Teaching and Learning the Language of Science:
A Case Study of Academic Language Acquisition in a Dual Language Middle School

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ABSTRACT OF THE DISSERTATION

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English language learners (EL) are the fastest growing sub-group of the student population in California, yet ELs also score the lowest on the science section of the California Standardized Tests. In the area of bilingual education, California has dramatically changed its approach to English learners since the passage of Proposition 227 in 1998, which called for most EL instruction to be conducted in English (Cummins, 2000; Echevarria, Vogt, & Short, 2008). In reality, this means that EL students are often placed in programs that focus on basic language skills rather than rigorous content, meaning that they are not getting access to grade level science content (Lee & Fradd, 1998). As a result, many EL students exit eighth grade without a strong foundation in science, and they continue to score below their English-speaking peers on standardized achievements.
While the usefulness of the academic language construct remains controversial (Bailey, 2012), the language used in science instruction is nevertheless often unfamiliar to both EL and English proficient students. The discourse is frequently specialized for discipline-specific interactions and activities (Bailey, 2007; Lemke, 1990). This qualitative case study examined academic language instruction in three middle school science classrooms at a dual language charter school. The goal was to understand how teachers integrate academic language and content for linguistically diverse students. The findings from this study indicate that targeting language instruction in isolation from science content instruction prohibits students from engaging in the “doing of science” and scientific discourse, or the ability to think, reason, and communicate about science. The recommendations of this study support authentically embedding language development into rigorous science instruction in order to maximize opportunities for learning in both domains.
I dedicate my dissertation to my father, the original Dr. Gose. Throughout my life you have provided inspiration, advice, and you have always believed me capable of anything and everything. Papi, your little engineer has followed in your footsteps both as a scientist and an academic. I love you.
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Chapter 1: Problem Statement

Introduction

The purpose of this study is to understand teachers’ current practices and beliefs regarding English language learners’ acquisition and application of academic language in science classrooms. Using and understanding the language of science is key to developing deeper knowledge of scientific concepts. Acquiring academic language fluency is a challenge for most students, but especially for English language learners (EL)1 because they must learn academic content while simultaneously developing a second language (Collier, 1987; Cummins, 1981; Rosebery, Warren, & Conant, 1992). EL students, as a sub-group of the student population, are the lowest performing in science as measured by the eighth grade California Standards Test (CST) (California Department of Education, 2010b). Though there is an extensive body of literature on bilingual and sheltered-English instruction for literacy, little research exists on specific instructional strategies to teach scientific discourse to EL students (Lee, 2005; Lee & Fradd, 1998). This study will further the research in science education by identifying challenges and successes faced by both the teachers and students in linguistically diverse science classrooms. Understanding these factors will help educators provide a more supportive, and ultimately more equitable, science learning experience for this academically vulnerable population.

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1 The terms English learner (EL) and English language learner (ELL) are used interchangeably within the literature; in this study the researcher will use EL for consistency.
Science Literacy

Science education standards established by the American Association for the Advancement of Science (AAAS) and the National Research Council (NRC) have an overarching goal of developing scientific literacy in all students (American Association for the Advancement of Science, 1993; National Research Council, 1996). According to the National Research Council (1996), “an understanding of science makes it possible to discuss scientific issues that affect society, to use scientific knowledge and processes in making personal decisions, and to share in the excitement of scientific discovery and comprehension” (p. ix). Mastery and control of academic language is key for content-area learning; it is the most important determinant of ongoing academic success for students (Cummins, 1981; Francis, Rivera, Lesaux, Kieffer, & Rivera, 2006; Wellington & Osborne, 2001). Yet most limited-English proficient students in California, especially those in middle and senior high schools, do not have access to aspects of the core curriculum that would permit them to advance to college preparatory courses or to receive a diploma (Berman, 1992). To compound the issue, EL students take two to three times longer than native speakers to achieve academic language fluency (Collier, 1987; Hakuta, 2001), placing them at a severe disadvantage to gaining equal footing in scientific literacy (Chamot & O’Malley, 1986; Cummins, 1981).

One component of scientific literacy is scientific discourse, or the ability to think, reason, and communicate about science (Lee & Fradd, 1998). Much of the language used is specific to science – technical vocabulary, passive voice, and the avoidance of metaphors–yet other parts of the language have multiple meanings across disciplines, i.e. vocabulary terms such as force, pressure, and energy (Lemke, 1990). The result is that the language is abstract and out of context, factors that make domain-specific language one of the most
challenging levels of second language acquisition (Cummins, 1981).

The Problem in a Local Context

The National Assessment of Educational Programs (NAEP), often referred to as “the nation’s report card,” reports that California’s students are consistently scoring lower than students in the rest of the country in science. In 2009, not only were California students’ average scores below those of their peers, but the number of students who scored in the “below basic” competency category was significantly greater in California than in almost every other state (National Center for Education Statistics, www.nces.ed.gov).

A closer look at the reported scores reveals that the lowest performing sub-group of students is English language learners. The EL population in California represents more than 30% of total enrollment and over 50 different languages, though the majority of these students are native Spanish speakers (California Department of Education, 2010b). In 2010, only 22% of EL students scored “proficient” or “advanced” in eighth grade science, compared to other historically low-performing groups: economically disadvantaged African Americans (36%), economically disadvantaged Latinos (44%), and economically disadvantaged Asians (70%). California has dramatically changed its approach to English learners and bilingual education since the passage of Proposition 227 in 1998, which called for most EL instruction to be conducted in English (Cummins, 2000; Echevarria, et al., 2008). In reality, this means that EL students are often placed in programs that focus on basic language skills rather than rigorous content, meaning that they are not getting access to grade level science content (Lee & Fradd, 1998). As a result, many EL students exit eighth grade without a strong foundation in science, and continue to score below their English-
speaking peers on standardized achievements.

**Who Are the EL Students?**

In California, any student whose home language is not English is required to take a language skills test, the California English Language Development Test ( CELDT), within 30 days of enrolling in a public school. The test is designed to assess a student’s listening comprehension, reading, writing, and speaking abilities in English. If a student’s test results meet the criteria for English proficiency, he or she is classified as Initial Fluent English Proficient (IFEP). However, test results that do not meet the requirements for proficiency allow the local district to rank the student according to the following EL performance levels: Beginning, Early Intermediate, Intermediate, Early Advanced, and Advanced. Once students are classified as EL, they are required to take the CELDT annually until they achieve proficiency. At this point the students would be redesignated as Reclassified Fluent English Proficient (RFEP) (California Department of Education, 2010a). In 2010-2011, EL and RFEP students composed 31% of the entire student enrollment in California; in 2011-2012, this number increased to 43% of the state’s 6.2 million students.

**Challenges for EL Students**

The California Education Code Section 52161 recognizes that “the lack of English language communication skills [for ELs] presents an obstacle to such pupils’ right to an equal educational opportunity.” This challenge is further compounded when science learning requires specialized language to pose questions, design experiments, and communicate observations that can be difficult even for native English speakers (Lee, 2004;
Extensive research in elementary classrooms suggests several reasons to explain the poor academic performance of EL students in science. EL students must confront the demands of learning content-specific academic language before they have mastered English (Lee, Buxton, Lewis, & LeRoy, 2006; Santau, Secada, Maerten-Rivera, Cone, & Lee, 2009). Others point to the lack of culturally responsive science teaching to make the concepts relevant to students’ lives (Lee & Fradd, 1998; Moll, Amanti, Neff, & Gonzalez, 1992; Tse, 2001). However, there is a need for more research on upper elementary and middle school science classrooms, when scientific concepts become more complex and there is less instructional support for language development (E. M. Anderman & Maehr, 1994; Eccles, et al., 1993; Gándara, Rumberger, Maxwell-Jolly, & Callahan, 2003; Spanos & Crandall, 1990).

This study focused on how teachers designed lessons and planned instruction to support academic language acquisition in science. My research will add to the body of knowledge of effective strategies for EL science achievement by answering the following questions:

1. What is the role of academic language instruction in science classrooms?
   a. How do teachers incorporate language instruction into science content instruction?
   b. How do teachers monitor and/or assess students’ use of academic language?

During the study, these additional sub-questions emerged:

   c. What are teachers’ perceptions of academic language?
   d. How is academic language addressed in a dual language school, i.e. is academic language broadly defined to include both Spanish and English usage?
Design of the Study

When taught through a hands-on experiential approach, science instruction can provide contextual learning opportunities to build comprehension of both concept and language (Chamot & O’Malley, 1996; Cummins, 1981; Stoddart, Pinal, Latzke, & Canaday, 2002). Thus, science can serve as a bridge between basic communication skills and cognitive academic language proficiency. With this framework, I observed academic language instruction in dual language middle school science classrooms and interviewed teachers about their practice. My specific goals for this study were: (a) to determine how teachers design and teach content-rich lessons that promote academic language acquisition, and (b) how students use academic language during classroom experiments and labs.

Methods

Site

The site for this study was Harbor Bridge Charter School, a K-8 charter school in a large metropolis in southern California. The school’s campus was located in a low socio-economic area of the city, and drew most of its student population from the local neighborhood. Based on the socio-economic status of about 70% of its students, the entire school received Title I funding for free and reduced lunches. The school had been operating for over ten years, but at the time of this study was facing financial difficulties because of under-enrollment. In addition to the financial challenges, this school was in Program

2 All place and people names are pseudonyms.
Improvement Year 4 due to low academic performance. At the beginning of school year 2011-2012, the district in which Harbor Bridge Charter School was located began asking some hard questions about the school’s turnaround plan. The district was demanding evidence of fiscal and academic responsibility – without which they would revoke the school’s charter. In response to the district’s demands, the school shifted from its 90:10 Spanish/English dual language program to the 50:50 Dual Language Enrichment Model developed by Dr. Leo Gómez and Dr. Richard Gómez. The Gómez model advocated teaching early elementary literacy in students’ primary languages, which was already a cornerstone of the school’s program. Although there were many similarities between the school’s existing program and the Gómez program, there was one major difference. The Gómez model required that the entire school day be 50% English and 50% Spanish, implemented by designating the language of instruction for core subjects and electives. In contrast to the existing program at Harbor Bridge, math was to be taught in English, history and science in Spanish. In an attempt to improve academic achievement to meet the district’s demands, Harbor Bridge adopted the Gómez and Gómez Dual Language Enrichment model in the middle of school year 2011-2012.

I selected Harbor Bridge Charter School because it was typical of many charter schools in urban areas across the nation that were balancing finances, academic achievement, and district oversight. In addition, the administration and teachers expressed a desire to strengthen their science program as part of the overall plan to improve students’ academic achievement.
Population

In the school year 2011-12, Harbor Bridge Charter School enrolled approximately 570 students, 56% of which were EL and RFEP students. The 2012-2013 saw a decline in enrollment, down to 428, with 43% EL and RFEP students. A breakdown of the EL percentages by grade level is included in Figure 1. The predominant language spoken at home by these students was Spanish (99%). Each faculty member was bilingual in Spanish and English. There were three middle school science teachers who agreed to participate in this study, plus the Executive Director and the Site Director agreed to be interviewed by me. The demographic information I gathered on these teachers regarding their classroom experience, EL experience, and science background is presented in Chapter Four.

