verbiage, it's above their level. But then, some of the things that are out there are below their level, and it's almost Mickey Mouse. And so we're trying hard to find things that work. There are some articles that we have been able to locate, but then the next part of that is. We have to teach them how to read it. And that's just another time issue. It'd be great if we said, "Here, go home and read this, and then write a summary or whatever." Like I said, the book-smart kids will do it, they'll be okay, they'll push through. But the kids on the fringe will say, "This is a lot of stuff I don't want to do."

We returned to the struggle of including authentic literature in the Chemistry classroom in the third interview, when I asked if there were chemistry readings that he would like to include but hadn't. Mr. Hayes mentioned there weren't a lot of short journal articles that they could give the kids. As a college student, he remembered a textbook that he had to read that he could use with high schoolers, but the whole book would only relate to the last unit that he taught. Plus there was a serious issue with the readability levels of authentic text:

> There are journals, technical journal writing or reading. And I'd like to, in a perfect world, I'd like to do that. But some of those journals, when you read them, I have a hard time deciphering them through the minutiae, data. Much less having a sixteen year-old kid who has very little chemical background knowledge.

He explained that students in the AP Biology classes had to work through a real journal article every week or month and write about it. But those weren't the majority of

the kids he had in regular Chemistry. Most of those kids were going to major in the sciences in college. "And to force a kid who's a music-oriented kid to read a highly technical chemistry journal, I might be hurting somebody, maybe myself, in the process," said Mr. Hayes.

We laughed, and I asked if there was a gap in what was written compared to what would be appropriate for a high school readability level.

> What I've found is, there's some things that are published, that are supposed to be for high school level kids, but the level of the reading is so low. It's kinda the old newspaper adage, that I believe it's published at a third or fourth grade reading level. So it kinda gets Mickey Mouse, and doesn't get really. I struggle with doing that also, because I feel as though it's sorta below the level. There's not a lot that's somewhere in the middle. I have spent some time looking for articles for the kids to read that appear to be in the middle, but again, it becomes an issue of time.

We talked a little about how other Chemistry teachers must be encountering the same problem. Mr. Hayes explained that when he started his searches, he used to Google with the parameters "chemistry articles for the high school student to read" or something similar. This gave him some good readings, and too many low level ones. But then he encountered another problem that seemed unique to high school Chemistry:

> Some of the things that come up are things that we don't actually cover. In the second semester of Chemistry, it's kinda wide open. The first semester in most schools, you cover very similar things. But the second semester is kinda wide open, depending on what book you're using. I mean, we do an organic unit, but

> our book also covers biochemistry and it also covers nuclear chemistry and it also covers electrochemistry. And really, many, many, many, many teachers pick whatever they want to out of the second half of the book to fill up the rest of the school year. And so we pick organic and we pick sometimes electro, but there's not necessarily a lot of articles that are written for electrochemistry that a kid would understand. Or that organic maybe. There's stuff out there for nuclear chemistry, but we don't necessarily do that. We're not going to change the curriculum because of that, because the organic chemistry part of it, there's going to be more students who will take an organic chemistry-style class, when you talk about nursing students and you talk about general science majors, than a nuclear chemistry class.

From interviewing Mr. Hayes, there were several important points I learned about incorporating authentic texts in a Chemistry class. Finding materials that were appropriate for average high school students to read was a major challenge. We even saw an example of this after the interview. I shared a feature of Google that allows one to search for articles based on the readability levels of the findings. He was interested in that, and ran a search for "stoichiometry" that annotated the results by readability levels. Ninety-seven percent of the results came up at the advanced level. Only two percent were intermediate, and one percent was labeled as basic. This supported his point that it was difficult to find multiple sources of chemistry background knowledge that were accessible to high school students.

Another important point is that the rarity of appropriate articles made it time-consuming for Mr. Hayes and his collaborating teacher to incorporate reading into the curriculum. Chemistry is a very broad field, and the authentic writing tended to fall squarely within certain

subfields. Mr. Hayes mentioned that he had found some general Chemistry articles that he would design reading guides for during the summer and include during the first semester of the next school year. It seemed like it would be the project of many years to supplement the textbook reading with appropriate, interesting outside sources.

When Mr. Hayes discussed creating Chemistry guided reading assignments that were good for high school students, the issue of time surfaced again:

> Like when I do give an assignment, I do go through it in class with them. But that's because the issue, too, because a lot of the articles are so long, it might become an entire hour of going through that particular one. Whereas, with the easier ones, and that's partially me, because I still need to go then ahead and cover the material I need to cover for that day. Whereas if I put the answers up and "Oh, those are the answers," and then we can go on. So now we're going to talk about that. And now I'll refer back to it often times when I'm lecturing. Originally we set the guided readings up as, "Hey, this is just something I want you to think about when we talk about it in class." Or, "Be familiar with some of these terms we'll talk about in class." And it wasn't really designed at that time to get the learning part. It was more saying, "Hey, get familiar with some of this. And now we're going to tell you about it a little bit more."

He couldn't spend enough time in class to help students problem-solve through difficult reading, without sacrificing time they needed to problem-solve through difficult lab work. We see in the last statement that the role of reading in Chemistry was changing to put more responsibility for learning from reading on students, but there was still room for improvement.

Mr. Hayes knew this, and was always updating and reconfiguring his curriculum to make it better in terms of making students learn more on their own, with his help as needed.

As Mr. Hayes mentioned, having interesting outside reading was not a priority for the department's decisions about what would be included in the curriculum. They were not designing the general Chemistry class for specialist students who would be going deeply into one of the subfields. Those students would typically enroll in the AP Chemistry classes. They wanted the regular Chemistry class to be valuable for students who would go into another field that would require some general knowledge of chemistry, like nursing. It also served as an introduction to the subfields for sophomores who would go on the AP Chemistry, like a survey course to help them choose their specialties in the future.

I asked Mr. Hayes whether there were local or national groups of Chemistry teachers who could help find appropriate reading materials for high school students. He explained that his local group had moved their meetings to a location forty miles away and met in the evenings. As the father of young children, it was impossible for him to attend those meetings. Another local chemistry educators group had recently lost the organizer who had run it for five years, and no one had yet filled in the void. It seemed that, aside from Mr. Wright, Mr. Hayes was pretty much on his own to find appropriate and interesting Chemistry readings on the high school level.

We see that despite some obstacles and constraints, Mr. Hayes was thriving on the challenge of incorporating disciplinary literacy into the Chemistry classroom. It was an accepted part of the Discourse of his field that students should learn how to write and speak Chemistry well. It was also a daily part of the Discourse in his class. Yet we know that not all Chemistry teachers accepted that challenge, as we saw in the counter-example of Mr. Jackson, the third Chemistry teacher who the students recognized was doing the thinking for them. We also

witnessed the amount of time and effort Mr. Hayes devoted to making his class an active site of Discourse learning. The scaffolding for learning was built into directions for assignments, focus lessons, guided instruction and in his formative assessments of the first lab reports. He was equally busy with students during class, offering just the level of help each student seemed to need, and being careful not to offer too much. Before we delve deeper into disciplinary literacy in Chemistry, let us leave Mr. Hayes' classroom and continue through my school day as an observer in the Psychology classroom of Mr. Garrett Leon, to see how he visualized and implemented disciplinary literacy.

Psychology

"Teaching is just that balance, isn't it? Trying to have engaging activities that show real-life skills but that are reasonably efficient and don't sacrifice content time. That's the little art and magic of the job, I guess." -- Mr. Garrett Leon, Psychology teacher

As a convenience sample, it may be noted that Mr. Leon's Psychology students were older than the ninth and tenth graders I had originally targeted. Also, Psychology was an elective class, not required like Chemistry was. Together, these factors may indicate that students in Mr. Leon's classes were more mature and had more interest in the subject area than the majority of Chemistry students did. However, Mr. Leon himself certainly fit my description of a teacher who was incorporating disciplinary literacy strategies into the curriculum. While he appreciated the role that lecture played in transmission of information, he valued the active learning that students did with partners and in large group discussions. He provided me with the perspective of a teacher who had used authentic learning based on the work of experts for years and had pulled back from it, but was reconsidering that decision.

Introducing Mr. Garrett Leon. Mr. Garrett Leon and I probably knew each other a little bit better before this research than I had known Mr. Hayes. We had had classrooms opposite one another for three years of summer school. We would sometimes chat in the hallway after class. This was the second time that Mr. Leon had agreed to interview with me, having helped me with a vocabulary instruction study for a graduate class two years earlier. During the school year, I subbed for Mr. Leon when I could, and he was comfortable calling me directly to ask if I would be available. I was thrilled that he volunteered to help me with my dissertation.

Mr. Garrett Leon was a Caucasian man in his mid-forties who laughed often during class and interviews. He shared that he had four children of his own, two of whom were at the high school at the time. His family life and his role as a parent were part of the ongoing conversation in class as it related to Psychology. It also seemed to infuse his personality as a teacher, in that he took a paternalistic stance toward students, encouraging them to become self-responsible before they left high school, and using a gentle but firm managing style. In class, I regularly observed Mr. Leon's paternal style of managing students. As an example of how Mr. Leon managed his classroom, at the beginning of May one student started a trend of not having the homework done. Mr. Leon told him, "You're taking a major nosedive. And I really don't want to call a seventeen year-old's parents, like you're in middle school, to tell them that you're not getting your homework done." He prompted the student to take responsibility for his own work without directly confronting the student. Usually I could only catch part of the conversation when Mr. Leon redirected students. The teacher used a quiet tone and spoke to students privately, either at their desks or took them out into the hall as necessary to defuse tempers and redirect inappropriate behaviors.

Mr. Leon mentioned to me that he particularly felt the need to help boys imitate a positive male role model, in case they didn't have one in their own lives. In explaining that his students were juniors and seniors, he said:

> For other kids who just don't do their homework, they've kinda slipped in and they're under the radar at this point, you know what I mean? We're not looking at samples when they're 17 and 18 years old. They're on the way out, and I'd have to, really I'd have to agree to say that personal responsibility is the best thing we can inculcate at this point. I'm not going to really change, maybe this is fatalistic, but I'm not really going to change the undermotivated students' reading comprehension. And I'll say with some boys in particular, cuz I think it's very motivating for them, I'll say, "You're really acting like a boy, and pretty darn soon, you're going to need to start acting like a man. So you can decide. Do you want to do my homework, or do you not want to do my homework? You're going to have to decide, cuz pretty soon you're going to be on your own. And so, if you think this is good for you, this is a choice you're going to have to make." So I am very much deflecting the responsibility for their learning at this point.

By "deflecting responsibility," Mr. Leon encouraged students to develop more responsibility for their own learning, a skill they would need after they graduated. Despite his admittedly pessimistic view of improving reading comprehension for older students, Mr. Leon included reading in his classes weekly, and held students accountable for outside reading as well.

During my research, I had more opportunities to speak casually with Mr. Leon than I did with the other teacher because of the timing of my observations. I observed his eighth hour class, the last period of the day. I was theoretically free to leave immediately after school. But

between buses and student drivers, the parking lots were chaotic for about ten to fifteen minutes after the last bell had rung. Instead of venturing into that, I waited out the chaos and chatted with Mr. Leon, first checking with him that it was all right to make note of anything interesting that he said during that time. When I knew we were going to talk about something directly related to my research, I asked his permission to record.

Mr. Leon had taught for eighteen years in the same school district, and had lived in the district for twenty-one years. But teaching wasn't his first career choice. In class during a unit on intelligence, he shared that he originally had wanted to be an architect, but realized that the job didn't match his personality. He described himself as having strong interpersonal and linguistic skills, which were excellent for teaching. He didn't elaborate on how he switched from architecture to education, but shared with me that he had studied psychology, history and broad field social studies for his bachelor's degree. He had thought about switching careers into the ministry, although never did so. His Masters in Education program was very open on what type of classes he could take. He earned his Masters in Religions and Sciences, with enough psychology classes to get the psychology certification through the state department of education.

In his eighteen years of teaching, he had always taught regular Psychology, along with Government and various History classes, but had just that year been pushed into teaching Advanced Placement (AP) Psychology. The previous AP Psychology teacher took a position in another district two weeks before the school year started, so Mr. Leon felt the pressure of teaching a new class with minimal time to prepare. While he enjoyed the intrinsic motivation of the students who took AP Psychology, he preferred the regular Psychology curriculum. We were talking one day after just after the Psychology students had completed a group work assignment.

Mr. Leon shared that he didn't have time to go in-depth or get students actively learning in AP Psychology:

> I have come to the realization that I cannot do anything in AP Psych. It's pretty much teacher-directed. And you just have to pound volumes and volumes of content. One of the reasons why I personally like Psych more than AP Psych is because you can do some things like this. You can talk. We'll have chances to take psychological tests. Like a mock IQ test or personality. We talk about, "Who shall I marry?", that you just don't have time to do that.

He explained that he was required to cover almost three times as much material for AP Psychology as he did for the regular class.

Mr. Leon and his AP Psych students had the additional pressure of preparing for the AP tests earlier than usual that year. Usually the tests were given at the end of the school year, but they had been moved up to the beginning of May. Everything in the AP class was driven by preparing students for the test. Once the test was over, the teacher and students would be able to relax, explore interesting topics in-depth, and maybe conduct experiments then.

When I asked Mr. Leon about his favorite part of teaching psychology, he replied:

> I think the thing I enjoy about psychology the most is that it's so relevant to kids' lives. As a result, it's very easy to argue that they should learn it, that it's motivating and it could make a difference in their lives. No slam to math class, but it's a lot more difficult to push that geometry is relevant than psychology. So when we talk about personality, intelligence, learning, psychological disorders. One, it's interesting. And two, it's really exploring who we are and why other people do what they do. I think the more intrinsically motivated kids are, the

more likely they are to do well. So in Psychology, it's not as difficult as it is, say in Government class, both classes that I teach. They're vastly different ages, ninth and twelfth, but for the most part I chalk that up to intrinsic motivation.

In this statement, Mr. Leon indicated that his class was preparation for understanding adult life for the students. Also, it was immediately relevant to their adolescent lives, to help them understand how people think. Although he mentioned preparation for college several times, while I was coding the observational data, I realized that one of his prevalent themes was that learning psychology would help students to make good choices, to know themselves and others better in their daily future lives as parents and adults. I never heard any mention of psychology as a career choice, although there were themes in class about thinking and researching like a psychologist does. From this statement and others, I classified Mr. Leon's approach to disciplinary literacy as helping students think like psychologists do, which would be difficult to observe during classes. To get a glimpse into students' thinking, I focused my coding on examples of what students said about psychology, to Mr. Leon and each other. I also focused on how Mr. Leon framed the ways students should think, in class discussions and in how he authored assignments and quizzes.

Mr. Leon was interested in how the district was attempting to improve literacy in individual classrooms. During our first interview, Mr. Leon showed me materials from the previous year's district-wide literacy initiative. It was an approach in which the teachers in each department decided which cognitive reading strategy to teach explicitly each month. He explained:

I admit that we got away from this, but last year we had the goal of. We had like a strategy of the month thing, so here we go. **Reading from the SMART goal**

worksheet. "We will improve readings skills across the curriculum by applying best instructional practices within the Social Studies." You can have this. And we had a strategy of the month. September was supposed to be pre-reading/ activating prior knowledge. October was looking at cause and effect. November was focusing on comparison/ contrast. And then December was identifying and analyzing perspective and bias. For example, in the author's perspective or probably more particularly in political cartoons. And since many of our classes are semester classes, those four just got refocused in the second semester, so they would be the same for January, February, March, April.

I started, "So, you'll be going through. . .?"

Mr. Leon shrugged, and continued:

Well, honestly, that's what we did last year. We have had less overt focus. So in other words, we did it intentionally last time. Y'know, I think we naturally do some of that stuff, maybe not as overtly as we did last semester. But in all honesty, here's a frustration: in education in general, they just continue to change the targets. So now, we're not doing that stuff, we're not coming up with our own departmental strategies any more, now they want us to do a WKCE-type question. And a reading sample. And so, that was the focus last year, which I thought was good. But of course we always need to be changing to some degree, maybe to validate the administrator's pay, I don't know.

We both laughed. So that's my rationale for why we're not doing that. They want us to be doing something else now.

It seemed like the last year's district initiative was helping teachers become cognizant of which reading strategies they expected students to master, and examining how best to implement

them in their subject areas. The departments designed a systematic way to teach the relevant reading strategies. As Mr. Leon pointed out, the teachers already used many strategies in the classroom without being aware of them. How much better could such strategy instruction have become, if the initiative had continued another year? Another year may have continued the conversation in each department about how students learn to read, write, speak and think in their professional fields, and how instructional practices could be improved to meet the literacy goals. After one year of general cognitive strategies, the departments could have targeted which strategies worked best within each of their instructional units, and begun a powerful disciplinary literacy approach aligned with policy and research on best practices. Instead, if we may extrapolate from Mr. Leon's comments, teachers were left with the impression that reading strategy instruction was just another fad, to be replaced at the administration's whim.

During our first interview, I clarified the idea of disciplinary literacy as helping students learn to think like a professional in a field, like a psychologist, and asked how familiar Mr. Leon was with that idea. He was very familiar with it:

> Our district, on the other hand, has some very overt goals for reading and writing, and so, those are probably the things that generate our focus a lot more than state standards, of course. One of the things that they're focusing on is really the idea that teachers, like it or not, are reading teachers. That is not just something that happens in English class. And so they've had us focus on, essentially making sure we record and collect data on writing pieces or we work on vocabulary issues and discuss those. And also do WKCE-type practice questions, which isn't overtly focusing on content. Maybe it's really more focused on analysis, on how to be effective test-takers. But that's what's driving most of the things that we do.

> The goal would be to have people do minimum amounts of writing that we can use to assess their understanding, the WKCE stuff. . . . I think we all have a common understanding that if you don't have that base of vocabulary, you're really going to struggle on tests, quizzes, and obviously application, "How is this part of my real life?"

We can see that Mr. Leon referred to the district's disciplinary literacy initiative as a way that the school helped students to think like professionals do. In his answer, we see reflections of Mr. Graham's ideas that the standards themselves were not as important in the district as getting the skill sets that students need to be successful after high school and on standardized tests. Mr. Leon mentioned that the district had "overt goals" that they were working towards for reading and writing. Yet it is difficult to tell what those goals were, aside from practice for standardized tests. Otherwise, it seemed that the district was focused on sharing rhetoric with the teachers, such as the old idea that all teachers are teachers of reading. As Shanahan and Shanahan (2008) note, this idea has not benefited secondary learners in the seventy years since the phrase was coined in 1937 by William S. Gray. The focus on disciplinary literacy as reading and writing specialized by subject area was supposed to move teachers and administrators beyond general goals for literacy into literacy targeted to subject goals.

I clarified whether it made sense that teaching students to think like professionals included teaching them to read, write, listen and speak in a field's Discourse. When Mr. Leon agreed that it did, I asked him if he did that and for an example. Mr. Leon said:

> We watch videos that are produced by the head of the American Psychological Association. They're called "Discovering Psychology." Dr. Philip Zimbardo is the gentleman's name. So those obviously introduce them, even if I don't, to

terminology and how psychologists think. We will look at research-based practices psychologists use. We'll look at historical perspectives on psychology. And so all of those, and we're doing a chapter on memory right now. I actually skip those intro chapters to start with a memory chapter, just specifically to focus on skill acquisition. Obviously we're introducing vocabulary there, but probably much more overtly introducing vocabulary of the subject field of psychology in the second and third chapters. Which chronologically in the book happen to be the first and second chapters, if that makes sense.

I agreed that it did, and he continued, "So they'll be exposed to thinking like a psychologist more in chapter one, which is an intro chapter, and chapter two, which is a research chapter." It was interesting that Mr. Leon planned his class around a memory unit, in order to make explicit to the students important study skills and reading strategies that they would need to use all semester long. He explicitly taught them how to use graphic organizers, mnemonic devices, and visualization strategies as "Tricks to Remember," which I describe below. Once they were prepared to study, Mr. Leon felt that they were prepared to start learning the Discourse of Psychology.

Mr. Leon described himself as a very traditional teacher, with strong teacher control over the classroom. This teaching style was apparent in my observations, in which the units usually began with a focus lesson of either lecture or a video, and Mr. Leon spent a great deal of the class talking with students. Yet we can see nuances in the definition of traditional when we look at the interaction that happened during his lectures and videos. It was very rare to hear Mr. Leon speak for any length of time without student input, even with new material. He asked students what they thought about the concepts he introduced, and had them actively draw connections to

their own lives. Even during videos, he would pause the video every few minutes to draw their attention to some detail, ask for their responses to startling or interesting information, or to connect information from the video to what they had read in the textbook.

Despite his self-description as a traditional teacher, we may not recognize him as a teacher from yesteryear. This was apparent in my observations and in our last interview, when I asked him how using reading-based and active learning methods compared to his own training as a student:

> Well, the things that I do have them do are not-quite daily but multiple times a unit are the reflection questions, the daily starters. And they require them digging into the text. I do them on purpose because I do want them to read the textbook. I do want them to feel it's important to bring their textbook. I do want them to see their textbook as a resource. I want them to come to class with the knowledge of the text. I don't feel the text is very valuable if I summarize what I want them to read. I prefer the opposite: they read, pull out, mine out what they can, and then we'll apply, presuming comprehension in some cases. So I do have them read quite a bit. I require them to read. Obviously they're rewarded in many ways for reading.

Despite his earlier statement about not being able to change the reading comprehension levels of students, Mr. Leon was emphatic about the students' responsibility to read to learn for his class. We see this particularly where he stated that the text was not valuable for them if he simply summarized what they were supposed to read.

To redirect him to the idea of his own teacher training, I asked, "Is it similar to how you were trained?"

> I don't think I had to reflect on readings as much. I think I was probably tested in college in a more objective, multiple-choice format. Where I think there's a lot of value to reflection questions, or summary questions, or comparison-contrast stuff. It requires upper level thinking and it also develops skills that are transferable to other classes. Just thinking skills that help, regardless of whether the content is psychology or something else. So I guess that's maybe one of the better things that I do that I hadn't been exposed to much. Or maybe I just repressed those things.

Mr. Leon reminisced about Psychology classes in high school and college, and a teacher who had inspired him, despite his old school, pure lecture style of teaching. The college classes steered him away from specializing in History to specializing in Psychology. Yet he did not emulate the primarily lecture format of those classes in his own classes. When he compared his style of teaching to his training, he argued that his style required students to reflect, to compare and contrast, and to generally work with the information in ways that represent deeper learning than he had experienced, increasing the likelihood of students transferring their learning to other classes. This is a reminder of how broad of a term "traditional teacher" really can be, and a caution about drawing unwarranted conclusions from this description. From Mr. Leon's example, we can argue that a teacher describing him or herself as "traditional" does not exclude disciplinary literacy from his or her classroom. We see this as we examine Mr. Leon in action with his students during class.

When I asked Mr. Leon how secondary teachers help students read like professionals in psychology through reading strategies, he described the important role that vocabulary learning played in the Psychology classes:

I refer to looking things up and trying. I refer to finding vocabulary words as the "search and destroy" method. "I don't want you to look at the term, search through the book, and then just write that particular sentence down. That is not an effective way to read." And so I'll tell them overtly, "I don't want the search and destroy method here. You can do that in the intro assignments, when we're looking at vocabulary generally. But when we go section by section, you really need to read." So then, other than of course making sure that they truly read the text, we do have a lot of focus at the beginning on prefixes, suffixes and roots.

"Oh, you do?" I asked. This was an approach Mr. Leon and I had discussed in the past, and I had shared some of my resources with him.

I do. As they apply. So the second day of class, I focused on the definition of psychology. I said, "This is a Greek word, the roots being 'psyche' and 'logy.' 'Logy,' obviously biology, anthropology, 'the study of,' and 'psyche' in Greek means 'mind or soul.' And so we talk a lot about those kinds of things. "You can increase your vocabulary a ton if you understand root words, prefixes and suffixes. Even if you REALLY don't get the word, you can reasonably pretend or figure it out, based on context and so forth." Ah, what else?

I prompted, "Do they do some work with that, then?" He shook his head:

It probably is more oral in class, where I'll be talking, kinda in our guided discussions, and when we're having conversations, I'll say, "Okay." If I think they may not be familiar with the word, I'll say, "What's the root here? Or what's this prefix mean?"

In my observations, I saw examples of the embedded vocabulary work during discussions that Mr. Leon described, some of which I share below. There was also explicit vocabulary work that students needed to do at the beginning of each unit, described below as part of the classroom routine.

Demographics of Psychology classes. There was little cultural and ethnic diversity in the Psychology classes. The students were juniors and seniors, mostly ages seventeen and eighteen. The students who were eighteen were able to sign the permission slips themselves and returned them to me the same day. Of all the permission slips that I received in the six classes, I only had one student deny permission to record and use his contributions, from the Psychology fourth hour class. I checked with the student that he had marked that intentionally, thinking that he may not have read the form correctly. After all, most students who didn't want to participate just didn't fill out the form. But he affirmed that he had intentionally declined participation. I let him know that it was fine, and proceeded to omit his contributions from my field notes, recording that he had said something, but not his words or the content of his remarks.

In fourth hour, there were twenty-eight students: fifteen girls and thirteen boys. Twenty-three of the students appeared to be Caucasian. Two of the boys appeared to be Asian American. Two boys and a girl may have been Latino, judging by their skin tones and last names. The Latino/a students were not part of my recorded groups, but when I heard each of them contribute ideas in the class discussions, no one seemed to have an audible accent or any language difficulties.

In eighth hour, there were twenty-eight students; fifteen girls and thirteen boys. There was more racial/ethnic variety in that class than in any other that I observed. Nineteen of the students appeared to be Caucasian American. There was one African American boy. Two girls

appeared to be Asian American. There were two boys who also appeared Asian American. During one recorded group activity, the Asian American boys talked about attending Hmong New Year, leading me to assume that both boys were Hmong American. One of the girls talked about how families behaved back in China, leading me to assume that she was Chinese American. There was another boy who regularly worked with the Asian American boys and girls who seemed to be East Indian American. He contributed a few ideas about his ethnic heritage during the same conversation. On the other side of the room, there was a girl whose last name and appearance seemed to indicate that she was of East Indian American heritage, but she didn't speak in class often and wasn't included in my recordings. There was one girl whose name and skin tone may have indicated Hispanic ethnicity, without any trace of an accent when she spoke. Another student was an Italian exchange student, a girl who was Caucasian but not American. She spoke with a heavy accent that was often difficult for me to understand, whether in person or on the tape recorder.

For the semester that I observed, Mr. Leon didn't have any students receiving support from Special Education, English Language Learning (ELL) or Reading teachers. However, Mr. Leon had had students requiring accommodations in the past, and was prepared. When I asked him if some students struggle in his class and who they might be, he answered:

> Let's see here. Well, in general, the Special Ed kids do have the freedom to work with somebody in an independent study hall, and they do have, if their IEP [individual education plan] says, extended time. And the ELL kids, same thing, they work with the ELL teacher, Mr. Stencil. And we kinda look at their functional access score, is what I think it's called, how much modification do we need to make, in terms of understanding vocabulary. Sometimes, with kids who

> are really functionally low, rather than having fill-in-the-blank, I'll provide word options. Rather than having some short answers, we might give them, the Special Ed teacher and I or the ELL teacher and I would come up with six or seven phrases or sentences that answer this statement. And they have to circle the ones that best apply, and leave the ones that don't apply. Since we do those things for those kids, I don't really think that those kids struggle. I don't fail Special Ed kids or ELL kids cuz they don't understand the vocabulary. The kids who don't do well are primarily undermotivated. Is it connected to poor reading strategies? Perhaps. But they're not in the ELL or Special Ed category.

As an example of his accommodations, during the third chapter of the unit, Mr. Leon handed me two copies of a quiz. The first copy was labeled Version A. The top had five matching questions, with eight possible answers. The bottom had five cloze questions without a word bank. The second copy was labeled Version B. The top was identical to Version A, with the same five matching questions and eight answers. The bottom had the same five cloze questions. But at the bottom was a word bank of nine possible answers, labeled *Word Bank for #6-10.* That was the only difference between the versions. The formatting of each was very similar and they were printed on the same color paper, requiring a close look to spot the difference. Mr. Leon had mentioned that it was important to him that other students didn't realize when he was providing modifications to Special Education or ELL students, to respect their privacy.

Class routines. When I observed in Mr. Leon's room, I had a teacher's desk at the back at which I sat. This placed me right behind the middle tripod of desks, with a clear view of most students and the drafting table at the front that the teacher used as a podium. There were about

three students in the back of the room, to the right side, whom I couldn't hear or see well, but I could observe the majority of the students. I could hear the students who sat in front of me very well, could always hear the teacher, and could usually hear the class discussion except for students who spoke softly, especially if they sat to my right or by the door.

Mr. Leon's class had a fairly regular weekly routine, which was always posted on a side chalkboard. His units generally lasted two weeks, with a test on the second Friday, and one to two quizzes in the middle of each week. Each unit followed a predictable pattern which can be described through the Gradual Release of Responsibility model. At the beginning, Mr. Leon passed out packets that included all of the homework worksheets. They started with a focus lesson of a video or lecture about new concepts. Each unit had five or six daily starter questions, which students usually worked on as bell ringers when they got to class. These often served as starting points for class discussions. Generally students had homework in the evenings, which Mr. Leon stamped to show it was finished at the beginning of class while they worked on their starters. On days that they didn't have starters, he sometimes had a reading or writing assignment for them to work on while he took attendance and walked around to stamp their work. Sometimes he encouraged them to compare answers they had gotten on the homework, or to study together for quizzes while he completed his circuit of the room.

The stamping served a few purposes. Mr. Leon didn't grade the packets until the end of the unit. But as he walked around, he looked at students' answers, using the stamping time as formative assessment. When students' answers were wrong or incomplete, he prompted them to correct or finish the assignment while he was stamping others' work. When the ideas were in the book, he cued them to specific pages. If the work was late, he made a note next to the stamp so that he could give partial credit. He encouraged the students to work together if they were

confused and was not concerned if they got answers from their neighbors. None of his tests were open-note, so simply copying a neighbor's work would not help them. He encouraged them to think about what they were learning.

For example, during the second chapter on the history of psychology, Mr. Leon prompted the class to get their notes out. He said, "Let's take a step back and talk about tomorrow's quiz. Go to your extra notes page, and copy this stuff down," speaking about a description of the concepts that were on the quiz.

"Can we use notes for the quiz?" asked Jasmine.

"No, but you can use all your brain," Mr. Leon replied. "If you know this stuff, you will do really well on the quiz. No secrets here."

When he was finished stamping, the class would generally do some sort of review of the previous day's lesson. Sometimes this would be a guided discussion of the daily starters, in which Mr. Leon called on students or asked for volunteers to share their responses. Another introductory activity was going through the night's homework, talking about the answers students had and elaborating on concepts and ideas from the unit. While he told me that he avoided calling on students to read difficult passages in class, he regularly called on students to share their responses or read questions and give their answers. He varied whom he called on so that it seemed that every student had to participate at least twice a week, and could always contribute more if they liked. I asked him once if he marked it down somewhere, but he said that he just kept track of who hadn't been called on recently in his head. It seemed to be effective, in that I didn't notice any students who were able to hide and avoid class participation.

Mr. Leon commented after class once that he had intentionally designed the layout of the room to prevent anyone from hiding. The desks were in three groups, with aisles around each

one so that he could move freely around the room. The arrangement also helped him to quickly group students for group work. After the review of previously learned content, the class would go into new materials for the day, from mini-lecture, discussions, videos, or a combination. Mr. Leon's classes often ran right up to the bell, especially when students were interested and engaged in the whole class conversation.

The packets were carefully designed to support student learning of each unit, and all followed a similar format. The cover sheet was entitled with the chapter number and topic, and the names of the class and teacher. Next was "Score Guide for:" and the topic of the chapter, such as "History of Psychology Unit Packet." Then he listed every assignment for the unit, how many points each was worth, spaces for him to record their scores, and a space to record their Total Points. The bottom of the cover sheet had spaces for students' names, the hour, and the due date for the packet. When he handed out a new packet, he instructed the class to write the appropriate due date in the last blank. By analyzing one of the packets, we can glimpse the amount of planning and preparation Mr. Leon invested in making his class move smoothly for students through the GRR phases of learning.

The back of the cover sheet listed the student objectives for the unit. They were written with a focus on what the student would be able to do after completing the unit. For example, for Chapter one: History of Psychology, the objective sheet read:

What is Psychology?

Student Objectives: Upon completion of this unit of study you should be able to:

Chapter 1

1. Understand the definition of psychology.
2. Identify the five goals of psychology.

3. Explain how psychology is a science.
4. Describe the variations of psychological theories and principles.
5. Explain the historical background and the early theories of psychology.
6. Describe the six main contemporary perspectives in psychology.

At the beginning of a new unit, sometimes Mr. Leon read the objectives to students, and sometimes he paraphrased to describe what they would learn. The objectives were mostly adapted from the textbook, although Mr. Leon selected from many possible objectives and reworded them to include additional skills and knowledge.

The second page of the packet was always vocabulary work, set up as a table with three columns. The first column was a selected list of vocabulary terms from the unit, usually about twenty words. From looking in the textbook, I saw that Mr. Leon had selected important terms from the multitude of vocabulary words listed, often fifty or more per chapter. The second column gave space to write the definition. The third column was labeled "Trick to Remember." He encouraged students to write whatever helped them to remember that term, whether it was a picture, a mnemonic device, or a personal connection, anything. Before quizzes and tests, he encouraged them to fill in the Tricks to Remember, even if they had to borrow one from their neighbors. During the first unit, on memory, Mr. Leon spent two class periods discussing many Tricks to Remember that students could use the rest of the semester to help them study for tests.

The rest of the packets varied by unit. They included guided question worksheets for the films shown in class and for each section of the assigned reading, including multiple sources beyond the textbook. There was always a PowerNotes sheet, an organizational strategy that I explain below. Sometimes there were graphic organizers that required students to regroup and organize concepts from the chapter. Sometimes there were additional worksheets that asked

students to analyze situations or perspectives and record their thoughts about them, as a basis for class discussion. At the end of each packet was a copy of the review worksheets from the textbook and two blank pages entitled "Extra Notes." Occasionally in class, Mr. Leon prompted students to write extra notes, either specifically what they should write, or in general if they didn't know answers to review questions or to take notes from videos. The back sheet of the packet had a blank Psychology Daily Starter Sheet with room for five starters.

Collaboration was a regular component of the Psychology curriculum, and used for a variety of purposes. Mr. Leon incorporated brief "turn to your neighbor and talk" or think-pair-share activities in class that encouraged students to review what they had learned and to process it more deeply by explaining it to others. Before quizzes, he encouraged students to use a few minutes to quiz each other on their understanding of terms and vocabulary. If there was time remaining at the end of class, he encouraged students to start the homework together or review in pairs for the next assessment. Often he explicitly explained why talking about the concepts would help them to remember them better, connecting Discourse skills to recent psychological knowledge they had gained about learning and memory. As we will see in the section on literacy strategies in the classroom, he incorporated formal collaboration into small group projects at different levels of learning, and used a small group-large group format for his review games before tests. Since Mr. Leon's disciplinary literacy focus was on how students applied psychology in their thinking, I focused on the collaborative activities as a way to hear students express their thoughts through psychological Discourse.

All of the summative assessments of the class were quizzes and tests, including a cumulative exam at the end. Mr. Leon explained to the classes that he intentionally made his quizzes harder than his tests. That way, students would study hard early on, and be better

prepared when they got to the tests. He also followed the department's policy of allowing students to make corrections and improve their grades on tests. He explained the procedure to students for filling out the Test Correction (TC) forms, as he passed back the first test, on which most students had done well:

> I think this is the same as other Social Studies classes. We kinda decided as a department to do exam corrections. If you complete the homework and do the TCs, there's no reason to fail. Of the ninety people I had in Psychology last semester, the only people who didn't pass were people who didn't come or didn't turn in their packets, or turned them in late. If you come to class and you do your whole packet, I almost guarantee you that you will pass this class. I hope you're not looking to get a 69.5 and skim through. I hope that you're looking to get an A. And based on the number of 90s [on the test], that seems true.

Mr. Leon paraphrased the first bullet point on the TC, which stated that all homework had to be completed before students could make test corrections, because homework was practice for the test. Directing their attention to the directions on the TC form, he read the second bullet point out loud, which stated that students would have to come in before or after school or during study hall to make corrections. Tests couldn't leave his classroom until after they were finished with the unit. The rest of the directions explained that if they needed to rewrite a short answer or essay question, they should attach a separate sheet of paper to the TC, they had two school days to make corrections, and that they needed to attach the completed TC to the original test.

Students could see how the test corrections would impact their score on the TC. In fact, doing the calculations was part of completing the TC. A series of four boxes showed students

how to recalculate their score: "Number of corrections made;" "Divide by 2 (4 for AP) = Points earned back;" "Original Test Score (# of score, not %);" and "New Test Score (after corrections)." The rest of the front and back of the TC had room for students to make corrections.

Mr. Leon indicated the back of the room where he had a station set up for test corrections, right next to my desk. When students came in to make corrections, they could find the tests for their hour in one bin and the TC forms in another. They were able to come and make test corrections while he was teaching a class, which I observed multiple times during the semester. When they were done, they were to put their tests and TCs in the bin labeled, "Completed Corrections."

Making corrections needed more than just the right answer; students had to prove that they had thought about why their revised answer was right. There was a specific format for how they would make corrections, as Mr. Leon explained:

> Each test correction has 3 answers: the question that was incorrect, where you write the question number and the whole question; correct answer – write the whole answer, not just the letter; why the answer above is the correct answer. The third question is most important. I don't want to hear, "The book says so," "I made a mistake," "It's the definition." Those are not reasons why. You're going to explain why it is what it is. You can summarize it in a sentence; a sentence is good. A phrase. You're going to explain what the answer should be. So you're not going to say, "My I looks like an L." You're going to say, "This is the answer because," and you're going to walk through the definition. And I understand that we all make little mistakes. But I want to know that you understand why it is

what it is. You won't get credit until you answer all three. Half point for every correction you make.

You'll be able to do this on every test. I don't actually agree with that, but that's what the superintendent wants us to do. It's a trial. I hope it makes you try harder on the next test, and jacks up your grade.

Although Mr. Leon said that he didn't agree with the department's test correction policy, we see that he explained to the students that the purpose of it was for them to demonstrate their reasoning and understanding of the correct answers. This was one of several ways that he evaluated how they thought about the subject and its important concepts.

Mr. Leon was explicit in advising the class that there were questions on his tests for which they would have to read the textbook, because they wouldn't discuss the answers in class. "This is a reward to those of you who read the book," he stated. Even during a review game where he ran out of test questions, he refused to ask them the extra questions from the book, because he wanted them to read.