The Project

I conducted a nested case study at an urban charter school with a large (>25%) EL population. I focused on individual science classrooms as microcosms of teacher/student interaction in California. After initial interviews with teachers to discuss their lesson planning process and learning objectives for students, I scheduled multiple observations of their science classes over the next several weeks. I immersed myself in the classrooms: listening to lectures, observing students conduct experiments, reviewing student work, and familiarizing myself with each teacher’s classroom culture. As a familiar, but non-intrusive presence in these classrooms, I had the opportunity to gather information on students’ use of academic language during labs, as well as teachers’ use of specific language instructional strategies. Finally, at the conclusion of all observations I interviewed each teacher again to reflect and discuss the perceptions and outcomes of focusing on academic language as part
of science instruction. Qualitative methods were appropriate for the major part of the study because I wanted to understand how science teachers perceive their role as language instructors, how teachers plan language-rich science lessons, and how students use language in the classroom (Maxwell, 2005). The teachers and I analyzed the quality of the students’ work and discourse in academic language, a domain that does not lend itself to quantitative analysis.

**Data Collection**

In this study I implemented three methods of data collection: interview transcriptions, classroom observations and student work. I developed a classroom observation protocol (Appendix A) based on the language observation protocols designed by CRESST researchers (Martínez, Bailey, Kerr, Huang, & Beauregard, 2009) as well as components of the RTOP, an inquiry-based science observation protocol (Piburn & Sawada, 2000). In addition I created a semi-structured interview protocol to use when interviewing teachers and key administrators (Appendix B).

**Public Engagement**

The EL population in public schools in the United States has been steadily increasing since 2000; California leads the nation in the number of EL students it must serve (National Center for Education Statistics, 2012). It is essential to address the educational needs of this population in order to close the achievement gap between EL students and their English-speaking peers. Focusing on academic language is one of the immediate needs, as proficiency in academic language is “the key to long-term success in school… [It] is needed
to enter and complete higher education as well as to advance in the labor market” (Scarcella & Rumberger, 2000, p. 1). For years the United States has seen a decline in the number of high school graduates choosing science majors in college, which results in fewer numbers of young adults entering careers in science, technology, engineering, and math (STEM) (National Science Foundation, 2010). President Obama’s Race to the Top program is prioritizing STEM education. With plans to engage scientists and engineers in partnerships with schools, the President hopes to recapture and harness the shared motivation this country experienced in the wake of Sputnik. Schools in the United States need to prioritize science if we want the nation to maintain its presence as a science and technology stakeholder in the 21st century.

The immediate goal of this project was to recommend to Harbor Bridge Charter School effective pedagogical strategies for teaching English academic language in science, especially for EL students. This research will benefit EL teachers, science teachers, and schools with dual language programs. There are several EL conferences and publications through which I intend to disseminate my research, including CABE (California Association for Bilingual Education). To reach out to science teachers, I plan to share my findings at conferences and in publications sponsored by the California Science Teachers Association and the National Science Teachers Association. In addition, I also plan to share this research with non-traditional educators, such as museum and youth center professionals who frequently work with non-English speaking populations. The long-term goal for this project is to create more equitable learning opportunities for ELs in science classrooms, so that we may inspire more young people to pursue careers in science, technology, engineering, and mathematics.
Chapter 2: Literature Review

Introduction

Knowing and understanding the language of science is an essential component of scientific literacy (Wellington & Osborne, 2001, p. 139).

My research is focused on English language learners’ acquisition and application of the academic language necessary to actively engage in the process of learning science. For this reason, the background of this study requires an understanding of English language development, academic language, and effective science instruction. This chapter synthesizes the existing research relevant to these themes. First, I situate my study within the context of the EL academic achievement gap. Next, I define academic language and its role in teaching and learning. I discuss second language acquisition theories, then review the research on instructional practices that have been developed out of these theories. I will focus on content-area sheltered instruction and dual language instruction. I follow with a review of sheltered instruction in science classrooms and its effects on academic language acquisition as a measure of science learning. Subsequently, I synthesize the best practices for engaging students in science learning. Finally, I review professional development methods that integrate science, language acquisition, and literacy.

English Learners and the Science Achievement Gap

This chapter reviews the history and research of second language acquisition and situates these linguistic theories within current English language learner instructional
practice. The academic achievement of ELs has come under scrutiny since the passage of the No Child Left Behind (NCLB) Act of 2001. NCLB established a system of high expectations and created strong accountability measures for public schools to demonstrate high student achievement. The goal is for every student, including ELs, to reach grade-level proficiency in all content areas, specifically language arts and mathematics by 2014 ("No Child Left Behind Act of 2001," 2002). This mandate poses a particular challenge for EL students, who consistently perform lower than other students and frequently lower than many other subgroups (Abedi & Dietel, 2006; de Jong, 2004; Kohler & Lazarín, 2007).

Researchers have identified several barriers that impede ELs’ academic success, including cultural mismatches between students and teachers; communication gaps between parents, teachers, administration, and students; lack of teacher preparation to teach ELs; premature reclassification of students’ fluency level; and the need for academic language acquisition (Abedi & Dietel, 2006; Cummins, 2000; Good, Masewicz, & Vogel, 2010). The scope of my study is on academic language acquisition, as mastery of the language of science is essential to the process of learning science (Fang, 2004; Lee & Fradd, 1998; Lemke, 1990; Wellington & Osborne, 2001).

Although there is an extensive body of literature on bilingual and sheltered-English instruction for language arts, there is a need for further research on effective science instruction for ELs (August & Hakuta, 1997; Lee, 2005). In California, where ELs make up 36% of the student population, their science achievement is far behind that of their English-speaking peers. On both the fifth grade and eighth grade general science CST, only 22% of ELs scored above basic, compared to 65% of the English-only population (California Department of Education, 2010b). Not only do ELs face the challenge of developing language skills while learning content, but they also face the additional barrier created by the
academic language used in science classrooms. Science has a specific linguistic style that
does not allow for colloquial or figurative language, humor or hyperbole (Lemke, 1990). In
other words, the language of science does not provide a space for students to bring their
own socio-culturally situated speech. Some researchers would argue that this excludes
students from participating in science, and sends the message that students’ own prior
experiences and culture do not provide an appropriate framework to discover and explain
how the world works (Gee, 1990; Lemke, 1990; Rosebery, et al., 1992). Focus on strategies
to develop fluency in academic language will broaden EL students’ access to rigorous science
curriculum, and will provide more equitable science learning opportunities for native and
non-native English speakers.

Theoretical Framework

This study is firmly situated in constructivist learning theory. Constructivism, as first
articulated by Piaget (1972) and Vygotsky (1978), describes learning as the development of
knowledge through experience and interactions with others. The learner’s own history
influences how the learner interprets and incorporates new ideas into their growing
conceptual understanding. Learning, therefore, is an active process. Constructivist learning
theory is the foundation for inquiry-based science; knowledge is built from actual experience
and observation, and learners investigate their own ideas. Constructivism also informs the
person learning a second language will bring his or her own prior knowledge and cultural
perceptions into the new language. Within the framework of constructivism, it is the
teacher’s responsibility to teach the student to access and apply this background to
developing his or her comprehension of the new language.

One of the major constructs from Vygotsky’s work is the Zone of Proximal Development (ZPD). This concept describes the distance between a learner’s current level of comprehension and their next level of potential development. When working within this zone, learners feel supported by their prior knowledge to approach learning more challenging concepts. ZPD underlies Krashen’s idea of comprehensible input; learners acquire new language through exposure to grammar and vocabulary that is slightly above their ability level (1983). Vygotsky further describes ZPD as “problem solving under the guidance of an adult or in collaboration with more capable peers” (1978, p. 86). Thus, a socio-cultural theory of learning is the cornerstone of inquiry-based science learning; students share questions, explanations, and investigations as they come to understand how the world works.

Second Language Acquisition Theory

Though more recent studies have challenged and refined our understanding of language, the seminal studies of Cummins (1981), Collier (1987) and Krashen (1981) provide much of the foundation for second language acquisition theory. Originally, Cummins identified two tiers of acquisition: basic interpersonal communication skills (BICS) and cognitive academic language proficiency (CALP). In this dichotomy, basic language is used to converse with others and navigate socially, whereas academic language is required in situations without much context, such as standardized testing, reading mainstream English textbooks, or listening to lectures with few visual aids (Cummins, 1981). Cummins found that students might be able to converse fluently with peers in English yet lack the language
needed to complete school tasks. These findings are based on the assumption that there is a difference in cognitive demand between BICS and CALP; however this assumption has come under scrutiny from more recent researchers (e.g. Bailey, Bunch, Gibbons, Butler, Schleppegrell), as well as Cummins himself (2000). These researchers posit that academic language is not necessarily more cognitively demanding, but rather the specialized vocabulary and complex grammatical structures are less familiar and occur more frequently in school than in conversational situations (Bailey, 2012, 2007). Furthermore, as Bunch (2006) observed in his research on middle school classrooms, students themselves do not separate conversational language from academic language. Instead, they use both genres when collaborating with other students, recognizing that language can be used in a variety of ways to accomplish a task.

**Academic Language**

A more complete definition of academic language encompasses both the written and oral registers of language. In the classroom, students confront academic language in textbooks, they must write to demonstrate knowledge, and they must speak and listen to participate in the classroom discourse (Bailey, 2012; Cervetti, Bravo, Duong, Hernandez, & Tilson, 2008; Wong Fillmore, 1982). The academic language of science is a unique genre. It has its own specific vocabulary, voice, and understood norms (Lemke, 1990). Linguistically, it is the syntax of science, more so than the technical vocabulary, that is difficult for both ELL and native English-speaking students to master. The patterns of grammar, figures of speech, and rhetorical questions are rarely explicitly taught, therefore conceptual understanding is second to linguistic mastery (Goldberg, Enyedy, Muir Welsh, & Galiani, 2009; Lemke, 1990). The
tendency for scientific texts to employ passive voice to present processes as things, rather than actions, further complicates students’ understanding of concepts (Chenhansa & Schleppegrell, 1998; Halliday & Martin, 1993). For example, in a chapter on marine invertebrates from a seventh grade life sciences textbook, an octopus’ locomotive style is described passively: “Cephalopods move by jet propulsion. Water is ejected through the siphon in one direction, which moves the animal in the opposite direction” (Life Sciences, 2001, p. 323).

Given that acquiring and applying the language of science is difficult for most students, specific to EL students is the challenge of presenting their knowledge in a less familiar language. It raises the question, what is being assessed, language skills or science understanding? In a study of two bilingual teachers in three elementary classrooms, Kelly and Breton (2001) examined how teachers can guide students through an inquiry-based science curriculum while simultaneously teaching them the specific discourse needed to frame problems and make observations. The goal was to provide opportunities for students to learn not just science, but also the ways to investigate science. This included how to ask a question, pose a hypothesis, record observations, and engage in spoken and written discourse practices. Using discourse analysis, the researchers found that teaching the conventions of the language of science required discursive work on the part of the teachers. The teachers were changing their practice in the moment, reflecting on how students were learning and making necessary adjustments to accommodate student needs. Teachers would incorporate scientific discourse into conversations with students so that students had multiple opportunities to practice this new form of communication.