Another part of Mr. Leon's classroom routine was using PowerNotes for studying and as a basis of assessment. Buehl (2009) describes PowerNotes as an organizational literacy strategy, where readers learn by reorganizing the ideas of the author. When I interviewed Mr. Leon about what kinds of reading strategies his students learned, he described PowerNotes:

One of the things we overtly focus on is what we call PowerNotes. It's really outlining. All social studies teachers have agreed that we should really do that at least once per unit, and so we have them take outline notes or what we call PowerNotes, on a section of the book. Usually it's maybe the most crucial section so that we are assured that they've read the text. That's probably the biggest

dilemma, actually getting the kids to read the book. I think we're naïve, too. If we think back to when we were in high school, and probably to a lesser degree in college, I think we tried to get by with, in many cases, reading as little as we had to. And so I want to have assignments that they have to read. And obviously note-taking can't be done without reading the text.

In this excerpt, Mr. Leon began to share how he selected the most important information students should learn and targeted those sections in a PowerNotes assignment for each unit. I asked him if someone showed them how to do the PowerNotes strategy:

Yeah. So in the first chapter **showing me pages 7-9 of a unit packet,** here's the outline format. So in the first, a power 1 is a bold-faced heading, blue bold-faced heading, which is the first heading. A power 2 is in the red bold-faced heading, which is like a supporting detail heading or subheading. Power 3 is the main idea or topic sentence of EACH paragraph. And then a power 4 would be a black bold-faced or italicized word. And that's only necessary if that's not already the main idea, which is often the case.

And so here, I will have worked through, I did this Tuesday. I worked through the first several paragraphs and said, "Okay, well, let's read this paragraph together. What's the main idea? And then I provided the examples. Then I do what's, I just broadly refer to it as PowerNotes on training wheels, **indicating partially filled-in outline on page 7** where I give them the number sequences and the indenting and so forth. And then the rest of the assignment they do on their own. And they are juniors and seniors. Most of them should have done PowerNotes in their other Social Studies classes, maybe in other classes as well.

> And so I walk through that, and at the end of that particular hour, on Tuesday, I said, "Okay, guys, show me your sign" **holds out thumb in three positions: thumb up, thumb sideways, or thumb down** "in regards to this skill. Thumbs up if I get it, sideways if I'm not sure, thumbs down for, Mr. Leon, are you speaking a foreign language?" **We laughed.** So that's kinda the way we do it after an overt, maybe 5-10 minutes of understanding the technique.

In this comment, we see an example of Mr. Leon's regular formative assessment techniques, the thumbs-up or thumbs-down check-in with students, as well as his description of his organizing strategy for note-taking. After his direct instruction lesson on PowerNotes, he checked students' understanding of what they were required to do. After that, students had full responsibility of demonstrating their skill at PowerNotes once each unit, through the nine or ten units of the semester. We can imagine how skillful students became at this style of note-taking by the end of the semester!

Then Mr. Leon asked if I was interested in how he used the PowerNotes for a quiz. When I agreed, he continued:

> Over there, where it says "Wednesday, P/N quiz?" **pointing to the schedule on the side board.** The day after we take PowerNotes, I put out a dartboard and have a kid come up. I talk about this ahead, they throw three practice darts and the fourth one counts. If they hit an even, we have no PowerNotes quiz. **He laughed.** If they hit an odd, we have an OPEN PowerNotes quiz. This is the assignment, if they skip any, this is the one they skip. So I want this variable interval schedule of reinforcement **We both laughed** for them to do their PowerNotes. And if they. . .

I was excited about the PowerNotes quiz, and accidentally interrupted, "And the fact that they can use it. . ."

> Right! And I say to them, Guys, if we have a five question quiz, that you can use your notes on, shouldn't that be pretty easy? And of course they all agree that it should be. I would say out of my 85 kids, granted this is still the second week of school [of the spring semester], I would say that probably 80-82 out of the 85 did it. Probably only three to four, max five, didn't do it.

"Wow. That's really good," I replied.

Mr. Leon said, "Some were still in the honeymoon phase, somewhat, and maybe some were scared of the quiz."

I asked, "Was it the first quiz?"

"Yeah, and one class had it and two didn't. Y'know, just there's a fifty-fifty shot, unless of course you can't even hit the dartboard," Mr. Leon replied. During observations, I saw the dartboard used a few times, usually successfully. A few times, I observed that when the class didn't have the PowerNotes quiz, Mr. Leon would still use the quiz as a formative assessment. He let students know that the quizzes wouldn't be graded or scored, and then passed them out and told students to try their best at answering them. When they were finished, they went over the answers as a class. Mr. Leon encouraged the kids to make notes of the answers they missed, and use that to review and study before the unit test.

Literacy strategies in the Psychology classroom. We return once again to Gee's idea of Discourse theory (2012) to remind readers that disciplinary literacy can take the form of writing, reading, speaking and/or thinking like experts do. For Psychology, Mr. Leon focused on

how students learned to think about Psychology and apply the content knowledge and skills to other classes and adult life, as we see when he described the learning of an ideal student:

> They will hopefully be able to have a mastery of the vocabulary, be able to integrate it into their discussions, to show they have some upper level understanding: analysis, evaluation, applications, etc. Ideally, they might be able to cite some of the studies, or things we've talked about. I think more than anything else, they might just show a critical thinking ability. In terms of understanding that there are various research methods that psychologists use, some of them more reliable than others. Each have advantages and disadvantages. So if we're looking at learning, intelligence, personality, understanding that there are multiple perspectives, all psychologists don't agree. Theory should be backed up with some sense of reality. So there's got to be some way to measure whether these theories are true or not. So I guess more than anything else, I would want them to be able to look at a situation, dissect it, be critical, and probably apply theory and vocab to understanding.

Mr. Leon envisioned his class as changing the way that students thought in their everyday lives. He wanted them to be reflective about what they saw happening around them and why. He also wanted them to demonstrate critical thinking and understanding of the bases of psychology in their words and actions. Students should learn that people's experiences are influenced by their own perspectives. While he was speaking about an ideal student here, we can see examples of Mr. Leon prompting students to think through psychological lenses in excerpts from his classes.

When I asked Mr. Leon about literacy, he focused on the practical application of psychological principles to students' real lives, immediately and in the future. He didn't focus

on literacy as only reading. Yet his classroom represented the only one that I observed where reading during class played a critical role. Psychology students were expected to bring their textbooks to class every day and to keep up with the assigned outside reading. Unlike in Chemistry, for Psychology the readability formula gave a valid text complexity level, so I was able to refer to reading levels in my discussions with Mr. Leon. The composite reading level of samples from the textbook was at about tenth grade, which should have been within most junior and senior students' comfort zone for comprehension. Often the homework required in-depth reading for information retrieval as well as personal interpretation of the concepts. In addition to the textbook, Mr. Leon enriched the topics by including popular psychology articles that were usually written at about a high school senior or college freshman reading level. These could have been challenging for students, but were well-scaffolded and on topics of high interest to adolescents, such as one article describing links between playing video games, acting violently, and watching pornography.

In Mr. Leon's classroom, I saw students reading and writing to learn, in the daily starters and on homework. He also had them speaking to each other to learn, in think-pair-share activities before a larger class discussion. He explained to the class how the activities would benefit their learning in psychological terms. For example, before a conversation on ethics, he had students review ethical guidelines for research on humans or animals from the American Psychological Association, and then turn to their partners to tell them at least three of the guidelines that they remembered. Mr. Leon explicitly told them why turning to their partner and talking would help them to learn:

> If you guys can say it out loud, this is kinda how your brain works. If you guys can say it out loud, if you can tell somebody else, it's going to register in your

> brain. So that's why I want you to turn to somebody else and say it, say a couple things that you remember. It enhances memory, that's why we do this kind of stuff.

Not only did Mr. Leon incorporate many active learning activities into Psychology, but he also used his explanation of what they would do and why to enhance students' learning about the human mind. He wanted them to know how they thought and how they might improve their habits of thinking.

To illustrate how Mr. Leon organized classes to provide opportunities for students to think through psychological lenses, I share two classroom examples showing combinations of large group discussions, student-to-student interactions, and small group collaborations. I chose these based on students' contributions that indicated they were internalizing the norms and conventions of psychology Discourse. Both of the Psychology classes I observed followed the same lesson plan. But in these interactive classrooms, the hours were different based upon the personalities and viewpoints of the students. I have combined the discussions, with notes on which hour student contributions occurred in, to present a composite picture of the students' engagement with the topics.

I tended to hone in on a few specific students in each class based on their proximity to where I sat, the volume and frequency with which they contributed to discussions, and from recognizing individuals in other classes. For example, Julia from the Chemistry class pointed out that she was in Mr. Leon's fourth hour Psychology when she handed in her research permission slip. Yet I never captured any data from her in Psychology, because I never heard her speak in the whole group, and her small group members didn't have their permission slips handed in to be recorded.

On the other hand, there was a student I had seen in math classes, Michael, in Psychology during eighth hour. In the math classes, Michael had refused to answer questions or demonstrate problems on the board. He truly seemed to struggle in that subject and seemed to be a poor student. But in Psychology, I witnessed how Michael voluntarily and regularly contributed to discussions, expanding on ideas from the book to add his own interpretations. As Buehl (2011) and others have noted, students have different comfort levels with the literacies in different classes. We can't observe how a student behaves in one class, and assume that we understand that student's overall capacity for learning. Psychology seemed to reach students who may not have been avid students in other classes. We see that in the first example, a whole-group discussion on different philosophies of life.

Worldview discussion. At the end of February, the fourth hour class had finished the first unit on memory and had begun the second unit, an introduction to the types of psychologists. To help students consider why psychologists have different perspectives on human thinking, Mr. Leon had designed a worksheet on their own worldviews. He reminded them that for the assignment, he was not grading their answers, but their effort.

As Mr. Leon prepared to have students discuss their worldviews, his lesson plan looped into a brief focus lesson on their study of psychological theories. He shared a graphic organizer that he had designed for himself in college, to help clarify differences among theories. He told them that they didn't need to copy it down, that it was just for their own information. "It's not going to be on the test, you don't have to worry about it. It's just that I have found it helpful, so maybe you'll find it helpful, too." I didn't see anyone in fourth hour writing, but in eighth hour, John and Anika pulled out their notebooks and copied the chart down. Not only was Mr. Leon

reviewing the theories they had learned by utilizing visual learning, but he also modeled how he sometimes created graphic organizers to aid his own learning.

The diagram presented four quadrants of "internal to external" on the x-axis and "determinism to free will" on the y-axis. Inside each square of the grid, the teacher had organized the different schools of psychology according to where on each continuum they fell. Using the diagram, Mr. Leon quickly thought aloud about the different schools of psychology they had learned according to their views on humanity's choices. When he had explained three of the quadrants, he pointed out the question mark drawn in the fourth one, the intersection of external control and free will. "So, question: There is no psychological theory in this quadrant. I'd like to say that there never will be. Why not? Why will there never be a psychological theory that fits this quadrant?"

Jasmine answered, "Can't be external and free will."

"You're right," Mr. Leon affirmed. "Explain."

"Cuz one's like external, so you don't have control, and the other is internal."

Mr. Leon said,

> Right. Very good. Will there ever be a thing that's outside of me that I'll ever have free will over? No. I don't have free will over my genes, I don't have free will over my environment, I don't have free well over whether it snows. I don't have influence over those things, so there will never be a theory. If there are any new psychological theories, they'll be in these categories.

He pointed to the other three quadrants as he finished talking.

But Jasmine was still thinking this through. "Don't you think that external forces could take over your free will?" she asked.

Mr. Leon answered, "There's no question that outside forces shape me, and then we'll be back up here again," as he pointed to the external forces and external control quadrant. "Right? Cuz I'm not in control of them. That's a great question. Remember: My environment shapes me," as he pointed to where he had written "behaviorism." "No, it's my gender," he continued, pointing to "sociocultural." "It's because I'm an American." Mr. Leon immediately praised Jasmine's willingness to challenge the ideas he presented in class, and then explained why his original claim was still accurate. This was one of the regular ways that he kept students engaged in classroom conversations. Before turning away from the graph, Mr. Leon used it quickly to remind students about different theories underlying psychology.

For the last activity of the day, he asked them to get out their homework assignment, the worldview worksheet. The worksheet presented six philosophical questions about how people view life. The unit included the idea that different types of psychologists viewed the world differently. Mr. Leon wanted the students to think about how their own perspectives colored their views on reality. In both hours, Mr. Leon went through the questions one by one and asked volunteers to share what they thought. The questions included scaffolding that guided readers to choose from some common answers. (Please see the worldviews worksheet in Appendix K.)

Students were assigned the worksheet the night before, and were expected to come to class with it completed. At the beginning of class, Mr. Leon had gone around and stamped them for completeness, reminding the class that there were no right or wrong answers. He guided the class into the activity:

> Alright, let's shift gears and look at your worldview sheet. These are very personal answers, they're more like philosophy or religion. But why are there different psychological perspectives? Cuz psychologists have different beliefs of

how people are. So let's do a little analysis for yourselves. My goal is to get you to start thinking about, Do I have a philosophy, or a worldview, or a filter? If you want to share, great. If you don't want to share, that's your call.

In framing the discussion of the worldview sheets, Mr. Leon acknowledged the personal, philosophical nature of the questions. He acknowledged that they may not want to share such sensitive ideas. At the same time, he reminded students how different philosophies could lead people to different psychological theories, connecting the activity to the current unit.

Mr. Leon continued, "Here's some tough questions. 'What if anything is the meaning of life?' And I gave you some theoretical options." He read the parenthetical options after the question, but still no students volunteered an answer.

After about five seconds of silence, Mr. Leon reassured them, "This is what usually happens. Okay, your answers may be somewhat close to these categories. How many people would say, 'My answer's kinda like, 'We're here to seek some kind of truth outside of ourselves'?" A couple of students raised their hands. Since none of the students were willing to venture an answer at first, Mr. Leon had shifted the method of participation to something less intimidating, a show of hands. This allowed students to indicate their thoughts without having to explain or defend their ideas in front of their peers until they were ready.

"Alright. We're here to basically pass on our genes. My answer's something like that." As Mr. Leon waited, three hands went up. He offered, "How about, 'I think, I don't know what, but I think we evolve to become something else.' Anybody's answer in that category?" After no one responded, Mr. Leon said, "Or how about the last one: 'Everything is really meaningless. There's not really any purpose.' About five hands went up. Despite the shift in participation style, approximately two-thirds of the class hadn't responded to Mr. Leon's polling.

"Okay. Anyone want to throw in their thoughts?" Mr. Leon asked.

Monica said, "I put that the purpose of life is just to enjoy yourself." Alayna started to respond, but stopped. The teacher turned to Alayna, but then caught himself and went back to Monica. "I'm sorry, did I just shut you down?" he asked. But Monica simply asked if she could go to the restroom. In his careful orchestration of the class discussion, Mr. Leon had no difficulty apologizing to a student when he thought that he had prevented her from adding to her original answer.

As she left, Mr. Leon picked the conversation back up. "If your purpose of life is to enjoy yourself, how could. The real bottom line is number 6. How could the above answers and thoughts affect your behavior? How could that influence how you act?"

Jasmine answered, "YOLO lifestyle."

"Okay," the teacher accepted her answer. "YOLO, meaning?"

"You only live once," replied Jasmine.

Mr. Leon clarified, "So, what is that like somewhat of an excuse for?"

"Not caring," Jasmine said.

"Doing whatever you damn well please," responded Mr. Leon. "I want to do it now. Have you ever heard the phrase, 'Carpe diem'?" Several students agreed they had. "Seize the day," said Mr. Leon. In eighth hour, Mr. Leon got more emphatic about what YOLO meant: "I'm going to do what I want, when I want, with who I want, as often as I want." The kids laughed in reaction and several said, "Whoa!" Mr. Leon continued, "Okay, YOLO, those are in the same category: I don't know what's going to happen. I'd rather have fun today. Any other thoughts on this one?"

Mary volunteered, "It's kinda like, live and learn."

"Live and learn," repeated Mr. Leon. "That's the goal. Is that something you decide for yourself? Do you think that's a goal for life always? You might not know."

Jasmine interjected, "I don't know. Of course there's like purpose in life, but there's not one big one, I don't really think. Cuz like, when we're gone, no one's going to miss us. Nothing will really have changed or altered."

"Okay," said Mr. Leon, and called on Anthony, who had his hand raised.

"It's to improve yourself," offered Anthony. "To make yourself better every day."

Mr. Leon questioned, "So does that mean we have to go to school, or we should go to school for as long as we possibly can?"

Several students responded at once. Alayna gained the floor and said, "I think it depends on your morals."

"Please explain," said Mr. Leon.

She continued, "Some people value school and some don't. Some people come here and they don't even go to class."

"You're absolutely correct," affirmed Mr. Leon. In fourth hour, they moved on to the second question, but we will first hear more of the student exchanges over the first question from eighth hour.

John volunteered immediately when Mr. Leon first asked what they thought of question one. "I personally think this is, I mean it is an opinion question, but for me, myself, I think it's the pursuit of happiness of myself and others, and the adventure of life."

Mr. Leon baited him, "Okay. Are you happier inside the school building or outside the school building?"

But John didn't take the bait. "Outside the school building, but because I'm investing my time in school so I can venture outside the school building."

"Alright," said Mr. Leon, acknowledging that John had avoided the verbal trap. "Any others?"

Anika spoke up, "Mine is kinda negative. I put to make a difference or to pass down your knowledge, but ultimately to die. Personally, I think it's pointless. I don't know. It's very negative."

Mr. Leon responded, "So you're somewhat torn. Alright. Any others?"

Emma said, "People have pretty much the same purpose as anything else in the world, any inanimate object, and we're not really here for a reason."

"So you are as purposeful as this stapler?" asked Mr. Leon, holding up his stapler. Several kids giggled. "Alright, okay. Anyone else?"

Loredana volunteered, "You do the best of your ability to make the world a better place. It may sound weird, but I really believe it. And anyway, we are here. Once you're born, you're here. So why, just make something that could be useful for you and for someone else."

Mr. Leon revoiced, "So even if there is no purpose, it's better to live as if there is one, because it makes life better." Loredana agreed. Notice that throughout the class conversations, Mr. Leon revoiced students' ideas, checking with them that he had added to or clarified their ideas accurately. When done well, this can be an effective instructional strategy for encouraging participation from students who may struggle to put their ideas into words in a public situation, such as English language learners or others (O'Connor & Michaels, 1993). It seemed to encourage Mr. Leon's students to continue voicing their thoughts in his psychology discussions. In fact, the discussion continued, and even got heated at times, as students explored their own

worldviews and challenged each other's thinking. (Interested readers may access the rest of the Worldview discussion in Appendix L.)

As class drew to a close, Mr. Leon concluded, "Here are the universal truths. The packet is due on Tuesday and there will be a test." He laughed. "You can say, 'Mr. Leon, how dare you impose your morals on me!'" Some of the kids laughed as the bell rang.

While this exchange happened in Psychology class, it took students far beyond the text to consider and debate tough ideas from philosophy and religion. Mr. Leon artfully orchestrated the discussion to encourage students to share and debate ideas. He praised students for their contributions and challenged them to extend their thinking past their personal boundaries in ways that were respectful and ascribed value to their thoughts and opinions. In this way, Mr. Leon was a master at drawing his students into whole group discussions and maintaining a healthy level of regard for each participant.

We saw participation from a range of students in both classes, not just the few who spoke frequently in every discussion. The reader may notice that students were interested enough in the conversation that they talked directly to one another, rather than waiting for the teacher's response in the typical classroom discussion pattern of Initiate-Response-Evaluation (I-R-E; Mehan, 1984). During I-R-E, the teacher asks a question, calls on a student to respond, and then evaluates the student's answer. Then the teacher calls on another student, and students never speak to each other. Instead, the students in Mr. Leon's classroom often spoke directly to one another during discussions.

This discussion even drew active participation from Monica, whom I knew from summer school as a struggling, angry student. It seemed to be a turning point for her in buckling down and taking more responsibility for doing well in Mr. Leon's class. She regularly announced her

scores on tests and quizzes to her friends and the teacher, and these went from being mostly Fs at the beginning of the semester to Bs and Cs. I even noticed that during one review game, she volunteered to be the scorekeeper, and had her note pages and a pen with her, furiously scribbling down notes after each question. It seemed that the atmosphere that Mr. Leon created encouraged students to prepare and participate in psychological Discourse.

Zzzquil Single Blind Study. Other collaborative activities in Psychology required students to go beyond simply learning information about psychology, deep into considering how to design the work of a psychologist. This second classroom example required students to synthesize information from the book, films and class discussion in order to create a new product, a verbal proposal for a psychological experiment.

The class was reviewing independent and dependent variables, and other elements of research design. They worked through worksheets and took a quiz on the concepts.
Then the class watched videos of previous years, when Mr. Leon had assigned students to design and record their own experiments. After the videos, the class discussed the research design, both positives and negatives, of those previous students' experiments, using appropriate terms such as "experimenter bias" and "testable hypothesis." Mr. Leon wound the discussion to an end and moved the class into a collaborative guided practice of the concepts they were learning:

> What we're going to do for the next twenty minutes, I'm going to let you pick groups of five, approximately. And I'm going to ask, give you maybe some guidelines. But I want you to theoretically design an experiment. You're going to come up with a topic you want to study, and then describe specifically how you'd carry it out. In a way that makes sense with the things we've been talking

about, how to conduct a good experiment. Go ahead, get into groups of five. Take your stuff with you. Five or slightly more or less, I guess.

I walked over and asked Anika, Madison, and Nina if it was okay to record their group. Madison asked, "Video recording?"

"Nope, just audiorecording," I explained.

"Oh, that's fine," she said. I set the recorder in the middle of the cluster of desks, on Nina's desk. It was convenient because I was close enough to listen to them and record their gestures as well as transcribe their words verbatim from the tape later. It was also funny, because the recorder caught several comments made by Anika under her breath during the presentations, perhaps because she knew she had an audience.

"I wish we had more people," said Anika. There were only the three girls in their group. They asked John to join them, he pulled his desk over, and they got to work.

Anika suggested, "The science of M & Ms and how they taste."

"No," Madison shot her suggestion down.

"Well, I don't know. What about brown ones?" insisted Anika. "Cuz there's less artificial coloring."

Mr. Leon got the whole class' attention to give them directions. Three of the groups would design controlled experiments, like on page forty-one.

Anika groaned, "Oh, he's going to tell us stuff." It seemed like Anika wanted less scaffolding from the teacher.

As the teacher reminded them about the differences between control and experimental groups, Madison asked, "Page thirty-one or forty-one?"

"Forty-one," confirmed Anika. Madison opened up her textbook.

Mr. Leon finished, "Okay? Each group, come up with a different study." To the first group he said, "You guys, I want you to come up with a study utilizing a placebo." The teacher continued, "That would be on page forty-two."

Mr. Leon made his way to my recorded group. "You guys over here are going to design a single blind study, which is on page forty-three." As he went to the next groups, he told the whole class, "Any topic. I'm most concerned with how you set it up."

In my group, Madison had her book open. Anika and John had their books on their desks, but closed. Nina didn't have a book out at all. Anika suggested, "We should do that thing they did on Family Guy. Weimar was about to go [indecipherable over background noise], and then the guy rips the skin off his arm, and Peter's like, 'Weimar, stop freaking out. One of us is about to go crazy!'"

Nina laughed, and then asked, "Wait, how would you test that?" Notice that Nina took Anika's humorous reference to pop culture seriously, relating it immediately back to the task at hand of designing an experiment. While it could have been a tangent or distraction in other circumstances, in this group each suggestion was considered through the lens of designing a psychological experiment.

"I'm not. I don't know," admitted Anika.

"So we need something with people," suggested Madison. It was interesting in this discussion to see how the students operated like adults, politely redirecting others back on topic and respectfully questioning the validity of each suggestion.

Nina and Anika agreed. Looking in her book, Madison read, "Single blind study."

"It's where the researchers know what they're doing."

Madison said, "Yeah, but they don't."

Nina contributed, “So it could be like a naturalistic observation, because they wouldn’t know.” Notice how easily Nina used the term “naturalistic,” assuming that her group members all understood what that was. By this point of the unit, Mr. Leon had taught the different types of observations several different ways, following the GRR model, so students seemed knowledgeable about them. Plus, students’ group posters on different observation types still hung in the room, adding a potential source of reference in the classroom’s environmental print.

Madison added, “It could be pills, too, placebo, because they still wouldn’t know. It’d still be single blind.”

“Um,” started Anika. “We could test.” She paused, then continued, “I wanna do something with puppies.” While the group’s discussion was following fairly mature lines, Anika’s comments and those of others remind us that high school juniors and seniors are still children. Their discourse during a task will reflect their immaturity, as well as their burgeoning maturity and gained knowledge.

“We can’t,” said Madison. “Is he going to make this real, though? Like, do we really need to?”

Anika said, “If he is, I have the puppies.”

“No, we don’t have to make movies on this,” said Nina.

“Yeah, we got the puppies,” repeated Anika. The three girls laughed.

“But do we actually have to like [indecipherable over background noise]?”

“No, it’s theoretical, he said,” responded Anika. “Let’s write it down.”

“Let’s buy turtles,” suggested Nina.

Madison asked them, “You guys know what a single blind study is, right?” When they both said, “Yeah,” Madison closed her book.

"Well, so," said Anika. "Animals don't know if it's an experiment or not."

"No, that's double blind," said Nina.

Anika insisted, "It would be single blind, because the people can see what they're getting, so like. . ."

Madison interjected, "So if I'm like a scientist, and I have two people, I give one a sugar pill and one a Tylenol. They don't know, but I know." As the three girls debated what would or would not be a single blind study, we see them grappling with the definition, using what they have learned to explore how to apply the definition to a real experiment.

Nina brought the group back on track with a main question that psychologists ask themselves, "What do we really want to know?"

John suggested, "Why am I thinking like energy drinks, and seeing if people would be more hyper if they had the placebo?"

"If they were just having like some caffeine-free soda, but they got all hyped up and rude?" asked Anika.

"Yeah," confirmed John.

Madison added, "Right, cuz my brother's always saying, 'Every time I drink a Mountain Dew, I get this much better at Call of Duty.' I'm like," she tilted her head back and rolled her eyes. The three girls laughed. Madison continued, "'Oh my god, no you don't! You really don't.'" There was a pause in the conversation.

Nina said, "Well? Okay, that's what we can do. We can. . ."

Madison asked, "Do you really think there could be a drink that would taste the same as an energy drink, but without the effects?"

"That's true," said Anika.

John said, “That’s why I was thinking more along the lines of a protein shake. But one would be like. . .”

“Like a vitamin water almost?” suggested Madison.

“Yeah,” agreed John. “But.”

Nina finished his thought, “Do you feel better?”

John admitted, “Well, you can’t do that.” Now the group began to grapple with selecting a measurable dependent variable. In class, they had learned and discussed whether or not certain dependent variables were measurable. Here, the group was synthesizing that learning into their own “product.”

Anika questioned, “Do you feel electrolyzed?”

“You can’t, because you can’t tell if they’re going to be hyper or not,” said Nina.

“That Gatorade does that,” said Madison. “If I drink that like, ‘Ooo, electrolyte Gatorade,’ before I go to bed, like I can’t go to bed. Like it kinda like tweaks me open.”

Anika responded:

> Ooo, I know. Okay. The Marley Mellow Mood stuff, that’s supposed to make you literally tired. Before you go to bed. It’s like Bob Marley drink. Brian [her boyfriend] drinks it all the time, right before we’re supposed to go to bed. And he’s like, “I’m not tired, I’m going to drink one of those.” And then he’s like, “Ah, so tired. Just going to go to bed.” I’m like, “That did not do anything to your tiredness.”

Madison agreed, “Yeah, it’s all in your head. I like that one.”

Nina offered critical feedback, “You can’t measure how tired someone is.”

“Yeah, I guess,” admitted Madison.

"Um, what about a low stress piece?" suggested Nina.

"No, you can't measure stress in someone," said Madison.

Anika suggested, "What you could do then, is you could time how long it takes for them to go to sleep."

Nina agreed, "Yeah, that would make sense."

Madison countered, "But some people naturally can't go to bed sometimes. Depending on how many hours of the day you've been awake and like."

"Yeah," said Nina shortly.

Anika sighed, and said, "Man!" They had been making progress, but had hit so many obstacles to their first idea that they were having a hard time working their way through them. But they continued to brainstorm.

"We're drawing a blank here," said Madison. There were a few seconds of silence, then Madison suggested, "Well, we could just give animals energy drinks."

Nina laughed, as Anika said, "No!"

Madison continued, "Cuz people are more likely to be like, 'Well, I'm hyper now,' and acting all obnoxious. But animals would be actually like. You can tell if they act different and are all bouncing around their cage."

Anika said, "We are not giving an animal an energy drink!"

Madison laughed, then said, "Sorry."

"It's a hypothesis. It's not real," pointed out Nina.

Anika said, "Let's just give them tabs of acid. God!"

The girls laughed. Nina said, "Oh my god! We're being recorded and she's hearing us. And you're saying that stuff."

Anika redirected the group. "Okay, anyway. We should see how many people think [indecipherable as she dropped her volume] smells good. And who doesn't."

"How can you make that into a single blind study, though?" asked Madison. "You can't." Even during this brief exchange of silly and inappropriate ideas, the group was still referring back to their group goal of designing a single blind study.

Nina said, "The only thing we could do is pills."

"Yeah, if you get a placebo," said Anika. "Or give them a Tylenol. Does it really work?"

Nina started, "What about. Give them like. Because it has to do something."

Anika suggested, "We should give them something that numbs their body, tell them it numbs their body. And then just poke them with something, and see which one says 'Ow' and which one doesn't."

Nina laughed, and Madison commented, "Wow."

"Um," started Nina, but then John said, "Or take Dayquil and Nyquil. Mix the two, and say."

"Yeah!" agreed Nina.

"There you go," said John.

Anika criticized, "But then again, we don't have the fundamentals to see what the negative effects are of them, if you take them during the day or at night."

Madison said, "Well, the night one's supposed to make you sleepy."

John clarified, "I mean, you tell people it's Nyquil, even though it's Dayquil, and see if they fall asleep. Their thinking about this will help them go to bed."

Madison directed, “But how do we put that into a ‘If-then’ statement?” Here we see the next logical step: they had chosen possible independent and dependent variables, which now must be phrased in the correct psychological format.

“If people think they’re taking Nyquil, but it’s actually Dayquil, they will fall asleep,” replied Anika.

Nina said, “Then they’ll believe they’re taking something that helps them fall asleep.”

“And then they’ll believe, yeah,” agreed Anika. She called across the room to the teacher, “Should we write it down, or?”

Madison asked, “What about the Zzzquil stuff? We could get a bit of action.”

“The what?” asked Anika.

“Zzzquil,” repeated Madison. “Zzzquil’s the best.”

Nina added, “The non-habit-forming night aid,” in a singsong voice.

Anika started, “It’s just like the. . .”

John said, “It’s like a sleeping pill.”

“It’s like Nyquil but it’s not for medicine, it’s just for sleep,” clarified Anika. “So we could say that we’ll give them the placebo one, and say that’s what it is, and see if they fall asleep around the same time as the ones that actually took that pill.”

Madison said, “Right.”

“Yeah. That or medicine,” continued Anika. “It fights all the same symptoms as medicine. Except you just sleep then.”

Nina asked, “But what does it say, what does it say on the pill, if you know how long it actually takes for them to go to bed? Or to get drowsy?” Notice as the group began to make progress again, they resumed their close analysis of each aspect of their theoretical experiment.

"I don't know," said Madison.

"It's probably one to two hours," Anika guessed.

Madison said, "Take thirty minutes prior to wanting to go to bed."

"Packages are supposed to say that," said Nina.

"Yeah," agreed Madison. There was a pause in the conversation.

"They do tests, actually, to see if it does that. Check your brainwaves and stuff," contributed Anika.

"Right," said Nina.

"Poke them with a stick to see if they sleep," suggested John.

Nina laughed as Anika said, "No."

As Mr. Leon walked by, Madison asked him if they needed to write the experiment down. "No, I'm just going to ask you to describe it," answered the teacher. "I'm going to ask for your examples in just a second. Just make sure you explain it specifically."

"Should we tell you what it is?" asked Madison.

"I trust you. Are you guys good?" asked Mr. Leon. They all gave him the thumbs-up, and he moved to talk to the next group. As the groups worked, Mr. Leon made his circuit to quickly check in on the progress of each group, and help any groups who were struggling, before requiring them to present their ideas to the whole class. These quick check-ins to each group's progress was another way that Mr. Leon scaffolded the upcoming discussion, to build students' confidence and encourage thoughtful, relevant conversations.

"I like this one. It's a good one," remarked Anika.

Nina said, "If we were to do it with like medicine, we'd have to actually find people who had the same sickness going on, with the same symptoms."

It's interesting that despite being ready to share, the group was still working through the details, improving the experiment. Madison said:

> We'd have to tell them to set an alarm for a certain time in the morning, so they would be up for the same period of time, and then tell them both to take it at eight o'clock at night and then see how long.

"And then it depends like, what if someone drinks alcohol?" asked Nina.

Madison suggested, "Just a normal day. Like, you eat breakfast."

"What if someone puffs during the day? Would it have to be someone who?" asked Anika.

Nina clarified, "We'd have to be specific about something like that. Or if someone comes and sits in this room, all day."

Madison added, "Like we could have them eat turkey for dinner, because that makes you tired anyway. Like the turkey has the effect of tiredness."

Anika said, "So we can just make a list of what they're supposed to eat."

"Right," responded Madison. "And then what about daily routine then, though? Like you should tell them that they have to exercise at this time. Like we have to keep them busy, we have to keep track of them."

"You have to watch TV," suggested Anika.

"Or they could just hang out together," said Nina.

Anika agreed, "Yeah, cuz I think we'd have to have them in a room all day."

"Yeah, cuz it'd be like a lab experiment," added Nina. By this point, the group had shifted their type of observation from their original naturalistic idea to a lab setting. The shift in setting followed naturally from their conversation about the requirements of their experiment.

"Yeah," agreed Anika.

"We could do that," said Nina.

John asked, "Is this one day, and tell them exactly what to do, and they get paid for the research?" Now John had moved further into the details, even considering whether or not participants should be offered financial incentives. Before anyone answered, Mr. Leon raised his voice to get everyone's attention, "Alright, guys!" As they moved their desks back into rows, Anika grabbed the recorder off of Nina's desk and put it on her own. She volunteered to share their experiment to the class.

The teacher reminded them of the different designs, and asked, "Remember, what's our goal here? What are we even doing this for?"

"To get results!" volunteered Anika.

"To figure out, to understand what are the components of a good experiment," said Mr. Leon. He called on the first group to share their experiment. It was a placebo test with Tums and sugar pills. Quietly into the recorder, Anika commented, "Poor kids. Think they're getting Tums."

The next group shared a double blind study using PowerAid or GatorAid with football players. The next experiment was a controlled experiment of water temperature on fish. Mr. Leon pointed out that measuring activity in fish was tough. Anika whispered to the recorder, "Because they swim all day." Then she sang a few lines from the movie *Finding Nemo,* "Just keep swimming, just keep swimming, just keep swimming, swimming, swimming." She added, "That'd be boring. I wouldn't want to watch a fish all day." As I transcribed this part, I chuckled to myself, wondering if Anika was narrating the group discussion for my benefit.

Mr. Leon told Anika's group to go ahead. Anika reported out:

Okay. So we were going to test the effects. What we have, single blind study. And we are going to basically put two people in a big room, so they're not bored. Wake them up at the exact same time of the day, and make them both do the same activities during the day. At the end of the day, around eight or nine o'clock, cuz they'd have to take a. One would take, what was that called?

Madison and Nina both said, "Zzzquil."

"Would have to take a Zzzquil," continued Anika.

"Okay," said Mr. Leon.

"And one would take a sugar pill. And we would test to see who would fall asleep first. Or who would be drowsiest." Although Anika didn't use her group's "if-then" statement, we see the independent and dependent variables in her description of their experiment.

"Is that a, I'm not familiar with that," said Mr. Leon.

"It's a non-habit-forming sleep aid," explained Nina.

"Okay. So who doesn't know what's going on?" asked Mr. Leon.

"The people," answered Nina.

"Does the experimenter know?" asked Mr. Leon.

"Yes," said Anika.

"In this case, it's only a?" prompted the teacher.

"Single blind," finished Anika.

"Single blind study," repeated Mr. Leon. "Good job."

Anika's group offered a strong example of how Mr. Leon structured his class to offer students many opportunities to speak about their Psychology learning. This example of a group creation of an experiment required students to apply the background knowledge they had gained

over the last several units. They synthesized the elements of an experiment through creating their own. Throughout the process, they challenged and critiqued their own ideas and each others' through the perspective of experimental psychology. From the recording, we can see that the discussion went more in-depth about the small details of the experiment than was shared with the class, such as the false starts, reasons to shift, and consideration of how to maintain equal circumstances for the participants. Since each group in Mr. Leon's class had a valid experiment to share during this activity, we may assume that similar conversations took place in all of the groups.

Mr. Leon's classroom had a lot happening in it each day, more than I can share here. There were a lot of literacy practices occurring when we think of literacy as capturing instances of students engaged in psychological Discourse through reading, writing, listening and speaking. We see examples above, especially in the Zzzquil activity, where the students thought like psychologists to create an experiment that helped them view the world through a psychological lens. They worked with the ideas of the independent and dependent variables, thoroughly evaluated the conditions and premises of their study, and even considered finer details like participant reimbursement. As a group, they evaluated each idea within the constraints of psychology and synthesized ideas that they had learned throughout the semester to create their own experiment. Students worked with the information from the textbook, videos and lectures to build a knowledge base about how psychology functions as a science. Mr. Leon regularly demanded this type of higher level thinking from students in discussions and small group collaborations. His careful structuring of the discussions and group activities encouraged students to speak about the ideas that they were learning from reading, and to use their increased knowledge to create new experiments.

Constraints on teaching. During our final interview in May, I asked Mr. Leon whether or not he had incorporated the district initiative writing into the regular Psychology classroom, and what type of writing students did. He responded:

> I have utilized my starters, my daily starters. I've done those for the last ten years. And so I modified them a tad, to make them more analysis, application, synthesis, evaluation, and less just straight comprehension. But I made some modifications and put them on the T drive. I have co-taught this class with other teachers and gave them the starters as a suggestion. That hasn't been for a while, so I assume others have done it that way. I love them. Regardless of whether it's a school improvement goal, I'm going to continue to do them, because I think it manages the students well at the beginning of class, redirects either on a lesson that we've previously taught or introduces a new one. It's developing skills. So I do think it's probably one of the more effective things that I do.

Just like we saw with Mr. Hayes, Mr. Leon described the writing initiative as having minimal impact on his instruction. He did make some improvements on the assigned writing, by making his daily starters require deeper thought from students. But this was an activity that he had done for ten years, so it seemed that he would have assigned these quick writing activities regardless of the initiative.