Learning a new language requires more than simply instruction in the new language (Cummins, 1981; Krashen, 1981). Children may demonstrate conversational fluency, yet
may not be fluent in academic and conceptual language. Transfer of academic knowledge across languages takes time and additional support from parents and teachers; it should not be assumed that transference would happen automatically for every student (Cashion & Eagan, 1990; Cummins, 1977). In order to practice fluency, students must have many opportunities to use the language in authentic situations. Teachers can build activities into the lesson that require students to talk with their peers about the new concepts by using the key vocabulary terms. Walqui (2006) refers to this strategy as “scaffolding of social interaction,” or creating contexts for linguistic and academic learning. Using Vygotsky’s Zone of Proximal Development as a foundation, Walqui further describes scaffolding as a fluid construct, one that is responsive to students’ needs. Scaffolded instruction is supportive when necessary, then scaled back when students are ready for new challenges. These new learning situations are collaborative in order to build on the social nature of learning; students receive support from peers rather than from the teacher. In Bunch’s (2006) study of linguistically diverse seventh grade social studies classrooms, he found that heterogeneous groups demonstrated the collective ability to complete the assignment. The students had a range of fluency in both conversational and academic language, yet they supported and corrected each other as necessary to cooperate and understand the task.

Science has often been characterized as an ideal language learning setting because of its hands-on experiences and opportunities for collaborative work, especially for ELs (Chamot & O’Malley, 1986). Research in science education has been limited largely to vocabulary and textbook usage, but with the constructivist movement gaining ground in the field, there is an increasing interest in children’s use of language to question, experiment, and analyze data (Amaral, Garrison, & Klentsch, 2002; Lee & Fradd, 1998; Stoddert, et al., 2002). In science, academic language involves observation, prediction, analysis, and
presenting information in a variety of formats, such as orally, in writing and drawing, and through tables and graphs (Lee & Fradd, 1998). These skills are put to use when students are actively involved with designing their own experiments, peer-to-peer discussion of concepts and brainstorming experiment ideas in collaborative learning groups. Furthermore, the use of hands-on activities reduces the linguistic burden on EL students. Incorporating hands-on science experiments and demonstrations into the curriculum provides contextual learning opportunities for students to build comprehension of both concept and language (Lee & Fradd, 1998; Rosebery, et al., 1992). Students must use both written and oral language to describe observations, make hypotheses and draw conclusions. Thus, science labs provide multiple situations for students to practice academic language.

**Instructional Strategies for English Learners**

In Collier’s (1987) 9-year study of recent immigrant children, she found that some children may acquire academic language proficiency in as little as two years, but most will take 4-6 years to catch up to their native-speaking peers. The students in her study received language arts instruction in a structured ESL program, but were mainstreamed into English-only math, science, and other courses. Without a supportive environment for second-language acquisition, students who are prematurely placed in English-only classrooms will not acquire academic language fluency nor achieve academic progress that is on par with their native English-speaking peers (Cummins, 1981; Lee & Fradd, 1998). Mastery and control of academic language is key for content-area learning; it is the most important determinant of ongoing academic success for students (Cummins, 1981; Francis, et al., 2006). One of the best methods for students to acquire both content and language literacy is
to receive academic instruction in their primary language while they simultaneously acquire English language proficiency (Cummins, 1981).

Despite such evidence, California’s Proposition 227 (now Education Code, Sections 300–340), passed in 1998, prohibits instruction in a student’s primary language. This mandate led to “sink or swim” immersion programs. Current trends in EL instruction have shifted practice away from this all-or-nothing model to a more sheltered, paced approach that gradually reduces the amount of linguistic support as students gain English proficiency (Cummins, 2000; Schleppegrell, Achugar, & Oteiza, 2004). Sheltered EL instruction has broadened its focus to include content-area learning as well as literacy. The most widely used of these instructional models are CALLA (Cognitive Academic Language Learning Approach) and SDAIE (Specially Designed Academic Instruction in English). Chamot and O’Malley (1996) developed CALLA to teach students to reflect on their own learning and to learn how to learn more effectively. This metacognitive approach is based on their research to identify the range of learning strategies used by high school students to learn English as a second language. In their study, the researchers interviewed high school students to learn which strategies, if any, the students used to acquire second language fluency and content knowledge. They found that most students utilized a variety of strategies to enhance their learning. The following were the most commonly used strategies: self-management, or a student’s awareness of his or her ideal learning conditions, followed by taking steps to arrange for those conditions; advance preparation, or practicing the language needed for the activity; and selective attention, or focus on certain details of the lesson to help with retention (O’Malley, Chamot, Stewner-Manzanares, Kupper, & Russo, 1985).

The overriding goal of SDAIE is to make the grade level core curriculum comprehensible, meaningful and challenging to ELs. New input is comprehensible when not
just the words but also the meaning are understood by the listener (Krashen, 1981). Therefore, SDAIE lessons include content objectives as well as specific language objectives. The language is embedded in the context of the subject being taught. Students are able to connect with the academic language when prior knowledge is activated and reinforced with visual aids, manipulatives, and gestures. SDAIE is based on Vygotsky’s fundamental notion that learning is social in nature; thus, it must involve collaborative and cooperative learning as well as scaffolding. Specific SDAIE techniques to support social learning include student-centered activities and reduced emphasis on oral demonstrations of knowledge. In other words, students can gain confidence in their comprehension by demonstrating understanding through drawings, gestures, or manipulating materials. This strategy creates a safe environment for students to try out their new language skills without fear of embarrassment or criticism. Employing multiple methods of teacher-student communication can also help clarify the uncertainty of an unsatisfactory student response – whether the incorrect response is a result of a lack of conceptual understanding or the inability to express the concept in English, or a combination of the two (Lee, et al., 2006). When given a variety of acceptable methods to demonstrate comprehension, students’ resulting gains in self-confidence will eventually pave the way for more formalized speech (Genzuk, 2011). In a small study of pre-service teachers, researchers observed that students with teachers who employed multiple SDAIE strategies scored higher on assessments and reported more positive attitudes towards science than their peers in classes with fewer SDAIE strategies (Keating, Diaz-Greenberg, Baldwin, & Thousand, 1998).

In addition to linguistic barriers, EL students also face cultural barriers when learning science. In a study of bilingual elementary science classrooms, Barba (1993) found that bilingual students were less likely to have access to appropriate science materials (e.g.,
manipulatives, laboratory apparatus). Textbooks and curriculum were not observed to be culturally relevant, nor were non-English reference materials available. In addition, teachers in these classrooms often used examples, analogies, and elaborations that were culturally unfamiliar.

The strategies suggested by CALLA and SDAIE are just that – suggestions. They do not provide lesson plans or scripts for teachers to follow. Rather, they recommend specific techniques that have proven success for ELs that can be incorporated into a lesson at a teacher’s discretion. Echevarria, Vogt and Short (2008) developed SIOP (Sheltered Instruction Observation Protocol) to help administrators and teachers operationalize EL instruction in their classrooms. There are several benefits to codifying model EL instruction into a protocol. With this observation tool, administrators can provide concrete feedback for teachers. Also, teachers can use SIOP to plan and deliver lessons to best meet the needs of their students learning English. SIOP can also provide a framework for professional development for EL teachers.

The protocol is divided into three sections: preparation, instruction, and review/assessment. There are several finer points included within each broader section, such as ‘use of supplementary materials’ under the heading for preparation. It is not expected that each item would be present in every daily lesson, but it is expected that effective EL teachers would incorporate all of the items over the course of a week. A central feature of the model is the inclusion of both a content and a language objective for every lesson so that the learning goals are made explicit to the students (Echevarria, et al., 2008; Himmel, Short, Richards, & Echevarria, 2009). The other items in the protocol are a combination of SDAIE and CALLA strategies, organized into a clear, concise framework for teachers to use.
A recent critique of the SIOP model finds that the strategies work well for some teachers, but not all (McIntyre, Kyle, Chen, Muñoz, & Beldon, 2010). When the SIOP model is fully implemented as the creators intended, McIntyre et al found gains in student achievement. However, it cannot be assumed that all teachers will incorporate the socio-cultural teaching techniques, such as collaborative group work, suggested by SIOP. These teaching strategies are not an explicit part of SIOP professional development, an omission that leaves some teachers unprepared to fully implement this model for optimal student achievement gains. SIOP, when combined with professional development in constructivist learning, could provide richer opportunities for teachers to provide linguistic support for academic language acquisition.

An alternative to sheltered instruction is the dual language model. The goal of dual language programs is for students to develop full proficiency in their first language and high levels of proficiency in their second language, in other words to possess bilingualism, biliteracy, and multi-culturalism (Gómez, Freeman, & Freeman, 2005; Lindholm-Leary, 2005). There are two different models most often used in dual language schools, the 90:10 model and the 50:50 model. In a 90:10 model, students receive 90% of their instruction in the target language and 10% in English; however this ratio gradually shifts from 1st-4th grade, so that by fourth grade the instruction is balanced between the two languages (Lindholm-Leary, 2004/2005). Contrast the 50:50 model, in which half of the instruction is in English, and half is in the target language throughout the entire program. Another unique feature of 50:50 programs is that ideally the student demographics are 50% English speakers and 50% non-English speakers who already speak the target language. With this type of model, the students are not only learning a new language, but they are also learning from one another.

In Lindholm-Leary’s extensive literature review (2005) on best practices of effective
dual language programs, she highlights seven features of highly effective programs. First, consistent and systematic assessment and accountability are key. Information gathered from assessments can not only help a school monitor its instructional program, but it can also help inform future professional development needs of teachers. She emphasizes that achievement must be measured in both languages to accurately gauge each student’s level of bilingualism and biliteracy. The second key feature in a successful dual language program is an academically challenging curriculum that is also culturally relevant to students. Third, she points to instructional practices that incorporate a variety of sheltered language instructional strategies, such as using visual aids, cooperative work, targeted language objectives, and genuine dialogue. Another hallmark of an effective dual language program is the quality of staff and professional development opportunities afforded to teachers.

Lindholm-Leary (2005) reports that dual language program teachers need not only content knowledge and pedagogical training, but should themselves be biliterate and bilingual in the target language. The professional development offered should introduce or enrich these skills, as well as target the goals of the dual language program itself. Finally, the presence of a cohesive, school-wide shared vision is fundamental to program success. The goals of the program should be supported not only by the school’s faculty, but also by the parents and surrounding community. There are many positive outcomes when all the stakeholders buy in to the mission of the dual language program: parents can support language learning at home, the community will value multiculturalism, and district policies can be beneficial to the school. Fidelity to the vision is ensured by effective oversight and support from school leaders. Such management should include instructional leadership and availability of resources.
Science and the English Language Learner

Learning and using the language of science, or scientific discourse, is key to developing deeper knowledge of scientific concepts and understanding the nature of science (Lemke, 1990; Moje, Collazo, Carrillo, & Marx, 2001; Rosebery, et al., 1992). When students use academic language in the classroom, they are “not only learning content but also learning how to participate in science-related communities” (Calabrese Barton, Tan, & Rivet, 2008, p. 74). The specialized vocabulary is also known as Tier 3 vocabulary in the CALLA scheme. Tier 3 vocabulary is context-specific but less frequently used, though these terms may have cognates in a student’s native language (e.g. photosynthesis/фотосинтез). In addition to technical vocabulary, science also employs non-technical terms that have meanings in multiple disciplines (e.g., matter, force, pressure, space). As science concepts become more complex in middle school and high school, the language also includes unfamiliar symbols and notational systems (Spanos & Crandall, 1990). Often, teachers and students expect science language to be correct and serious, without employing metaphors or figurative language. This style of talking about science presents a description of the way the world works, but does not present the humanistic side of science and the pursuit of knowledge and understanding. The objective, rather than humanized, voice of scientific language can be a barrier to student engagement in a lesson, even for native English language speakers.

Research has found that students are more receptive to learning science when the norms of scientific language are broken. In a classroom observational study for the National Science Foundation, students were three to four times as likely to be attentive to “humanized” science talk as they would be to “normal” science talk in the classroom (Lemke, 1983, 1990). In her work with Haitian Creole ELs, Ballenger (1997) found that allowing atypical science talk, such as storytelling and joking, created multiple points of entry for students to access
the curriculum. Students made connections between their classroom experiments and their personal experiences, broadening their depth of understanding of mold growth.

These findings coincide with current research in teaching English to second-language learners. Making content relevant to students by activating students’ own personal experiences and background knowledge is a method of engaging student learning found in both effective teaching and effective EL instruction. The overlap of curriculum and students’ social, linguistic, and cultural backgrounds has been referred to as a third space (Moje, et al., 2004) or a hybrid learning space (Calabrese Barton, et al., 2008). These ideas draw heavily from Moll’s research on funds of knowledge (Moll, et al., 1992) and Ladson-Billings description of culturally responsive pedagogy (Ladson-Billings, 1995). In Moll’s study, teachers visited students’ homes to learn about the families’ skills, expertise, and hobbies. Opening these lines of communication enabled the teachers to incorporate aspects of the students’ cultural environment into a unit about candy. The teachers found that the lesson was more meaningful to students with the connection to their cultural backgrounds and the inclusion of family. Ladson-Billings (1995) also found that acknowledging and encouraging students to express their diverse cultural backgrounds resulted in deeper academic engagement and achievement. Thus, allowing space for these hybrid learning opportunities humanizes the process of learning and makes content more accessible to diverse student populations, including both native English speakers and EL students.

Calabrese Barton and her team (2008) examined the effectiveness of hybrid learning spaces in their qualitative case studies of girls enrolled in middle school science classes at three different New York City public schools. The girls selected represented a wide range of ethnic backgrounds, science achievement, and personal interests. The first year, seven girls were observed and interviewed twice a week for fifteen weeks. The second year, thirteen
girls were observed and interviewed twice a week for 31 weeks. The researchers observed that the girls infused their personalities into projects in ways that the teacher had not even imagined. For example, an active singer and dancer created a pneumonic song to remember the bones of the human body – her own extension of an assignment given by the teacher. The teacher validated her creativity with both private and public praise, enabling the student to feel she was a central part of her science learning community. Other girls from this study also found their own ways to contribute to the class. One girl established herself as the scribe for her small cooperative groups – a reaction to her distaste for touching the earthworms for the lab that day. By the end of the lab, she had become the expert for her group since she had noted everyone’s detailed observations. She was still able to participate in the concluding discussion, but on her own terms. These results suggest that creating hybrid learning spaces would enable girls to engage in science in ways that would ultimately made their science learning experiences more personal and meaningful.

These findings are also true for English learners. When EL students are encouraged to establish and explore their own interests, and actively engage in science inquiry and discourse, they are better able to appropriate the language and culture of science (Rosebery, et al., 1992). In the Chèche Konnen Project, the researchers’ multi-year study, elementary students in a linguistically diverse setting were asked to plan and carry out investigations. After one school year of culturally responsive science curriculum, students made noticeable changes in their abilities to hypothesize and reason scientifically.

Moje, Collazo, Carrillo, and Marx (2001) describe the interactions between a bilingual middle school science teacher and his students. Both students and teacher shared similar language and cultural backgrounds, yet the teacher recognized that there were multiple discourses to interweave to create an environment for student success: classroom,
disciplinary, and social. In situations in which the teacher was not able to effectively integrate students’ primary social discourse and everyday knowledge with scientific discourse and knowledge, the students did not fully comprehend the meaning of the science vocabulary. For example, in discussing the meaning of the word “quality,” the teacher’s explanation was grounded only in scientific discourse, at the expense of the students’ own prior understanding of water quality. The successful integration of multiple discourses creates the hybrid third space in which students are best able to access the curriculum. The third space brings together students’ prior experiences and funds of knowledge with the classroom expectations to make the curriculum meaningful and relevant to students.

**Effective Science Instruction**

In the 1990s, the Benchmarks for Science Literacy and the National Science Education Standards framed the scope and sequence of science knowledge, attitudes, and skills that students should retain from a public K-12 education (American Association for the Advancement of Science, 1993; National Committee on Science Education Standards and Assessment, 1996). Both publications advocate teaching science through inquiry in order to provide students with the experience of actively doing science, regarded by many as “the best way for students to learn science concepts effectively, think scientifically, and understand the nature of science” (Leonard & Penick, 2009, p. 41). With curriculum that is inquiry-driven, students are the ones who ask questions, develop experiments to test ideas, gather and analyze data, and create conclusions based on evidence. True inquiry is a student-driven model of learning: students develop their own questions and experiments; make conclusions based on evidence and first-hand observations; and share findings with
peers. The collaborative nature of an inquiry-based science classroom promotes the social and emotional development of students as well as their conceptual understanding of science (Kluger-Bell, 1999). Teachers act as facilitators who guide, rather than direct, the discussion (Fradd & Lee, 1999; Wolf & Fraser, 2008). Given this freedom, students have the opportunity to establish and explore their own interests. Research has demonstrated that supporting self-directed science learning can increase academic achievement for girls and students of color (August, Branum-Martin, Cardenas-Hagan, & Francis, 2009; Geier, et al., 2008; Marx, et al., 2004; Patrick, Mantzicopoulos, & Samarakunav, 2009).

Inquiry-based instruction is proven to engage students in learning. In a study of kindergarten classrooms from three schools in a mid-western, suburban public school district, Patrick and her colleagues (2009) conducted the Scientific Literacy Project (SLP), a program that integrated science inquiry with literacy. After participating in the program for five weeks, boys and girls both reported an increase in “science liking.” Students in the ten-week SLP reported an even greater increase in liking science. These results demonstrate a direct connection between engaging, student-driven inquiry and children’s motivation to learn science. More than simply bolstering students’ attitudes towards science, inquiry-based science instruction can also improve student achievement. The Valle Imperial Project in Science (VIPS), a pilot program in a rural southern California school district, introduced kit-based science units to K-6 classrooms over a four-year period (Amaral, et al., 2002). The program utilized a variety of high quality, research-based kits from Science and Technology for Children (STC), FOSS, and Insights³. Fourth- and sixth-grade students were assessed

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³ *Science and Technology for Children* (STC) developed by the National Science Resource Center (NSRC) at the Smithsonian Institute supported by the National Academy of Sciences; *Full Option Science System* (FOSS)
annually using the science section of the SAT-9 test in addition to their performance on the district-administered writing proficiency test. The results were disaggregated into groups based on number of years students had received the kit-based instruction as well as English language proficiency. The results showed consistent improvements among English learners the longer they were exposed to the inquiry-based program.

In one of a scant number of studies on middle school science classrooms, August and her colleagues (2009) conducted a quasi-experimental study comparing the district-approved science curriculum with an inquiry-based curriculum called Project QuEST in a low income, high minority district in the Rio Grande Valley of south Texas. The classes participating in the study ranged from 16-92% EL per class. The ten teacher participants taught two randomly selected sections of their science classes using the district-approved materials and two randomly selected sections using the intervention curriculum. The instructional intervention included professional development for the ten teachers as well as instructional support materials such as a teacher guide and instructional charts, a student guide and instructional charts, and supplies for hands-on science activities. The authors measured the impact of the intervention through analysis of students’ performance on researcher-designed pre- and post-assessments of vocabulary and content. The pre-test showed minimal differences between treatment and control groups; the post-test measured a positive effect of .25 for the treatment groups. The overall effect was positive for both EL and native English speakers, highlighting the impact of inquiry-based instruction for content and vocabulary acquisition for all students regardless of English language proficiency.

developed at the Lawrence Hall of Science, University of California, Berkeley; and Insights created by the Education Development Center in Newton, Massachusetts.
A three-year quantitative study of seventh- and eighth-grade students in Detroit Public Schools provides longitudinal data on the cumulative effect of inquiry-based science instruction (Geier, et al., 2008). The researchers studied the learning outcomes of two cohorts of students during and after participation in project-based science units developed by the University of Michigan’s Center for Learning Technologies in Urban Schools (LeTUS). The LeTUS program was an NSF-funded urban systemic reform initiative. The program offered a highly collaborative environment for university researchers, teachers, and school administrators to develop curriculum that was responsive to teacher feedback and annual student outcome data. Geier et al recorded gains in student achievement, especially for African-American boys, on state standardized tests when compared to students who did not participate in the LeTUS curriculum. After one year in the program, the students who had received the project-based intervention had a mean score on state standardized tests that demonstrated a 14% improvement over the control group, and after two years showed 13% improvement. The researchers collected additional data in this study using pre- and post-assessments designed by the researchers to measure content knowledge and science process skills (Marx, et al., 2004). Again, the results showed increasing gains in student achievement, particularly with each additional year the students were involved in the intervention. This increase demonstrates the cumulative effect of learning through inquiry, as each year the effect sizes were more robust. In this study, the gains were more significant for students’ content knowledge than process skills. This discrepancy suggests that science curriculum reform needs to specifically address process skills as well as content. Overall, data from this longitudinal study asserts that science instruction that utilizes inquiry and project-based learning improves science achievement for low-income, minority students in urban middle schools (Geier, et al., 2008; Marx, et al., 2004; Patrick, et al., 2009).
Inquiry-based science establishes scientific discourse through specific science practices such as asking questions, conducting investigations, creating knowledge based on observation, and forming conclusions framed in scientific terms. Yet engaging in scientific discourse can be challenging for students as they encounter different ways of talking, reading, and writing, or the “doing” of science (Lee & Fradd, 1998). Learning science is more than simply the mastery of language, it is “a matter of understanding the approach to knowledge and reasoning, and the values and assumptions that science embodies, and of finding a way to accommodate one’s purposes and values alongside those of the scientific and the school cultures” (Rosebery, et al., 1992, p. 26). The thrust of current science education reform emphasizes building students’ understanding of scientific concepts beyond rote memorization of facts and terms, in order to develop students’ abilities to apply scientific phenomena to real world situations, in other words “to acquire both scientific knowledge of the world and scientific habits of mind at the same time” (American Association for the Advancement of Science (AAAS), 1989, p. 190).