I asked Mr. Leon how effective the district's writing initiative had been. He replied specifically about his own activity:

> Motivating people to get it done. And I don't want to necessarily do it through negative reinforcement, but I do do that. I try to mix, I think you've noticed, I try to mix up who I call on. But I definitely imply to kids, as I'm walking around,

that if they haven't done their starter, I'm likely to call on them. **We both laughed.** So is this punitive? To some degree it is. But for the most part, I think that kids do it willingly and I think that it makes the stuff more interesting. I get pretty solid responses from most kids.

We see that Mr. Leon intentionally used his daily starters to get students thinking about the day's topic, as a type of quick-write strategy. He didn't quite answer the question the way I had intended, focusing on how well his students did the daily starters, not the impact the writing initiative had had on student learning.

Trying to get back to the disciplinary literacy initiative, I asked Mr. Leon if he had posted both his questions and student responses to the T-drive yet. He replied that it was just the questions, and that they would have to post responses next year, which may change some of his instruction:

The point of which is to get us more focused on data, making data-driven decisions or using these as informal assessments to gauge whether kids get it, whether they don't get it, and so forth. I probably should be more intentional about that. I gauge subjectively whether the kids are getting it or not by those. But I suppose next year, I'll be forced to be more objective about that. Looking things over and ranking them as advanced, proficient, basis, minimal, based on their responses.

"Yeah, so you'd have to be able to just put some kind of ranking unto the T-drive," I replied. "And not all those responses, each week."

Right. Right. I might go with somewhat subjective rankings, where the kids tell me what they feel their comprehension of the topic is. **Held out his hand,**

fingers curled, thumb out, moving as he said: A thumbs up, thumbs sideways, or thumbs down thing. "I get this topic." "I don't understand it," or whatever the case might be, "I'm clueless, Mr. Leon, help me out on this!" That might be an efficient way. It would be an efficient way. If they're formative assessments, the point is really to gauge on whether they know it and figure out how I need to change my instruction. I'm not sure it has to be super-duper detailed, as long as it gives me a thumbnail sketch of what they do or don't understand. That's my premise.

At this point in my research, I was just learning about the district initiative, in bits and pieces from Mr. Graham and the teachers. I checked, "Is that the idea, that it's supposed to be formative assessment?"

Mr. Leon agreed:

That it's supposed to be formative assessment. One, in keeping with practicing for WKCE and ACT style tests. So it's an underlying skill developing issue. And two, obviously, it reflects the curriculum. And three, that it be used as a formative assessment to guide our practice. I think the point is that they want to get away from the whole idea of you find out what kids know when you give them the test. Well, let's do some more objective measures before that, so that if we need to reteach or re-explain, we can do that before the test.

"Right," I agreed, "Before you find out that they failed."

"Right! Correct," Mr. Leon agreed.

Mr. Leon viewed the district's disciplinary literacy initiative as a way to encourage teachers to use formative assessment to catch students before they failed and to adjust instruction

appropriately. He also saw it as practice for the state's standardized testing that reflected the curriculum. He never mentioned how the writing would help students practice disciplinary literacy, which was the goal that Mr. Graham had set for the initiative. Neither Mr. Graham nor Mr. Hayes had mentioned anything about the writing initiative serving as formative assessment, hinting at the diverse interpretations teachers had about what the initiative was supposed to accomplish.

There were many more examples of activities in the Psychology classes that demonstrated students engaging in psychological Discourse, more than I can share here. To keep the text structure of this section on the Psychology class parallel to Chemistry, next I examine constraints and obstacles that prevented Mr. Leon from completely teaching how he wanted to. Mr. Leon offered a unique perspective on the challenges of using disciplinary literacy in a high school setting.

For Mr. Leon, the incoming standards and standardized testing mattered little for the Psychological classes. As juniors and seniors, his students no longer had to take standardized tests, although in the 2012-2103 school year, they could still choose whether or not to take the ACT. Two years later, the state adopted the ACT as a standardized test, and all juniors were required to take it, which may have changed Mr. Leon's impression of the effect of standardized testing on older students. After school one day, we talked about how teachers of eleventh and twelfth graders could possibly be judged on the results from tenth grade tests, without reaching any conclusions.

Instead, Mr. Leon had constraints and obstacles related to having mentally and emotionally immature students doing psychological work, which requires discretion, caution about following rules, and ethical reflection. Mr. Leon discussed in class how he used to have

students conduct experiments with rats. In our second interview, he went into detail about how he used to do that, and why he stopped.

He explained that he had had an experimental psychology class in college that he loved, and so wanted to replicate some of the experiments with students. He worked with other teachers and professors to design rat mazes, Skinner boxes, and cages. In Psychology classes, he organized repeated trials, to test whether rats were learning through trial and error, and whether different interventions could improve the rats' recall. He conducted rat trials with students for about six years.

When I asked why he stopped the rat trials, he explained a complicated situation in which a student had been bitten. Her partner ignored all of Mr. Leon's training about how to handle the rats, and picked one up by the tail. When he threw it to his partner, naturally the frightened rat bit her. Mr. Leon had dealt with students being bitten in the past, but this situation rapidly got worse. For unknown reasons, the rat who bit the girl died the next day. Then seven other rats in nearby cages died, too. When the girl's mother found out about this, she threatened to sue the school. Mr. Leon had to have the rats shipped to a premiere university laboratory in another state to be tested, but with inconclusive results. He also had to explain the situation to people from the school's insurance, from animal control, and from the university whose professors were helping him. In the end, his principal strongly recommended that he abandon the authentic practice of experimental psychology with rats.

There was a lot of information about disciplinary literacy that Mr. Leon shared in his story about the rat trials. We see that he had students doing experiments based directly on activities from his college experimental psychology classes. He even used modified equipment similar to what college psychology students would use. Some of his resources on how to

proceed were experimental psychologists at a local college. But despite his preparation, not all of his high school students were emotionally mature enough to handle the rats appropriately and avoid injury. As minors, high school students are protected from exposure to the types of hazards that psychologists might encounter when doing experiments with live rats. Parents and principals may object to true disciplinary literacy when it potentially places high school students at risk, despite the best preparations by a teacher.

Mr. Leon also had students design and conduct their own research projects in social psychology. They had to arrive at a hypothesis, have it confirmed by the teacher, test it, and then present the results. He mentioned that he had students conduct these studies for about fifteen years, and had just recently stopped. He mentioned that there were several reasons why he stopped. The research took a long time: about three school days to gather data, and two or three days to report out results. His normal units ran about ten to twelve days, but the research unit extended to sixteen or eighteen days, forcing him to eliminate other parts of his curriculum.

He also found that grading the research projects became an issue:

> And we had the social loafing issue. Some people do all the work and other people do none. I did have, not a lot but a few of the overachieving kids complaining about the fact that their grade was tied in to other people's grades. So I gave them a composite grade. To try to minimize that, I developed an individual grade assessment that was confidential. You would write your name and every other person's name in the group. You would circle the quantity and quality of the work they did. I would average it to give you. So I'd take the base grade off the project. And then the independent secret grade I would use to determine if your grade should float higher or lower than that. And I'll just be

> honest, it was a massive hassle. **Mr. Leon laughed.** And I did come to the realization with all these kids, a few kids complaining, a bunch of kids slacking, losing four to six days of content, that it was better to just do theoretical discussions about or videos on studies. And to redeem the time and minimize the conflict.

I appreciated Mr. Leon's honesty in describing his reasons for dropping the research experiment. Allowing the students to design, conduct and present their research consumed a great deal of class time. As with any classroom, whenever something is added to the curriculum, something else must be removed. He also described the challenges of assessing student work in ways that discouraged some students from letting their group members do all the work. His solution to that became a major time commitment for him to correct, a valid consideration for teachers who are often very busy with their classes and other commitments.

In class, Mr. Leon had mentioned that one group of students had hypothesized that teachers would get more annoyed about students crashing into them in the halls than other students would. This led to an English teacher complaining about being involved in research, and knocked over in the hallway, without giving consent. I asked if that had caused him to move away from having students conduct research. He explained:

> No. That didn't. That just changed my focus on ethical research, on really talking about the ethics before they do the studies. I did have, irregularly, conflicts that would come up. Like a principal saw or heard about the nature of the sexual questions that were going on in a study that kids were doing in a big study hall. **He mimicked the principal speaking,** "Mr. Leon, I heard these questions were asked of kids. Did you authorize this? Blah blah, blah blah blah."

So then I got real tight on no questions of a sexual nature, no drug questions, no alcohol questions, etc. And that tightened things up. I did okay their hypotheses.

Again, we see that Mr. Leon had to take into account the relevant immaturity level of his students, which he did by previewing their hypotheses before allowing them to begin research. There were other ethical issues with teenagers conducting psychological research. He continued:

> And I wanted, you know how it is, I kinda wanted the kids to be driven to do the research, so the more interesting the topic, the more likely they were to actually invest in it. But obviously I had to subdue that. We did talk about confidentiality, but nonetheless, some kids would read people's responses right in front of their face and kind of laugh sometimes. I got people yelling at me for that. There were sometimes when they used deception and clearly some people were irritated that they were deceived. Did I tell you about the stopping people by the side of the road to help?

"Uh-uh," I replied, not having heard about the experiment.

> There was a study, their hypothesis was females would be more likely to have someone. A female in distress was more likely to have someone help them than a male in distress. So they would sit over here on [highway that ran past the school] with the hood of the car up. Two guys would stand there looking at the engine like they didn't know what was going on, and they'd see how many people would stop. And then the same location, same car, same time of the day, two girls would do it. And guys were much more likely to stop to help the girls. And some of them actually got really irritated when they found out that it was just for a psychology study. **We laughed**. So, and then there was a teacher who got

> bumped into and blah blah blah. So even when I checked their hypothesis, the way that they conducted the study. Not very frequently, but irregularly, got me some flack. And so I thought, When you add all this stuff up, it's a lot of fun, but I'm not sure if it's worth it. So. That was not the primary reason. The primary reason was time and the grading issue. That would be a secondary reason.

We see that Mr. Leon had tried forms of active disciplinary literacy for Psychology years ago, where students designed and conducted experiments based on behavioral and social psychology. But he eventually discontinued the experiments because of the problems they created. The kids weren't mature or responsible enough to function professionally like a psychologist needs to do. While he was initially eager to have students experience the real work of psychologists, he eventually realized that they weren't emotionally ready for such an undertaking.

Despite the anger expressed by the English teacher at being involuntarily included in a psychological study, we saw that negative feedback from colleagues was not the primary reason that Mr. Leon stopped including experimental studies in his Psychology curriculum. It was simply too much time and hassle when the students designed their own study. The grading got complicated, and the entire unit took too long, when there was always a lot of content to cover. And with the rats, there was the threat of litigation from parents when something went wrong. These were enough to make Mr. Leon decide it was safer and more efficient to talk with students about experiments and ethics, without getting them actively involved.

And yet, he wasn't completely convinced that it was the right decision. During the same interview, I asked Mr. Leon what, in an ideal world, would help psychology teachers engage students in conducting experiments. He mentioned that a block schedule would help, because of the time it took for students to gather data and summarize their results. He talked a little about

how it would be easier to conduct studies with the AP kids, who tended to be more intrinsically motivated than students who took regular Psychology. Then he began thinking aloud:

> I suppose you could set up scenarios, rather than having the kids arrive at the hypothesis themselves, perhaps I could give them three or four options which would expedite the process. I suppose we could even assign hypotheses, and maybe even assign the methodology, like this group is going to do this hypothesis with a case study, this group is going to do this hypothesis with natural observation.

I checked, "Is this with the regular classes?" He affirmed it was:

> Yeah, I suppose we could do that. So if I were to encourage other teachers, I guess I would try to maximize the efficiency of the studies. How can we do this, learn the lessons, but lose as little time as possible? And that's always the dilemma, isn't it? That's always the trick. I guess one thing that's hard to teach teachers is personal applications. The more studies that they've done. The reason that I did rat studies is that I loved doing rat studies and animal studies in college. And so I had a, not unlimited, but I had a bank of examples that I could use about what we did. So I guess, personal experimentation, doing personal investigation on their own, all those things that can anchor the thing they're talking about, the content, to reality. You know how it is: it's hard to relate conceptual things to seventeen and eighteen year old kids. If you can talk about real things, or you can exemplify them or show them on video, I think that would help the teacher be more effective.

It seemed as if, while Mr. Leon was offering advice to help other teachers use active learning in psychology, he was also problem-solving some of the issues he had brought up for his own classes. Discussing the challenges with me seemed to be benefitting him, allowing him a sounding board for finding solutions to the obstacles that had made him stop experiments in class. This seemed to be indicated in his final remarks in our last interview, when I asked him if there was anything he wanted to add. He said:

> Really, this whole discussion makes me second-guess whether I should do more studies again. **We both laughed.** If I don't, and I'll use the word "have" to, if I don't have to teach AP Psych, and I have two classes that I taught before, so there's less prep required, I might reconsider doing some studies during the methodology unit. Where I'd make it a little more efficient for myself, but actually make them do studies.

"Yeah," I prompted. "Like you were saying, maybe having the hypothesis . . .?"

> Yeah, the prescribed studies. "Here's your hypothesis, here's your method. Here's when you're going to conduct it. Go do it." Rather than letting them arrive at those things on their own. If you have a group that's on-task, it can be a great process. But if you don't, it can be a lot of wasted time. And so that's the dilemma.

Mr. Leon didn't commit to whether or not he would reinstate the experiments. As he said, he had a large time commitment with preparing materials for the AP Psych class. He didn't feel like he had the time it took, in class and in his grading, to expand many of the Psychology activities in the ways he wanted to.

We see throughout the section on Mr. Leon's class that he encouraged students to demonstrate how they thought like psychologists through class discussion, small group work, one-on-one interactions, as well as demonstrating their growing knowledge base on quizzes and tests. He required students to learn from reading the textbook, and enforced this requirement by incorporating in-class reading into his curriculum. He also required them to learn and demonstrate how they practiced the organizational strategy of PowerNotes, which they could use to study in this class and others. Additionally, they were required to design vocabulary study guides, in the "Tricks to Remember" column for each new term. His units were organized to take students systematically through the GRR model, so that by the time they were required to demonstrate their learning independently, they had learned through focus lessons, guided instruction, collaborative and independent homework. He structured his class to get the students to think like psychologists, even though he had reservations about having teenagers do the work of psychologists.

Chapter Five

Discussion

Teaching is a complex undertaking, and any kind of school reform effort will necessarily be complicated. Best practices in teaching are subject to multiple interpretations, even when grounded in a research base of improved student learning. In this multi-case study of teachers' perspectives on implementing disciplinary literacy, I have presented the underlying concern for increasing adolescent literacy. I have surveyed the knowledge base on instructional strategies for helping struggling readers learn effectively from text. I have utilized James Gee's Discourse theory to frame an argument that teachers will help all of their students to learn if they seek to understand the active learning done by experts in their field, and replicate that in the classroom. Through the generosity of the teachers who volunteered their time and classrooms, I have observed and interviewed with teachers who are attempting to make their classrooms more active sites of learning for students who speak, write, listen and think in their subject's Discourse, as part of a disciplinary literacy approach to education.

Schools across the nation are facing the same situation as my high school research site: teachers are pushed to include disciplinary literacy practices across the curriculum, yet given little guidance on how to do so from the state or federal levels. But some school districts provide guidance to help teachers navigate potentially intimidating policy changes and ever-changing school reforms. Just as there are multiple interpretations of good teaching practices, so there are many forms of guidance that a school district may offer its teachers, with different levels of support. For example, some schools undertake reform in an intentional way, by creating a plan for change, and then following it systematically, accessing throughout the process whether the changes are successful, or if there is a need to refine and adjust the plan (i.e. Loucks-Horsely,

Stiles, Mundry, Love, & Hewson, 2010). Others may design whole-school reform based on principles of learning that describe instructional practices and create environments that "promote rigorous teaching and learning" (McConachie & Petrosky, 2010, p. 24). In McConachie and Petrosky's study, the schools were guided by nine principles provided by the Institute for Learning at the University of Pittsburgh: organizing for effort, clear expectations, fair and credible evaluations, recognition of accomplishment, academic rigor in a thinking curriculum, accountable talk, socializing intelligence, self-management of learning, and learning as apprenticeship. Such an effort required a great deal of time planning, and then refining during the process, but teachers and students reported feeling successful as a result. In each of these examples, teachers were included in the schools' visions for student learning. Administration, teachers and parents shared a vision of positive outcomes for students, and the initiatives lasted for a substantial period of time.

It does not seem as if my high school research site was likely to implement one of these systematic, whole-school reform approaches. They seemed mired in an ineffective model of occasional professional development isolated from teachers' immediate classroom needs. We saw this in the differing descriptions of the disciplinary literacy initiative given by each teacher as compared to the curriculum director's description. Yet there are other options for schools that wish to address the challenges of improving adolescent literacy through a disciplinary literacy approach without the commitment of time and investment that a whole-school reform effort may require. For example, some schools offer teachers the support of trained, on-site instructional coaches. Knight (2013) describes how his organization, Instructional Coaching Group, has trained thousands of instructional coaches who help teachers to identify problem areas in their instruction. Using a partnership approach, the coach and the teacher then brainstorm methods for

addressing a specific problem area, implement the method and evaluate the results, and adjust or continue as needed. Rather than undertake the expense and time for planning an elaborate, whole-school overhaul, schools can expend the money to hire and train an instructional coach, who could then work one-on-one with teachers to improve instruction. In the case of my research site, the coaches could be trained on specific goals of the disciplinary literacy initiative, to expand it beyond simply including some kind of additional writing exercises for students. This may make the work meaningful to teachers, who could then communicate the purpose of the initiative to the students.

When I observed the classrooms of two teachers at my research site, there was only a loosely-defined approach to disciplinary literacy from the district administration. We see this in the interviews with the teachers. Mr. Hayes knew about the initiative, but saw it as a pale reflection of the work that he and Mr. Wright had already begun. He simply cut-and-pasted existing questions onto the school's internal drive to fulfill the initiative requirements. Mr. Leon was able to describe the initiative in more detail, as an approach to including questions that served as formative assessment, matched the curriculum, and gave students practice with questions similar to those on standardized, high-stakes tests. He identified his daily starters as his approach to the initiative, and improved the depths of thinking required according to principles of psychology. While detailed, Mr. Leon's description did not match that of the curriculum director's. Mr. Leon was the only one who described how the initiative had caused him to improve the writing task he selected, when he rewrote his daily starters to include more analysis, synthesis, and evaluation of the reading. Each teacher handled the additional responsibilities of the writing initiative in distinctive ways that reflected his subject and

department. Both teachers thought the initiative was a nice idea, but was unlikely to have much impact on learning or teaching.

Reflecting on limitations

As I undertook the observations, interviews, transcribing, coding, and especially the writing of this dissertation, I understood firsthand what I had learned in qualitative research classes: that naturalistic study can be messy and confusing (Creswell, 2012). As I wrote, I reflected on how I was only pulling one narrative from my data, which seemed to hold many possible stories. I was often amazed at how difficult it was to capture the multiple voices of students in small and large group discussions, even from the audio recordings. As an outside observer who wasn't organizing the lessons, I often felt as if I didn't understand what was happening in class, especially in Chemistry, well enough to judge the students' understanding. My every-other day schedule increased my confusion, and I spent a great deal of time catching up on what the students were learning when I spoke with the teachers.