**Professional Development**

Given such rich knowledge about EL instruction and science instruction, how are teachers accessing this information and implementing these strategies in their classrooms? Professional development is essential to the implementation of standards-based reform (Committee on Science and Mathematics Teacher Preparation, 2001), yet professional development is under increasing scrutiny for its immediate relevance to improving student outcomes (Fishman, Marx, Best, & Tal, 2003; Loucks-Horsley & Matsumoto, 1999). Student outcomes in science are defined “not only as achievement on standardized tests, but
also meaningful learning of classroom tasks and affect (attitudes, interest, motivation), course enrollments, high school completion, higher education, and career choices’” (Lee, 2005, p. 434). However, it is challenging to directly link these outcomes to teacher learning through professional development. Ruiz-Primo and colleagues (Ruiz-Primo, Shavelson, Hamilton, & Klein, 2002) present a different framework for measuring evidence of student performance other than standardized test scores. They describe the “multilevel-multifaceted” approach as a method to assess student achievement at different distances from the enactment of the curriculum: immediate, close, proximal, distal, and remote. 

*Immediate* assessment may come from students’ notebooks; *close* assessment from embedded assessments, or observations of student interactions; *proximal* assessment gathers evidence from unit tests or application of critical thinking; *distal* assessments come from state and national standardized tests; and *remote* assessment looks at general measures of achievement. Collecting data on student outcomes from these various sources, or multi-facets, provides a much broader picture of student achievement. Using this framework can allow multiple pathways for researchers to link teacher learning to student outcomes to fill in this gap in the research on professional development. Many outside factors, such as language proficiency, can influence distal measures; therefore they are unlikely to yield relevant information for the design of professional development related to the curriculum at hand.

Another need in the field of professional development is the adequate preparation of teachers to integrate English language and literacy instruction with subject area instruction (Stoddart, et al., 2002). Professional development efforts must provide teachers with the tools to provide simultaneous instruction and practice in academic language acquisition and content comprehension. Researchers designed SIOP with this need in mind (Echevarria, Short, & Powers, 2006). Teachers use sheltered instruction to make core content accessible
to ELs with strategies such as use of visual aids and demonstrations, scaffolded instruction, targeted vocabulary development, and connections to student experiences (Echevarria, et al., 2008). Despite agreement on the effectiveness of individual techniques, few measurements existed on how to interweave these sheltered instruction strategies into an effective, cohesive lesson (August & Hakuta, 1997). Echevarria and her colleagues developed the SIOP model as a rubric: teachers can use SIOP to plan lessons that incorporate systematic language development alongside content comprehension; researchers and administrators can use SIOP to measure how well teachers are including essential sheltered instruction features in their lessons. Using the tool in this way provides opportunities for reflection on practice and targeted feedback to support teachers’ changes in practice (Echevarria, et al., 2006; Loucks-Horsley & Matsumoto, 1999). However, one of the limitations of the SIOP model is that it has not been empirically tested in middle school science classrooms. Although academic writing skills are important to achievement in science learning, these skills are but a small piece of the overall comprehension of the nature of science (Lee & Fradd, 1998; Rosebery, et al., 1992). Furthermore, SIOP does not adequately train teachers to use the socio-cultural techniques necessary for the model’s success (McIntyre, et al., 2010). These critiques highlight the need for further research into effective content-based language instruction for middle school students.

Studies that are specific to professional development in science instruction and language acquisition have been largely focused on elementary teachers and pre-service teachers (Luykx, Lee, & Edwards, 2008; Marble, 2007; Santau, et al., 2009; Stoddart, et al., 2002; Wong Fillmore, 1982). Several studies examine the effect of teaching inquiry to pre-service teachers and the resulting impact on their own beliefs of the nature of science and their teaching efficacy (Abd-El-Khalick & Akerson, 2009; Abd-El-Khalick, Bell, &
Lederman, 1998; Marble, 2007; Roberts, Gott, & Glaesser, 2010). After receiving explicit, reflective instruction in the nature of science, only some teachers reported an intention to teach their future students in the same way. Even those who did intend to teach the nature of science through inquiry made projections about perceived constraints, such as lack of adequate preparation to teach the nature of science, their own lack of understanding, and inexperience with classroom management (Abd-El-Khalick, et al., 1998).

Once teachers are in service in the classroom, research shows that several barriers inhibit the effective instruction of inquiry, such as low teacher content knowledge, large class size, lack of school level support, lack of planning time, limited access to technological resources and hands-on materials, and limited instructional freedom (Johnson & Fargo, 2010; Songer, Lee, & Kam, 2002). In a study of 19 sixth-grade classrooms in Detroit, researchers examined teachers’ responses to a district initiative to implement a technology-rich, inquiry-based science curriculum (Songer, et al., 2002). Using frequent classroom observations and post-intervention interviews, the authors gathered qualitative data on teachers’ perceptions of the barriers to implementing the curriculum. In addition, student achievement was measured with a pre- and post-assessment. The teachers in this study cited several constraints to effective teaching: inadequate prep time, inadequate time for reflection, large class size, high student mobility, inconsistent Internet access, and low levels of content knowledge and computer training (Songer, et al., 2002, p. 145). Despite these barriers, however, the researchers did identify several positive values to support the implementation of inquiry-based curriculum in urban classrooms. First, the teachers reported that the students were more enthusiastic to participate in science because the curriculum made the content relevant to their lives and improved students’ self-esteem. The second positive value was that the more rigorous curriculum established higher expectations for student
success; a challenge to which many of the students rose. Third, the integration of computer technology addressed different learning modalities, giving students different pathways to access the content. This additional computer use also increased students’ comfort level with the technology. The fourth finding directly related to teacher learning. The teachers felt creatively challenged to learn new technology as part of this curriculum implementation. Both the positive and negative findings from this study are helpful to other researchers. Awareness of the reality of urban classrooms will help future researchers avoid these pitfalls, while at the same time focusing on the positive outcomes that are possible.

The previous study described the implementation of a new curriculum; Marble’s work (2007) with pre-service elementary teachers focused on lesson study of existing curriculum. The cohort of 24 pre-service teachers worked in three different K-5 classrooms in their final semester before graduating. Each small team taught the same lesson three times, after each occasion reflecting and making adjustments based on their classroom experience. Going through the collaborative, iterative process of lesson study, the participants self-reported their satisfaction with the lessons in the categories of planning and design; creating a positive learning environment; engaging students in deliberating meaningful content; and assessing student learning. Each team reported a significant increase in satisfaction with their performance on all four measurements with each iteration of the lesson. The author recommends that the implication for practice is to establish such inquiry-based learning experiences for all pre-service teaching programs. I suggest that these findings be taken a step further, and incorporated into professional development models for teachers already in service in the classroom.

A significant contribution to the research on language and science comes from the work of Lee and Fradd (1998, 2001). They define their framework of instructional congruence as
the integration of science education and literacy to promote achievement in both areas (Lee & Fradd, 1998). Specifically, they suggest that “teachers need to integrate knowledge of (a) the students’ language and cultural experiences, (b) science learning, and (c) literacy development” (2001, p. 111) to make science content accessible, meaningful, and relevant for diverse students. Instructional congruence provides an opportunity for teachers to build connections between a student’s cultural background, literacy, and content knowledge.

Johnson and Marx (2009) used the instructional congruence framework as the basis for their 3-year intervention with middle school science teachers at two urban schools. They designed the Transformative Professional Development (TPD) model to enable teachers to create more effective classroom learning environments. The sustained, collaborative model of TPD was specifically designed to positively transform the beliefs and practices of the teachers, as well as the overall school climate. TPD is based on three main components: 1) sustained, whole-school efforts to make science culturally relevant; 2) relationship building among faculty; and 3) establishing procedures and routines for participation in science classrooms and high expectations for success. A key feature of the TPD model is its responsiveness to teacher suggestions. This reaction to feedback creates a continuous cycle of learning, also known as a positive feedback loop (Kauffman, 1980). In this way, the TPD model can be responsive to the school climate by analyzing input from the teachers and making adjustments as necessary.

After the first year of the TPD study, the researchers found that a majority of the teachers (4 out of 5) improved their instructional effectiveness, as measured by their observation protocol4. The researchers attribute these changes to the trusting relationships

4 Local Systemic Change (LSC) Classroom Observation Protocol (Horizon Research, Inc. 2005)
established between teachers, teachers and students, and teachers and the university researchers/group leaders. These findings suggest that cultivating a collaborative team creates a safe environment for educators to reflect on their practice and create change. Many studies address specific needs for the EL science classroom, but very few are able to create sustainable change in teacher practice. The Transformative Professional Development model provides a useful foundation for further research into collaborative professional development for impacting science achievement for ELs.

**Conclusion**

The research reviewed in this chapter demonstrates that inquiry-based science is effective for improving achievement for all students, and specifically ELs. However, the literature is heavily biased towards elementary classrooms. A number of studies have indicated that middle school students often exhibit a disturbing downturn in achievement after the critical transition from elementary school (E. M. Anderman & Maehr, 1994; Eccles, et al., 1993). They not only experience physical and emotional changes, but also social and academic pressures. As a result, we see an academic decline, especially in math and science (L. H. Anderman & Midgley, 1997; Osborne, Simon, & Collins, 2003; Roeser, Eccles, & Sameroff, 2000). The transition to middle school has a negative effect on students’ academic motivation as well (E. M. Anderman & Maehr, 1994; Eccles, et al., 1993). In one large scale, two-year study of students’ transition from elementary to middle school math classrooms, researchers found that the decline in academic motivation is not simply an inevitable characteristic of early adolescence, but rather a mismatch between students’ needs and educational opportunities; a misalignment of the “stage-environment fit” (Eccles, et al.,
Developmentally, adolescents desire increased autonomy in various areas of their lives; however, this study found that middle school teachers are more controlling and less likely to let students make decisions in the classroom. Further, the middle school teacher/student relationships examined in this study were less supportive, friendly, and warm than the relationships between elementary teachers and students. This decrease in motivation, compounded by more complex content, makes the middle school environment a particularly challenging space for student achievement (Spanos & Crandall, 1990).