During observations, what I was observing shifted slightly over time, as I watched the students more closely than I did the teachers, trying to focus on and capture moments when the students' words indicated their understanding of the subject area. I could feel myself becoming increasingly fascinated by how students' speech reflected their learning, to their teachers and each other. After the first interviews, I had to make a mental shift away from watching for evidence of the Common Core in practice, to search out examples of disciplinary literacy itself. By the end of my study, I felt like I finally was ready to begin the research. Most importantly, I felt my conceived role in the classrooms shift from watching for ways to incorporate better disciplinary literacy practices, to witnessing the literacy practices that were already in use. To examine some of the learning that emerged from my research, I organized the remainder of the

Discussion section by addressing each research question individually, then considering implications for the roles of literacy coaches in secondary schools, and proposing ideas for further research.

Research question #1: How do secondary teachers engage students in disciplinary Discourses?

Each teacher had a different vision of what specific literacy practices student would practice and master during his class. To review, in Chemistry Mr. Hayes focused on helping his students master technical writing informed by the conventions of the field. For Psychology, Mr. Leon focused on how students would learn to think about Psychology and be able to apply the content knowledge and skills to other classes and adult life. Yet these visions were not related to or guided by the district's disciplinary literacy initiative.

While there was a disciplinary literacy initiative underway in the high school, it was unclear from my interviews with the curriculum director and the teachers exactly what the teachers were being asked to do. Since there was no shared vision for what students should learn and be able to do, the district's desired changes in instruction were vague. During our interview, Mr. Graham described the disciplinary literacy changes that the district administration would like to see teachers make as minimal and easy to implement, and then later he described the changes as a major shift in thinking that would be challenging for some teachers. It was clear that he wanted teachers to examine the level of questions they were asking in the classroom, and to incorporate higher order thinking demands when possible. Otherwise, I was not certain what types of changes the district office wanted from the high school teachers.

The teachers knew that the administration wanted more writing by students, but they each already had some writing in their weekly schedules that seemed to match the administration's

demand. The lack of a common vision for what students would learn and be able to do, whether in the form of standards or another clear set of guidelines, seemed to fragment the departments of the school into each seeking to meet or avoid the district goals in their own ways. Department members decided if their instruction needed to improve, and how, and what guidelines, if any, would help them to accomplish that.

Even within departments, the importance of improving instruction according to disciplinary literacy ideas varied considerably. Two teachers of the Chemistry department, Mr. Hayes and Mr. Wright, were very active at trying to improve students' abilities to speak, read, think, and especially write about Chemistry. They were following the National Science Teachers model, and were transitioning to the Next Generation Science Standards, using standards as guides for how students should be able to perform Chemistry. We can see that such an approach was not required within the Science department, since the third Chemistry teacher chose not to be part of that effort and did not collaborate.

In Psychology, Mr. Leon seemed to act as an island as far as his vision of disciplinary literacy. I never heard mention of any psychology standards during our interviews, conversations or classes. Instead, he pulled his ideas of best practices directly from his curriculum on learning. It seemed like his students' age as beyond the mandatory standardized testing of sophomores also made standards seem unnecessary to him. Other tests that students would take to get into college, like the ACT, were part of the classroom conversation, but not their complementary standards. Mr. Leon had his own objectives and had a clear vision of the most important elements of psychology for high school students to learn, based on his years of experience teaching the class.

When we consider learning within disciplinary literacy, we focus instruction on what students will learn and be able to do. Students are active learners in this view of teaching. Having students play the active role of learning in the classroom represents a substantial shift in how teachers may perceive classroom interactions. It requires moving away from the decades-old model of Initiate-Response-Evaluation (I-R-E; Mehan, 1984), in which the teacher begins and ends each interaction with a student, and evaluates the quality of each contribution as it is made. If students are asked to speak about what they are learning, to give us a window into their thinking on concepts and skills, then we need to move away from this model. Instead, we need ways to get students to communicate with each other, but in on-task conversations, not gossip or off-task talk.

In addition to providing time for students to speak, teachers who want on-task Discourse among students that helps them learn should provide some direct instruction on effective collaboration, specifically on interpersonal skills (Fisher, Frey & Everlove, 2009). Students can learn how to speak to each other politely about their confusions and revelations, and they can learn how to verbally problem-solve together. In the examples from classrooms, we saw that some students could do this already, like the group of sophomore girls reviewing for Mr. Hayes' Chemistry test. They asked each other questions and answered politely, directed each other to resources as needed, and talked about their own strategies for independent learning. Likewise we saw a good collaborative effort in Psychology, with Anika, John, Madison and Nina as they designed their single blind Zzzquil experiment. They challenged each other politely but firmly on each step of their research design, and analyzed together all of the obstacles they discovered along the way.

In contrast, we saw examples of groups that excluded some members or in which the entire group fumbled through the project without a clear sense of what was learned. During the Unknown Solutions lab experiment, we saw a clear contrast between strong collaborative skills and a lack thereof when we observed Daniel and Kapil working within their group. Daniel ignored the other group members except Kapil. His description of the problem-solving made it clear that he expected to be the only one doing the thinking. Whereas Kapil included all of the group members, answering their questions and asking them their thoughts about the reactions they saw, keeping them involved in the lab. Eventually, Daniel's rejection of the other group members' contributions prevailed over Kapil's collaboration, and the three other boys withdrew from the learning and simply copied Daniel's answers.

In the flowchart lab, Julia, Kristina and Maren's group did not display many verbal skills of using Discourse to help each group member to understand the lab. Once in a while, one of the girls would declare that she understood something, but never clarified what her new understanding entailed. Her group did not benefit from the three times that Kristina or Maren announced that they finally understood something. We know that they could have spoken through their new understanding of the lab, as we saw evidence at the end when Maren announced that the black color was "obviously" indicating the presence of mercury. Each of these groups could have benefitted from reminders of how to speak with each other collaboratively, to use group dynamics to problem-solve, analyze and apply their new learning.

Both Mr. Hayes' and Mr. Leon's classes were filled with opportunities for students to communicate with one another, as well as with the teacher. Both teachers arranged their learning to regularly change the make-up of student groups, from whole class to small groups or partners to individuals. When we apply the GRR framework to understanding instruction, we see that

both Chemistry and Psychology moved recursively through the phases. It was particularly noticeable that the often-neglected collaboration stage (Fisher & Frey, 2008) was required in both courses. Students had to discuss with each other how to figure out which chemical they had in Chemistry, or to figure out how to set up an experiment in Psychology. The required collaborations made it normal for most students to contribute voluntarily on other occasions, such as other labs or in the debate about worldviews. It seemed like most of the students took advantage of these opportunities and stayed on topic in their conversations. Each teacher was careful to set a goal for students to accomplish, with collaboration and on-task socialization as methods for reaching that goal. There was no question about whether students would be active participants, because it was the minimum expectation for the class. Mr. Hayes and Mr. Leon offered encouragement as needed to get students into groups, and regrouped students if necessary, but they didn't leave space for students to check-out of the learning process. They included students' voices and thoughts in the ongoing learning conversation, and as a result, students demonstrated that they learned to speak the Discourse of Chemistry and Psychology.

Research question #2: What are teachers' experiences with modifying literacy strategies according to the needs of readers in their discipline?

It seemed like neither of the teachers had access or time to consider the curricular needs of individual students, unless they were already identified as receiving Special Education or English Language Learning services. The only mention of differentiation for individual students was in Mr. Hayes' room, when he admitted that he asked for more from students whom he knew were capable when they turned in assignments that could have been much better. In both classrooms, I didn't observe any planned differentiation of content or product. While we know that classrooms include students with wide ranges of reading abilities (Allington, 2012), neither

of the teachers I observed had more than one level of text available. When the online readability formula worked correctly with class readings, I was able to share this information with the teachers, but didn't witness any changes that occurred as a result.

But I witnessed examples of differentiation of process. Teachers revoiced what students said on a regular basis, such as when Mr. Leon repeated students' points during the worldview discussion. Mr. Hayes recognized that he may get deeper levels of technical writing from his advanced sophomores than from his regular juniors, and had higher expectations for the advanced students. Both teachers incorporated group work to some degree to disrupt the traditional whole group class that places the teacher as the single active participant. The teachers were willing to move away from solely lecture and I-R-E discussion formats to reach students who may learn more effectively from hands-on work or conversation.

When we consider the needs of the student as defined through disciplinary literacy, then we can see that my teachers had already done substantial modifications to how the curriculum was when they were hired. Mr. Hayes mentioned that he had wanted Chemistry to be active learning for students for eight of his ten years of teaching. It seemed like he already had a disciplinary literacy vision for his classroom, and the Next Generation Science Standards finally caught up to him. He was putting a lot of time and effort into helping students learn how to write technical reports. He had described some of the challenges he and Mr. Wright had in trying to bring in multiple texts for Chemistry at appropriate reading levels for high school students. Yet they continued to gather the sources they found, and deepen the curriculum for the next year. The two teachers worked together to create guided reading assignments on the new readings, taking care to structure their questions to require more thinking than simply finding the right answer.

Mr. Leon was in some ways the most interesting to observe in terms of how he modified his instruction. On several occasions, during and after school, he described himself as a traditional teacher. He talked frequently about the value of lecture as an efficient means of transmitting information. Despite this, his class kept students very active. They had a regular routine that included a fair amount of reading, regular note-taking, group activities and time for videos that illustrated ideas from the text. There was not a lot of lecture, because Mr. Leon rarely spoke without soliciting student input. He tied what they were studying to students' lives, and asked them to share their thoughts about it. While Mr. Leon clearly valued lecture as an instructional tool, the time I spent in his classroom seemed to indicate that he valued conversations with the students far more.

In our interviews, the teachers didn't mention their feelings about shifting to a disciplinary literacy approach for student learning. I offer my own speculation about why this may be. Based on my experience with the teachers, I speculate that adopting disciplinary literacy may have seemed like another trend that would pass. This seems particularly possible when we remember that the district's content area literacy initiative the year before had simply faded away. It is my opinion as an educator that in a district such as this one, where there is no common vision for student success, that teachers will not believe that reform is necessary or even beneficial enough to change their practices. As Mr. Graham noted, the district's test scores were "not great, but okay. And so, there isn't necessarily the fire underneath the feet to make massive changes." That lack of urgency for change was communicated top-down throughout the whole district, and so few changes were made. Those teachers who sought to change and improve their instruction were motivated by forces external to the district administration.

Research question #3: How might these modified strategies expand teachers' worldviews about and experiences with the subject area?

While the teachers I observed were not necessarily motivated by the district's disciplinary literacy initiative to modify their instructional practices, they each were working to improve student learning and were aware of the need for students to be active participants in the classroom. During my interview with Mr. Graham, he mentioned that teachers should be able to describe what the purpose of their subject is. Both of my teachers clearly knew and were prepared to share why the subjects mattered for students. We can see this in Mr. Hayes' philosophy statement, that teachers are teaching high school kids how to reason and problem-solve, plus to write in required ways for future science classes. And we can see this clearly in Mr. Leon's idea that psychology is immediately relevant to adolescents' lives, and to their futures as people and parents. Each of the teachers had an answer ready for the perpetual adolescent complaint, "Why do we need to know this?"

Otherwise, the teachers tended to deflect the questions I asked in the interviews about how the change to active student learning changed how they thought about their subject areas. Mr. Hayes used my questions about any shifts he realized in his view of his subject matter as a springboard for explaining his overall philosophy of teaching. While that was fascinating, and helped to illuminate his approach to Chemistry as a first step in a science apprenticeship, I didn't get a sense of how adopting disciplinary literacy practices may have made him view Chemistry differently. It is possible that he did not experience any changes in instruction, since he described his philosophy of active learning for students as the product of the last eight years of teaching.

But in Mr. Leon's response, I believe we see a common theme in education: that we've done this before. Mr. Leon talked about how cyclical education is, and about how every new idea is simply an old idea that has been slightly rephrased and then recycled. The rapid pace of change in education, and the waves of reform that teachers have withstood for decades, seem to encourage pessimism in teachers that no progress can be made toward improving instruction, because there's no agreement on how good instruction should be conceptualized. Instead, teachers may feel doomed to repeat old reforms on administrators' whims, as Mr. Hayes put it: "We got the directive because somebody watched a video or went to a seminar about how some school out East that they forced their kids to write every single day, or something like that, and that improved their ACT scores." Rather than succumb to pessimism about whether educational change is possible, I would like to shift to the implications of this study for the field, in the form of examining the possible roles of a literacy coach in a secondary setting.

Roles for literacy coaches in secondary settings

In this educational environment of rapid change, secondary teachers are asked to implement disciplinary literacy without much guidance on how to do so, or feedback on whether their attempts are successful. Instead of lamenting this sad state of affairs, let us consider this as an opportunity to re-evaluate the roles that reading specialists or literacy coaches may play in secondary settings, using the current study to ground theoretical examples of assistance.

In my literature review, I repeatedly encountered the idea that content area teachers do not adopt cognitive strategy instruction, no matter how many times strategies are introduced. Is this a fault in content area teachers? Or maybe in the strategies being offered? Let us consider for a moment that the flaw does not have to lie either in the teachers or in the effectiveness of the strategies. Instead, I speculate that what has been missing is the expertise to link teachers,

strategies, and current curricula so that the strategies make sense. As Gritter (2010) described with pre-service teachers, teachers need to think through how to "map" specific strategies onto the ways that knowledge is constructed in their disciplines. That seems to be key in making disciplinary literacy strategies effective for students to learn subject matter at a deep level. Through long-term collaboration among equals, teachers and literacy coaches may be able to implement disciplinary literacy effectively. Let me propose some theoretical examples from my participants in Chemistry and Psychology.

In Chemistry, there were several ways that a literacy coach could collaborate with Mr. Hayes to improve his disciplinary literacy instruction. When I reflected about how Mr. Hayes described a reading assignment from the text as requiring students to synthesize their thinking from several places in the reading, I knew one way a literacy coach could work with him. He was already using an informal theory of levels of questions similar to Raphael's (1982) Question-Answer Relationships. By introducing him to the full theory, I could help him to identify the types of questions he asked and which levels were missing. If we worked together in a long-term relationship, I would be able to help him create guided reading that challenged students at every level of thinking he wanted for them, serving as a co-author or first reader of assignments at his preference.

As a literacy coach, I would also pursue Mr. Hayes' concern about the lack of appropriate Chemistry materials for high school students through networking with science education organizations, such as my state's Society of Science Teachers. Through building contacts there, and in similar groups of science educators, I would be able to address Mr. Hayes' concern for bringing authentic but accessible Chemistry texts into his high school classroom. As his curriculum changed, we could begin the process anew to refresh the supplemental reading he

assigned to his students. We could even use the online readability formulas selectively to level his text, avoiding parts of the text that relied on symbolic notations for meaning, and discuss scaffolding strategies for using materials that are written above most high school students' reading levels.

Psychology was a little trickier to identify opportunities for collaboration between Mr. Leon and a literacy coach. When I considered what types of literacy strategies I might offer Mr. Leon, it took me awhile to think of something. He seemed to have already designed his class so carefully, following tenets of psychology to improve student learning. He intentionally began with a big picture of what students would learn, as demonstrated in his objectives. He knew his assessments before he began, and gave students many formative opportunities to demonstrate their learning before they took summative assessments. He had recently revised his questions on the daily starters to align with Bloom's taxonomy for levels of learning. All of his assignments aligned to both objectives and assessments. He was fearless about including student voices in the classroom. What could a literacy coach offer this teacher? I might suggest Think Alouds again, and model how effective they can be. But he had disregarded that suggestion once.

But I did realize one strategy I could suggest, which I think would appeal to Mr. Leon. He encouraged students to quiz one another, when they worked collaboratively to study for quizzes. But it was left to them to decide how to do so. A strategy that might give structure to the activity, and lead to more learning by students as a result, is the ReQuest strategy by Anthony Manzo (1969). In using ReQuest, the teacher first models questions that one could ask from a text, and the students answer. Then the students ask the teacher similar questions. When students are comfortable asking questions from their reading, then they pair up with another student to read and write questions about the important ideas in the reading. When both have

written their questions down, they take turns asking each other. The student who is being asked may look back into the text for the answer. If he or she is unable to answer, the student who asked the question must be able to demonstrate that the question was answerable, by showing the partner where in the text the information may be found. Mr. Leon could modify ReQuest to disallow looking back into the book for answers, since students could not use any notes or resources outside of their heads for tests and quizzes. It seems like this small shift into formalizing the partner studying could help students who may not know what questions to ask. If I were partnering with Mr. Leon as an instructional coach, we would follow Knight's (2013) coaching cycle: after I suggested the method of ReQuest as a way to strengthen peer-quizzing and he agreed, Mr. Leon would implement it, and we could dialogue about how it went well or how it should be adjusted or abandoned for another approach.

Additionally, when I reflected on how valuable conversation seemed to be for Mr. Leon's classroom instruction, it struck me that the most important role a literacy coach could play for him might be simply to listen as a sounding board. I reflected on how often Mr. Leon explained activities or objectives to me after class, during interviews and sometimes during class. In our last interview, when I asked him if there was anything else I missed, he speculated on whether he should revisit some of his more exciting, active experiments designed by students. He talked through ideas of how to make them more time efficient and yet fair to all student participants. It seemed like most of Mr. Leon's classroom reforms could be undertaken himself if he only had a willing set of ears to listen to what he was mulling over in his head.

For both teachers, as a literacy coach, I would recommend reflecting on how they currently used reading as a way of learning materials. As I noted above, with the exception of Psychology, there was not much in-class reading. Students were mostly expected to read

independently outside of school. When the teachers included reading in the classes, I did see some reading strategies in use. But what I saw was mostly the teacher doing the harder types of strategies *for* students. Students were relegated to copying the teachers' work, which is only rehearsal, the least cognitively challenging type of reading strategy. This was apparent in Mr. Leon's use of pre-designed graphic organizers, which became simply blanks on a worksheet for students to fill in. Graphic organizers are at their most effective to get students thinking when students design them and then fill them in (Conley, 2008). And we saw this in Mr. Hayes' Powerpoint notes, which students copied down. We can assume, then, that the teachers were doing the majority of the learning by processing the written materials in the more sophisticated ways, like elaborating and organizing. To maximize students' learning and increasing their independence, they need to be responsible for tackling the harder cognitive elements of learning, within an instructional approach that provides them with feedback and practice with the harder skills.

Another specific suggestion I would make to the two respondents in my research would center on how they explicitly guide students' discourse, the speaking they do to one another and the teacher about their learning. Several times in this research, I have highlighted strong and weaker points in students' dialogues during class. If teachers do not address ways to speak more effectively, we leave how well students learn from speaking about our discipline to chance. But there are methods and strategies for improving how students communicate with one another. Some are as simple as reminding students to ask each other questions when they are confused, to talk through what they are learning, and to try to figure out problems among their group members before seeking teacher help. Some suggestions may be even simpler, such as when teachers remind students to use good manners among themselves. Or there are strategies that are

more discipline-specific for helping students incorporate the vocabulary and ways of speaking of a discipline into their explanations and conversations. A simple example for Chemistry could be reminding students to refer to their lab directions for sentence frames to use when discussing their conclusions about which compound was which in the problem-solving lab: "I believe test tube ____ contains _____ because." An equally simple example for Psychology would be for Mr. Leon to remind students to refer to their vocabulary page in their packets, and to include specific terms when they described their hypothetical experiment: "Our independent variable is _____ and our dependent variable is _____." The more explicit we are about how we want students to speak about our subjects, the easiest it becomes for them to demonstrate that they can speak our Discourse.

I have proposed some possible instructional suggestions that my teachers might accept from a literacy coach, assuming that they would have a positive relationship with the coach. For a literacy coach to make these types of suggestions would require a strong working relationship with individual teachers. One could not simply come in to the school as an outsider and dictate what the teachers should be doing and expect compliance. Instead, it would take time to build the relationship between teachers and literacy coach.