The extant literature on middle school classrooms is significant, but reveals the need for further investigation into the impact of instructional intervention on EL science achievement. Middle school English language learners face the challenge of learning and engaging in science in a language they do not speak, write, or read proficiently. This chapter synthesizes the research on academic language acquisition, inquiry-based science, and the professional development necessary to integrate both areas. Current teaching models focus on engaging students in the hands-on work, but not on how to use the academic language to “talk science” with their peers. It is my intention to add to the body of research on EL science learning by conducting my own qualitative research with middle school teachers with the common goal of creating opportunities for ELs to acquire and apply the language of science to their classroom experiments and investigations.
Chapter 3: Methodology

Introduction

This project focused on middle school English language learners’ acquisition and application of the academic language necessary to actively engage in science experiments. *Academic language* (AL) is both a written and an oral register of language. AL refers to the vocabulary, grammar, and genre of a particular discipline. AL provides a means of expressing complex ideas and concepts more precisely than conversational language (Bailey, 2007; Gibbons, 2009; Lemke, 1990). English language learners face unique challenges when acquiring and applying academic language; non-native speakers take 4-6 years to acquire academic language skills, compared to just two years for their English speaking peers (Collier, 1987; Hakuta, 2001). Yet content-specific academic language is essential to fully engage in scientific exploration: to ask questions, pose hypotheses, make detailed observations, record data, and collaborate with other students (Lemke, 1990). This type of active participation involves students in the true nature of science, as well as making science relevant and meaningful to their lives. Absent this full engagement, EL students are not mastering the concepts embedded in state and national standards, as evidenced by their achievement on the California Standardized Test. As a sub-group of the entire student population, EL students are the lowest performing in science as measured by the eighth grade CST. In 2010, 75% of English-speaking students measured “advanced or proficient” on the eighth grade science CST, compared to 22% of English language learners (California Department of Education, 2010).
The goal of this embedded case study was to understand how middle school teachers address the role of language in science learning when teaching a class of linguistically diverse students. A clear understanding of this phenomenon will help inform educators of appropriate methods to simultaneously improve their students’ academic language acquisition and increase their engagement in science learning. The research questions that guided my study were:

1. What is the role of academic language instruction in science classrooms?
   a. How do teachers incorporate language instruction into science content instruction?
   b. How do teachers monitor and/or assess students’ use of academic language?

During the study, these additional sub-questions emerged:

   c. What are teachers’ perceptions of academic language?
   d. How is academic language addressed in a dual language school, i.e. is academic language broadly defined to include both Spanish and English usage?

The Project

Though there is some research that examines EL students’ achievement in science (e.g. Lee & Fradd, 1998; Stoddart, et al., 2002), these studies have observed the effect of researcher-designed interventions. There is a need to study how these classrooms and teachers operate on a daily basis, that is, to study how this “thing” works (Stake, 2010). During the course of this study, I observed the current classroom landscape that is the reality in many urban areas: limited access to science equipment and materials, teachers with varying degrees of science background, and linguistically diverse students. Using a case study
methodology allowed me to “investigate a contemporary phenomenon within its real-life context” (Yin, 1994, p. 13). Specifically, performing an embedded case study allowed me to analyze the microcases of individual classrooms within the greater macrocase of equitable access to science learning opportunities for students from diverse linguistic backgrounds. Microanalysis elicited rich detail and understanding of how these middle school science classrooms work, with the implication that my findings will be generalizable to other, similar, classrooms (Stake, 2010).

I employed an embedded case study design to observe multiple teachers at one school site. This design was appropriate for my investigation because it eliminated certain variables, such as differences in curriculum and time allotted for lesson planning, yet also provided me with a window into different teachers’ classrooms. To gather information on the role of academic language in middle school science classes, I observed classrooms and examined students’ written work for evidence of academic language usage. During the observations I was looking for: basic language instructional strategies, academic language instructional strategies, amount of time allotted for student dialogue, and amount of time focused on science content. When reviewing student work, I aimed to identify both quantity and quality of academic language use. I formally interviewed teachers twice, focusing on their perceptions of the role of academic language in science. In addition, I had informal conversations with these teachers about their perceptions of the success of the lesson and individual student performance. Furthermore, I interviewed two key administrators about the overall mission of the school and the role of academic language in the pursuit of that mission. The rich data gathered from qualitative inquiry provided me with the detail needed to describe the role that language plays in an urban classroom (Maxwell, 2005).
Research Design

This study was an embedded case study of multiple classrooms at one school site. I approached this research from an ethnographic perspective; my role as a researcher was that of “participant-observer,” with more emphasis on observation (Long, 1980; Stake, 2010). I presented myself to the participating teachers as both fellow teacher and external observer; someone who could provide guidance when needed, but would not interfere in regular classroom business. My participation was limited to discussing with teachers their perceptions of students’ language needs and sharing my own observations of their classrooms, and asking students to share their work with me. I gathered observational data from detailed field notes of classroom observations using a protocol I developed. I supplemented this data with additional resources such as student work, individual teacher interviews, and teacher-created materials.

Initially, I met with teachers to discuss their goals for the lessons I was to observe. From these conversations I discovered what the teacher might appreciate learning from my observations, as well as their lesson objectives and expectations for student work. Also during this conversation I probed more deeply to learn about teachers’ perspectives on language use in science, and to dialogue about appropriate methods to incorporate language use into the science curriculum. After these initial interviews, I began my observations in each teacher’s classroom; my observations coincided with the beginning of two new units, *States of Matter* and *Plate Tectonics*, and the wrap-up of a third unit, *Diversity of Life*.

Throughout the course of my observations, I reviewed student work, examined the classroom resources (such as bulletin boards), and listen to students’ presentations of their work. At the end of my observations, I formally interviewed the teachers a second time, this time seeking more self-reflection on practice and assessment of students’ learning.
The cases of the individual teachers were nested within the broader circle of the local school district, which was nested within the California Department of Education’s mandates and policies. Rather than simply implementing a targeted intervention, focusing on the microcases engaged the teachers in cognitive reflection on their own perceptions and practices surrounding academic language development, and their responsiveness to students’ needs. Involving teachers in a reflective process is a hallmark of effective professional development: it promotes buy-in and sustainable change (McNiff & Whitehead, 2006). Furthermore, effective professional development not only allows space for self-assessment but also provides opportunities for teachers to act on the new knowledge gained from the reflection and respond to the needs of the students (Johnson & Marx, 2009; Kelly & Breton, 2001; Loucks-Horsley & Matsumoto, 1999).

Methods

Site Selection

The site for this study was Harbor Bridge Charter School (a pseudonym), a K-8 Spanish and English dual language school operating within a unified school district in southern California. Harbor Bridge was a Title I school. Of its approximately 430 students, 42.8% were EL students; the predominant language spoken at home by these students was Spanish (99%). Over the course of this study, Harbor Bridge transitioned from Program Improvement Year 3 to Year 4, meaning that the school’s API had not demonstrated adequate progress according to the district’s requirements.

The Harbor Bridge Charter School campus was located on a busy street surrounded by auto body shops, used car lots, laundromats, and discount markets. It was situated in a
low-income neighborhood with a high Spanish-speaking population, as evidenced by several stores that accepted EBT and the numerous signs and storefronts in Spanish. Many students walked to school with their parents, checking in at the front desk where they were greeted by name to begin their day. A laminated sign taped to the front of the desk indicated the “language of the day,” either Spanish or English, that was to be used during passing periods, conversations, announcements, lunchtime, and recess. Other informational signs at the front desk included the school calendar and lunch menu, each of which was translated into Spanish. A hand-painted banner said “Si se puede” (Yes we can!), and another one, in English, celebrated the school’s mascot.

The student population at Harbor Bridge Charter School was roughly 40% EL and RFEP students. Looking at the CST scores from the past four years, on average 70% of the students at Harbor Bridge scored Basic, Below Basic, or Far Below Basic on the eighth grade science test (Appendix A). These demographics made this site representative of urban middle schools throughout California. In addition, I selected Harbor Bridge Charter School because the administration had expressed interest in focusing on academic language in all content areas.

**Site Sample**

Harbor Bridge Charter School’s pedagogy embraced a multi-age approach, to that end the students were grouped into grade level clusters, i.e. K-2, 3-5, 6-8. At the beginning of my study, there was only one science teacher for the 6-8 cluster. Over the summer, that teacher left the school and was replaced by two different science teachers. All three teachers were invited to work with me, and all willingly chose to participate in my research. After
initial individual interviews, I worked with teachers to schedule my observations of their classes; two of the teachers started new units when I began my observations, allowing me to see the entire scope of the unit. After I completed my observations, I interviewed the teachers a second time to reflect on their practice. At the completion of the project I provided each teacher a modest gift card as compensation and appreciation for their time.

Data Collection

I collected data in two phases, Spring 2012 and Winter 2013.

Spring 2012 (April-June)

1. Susanne, 6th-8th grade science teacher
   a. Initial interview
   b. Classroom observations (4)
   c. Review of student work
   d. Final interview

2. Christina, Co-Founder and Principal
   a. Interview

3. Maricela, Executive Director
   a. Interview

Winter 2013 (January-February)

1. Carla, 7th-8th grade science teacher
   a. Initial interview
   b. Classroom observations (11)
2. Gina, 6th grade science teacher
   a. Initial interview
   b. Classroom observations (6)
   c. Review of student work
   d. Final interview

Detailed observational field notes served as a major source of data in this study. I created an observation protocol (Appendix B) based on language observation protocols piloted as part of a survey-based measure of opportunity to learn and academic language exposure in fourth grade science classrooms (Martínez, et al., 2009). These protocols had been developed from a combination of the constructs of second language acquisition, academic language exposure, and opportunity to learn. In addition, I incorporated some elements from RTOP (Piburn & Sawada, 2000), an observational protocol specific to science classrooms to determine the level of inquiry occurring. Though researching quantity and quality of inquiry-based science is beyond the scope of this study, gathering data on the frequency of its occurrence in urban schools will add to the holistic understanding of contemporary science classrooms. The protocol provided a framework for my field notes, but also allowed room to document the minutiae of the classroom – the conversations between students, the pace of the lesson, and the work expectations. This open-endedness allowed themes to emerge from the data that otherwise may have been overlooked.

In addition to observational field notes, I conducted individual interviews with 3 teachers, the principal, and the executive director. I developed semi-structured protocols for
these interviews (Appendix C). Each interview was approximately 30 minutes long, and took place on the campus of Harbor Bridge Charter School. The teachers’ interview questions focused on their perspectives of their lessons and the teaching strategies implemented and their perceptions of students’ academic language learning (Merino & Hammond, 2001). During the interviews I allowed time for the teacher and me to work together to identify particular areas for supplementing language and the best strategies to accomplish this task.

Another key piece of data was student work. The teachers shared selected pieces of written work that they privileged as artifacts of student learning, such as lab reports, responses to critical thinking questions, posters, and science notebook entries. As I examined the work, I looked for areas of strength and weakness in use of academic language. I also compared the work created with the rubric or instructions provided by the teacher. I used the data gathered to raise questions during the individual teacher interviews around perceived strengths and weaknesses of their students’ work.