The time would be necessary on both sides: the coach needs time to learn what the teacher is doing and the intended outcomes of the lesson before he or she can begin to make suggestions. Ideally, the coach would research which forms of disciplinary literacy are most valued in that specific subject, and ask the teacher to verify the accuracy of their research. The teacher needs time to build enough trust with the coach to accept or modify the suggestions without feeling coerced into making unwanted changes. The collaboration would need to be strong enough to weather disagreement between teachers and coach as equals on the best

possible approach to specific instruction. Also, the coach's suggestions would have to yield measurable success in student outcomes, to build confidence that the suggested approach represents more effective instruction than what the teacher was already doing.

This sense that the collaboration needs to create tangible improvement in student outcomes is important when we reflect on the authority of a literacy coach in a secondary setting. If a literacy coach holds a reading specialist license, that person is an administrator in name alone. He or she holds no authority over teachers except that of persuasion. A coach must be persuasive enough to instill confidence in the first teacher who agrees to collaborate and to change instructional practices in suggested ways. If that collaboration is successful, then the coach gains credibility in the eyes of the other teachers and may begin to expand collaborations into other classrooms.

Lastly, from this research and my own experience, it seems that a literacy coach in a secondary setting must be honest about the limits of what he or she knows about the teachers' subject areas. The collaboration must be framed as among equals, in that the teacher's considerable expertise about the subject must be acknowledged and treated as a resource to be drawn upon. The literacy coach contributes expertise about a range of cognitive strategies for reading, writing, and speaking academically. But it is the teacher's vision of the knowledge and skills the students will gain which will determine the types of literacy strategies that will be appropriate for learning the Discourse.

Future research

As I reflect on what I have shared in my examination of disciplinary literacy, I realized something that I had missed: the importance of departments in high schools for improving teachers' instruction. Thinking about my interviews, my teachers relied on their colleagues to

determine which reforms or changes to implement. Yet most of the disciplinary literacy literature seems to focus on individual teachers as the intended audience, and certainly the importance of individual teachers to create and support instructional improvement cannot be overstated. But perhaps the literature is missing the important role that departments play at a high school. Further research should be done, to expand the work into examining how departments at high schools support individual teachers in specific fields as they attempt to implement disciplinary literacy. Researchers could begin by examining how professional learning communities may guide disciplinary literacy practices. A further extension could consider how a literacy coach would then guide and support an entire department within a high school.

Thinking about groups within schools may lead us to think beyond the school walls, to professional groups across secondary schools. Further research should be done that illuminates how professional organizations frame the important elements of literacy for their subject areas. How are the teachers' subject-area organizations helping them to implement disciplinary literacy? Do the subject-area organizations discuss disciplinary literacy? Do those organizations communicate with the states' literacy organizations to collaborate on how their respective members can improve disciplinary literacy instruction? It seems that there may be large groups of educators having similar conversations about common challenges, yet not sharing ideas with one another.

In this research on disciplinary literacy, I have analyzed how low adolescent literacy levels have created a need for active student learning, in the form of disciplinary literacy, guided by Discourse theory. The teachers who were kind enough to allow me access to their classrooms have shared their ideas, their hopes and their fears about how this current school reform may

affect their work with students. I revealed the picture of a district that accepted the current level of learning experienced by its students as adequate, and therefore did not expend time or effort on improvement. Through this work, and many hours pouring over and contemplating the data, I have gained some insights into disciplinary literacy instruction and how it may be achieved as collaboration between teachers and an on-site literacy coach. I do not believe disciplinary literacy should be visualized as something that is done by individual teachers in their classrooms. It requires respectful collaboration among teachers and experts in literacy who can work together in an ongoing effort to improve ways that students read, write, speak and think in the Discourses of the disciplines.

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Appendix A: Participant Recruitment Email

Dear [School name] Teachers, [Date emailed]

Happy New Year, and I hope your spring semesters have started well. As many of you know, I have been leading up to my dissertation research on disciplinary literacy for the last three years. Finally, I have reached the stage of active research, and am asking for your help. For my case study, I am looking for three volunteers, one each in social studies, mathematics, and science, to work with me this semester.

Specifically, I am looking for teachers, working with 9th and 10th graders, who are interested in investigating how students use reading and writing strategies to improve how they learn your subject matter. Over a five-month period (Jan. – Jun.), I ask to be allowed to observe in your classrooms from 3-5 hours a week and to audiotape parts of instruction. On days I observe, I would ask for a copy of lesson plans in advance to guide the observation. Students will be asked to have parents sign a permission slip; students without parent permission will not be included in the study. I would like to run textual analysis on any textbooks or reading passages used, and conduct content analysis on anonymous examples of student work resulting from reading and writing strategies. You and I would conduct interviews every two weeks (30-45 minutes), ten total, related to the observations and ideas around how students learn to argue, reason, provide evidence, and problem-solve according to the conventions of your field. Lastly, you would be asked to write five brief reflections (1-3 pages), focusing on a particular literacy strategy that you are using in the classroom. All identifying information will be kept confidential, but findings will be shared with participants at any point, and checked with individuals before publication.

If you are interested or have questions, please contact me at hillmana@uwm.edu or (262) 902-0050. We can arrange a preliminary interview at your convenience. I appreciate you considering my request, and look forward to a great semester of research.

Wishing you the best,

Ann Marie Hillman

Appendix B: Phases of Research

Phases of Research	
1. Access	Entering site in new role as researcher; through participant recruitment email and principal introduction of study
2. Initial interviews	Will be used to narrow selection to 3 participants if needed; will ask for lesson plans at least one day in advance to guide observation protocols
3. Preliminary analysis of initial interviews	Learn about specific teachers' approaches to disciplinary literacy, and placement on spectrum of adjustment to disciplinary literacy strategies
4. Refinement of observation and interview protocols	Based on initial interviews and advance lesson plans; ongoing process throughout study, building from previous observations and interviews
5. Data collection of observations, interviews, and student work	Interview and observation protocols will build on previous sessions. Student work chosen by teachers to reflect use of reading and writing strategies that aid content understanding
6. Data analysis	Transformation into ATLASti, analyzed for codes, condensed into 6-7 themes. Any missing or additional interviews, observations, reflections, or student work collected as needed.
7. Member-checking	Checking with participants that they are accurately represented before publication; let participants choose names to be used in publication
8. Writing	Ongoing; compiling notes, memos, and themes into findings and discussion

Appendix C: Science Initial Interview Protocol

Date, time, location:

Participant identifier:

Data collector name: Ann Marie Hillman

Main Research Question: *How do secondary teachers engage diverse students in disciplinary Discourses, as required by the Common Core State Standards for literacy?*

Selection criteria: *I am looking to conduct interviews with teachers who are adjusting their instruction to include disciplinary literacy strategies for reading and writing during instruction, and acknowledge areas where they would like to improve.*

Hello, and thank you for taking the time to talk with me today. I'd like to ask you several questions about how you help students to use reading and writing to learn from complex texts in your subject area. Your answers will be used to guide my classroom observations and our next interview.

1. Have you heard of the Common Core State Standards for literacy (CCSS)? How familiar would you say that you are with them? How about with the literacy standards specifically tailored for science?

    a. (If not mentioned in Q1) Do you use the CCSS to guide your instruction now?

2. One of the main ideas in CCSS is that secondary teachers can help students learn how to think like a professional in a field, such as thinking like a scientist. How familiar would you say you are with this idea?

    a. Some researchers describe this as using the Discourse of a field, in which students learn to read, write, listen, speak, and think like a professional insider does. My research centers on how teachers help students learn to think in the field's Discourse. To start off, does this idea make sense so far? (If not, clarify definition as needed.)

    b. Is introducing students to your Discourse something that you do in your classroom? If so, can you think of an example?

3. Think about an ideal student who, at the end of the school year, has learned how to act like a science insider.

    a. What has this student learned about reading like a scientist?

    b. What has this student learned about writing like a scientist?

4. Now think about how this ideal student reached the point of acting like a science insider.

    a. What are some reading strategies that secondary teachers teach students to use, to help them reach this point?
        i. (Probe to clarify or gain additional descriptions as needed.)

    b. What are some writing strategies that secondary teachers teach students to use, to help them reach this point?
        i. (Probe to clarify or gain additional descriptions as needed.)

5. Think about the real students in your own classroom.
    a. What are some areas where students struggle to understand what they read in your class?

    b. Do some students struggle more than others? If so, who and why might this be?

6. What do you currently do to help struggling students understand class reading?

7. Finally, think back to the ideal student, and how he/she got to the point of competence in science Discourse.

    a. What are some reading strategies that you would be willing to incorporate into instruction, beyond what you already do?

    b. What are some writing strategies that you would be willing to incorporate into instruction, beyond what you already do?

    c. How interested are you in learning other reading and writing strategies to adapt to teaching your disciplinary Discourse? What would you like to learn about?

Appendix D: Social Studies Initial Interview Protocol

Date, time, location:

Participant identifier:

Data collector name: Ann Marie Hillman

Main Research Question: *How do secondary teachers engage diverse students in disciplinary Discourses, as required by the Common Core State Standards for literacy?*

Selection criteria: *I am looking to conduct interviews with teachers who are adjusting their instruction to include disciplinary literacy strategies for reading and writing during instruction, and acknowledge areas where they would like to improve.*

Hello, and thank you for taking the time to talk with me today. I'd like to ask you several questions about how you help students to use reading and writing to learn from complex texts in your subject area. Your answers will be used to guide my classroom observations and our next interview.

1. Have you heard of the Common Core State Standards for literacy (CCSS)? How familiar would you say that you are with them? How about with the literacy standards specifically tailored for history or social studies?

    a. (If not mentioned in Q1) Do you use the CCSS to guide your instruction now?

2. One of the main ideas in CCSS is that secondary teachers can help students learn how to think like a professional in a field, such as thinking like a historian or social scientist. How familiar would you say you are with this idea?

    a. Some researchers describe this as using the Discourse of a field, in which students learn to read, write, listen, speak, and think like a professional insider does. My research centers on how teachers help students learn to think in the field's Discourse. To start off, does this idea make sense so far? (If not, clarify definition as needed.)

    b. Is introducing students to your Discourse something that you do in your classroom? If so, can you think of an example?

3. Think about an ideal student who, at the end of the school year, has learned how to act like a social studies or history insider.

    a. What has this student learned about reading like a historian or social scientist?

    b. What has this student learned about writing like a historian or social scientist?

4. Now think about how this ideal student reached the point of acting like a social studies or history insider.

    a. What are some reading strategies that secondary teachers teach students to use, to help them reach this point?
    (Probe to clarify or gain additional descriptions as needed.)

    b. What are some writing strategies that secondary teachers teach students to use, to help them reach this point?
    (Probe to clarify or gain additional descriptions as needed.)

5. Think about the real students in your own classroom.
    a. What are some areas where students struggle to understand what they read in your class?

    b. Do some students struggle more than others? If so, who and why might this be?

6. What do you currently do to help struggling students understand class reading?

7. Finally, think back to the ideal student, and how he/she got to the point of competence in social studies or history Discourse.
    a. What are some reading strategies that you would be willing to incorporate into instruction, beyond what you already do?

    b. What are some writing strategies that you would be willing to incorporate into instruction, beyond what you already do?

    c. How interested are you in learning other reading and writing strategies to adapt to teaching your disciplinary Discourse? What would you like to learn about?

Appendix E: Initial Observation Protocol

Date/Time/Setting:

Participant/Subject observed:

Length of Observation:

Observer: Ann Marie Hillman

Observer role: Non-participant

Time	Strategy observed	R, E, or O	GRR Instructional Phase	Reflective notes

Strategy Key: R = rehearsal E = elaboration O = organization

Additional notes:

Appendix F: Initial Reflection Guide

Date:

Participant pseudonym:

Content area:

Think about your recent use of (specific literacy strategy). How did it work to teach students how to think like a (historian, mathematician, or scientist)? Did it work equally well for all students, or did some struggle? If so, who? How could you modify (specific literacy strategy) to help all students learn to think like an insider in your field?

Appendix G: Audiotaping Permission

Your child's teacher has agreed to participate in an educational research project on how teachers incorporate reading and writing strategies into classroom instruction. While the main focus is on the teacher, the research also examines how teachers interact with students to help them understand complex texts in different subject areas. Therefore, we ask your permission to audiotape your child's in-class contributions as part of the project. We will be audiotaping the whole class during selected class discussions, but will only include your child's contributions in the data set with your permission.

Use of these audiotapes shall be restricted to University of Wisconsin-Milwaukee dissertation research. All recordings will be erased after the data is transcribed, no longer than two months after the initial recording. All identifying information will be kept confidential. Any students who are mentioned in the final report will be given pseudonyms to protect their identities.

Please contact Ann Marie Hillman with any questions or concerns you may have at hillmana@uwm.edu or (262) 902-0050. Thank you!

Please check one of the following:

- ❑ I do hereby grant permission for _____'s audiotape data to be used for educational research purposes only.

- ❑ I do not grant permission for _____'s audiotape data to be used for educational research purposes only.

Student's Full Name_____

Home Address_____

_____

Telephone_____

_____
Student Signature

_____
Parent/Guardian Signature

_____
Date

Appendix H: Remainder of Sophomore Girls' Study Group Discussion in Chemistry

Mr. Hayes had just described how to identify if silver in an equation was silver or silver nitrate, and asked her if she understood him.

Rhonda agreed. The other girls had been listening to the teacher's explanation, and then Mary asked, "When you're writing the equation like this, do you have to put 'equates'?"

Mr. Hayes checked, "For the double replacement reaction? Yeah."

"And for the other ones?" she continued. The teacher nodded. "Okay."

Rhonda said, "My brain hurts."

"Good," teased the teacher as he moved away.

"Looks like I'll be reading out of the textbook tonight," Rhonda said.

Alicia protested, "He didn't assign textbook reading."

"I know that," Rhonda told her, "But I do that when I don't understand this class. Or if I don't understand how to do the math in it, I YouTube it."

Mary sound surprised, "You YouTube math?"

"I YouTubed this math," Rhonda said. "I YouTubed how to find these theoretical yield things." There was a pause in the conversation.

"Oh, do you guys know how to get the excess reactants?" asked Rhonda.

Mary said, "Excess is just when you do the two things, and it's not the limiting."

Rhonda worked through the problem. "Okay, and then there's just the main reactant. That was in our homework. How much did we use?"

Mary said, "Oh, and then you have to convert the limiting to the. . ."

Rhonda interrupted, "Yeah, the other one. Get the packet."

Looking over the packet, Rhonda ventured, "It's like, you do two problems and then you get the limiting, and then you put the limiting into the other one that you tested, right?"

Becky said, "Yeah, I think so."

Mary broke in, "See, that's what I was trying to explain before, but then. I didn't know what I was talking about."

Becky added, "Yeah, it's very confusing. He doesn't like explain it, because you can't. . ."

Mary interjected again, "I knew what I was talking about, I knew in my brain what it said, but nothing made sense."

The girls continued talking through the review, chatting occasionally. They discussed how to balance formulas and multiply subscripts, and clarified for Mary that a subscript "is the bottom number, like the little 2s."

Appendix I: Directions for the Problem-Solving Lab

Purpose: In this lab, you will be given a set of bottles labeled "A" through "I." You are to use your knowledge of double replacement reactions and the formation of precipitates along with observations in lab to deductively identify each solution.

Background: The solutions are the following:

Silver nitrate
Calcium chloride
Copper (II) sulfate
Hydrochloric acid
Barium chloride
Sodium carbonate
Sodium bromide
Lead (II) nitrate
Nitric acid

By combining TWO solutions from bottles ***A*** through ***I*** on a spot plate and observing the reactions, determine the identity of each solution.

Write-up: This sheet is not to be handed in with your final TYPED lab report. You may use this sheet to take any notes during the lab, but you must hand in a TYPED lab report. This lab report needs to include the following sections:

- *Title – bold and underlined* ***(1 pt)***
- *Purpose – one point for having one. . .one point for an original one that states concisely what the ultimate goal of the lab is.* ***(2 pt)***
- *Materials List – bulleted* ***(1 pt)***
- *Step-by-Step Procedure – that accounts for how you did the lab* ***(1 pt)***
- *Data Table – should represent the observations of each bottle as it reacts with* ***all*** *the other bottles. . . including no reactions* ***(5 points)***

- *Analysis – a detailed, bulleted step-by-step account of how you determined the identity of each solution, in the order of discovery, and the reasoning that you used*
    - *I determined that Bottle A is the _____ solution because . . . supporting evidence and reasoning that backs up this statement.* ***(8 points)***
- *Conclusion – include which tray number you worked with, and a bulleted list of the correct identity of each of the solutions in that tray* ***(2 points)***
- *Double replacement reactions for ALL 36 reactions. Indicate the formation of precipitate, NO REACTION, or formation of CO_2 and H_2O. Can be hand-written if typing is too difficult but must be legible* ***(5 points)***

Again, this sheet will NOT be handed back into the teacher.

This lab will be a 25 point lab. Point will be deducted for Labs turned in late. Points will be deducted for Labs that are not typed.

Appendix J: Qualitative Analysis and Development of Flow Chart

Lab Directions for Lab Report

Write-up: This sheet is not to be handed in with your final lab report. You may use this sheet to take any notes during lab, but you must hand in a TYPED lab report. This lab report needs to include the following sections:

To be done as a group:

*Title (**1 pt**)*

*Purpose (**1 pt**)*

*Data (in table format) (**4 points**)*

*Flowchart – Shows how you will be able to identify each metallic ion in a flowchart (**4 points**)*

To be done individually:

*Conclusion – Thoroughly recount your step-by-step procedure to explain what you did to determine that presence of each ion. Include any observations and explain the meaning of the observations. (**6 points**)*

*The final **4 points** of the lab will be assessed according to the number of tries it took to achieve the correct identity of your unknown solution.*

Again, this sheet will NOT be handed back into the teacher.

This lab will be a 20 point lab. Late work will be deducted points. Labs that are not typed will be deducted points.

Appendix K: Worldview Worksheet for Psychology

What is your Worldview?

The things that you believe in and the way you look at the world around you will act like a lens, filtering new experiences and ideas through the set of preconceived notions. Identifying or better establishing your worldview will help you better understand yourself and the people you come in contact with. Answer these questions to the best of your ability.

1. What, if anything, is the purpose of life? (Are we here to seek truth, perpetuate our gene pool, evolve to a higher life form, or is everything really meaningless?)
2. Where do we come from? (Is there a cause behind our existence, or are we here due to chance?)
3. What happens to an individual when he or she dies? (Does a person simply become food for worms, become reincarnated, or go to heaven or hell?)
4. How or who determines ethics? (Do I create my own morals, is there absolute truth that exists for all people, do all beliefs hold equal value, or is right or wrong our own creation to protect us from each other?)
5. What is the nature of time? (Is time linear with a beginning and an end, a perpetual cycle, or only a creation of our imagination?)
6. What influence could the above answers have on your thoughts and behavior? (Do you have a worldview or philosophy of life?)

Appendix L: Continuation of Worldview Discussion

In fourth hour, Mr. Leon read the second question, about where people come from, and polled the class on which option they agreed with. About half to one-third of the class raised their hands, but they all seemed attentive to the conversation. I didn't see any students texting, staring at walls, or working on homework.

"Anyone want to throw in on this one?" encouraged Mr. Leon.

Anthony volunteered "I think that there's a purpose behind our existence, because you somewhat are here to build a world with more people like you, or anyone else. It's like balance."

Jasmine challenged Anthony, "But what's the point of our world?" A few students laughed, but Anthony responded, "Well, that's what we have to find out still."