**Data Analysis**

I had three types of data to analyze: interview transcripts, field notes and student work. I developed a common coding scheme based on themes found in the relevant literature on second language acquisition, academic language, and science learning. The four main themes I was looking for were: type and frequency of academic language instructional strategies, amount of time allotted for student dialogue, amount of time focused on science content, and assessment of academic language. Though I predetermined these categories, I also allowed for additional themes to emerge from the data that I may not have anticipated.
Taking this grounded theory approach was particularly useful in revealing the processes that lead to specific outcomes in a particular situation (Maxwell, 2005; Miles & Huberman, 1994). Through this lens, I further refined my coding scheme to include the themes of perceptions of academic language and dual language instruction. A summary of my data analysis is described in Table 1.

Table 1

*Data Analysis*

<table>
<thead>
<tr>
<th>Data</th>
<th>Collection Method</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Classroom Observations</td>
<td>Observation protocol; field notes</td>
<td>Used framework to establish frequency of instructional strategies; documented student/teacher interactions.</td>
</tr>
<tr>
<td>2. Interviews</td>
<td>Semi-structured, audio recorded</td>
<td>Established broad organizational categories; allowed for emergent themes; probed themes noticed during classroom observations.</td>
</tr>
<tr>
<td>3. Student Work</td>
<td>Lab reports, posters, student notebooks, observation of oral assessment</td>
<td>Generated object-based discussion during teacher interviews.</td>
</tr>
</tbody>
</table>

The school’s mission and dual-language pedagogy provided a framework for my analysis. I examined the data to understand teachers’ perceptions of the role of language instruction in science content instruction. I reviewed interview transcripts, teaching materials, student work, and classroom observations to identify what teachers say they do and plan to do, compared to evidence of what teachers actually do. When analyzing student work, I was looking for frequency and accuracy of academic language usage. In addition, I was looking to see which aspects of the teacher’s language instruction, if any, were reflected
in the students’ writing. I also used publically available information, such as CST scores and California State Content Standards, to provide further detail.

**Ethical Issues**

There were several ethical considerations to maintain the integrity of this study. First and foremost, I made certain that no individual teacher felt coerced into participating in the study. I assured each participant of his or her confidentiality and privacy during and after the study, to the best of my ability. In addition, I made it clear that data collected during my study was not to be used to inform performance evaluations, and that identifying information would not be shared with administrators or other faculty members. I gained permission from the teachers and administrators to observe classrooms, to record interviews with teachers, and to review student work.

**Credibility and Trustworthiness**

An area to consider for the reliability of my study was the curriculum itself. Harbor Bridge Charter School used FOSS modules and science texts from Holt, Rinehart, and Winston. The California Department of Education reviews and approves curriculum for public schools; the Holt series is one of their recommendations. I did not ask teachers in this study to invent new lessons, as creating new curriculum would be difficult to replicate at another site. For this reason, adherence to the district-adopted textbooks and state-mandated science curriculum ensures that the results from this study could be generalized to include other middle schools that use this curriculum.

Credibility was further established by the joint review of student work between the
teachers and myself. Engaging in this process meant that the teachers who knew the students well, and were familiar with their other work, could speak knowledgeably about the quality of the science work students produced. With this collaborative communication, I could monitor and eliminate my own bias.

Summary

The purpose of my study was to learn how teachers address the linguistic needs of students within the science classroom, specifically for EL students. Through observations and interviews, I understood how teachers would plan, teach, and assess student learning in a linguistically diverse environment. Furthermore, I learned about the challenges faced in a typical middle school science classroom. It is my intention to share these findings with other educators who are working with this marginalized student population so that schools can create sustainable teaching models and target professional development for their science departments.
Chapter 4: Findings

Introduction

As complexity of academic content increases, so too do the demands of academic language. The more abstract nature of the science concepts taught in upper grades adds yet another layer of difficulty for students (Quinn, Lee, & Valdes, 2012). To fully comprehend scientific concepts, students must learn and practice the discipline-specific written and oral registers of language (Shanahan & Shanahan, 2008). EL students face the additional challenge of acquiring this academic language in a new language. In order to understand the process of lesson planning, instruction, and assessment for academic language instruction in science for linguistically diverse students, I immersed myself in an observational case study of the middle school science classrooms at Harbor Bridge Charter School. This school was a Spanish-English dual language school in an urban area of southern California. Over the course of six weeks in Spring 2012 and nine weeks Winter 2013, I set out to “investigate a contemporary phenomenon within its real-life context” (Yin, 1994, p. 13). Repeated visits in order to conduct classroom observations and conversations with stakeholders yielded details and nuance that gave the research depth. Through qualitative analysis of the data, my goal was to learn about the role of academic language instruction in science classrooms as perceived by the teachers themselves, based on their actual teaching practices, their assessment, and their definitions of academic language. In addition, I wanted to learn how academic language is addressed in a dual language school, and if academic language instruction included both languages.
Conducting an observational case study allowed for a deep understanding of three science classrooms over two consecutive school years during a period of dramatic change for Harbor Bridge Charter School. The quantity and quality of time spent at the site gave me insight into a very tumultuous situation; teachers and administrators were eager to talk with me about the challenges facing the school, as well as their own individual struggles. This chapter begins with a description of the school to provide context and opportunity for the reader to visualize the school through the eyes of the observer. The subsequent sections describe the three classrooms as individual microcases within the macrocase of the school itself; detailed accounts of the individual science classrooms will further immerse the reader in the experience of this case study. Although each classroom was quite discrete from the others, each shared the common goals of dual language instruction, academic language instruction, and science content instruction. The differences, and thus the findings, are embedded in the way the teachers addressed these needs in their classrooms. First, the teachers were more focused on targeted language instruction, isolated from science content instruction, at the expense of engaging students in the “doing of science.” Second, the administration did not effectively communicate their vision to the teachers so that teachers practiced inconsistent monitoring and assessment of student learning. Third, the stakeholders did not hold a shared perception of academic language or the role of academic language in the science classroom; while the administration held a holistic view of academic language, the teachers narrowly focused on vocabulary and assessed only this aspect of academic language. I will address each research question and its related findings within the individual teacher’s case studies.
Section I: The School/La Escuela

A School in Transition

When I began my study at Harbor Bridge Charter School, the school had been operating for twelve years. During the course of my case study, it became clear that the school was facing a major crossroads in its existence. Though students’ test scores had shown improvement the first few years after the school’s opening, at the time of my study test scores were in such decline that the school was in Program Improvement Year 4. In addition to its academic underperformance, the school was also facing financial difficulties as it struggled to pay the lease on recently expanded facilities. The district was threatening to revoke the school’s charter and take over the school due to these shortcomings. Maricela, the executive director of the school, met with lenders to see if the school could receive any financial leniency, all the while submitting revised budgets to the school board. In the midst of these changes, several Harbor Bridge board members resigned, including the board president.

Over Summer 2012, the local school board held several meetings to discuss the future of the school. Faculty, staff, and families attended these meetings to protest what seemed to be the inevitable demise of Harbor Bridge Charter School. At one critical meeting, in late July 2012, dozens of parents and faculty crowded into the cramped meeting room, prepared to fight to keep their school open. The passion for this school was palpable. Students were in tears and parents were yelling. Parents stood to read their plea to the board, but one by one officers escorted them out of the building. When one parent would exit, another would take over reading the plea. This continued until the board called a
recess, at which point the parents, teachers, and students gathered outside the building and began chanting and raising signs in the air with the message “Save our School!”

It was only in late August, mere days before the start of the school year, that the school board decided to allow the school to operate on a provisional basis for the remainder of the original charter’s terms (through June 2015). However, such a late decision meant that many teachers and families had already left the school, assuming it would not be open in 2012-2013. Thus, the new school year began with enrollment down by 25%, less than half returning faculty, and increased accountability to district officials.

The Executive Director, Maricela, was working to keep the school’s finances afloat while Christina, the Site Director, was working to improve the academic program at Harbor Bridge Charter School. To alleviate some of the fiscal distress, Maricela and the board decided to reorganize the faculty; as a result Christina was moved back into the classroom part-time, the other site director was moved back into the classroom full time and her site was shut down, three teachers were laid off, they added ten furlough days to the calendar, and everyone took a 5% pay cut. When asked about faculty response to these changes, Maricela frankly replied, “the morale is in the toilet.” In short, this was a school in crisis.

**The Promise of a New Language Model**

In response to the district’s demands for academic accountability, Christina made adjustments to align the school’s existing program with the Gómez and Gómez Dual Language Enrichment model. Maricela, the executive director, agreed that training for the new language model was “a really good investment… giving structure to what we already do and then enriching that.” Christina attended the training in Fall 2011 and introduced the
model to the faculty in January 2012. As a result, the language of instruction switched – midyear – for both history and math. Christina acknowledged that this programmatic change was “pretty significant to get your head around” for the faculty who had been teaching the first part of the year in one language, then made to switch to the other language for the second part of the year. As one of the teachers put it, “it was a little hectic – everything had to be changed overnight.” At the same time these changes were implemented in language of instruction, the classroom structure also changed. Because the Gómez model emphasized learning at grade level, the multiage clusters that had been a cornerstone of the school’s pedagogy were broken apart into individual grades, i.e. K-2 became three individual classes, Kindergarten, 1st, and 2nd grade.

The parents responded to these mid-year changes with concern. Christina recalled a conversation with a parent about the new class groupings: “My third grader had one teacher in the beginning of the year, had another teacher last month and has another teacher this month, and you’re saying ‘Oh, this is to get their scores to go up? Don’t think that’s gonna [sic] happen.’” Teachers and students also expressed dismay at these changes. Christina shared that “this [multi-age classes] has been something hard for some people to give up, myself included.” In particular, this modification to class structure changed the way teachers planned lessons. She noted “it’s easier as a planner to do a lesson plan that’s just fourth grade standards, but then where are all my fifth graders who are gonna [sic] help everybody?” Christina went on to acknowledge that this restructuring impacted the students, too: “Many of the kids were upset because we lost some things that they really liked.”

In addition to identifying the language of instruction and recommending class groupings, the Dual Language Enrichment model also called for Specialized Vocabulary
Enrichment, or SVE, to support bilingual language development. SVE, as described by Gómez and Gómez, is a structured 30-45 minute lesson, at least once per week in each content area, focusing on previously introduced vocabulary in the opposite language for the subject. This would mean that a subject taught primarily in Spanish would have an English SVE lesson to review vocabulary. This SVE framework differed from most EL guidelines (i.e. CALLA, SIOP, WestEd) that recommend front-loading vocabulary to familiarize students with new words and phrases prior to content-based instruction. Front-loading introduces terms prior to their contextual use so that students will be better equipped to comprehend the new content using appropriate academic language. At Harbor Bridge Charter School, 6th-8th grade science was taught in English Monday-Thursday, with a 20-minute SVE lesson in Spanish on Fridays. This arrangement meant that vocabulary and language were targeted after content instruction. However, even this short lesson was often cancelled for other school events, such as fire drills, assemblies, field trips, or school holidays.