Mr. Leon allowed Anthony his victory and called on Jasmine, whose hand was up, "Jasmine, what is the point?"

She replied, "That's what I'm saying. There might not be one."

Mr. Leon clarified the point of the worksheet:

> Let me say this right now. My goal is to get you starting to think about these questions. Most 17 and 18 year olds have never, ever thought about these. You know what? Many forty year-olds don't think about these questions. And so my goal is to help you begin to. I don't expect you to know the answers. So when I push you, and say, "What is the purpose?" saying, "I don't know" is a perfectly good answer. It's probably a normal answer. Anyone else on that one? Diane?

Despite Mr. Leon's explanation of why they were doing the activity, Diane challenged him on it. "I don't see why we have to have answers to these. Like I don't know, I mean, I'm

only 18 years old and I don't really care what the purpose of life is. I'm just trying to get through school right now."

Mr. Leon was unfazed as he asked, "Does the purpose of life influence what you do after high school?"

"No," said Diane quickly, then admitted, "Well, if you look at it like that, I suppose then the purpose of life is to go through high school, go to college, get a job, and try to live comfortably."

"So the purpose of life is comfort and ease," revoiced Mr. Leon.

Diane said, "Well, I'm not saying it is, but. Maybe just in society, it is."

Mr. Leon elaborated on Diane's answer:

> Okay, there you go. So society is definitely. Probably parents, right? Definitely guidance counselors are saying, "Hey, you need to have a good job. You need to go to school, so you can have a good life, so you can have a happy life so, I don't know, so you're not on Welfare. You're not drunk in the gutter. I don't know.

Karli blurted out, "Social."

"What do you want to say?" encouraged Mr. Leon.

But she backed down from contributing with, "Oh no, nothing." Despite Mr. Leon's prompting, Karli did not seem comfortable adding to the conversation. There could be many possible reasons she didn't, which we can not know without asking her. But we can see that even the best scaffolding, a great teacher may not be able to involve every student every time in a high interest, disciplinary-based discussion.

In eighth hour, they had an odd tangent from Renee in the discussion on the second question. While Mr. Leon seemed uncertain of the validity of Renee's idea, he included it in the

conversation, always encouraging all of the students to speak up without fear of ridicule. Bruce began the student discussion by contributing, "I just wanted to say that I think this answer is truly unknown. Just the fact of accepting that it's unknown, is definitely not siding one way or another."

Mr. Leon checked, "So it's both?"

Bruce insisted, "Personally in myself, I have more comfort in not leaning one way or another on that subject. I'd rather say that I do not know, and accept that."

"Okay," acknowledged Mr. Leon.

Renee piped up, "Me and Anika were kinda talking about that yesterday, that if you build a pond with no fish in it at all, they'll just appear there."

Mr. Leon seemed surprised. "They will?"

"Yeah, that's a real thing," Renee assured him. "Like if you build a pond somewhere, fish will come there, somehow. But like how do they get there, because they swim in water."

"Really? I haven't ever heard this," answered Mr. Leon.

Renee continued, "I think it's because everything starts to evolve."

Mr. Leon teased, "Hmm, I'm going to go fill up my bathtub tonight." The class and the teacher laughed.

"Like in the ground!" corrected Renee.

Although Mr. Leon seemed skeptical of Renee's idea, he accepted it, "Okay. I have never heard that before. That's interesting. But if that is true, then that could definitely be impacting. Go ahead," he said to Megan.

Megan shared, "I put, it's like whether you believe in the Big Bang Theory or God. Cuz it's either by God or by chance."

Mr. Leon synthesized her answer into his next point, that all of the worldview answers should be somewhat aligned within their particular viewpoint:

> Since you're kinda moving us down this road, if you say, "We're here due to chance, then to be consistent, to have a cohesive point of view, if that's what you believe, what should your answer to number 1 have been? **The class was silent.** We're just here by chance, or possibly by mistake, it's genetic impossibilities that became possible, then probably the most likely answer is everything is meaningless, or maybe, I'm here to pass on my genes, it's part of the evolutionary process. Let's move onto number 3.

In fourth hour, Mr. Leon asked the next question, about what happens to a person when he or she dies. He polled about the listed options, if they simply decayed, went to an afterlife, or reincarnated. In eighth hour, he added the joke of asking if anyone in the class would sing the theme song of "The Lion King," after he mentioned the circle of life. The students chuckled, but no one sang. After some people raised their hands for each category, Mr. Leon asked for their input.

Alayna said, "I think the body decays but the soul still lives on."

"So there might be a possibility of both," Mr. Leon clarified. "Alright. Since we started on that, what worldview – you might not know these phrases. What worldview is that? I'll give you a hint, starting with a. . ."

Anthony interrupted, "There is one where they say when an old person dies, a baby gets born."

"Okay," said Mr. Leon. "So that's like an energy thing?" Mr. Leon was confident enough in leading the open discussion that he was able to shift his train of thought and address Anthony's tangent respectfully.

Anthony agreed, "Yeah."

"There's constant energy, just like there's a constant number of souls, perhaps."

Jasmine argued, "But there's more people on the Earth than there's ever been."

Mr. Leon countered, "Maybe they were blades of grass before." The class and the teacher laughed.

In eighth hour, Emma had a lot to say about what happens when we die:

> I don't exactly really know what happens, but I think it has something to do with the soul is really life. The body is just a vessel for the soul to reside in. And after the person dies, the soul leaves and the body just goes without the soul.

Mr. Leon said, "Okay, there's a lot of, there's probably billions and billions of people who agree with that. . . Who's going to agree with what you said, what worldview?" The class was silent. The teacher prompted, "Think big. What worldview is going to say, 'There's a difference between the body and the soul'?" When no one responded, he walked to the front of the room and pulled up the projector screen.

At this point of the lesson, Mr. Leon included a brief focus lesson on five major worldviews: Theism/Deism, Monism, Polytheism, Naturalism, and Post-Modernism. He had the views written on the chalkboard underneath the projector screen, so that he could pull the screen up when he was ready. Underneath each view were several examples of religions or philosophies that fit it. He told the students that they didn't have to copy them down, that it was

just for the discussion. The focus lesson could be described as a mini-lesson, because Mr. Leon continued interacting with students throughout it.

"Alayna was starting to tell us about which one?"

Several students responded, "Theism."

"A theistic worldview," agreed Mr. Leon. "What does theism mean? What's the root, theo?" Here was one of the embedded vocabulary strategies that Mr. Leon described during our interviews.

"Theory," guessed Mary.

> God. There is a God. Okay? Theism is kinda along the lines of the idea. This one means that there is a God who's involved in the world. **Mr. Leon pointed at Theism first, and then pointed at Deism.** This one means there was a God who created the world. He set it, and started it, but it's kinda a wash, and it's going to keep going and He could care less. It's like winding up a watch. So if you're a Christian, or a Muslim, or a Jew, then what's probably your answer to number one?

The class had fallen silent, and no one raised their hands. Mr. Leon answered his own question, and fell into a monologue about the worldviews and their beliefs. As he finished the lecture with nihilism under Post-Modernism, he explained, "Nihilism means basically there's no purpose in the world, I might as well kill myself today." A couple of students giggled rather nervously. "There's a lot of rock bands that kinda have that philosophy," Mr. Leon noted, connecting the idea to something familiar to students.

"And then Post-Modernism is probably one of the more pervading worldviews in youth culture. Have you heard this: 'I believe what I believe. You believe what you believe. Let's just all be happy and not bug each other.'"

Diane and a few other students chimed in, "Co-exist."

Mr. Leon nodded. "The coexist bumper sticker. Exactly." He continued with the focus lesson, expanding on post-modernism and explaining that there were other philosophies, too, like Earth magic, but these were the five major groups. The class was beginning to run short on time, especially in eighth hour. Mr. Leon read the question and options for the fourth question, asking who determines ethics and how.

"Ethics basically are fancy words for right or wrong, okay?" He read aloud the parenthetical options after question four, then added:

> Or how about this: Is right or wrong just something that we make up, to protect ourselves from each other? Just like the speed limit on [major highway near the school], mainly so we don't kill each other. No other reason other than that. Who creates ethics? Who determines right or wrong?
>
> Jasmine answered, "Our government." Mr. Leon repeated her answer, then waited.
>
> "Our religion," answered Anthony. Mr. Leon repeated his answer, and then waited.
>
> "Whatever your higher power is. Parents, teachers," continued Jasmine.
>
> Mr. Leon said:
>
> Okay. Different people do have different ethics. Question: Adolf Hitler really felt like there were a lot of people who were inferior. Jews, Gypsies, homosexuals, Communists. He really felt that he needed to elevate the German pure race, to make the world a better place and wipe everyone else out. And Jews

and Communists and so forth said, "No, no, no. That's not okay." Can we say, "Well, Hitler's right and the Jews are right. Let's just all be happy and get along?"

Several students responded with feeling, "No!"

Mr. Leon challenged them again, "Can we say that?"

"No," the class replied.

"Does that work in the world?" he asked.

"No," the students said.

Mr. Leon asked, "So don't we argue about ethics all the time? What are some of the big controversial issues in American politics right now?" Here, Mr. Leon connected the idea of ethics to students' knowledge of society beyond school.

There was a couple seconds of silence, and then a couple students volunteered answers like "Abortion," and "Social Security." Jasmine suggested, "The economy. Are you talking about things that are going on right now?"

"Yes," answered Mr. Leon, and continued:

So, abortion. Homosexual marriage. Should the government take care of your medical needs? Are you responsible for your own medical needs? Should we let people come into our country whenever they want, or should we keep them out? All those kinds of issues, right? Those are all huge issues, right? And they definitely. Okay. People who are against abortion and homosexuality are mostly in the theist category, because they believe that God sets the rules. People who are in favor of those things are mostly in the post-modern or naturalist worldview, because they believe that we make up our own rules. Is this making sense?

Monica nodded at Mr. Leon.

In eighth hour, the clock had been whittled down to two minutes left, and Mr. Leon was in overdrive, talking fast to try to get further. Yet he still remained interactive with students. After he read the options for ethics, he asked Kyle, "Kyle, why'd you come to my class today?"

"I had to," said Kyle. The class laughed.

"You had to? Why?" asked Mr. Leon.

Kyle said, "Because I have to go to school."

Mr. Leon asked him, "Who says you have to go to school?"

"My mom and dad," he responded. The other students and Mr. Leon laughed.

Mr. Leon added, "The state of Wisconsin says you do, too. Isn't it extremely arrogant and demeaning for the state of Wisconsin and your parents to impose their morals on you?"

"Yeah, I know," agreed Kyle.

Mr. Leon suggested, "I think we should rise up and have a revolution." The kids laughed, and John cried, "Vive la revolution!"

The teacher laughed, too. Mr. Leon had taken Kyle's potentially rude admission that he came to the Psychology class under duress, made it a humorous moment for the class to share, and then brought it back into the discussion about morality. "Anyone want to explain, where do morals come from?"

Loredana volunteered, "So I put, I believe that people have their own morals, but they come, of course, from where people come from, their culture, their mom and dad, family, and then experience. But I don't think there are like absolute, like I don't perceive something. Of course, it's just like everybody knows [indecipherable]."

Mr. Leon agreed, "It's a truth, but it's not a moral statement." In eighth hour, the bell rang and the students' school day was over. In fourth hour, they had time to get through the last two questions.

After reading the question about the nature of time, Mr. Leon polled, and then asked, "There was a beginning and there will be an end. Those of you who agree with this would probably be in what worldview?"

Alayna said, "Naturalist," as Karli said, "Theism."

"Theism," Mr. Leon repeated. He explained the second answer for time, that it is a perpetual cycle, as most likely fitting the Monism worldview. Then he said, "Or, time is something we make up, because the earth revolves around the sun. Which one might that come from?"

Monica volunteered, "Naturalism."

Mr. Leon agreed, "That would be a naturalist perspective, right? Lastly, last question. How could the above answers influence your thoughts and behaviors? So, Ruthann, how do your beliefs influence your behaviors?"

Ruthann responded, "Um, make you act different compared to living by different beliefs."

Mr. Leon said, "Okay. Anybody else? I don't want to force you guys to say stuff, but I do want to have a good conversation. What do you think?"

Donna volunteered, "It affects like everything you do."

"Okay," said the teacher. "How? How so?"

"Because, depending on your morals and stuff, you could get into drugs and stuff like that," Donna shared. "Or drop out of school. Or if you believe in God, you won't do stuff like

that, you'll get a job. So it pretty much affects everything, like who you marry, who your friends are."

"Mmm-hmm," agreed Mr. Leon. "How about this? And I know this isn't really important to you guys, but, would your beliefs ultimately influence what kind of psychologist you would be?"

James said, "Yeah."

"Because they have different perspectives on people, right? Alright, you guys did a very good job. This is a really hard topic. Anyone want to finish us up? Or are we all good?" After a couple seconds of silence, Mr. Leon continued, "We're good. Have a great weekend."

CURRICULUM VITAE

Ann Marie Hillman

Professional Experience

Westosha Central High School – Salem, WI

Reading specialist/ Literacy coach, August 2013 - present

Teach students who struggle to read and write at the secondary level in remedial reading classes and offer homework assistance in all subjects. Offer assistance to approximately 85 teachers in 13 different departments in strategies for reading, writing, speaking or vocabulary; find supplemental reading materials on designated classroom topics; design and model sample lessons; and provide assistance with teacher evaluation preparation.

University of Wisconsin – Milwaukee, in Milwaukee, Wisconsin

Associate lecturer, September 2012 - present

CURRINS 545, Content Area Literacy, for teacher certification. Coursework includes strategies for disciplinary literacy, designing collaborations, using formative assessments to adjust instruction, and Gradual Release of Responsibility unit plan to demonstrate summative understanding.

Oak Creek-Franklin Joint School District, in Oak Creek, Wisconsin

Substitute K4-12, and summer high school teacher, September 2010 – present
Long-term substitute teacher, high school German, March 2011 – June 2011

Cleveland State University, in Cleveland, Ohio

Graduate assistant, September 2008 – May 2010

Conducted soft skill training for tutors and freshmen survey reports; edited Journal of Teacher Research; coordinator for Chinese licensure program for Confucius Institute.

Esperanza, Inc., in Cleveland, Ohio

Grant writer, September 2006 – August 2008

Wrote grants for nonprofit organization dedicated to education of Hispanics in Northeast Ohio. Collaborated on 2008 Workforce Investment Act for Youth Grant funded at over $90,000. Designed grant proposal templates for five of the organization's programs for elementary, secondary and adult education.

Kent State University, in Kent, Ohio

Graduate assistant, September 2004 – May 2005, September 2006 – May 2008

Assisted two professors with research in educational policy and legislation; performed administrative and office duties. Compiled database on educational and political influences on public education. Conducted literature and website reviews of school ethos and democratic schooling.

Safely Home, Inc., in Bedford, Ohio
Teacher/Counselor, August 2005-August 2006
Taught at residential treatment facility for abusive reactive boys aged 14-17; responsible for English, Science, therapeutic education, Ohio Graduation Test preparation, additional duties as necessary

Ombudsman Educational Services, in Olmsted Falls, Ohio
Reading Skills Lab Teacher, October 2003-June 2004
Constructed personalized lessons for computer-based instruction. Assisted at-risk learners ages 14-20 in concept clarification in 4 core subjects. Offered one-on-one instruction in spelling and grammar, comprehension of literature and informational texts, vocabulary building, and composition.
Minnesota Transitions Charter School, in Minneapolis, Minnesota
English Teacher, October 2000-June 2003
Taught range of standards-based English classes, remedial to Honors, to alternative learners ages 14-20. Wrote curriculum and objectives for 14 courses. Responsible for Minnesota Basic Skills Test in Reading preparation. Founded Catalyst, an independent research program aligned with Minnesota standards.

Current Certification
Wisconsin Teaching Licenses: English 6-12, DPI #300; German 6-12, DPI #370; Reading K-12 DPI #316; Reading specialist K-12 DPI #17

Educational Background
University of Wisconsin – Milwaukee. September 2010 – December 2015
Studying toward Ph.D. in Urban Education, Curriculum & Instruction - Literacy; GPA of 3.945
Dissertation entitled "Disciplinary literacy: A case study on how secondary teachers engage students in disciplinary discourses"

Kent State University – Kent, Ohio. September 2004 – May 2008
Received Master of Arts in Cultural Foundations of Education, GPA of 4.0
Thesis entitled, "Analysis of individuality in the context of schooling for democratic community"

University of Wisconsin – Eau Claire. September 1993 – December 1997
Bachelor of Arts in English Secondary Education; Graduated *cum laude*

Awards
Advanced Opportunity Program Fellowship, University of Wisconsin-Milwaukee, 2011-2014 academic years
Chancellor's Graduate Student Award, University of Wisconsin-Milwaukee, 2010-2012 academic years
Graduate assistantship, Cleveland State University, 2008-2009 and 2009-2010 academic years
Graduate assistantship, Kent State University, 2004-2005 and 2006-2008 academic years
Educational Testing Services Recognition of Excellence in English, November 15, 2003

Publications

Hillman, A.M. (2014). A literature review on disciplinary literacy: How do secondary teachers apprentice students into mathematical literacy? *Journal of Adolescent & Adult Literacy*, *57*(4), 397-406.

Hillman, A.M. (September, 2014). Disciplinary literacy. *Update: WSRA, Newsletter of the Wisconsin State Reading Association, 26*(1), 3.

Hillman, A.M., Glaus, M., Arkens, B., Arshem, S., Bradley, M., Bunnow, N., Horsley, N., Reichenberger, A., Smiley, C. & Wachtel, A. (2014). Interviews with Wisconsin teachers about disciplinary literacy under the Common Core Standards. *Wisconsin State Reading Association Journal, 52*(1), 9-12.

Hillman, A.M. (2013). Suzanne Plaut's *The right to literacy in secondary schools: Creating a culture of thinking*. *Wisconsin State Reading Association Journal, 51*(1), 57-59.

Hillman, A.M. (2012). Diane Ravitch's Change of Heart. *Wisconsin State Reading Association Journal, 50*(1), 95-96.

Presentations

"Supporting Secondary Teachers with Disciplinary Literacy" Presentation at International Reading Association Convention in New Orleans, LA on May 12, 2014

Professional development on readability formulas and leveled text at Westosha Central High School on August 31, 2013 and August 30, 2014

Teachers' workshops on formative assessment techniques at George Washington Carver School, Milwaukee, WI, K-2nd grade on January 10, 3rd – 5th grade on January 17, and 6-8th grade on January 24, 2012

Teachers' workshop on content area literacy strategies at Oak Creek High School, November 23, 2011

Professional development on vocabulary development at Oak Creek High School, May 27, 2011

Midwestern Educational Research Association Conference, St. Louis, MO, October 16, 2009

Education Research Exchange Conference at Cleveland State University, March 6, 2009

Kent State University's 22nd Annual Graduate Student Senate Colloquium, March 3, 2007

Memberships

Milwaukee Area Reading Council, 2010 – present, served as Secretary 2012-2014

Wisconsin State Reading Association, 2010 – present
Chair of High School Literacy committee, May 2012 – 2015

International Reading Association, 2010 – present

Graduate Student Advisory Council member at University of Wisconsin – Milwaukee, Sept. 2012 – 2013

Graduate Education Senator for Student Government Association for Cleveland State University, 2009-2010
Student representative on University Curriculum Committee, 2008 – 2010
Student representative on Distinguished Faculty Awards Committee, 2010

Senator for Cultural Foundations of Education, Kent State Graduate Student Senate, 2006-2008
Representative on International Travel Grant Committee and Research Grant Committee