**The Language of the Day/La Lengua del Día**

Christina, the site director and co-founder of the school, described her motivation to open a bilingual school “combined with an appropriate teaching and social justice component.” She emphasized that students should “learn to read and write first in their home language. If it’s good theory it should work for everyone.” Christina and the other founding members initially based the language model of the school on the research of Thomas and Collier, Krashen, and Cummins. K-2 students were learning reading and writing in their home language until third grade, at which time all students would receive
language arts instruction in both languages. The goal of the school was to graduate students who were bilingual and biliterate in Spanish and English.

On my first visit to the school, the language of the day was Spanish. I heard teachers giving instructions to middle school students in the hallway in Spanish, and the students asking the teacher questions in English. Every teacher employed at the school was bilingual, so they transitioned easily between the two languages to respond to the students’ questions. Although being bilingual was not required for employment, it was a skill that facilitated the school’s mission to follow a 50:50 dual language model. In the arena of dual language models, 50:50 refers both to percentage of students who speak the home language and the target language, as well as the amount of instruction in each language. While the K-4 population at Harbor Bridge Charter School was roughly 50% EL in each grade level, this percentage decreased to approximately 30% in 5th-8th grade; in the 2012-2013 school year, only 5% of the 8th grade students were classified as EL (Appendix D). Part of the reason for this decrease in the older grades is that as EL students gain English proficiency, they can be reclassified as RFEP (Redesignated as Fluent English Proficient); another reason is natural attrition. Maricela, the executive director, noted this middle school shift in the linguistic diversity of Harbor Bridge students, saying, “we’re trying to focus on recruiting Spanish-speaking kids because…right now our program is de facto. It’s a one-way immersion program. We’re way too English-dominant in terms of the students’ language heritage.”

In addition to the dual language component, it was important to Christina and the founding members to create a school based on Piaget’s constructivist learning theory. Specifically, they embraced the model of children at different developmental levels helping each other construct their own conceptual understanding of new ideas. For this reason, the K-8 program operated in multiage clusters: K-2, 3-5, 6-8. Social learning and cooperative
group work were emphasized in all subjects, particularly math and science. The school used FOSS modules for the science curriculum, as Christina justified that they provided “real experiences that we thought kids could truly enjoy.” Prior to January 2012, science and math were taught in Spanish, history was taught in English. Christina explained that the school initially made the choice to teach math and science in Spanish because “90 percent of the vocabulary in math and science lends itself as Spanish cognates, which are easily accessible to English or Spanish.” However, Christina noted that, “the middle school then ran into trouble because all the FOSS kits are not translated.” In fact, an examination of the FOSS website reveals that while most of the 5th-6th grade modules are available in Spanish, there are no Spanish materials for 7th-8th grade modules. Because of this obstacle, science for grades 6-8 was taught in English instead. It is interesting that the school made the concession to teach science in English when teaching in two languages was so integral to the mission of the school, especially given that all faculty were bilingual themselves. This could have been an opportunity for teachers to create or translate their own materials; instead, the ease of access to materials took precedence over bilingual instruction.

The primary academic language construct in place at Harbor Bridge Charter School was the Specialized Vocabulary Enrichment period, a critical component of the Gómez Dual Language model. In following the Gómez guidelines, SVE was offered in the language opposite the language of instruction; for science, this meant that the teachers taught SVE in Spanish. Though SVE was always scheduled for Fridays, the length of time for these lessons varied for each teacher observed, as I will detail below. In addition to the variance of amount of time spent on SVE, often these lessons were cancelled for other school events such as field trips, assemblies, or fire drills. There was little opportunity to reschedule these missed lessons, as the school observed a late start on Fridays, which already truncated the
regular schedule. Another obstacle preventing rescheduling the SVE was the teachers’ schedules; each teacher I worked with also taught sections of math, language arts, advisory, physical education, and an elective in addition to the science classes I observed. Teaching multiple subjects in this way is more akin to an elementary model than to the typical format of subject-specialization found in middle schools. Due to such full schedules, it was challenging for teachers to find time to teach the SVE lessons, even though this instructional piece was a cornerstone of the newly adopted Gómez Dual Language model.

Section II: The Teachers and their Classrooms/Los Profesores y Sus Aulas

Although the learning environment of the classroom is shaped by the school, it is the teacher’s interpretation of the curriculum and his or her interaction with students that creates the individual classroom culture (Barth, 2006; Clandinin, 1985). Thus, it is important to understand who the science teachers were at Harbor Bridge Charter School. In this section I briefly describe each teacher’s professional background, the times and timing of my observations, and the materials/resources that interviews revealed they used. I will detail the lessons that I observed, paying special attention to each teacher’s “best” lesson in which she capitalized on multiple opportunities for student learning. In contrast, I will also identify missed learning opportunities that I observed. Using my research-based observation protocol as a guide, I tabulated each teacher’s use of targeted language and science-content instructional strategies. The individual results are displayed in Table 2 in the appendices, while the aggregated data is displayed in Table 3. Each research question will be addressed within the individual case studies, then will be highlighted at the conclusion of the chapter.
Table 3
Summary of Observation Protocols

<table>
<thead>
<tr>
<th>Instructional Strategies</th>
<th>Susanne (n = 4)</th>
<th>Carla (n = 11)</th>
<th>Gina (n = 6)</th>
<th>TOTAL (n = 21)</th>
<th>Percent</th>
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</thead>
<tbody>
<tr>
<td>Communication of content objectives</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0</td>
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<td>0%</td>
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<td>Communication of language objectives</td>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>Orally</td>
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<td>1</td>
<td>9</td>
<td>43%</td>
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<td>3</td>
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<td>Scaffolding Techniques</td>
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<td>Visual aids</td>
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**Teacher #1: Susanne, Spring 2012**

When I started working with Susanne in Spring 2012, she was in her second year teaching science to the 6th grade class and two blended 7th-8th grade classes. She had her master’s degree in education and a multiple subject teaching credential. During her master’s program, she chose to concentrate on math and science teaching courses. Susanne reflected that her own interest in teaching math and science “stems from it being a weakness of mine growing up. I never had very meaningful science experiences.” Susanne used FOSS kits to teach science: using the hands-on materials, distributing copies of the workbook pages, and administering the pre-made assessments. Prior to January 2012, Susanne taught science exclusively in English, even though the school’s bilingual model called for science to be taught in Spanish. She did this because FOSS did not offer Spanish versions of the 7th-8th grade modules. In an attempt to align her teaching with the school’s philosophy, she did begin a sixth grade FOSS module in Spanish, “because that’s all we had, and then we found the same kit in English, so we kind of repeated it [the unit] because it [the Spanish module] was incomplete.”

During the course of my observations of Susanne’s classroom, which covered seven weeks between April-June 2012, there was only one day on which the Specialized Vocabulary Enrichment for Spanish academic language was scheduled for seventh and eighth grade. Each of the other six potential SVE dates had something else scheduled instead – a field trip, the Science Fair, CSTs, the school-wide jog-a-thon, and a professional development day. Many of her other classes were also impacted by scheduling conflicts, which meant I was only able to observe two labs and two SVE lessons during this period.
When I began observing Susanne, she was in the middle of two different units: the sixth grade class was working from the FOSS “Landforms” module, and the 7th-8th grade classes were working from the FOSS “Diversity of Life” module.

When I first walked into Susanne’s classroom, I noted a lack of visual aids and student work on the walls. On closer inspection, I realized that the room had no doors and no ceiling. The only floor to ceiling wall in the room was the front wall, on which there was a whiteboard mounted across the entire length. Several bookcases pushed together made part of another wall. The back wall had a metal roll-up door, like a loading dock, which Susanne would occasionally open for fresh air. The other sidewall contained the entrances to two unisex, single occupant restrooms. There were two student computers on a desk pushed to one side of the room, next to the teacher’s small desk and a small classroom library that fit into one bookcase. There were several long tables and chairs set up for students to sit in groups. Susanne told me, “It’s definitely not an easy environment to be working in. Sometimes they [the students] get too loud... and other times it’s just, ‘Oh, let’s just wait until the other students pass by.’” During my observations of Susanne’s classroom, I could hear other students and adults passing in the hallways, their conversations carried over the low walls.

To answer my first research question, “How do teachers incorporate language instruction into science content instruction?” I made detailed observations of the classroom environment, the teachers’ lesson delivery, and listened to teachers’ own answers to this question. In terms of classroom environment and lesson delivery, I was looking for evidence of research-based best practices for EL content-area instruction, such as word walls, visual aids, use of primary language, culturally relevant instruction, and wait time. In Susanne’s classroom, I expected to see a bilingual word wall, as one of the strategic
vocabulary suggestions from the Gómez model was to display a word wall in both Spanish and English. Though I noticed that both Carla and Gina did maintain current, monolingual word walls in English, I noted that Susanne did not maintain one in either language. When I asked Susanne about this omission, she shared that she felt that without the research from successful implementation in middle school classrooms the word wall recommendation was not relevant to her: “The Gómez and Gómez Dual Language Enrichment Model that we’re adopting, it kind of goes K-5, 6, I believe… so we’re kind of on the cusp of it.” She mentioned that she had previously had a word wall, but then covered it with student work when she needed the wall space.

Much of the EL research recommends using visual aids to assist ELs’ understanding of new vocabulary and concepts. Perhaps because of the limited amount of wall space available in her classroom, Susanne used very few visual aids. She had the stream tables from the FOSS modules so that students could experience the concepts firsthand, but there were no additional posters or diagrams of the landforms about which they were learning. Similarly, the FOSS characteristics of life unit provided some black and white photos in the workbook for students to refer to while reading or working, but Susanne did not incorporate any other visual aids into her instruction or the classroom environment. In fact, over the course of my four observations in Susanne’s classroom, I only witnessed one instance of a specific scaffolding strategy, gesturing, when she was reinforcing the concept of a river delta (Table 2).

In addition to these direct instructional practices, scaffolding strategies for EL students also include peer-to-peer discourse. I found that Susanne used this technique to monitor and informally assess students’ use of academic language, which answered my second research question, “How do teachers monitor and/or assess students’ use of
academic language?” Susanne made an effort to design lessons that incorporated partner or group work, rather than whole class instruction. A specific Gómez recommendation is to strategically group linguistically heterogeneous students for collaborative work. Although she had purposefully assigned students with linguistically diverse partners, Susanne was not particularly stringent about the seating arrangements. In her classroom, students were often sitting away from their assigned tables; only a few times did she ask students to return to their assigned seats. As a result, students sat with friends who may or may not have been linguistically heterogeneous. Regardless, students were still working collaboratively to discuss science even if the language support mechanism was missing. Susanne also built in time for students to practice using academic language. Four out of four classes provided students with opportunities to practice academic language orally, three out of four classes offered time to practice academic writing, and three out of four times Susanne provided immediate feedback on students’ use of academic language (Table 2).

To illustrate Susanne’s approach to teaching science to linguistically diverse students, I will highlight the best examples of her instructional strategies, but will also identify missed opportunities to capitalize on integrated language and content learning. Of the four classes I observed in Spring 2012, there was one lab that stood out as the best example of Susanne’s integrated approach to language instruction and science content. The academic language for the lesson was embedded in the activity, providing students with the context to recall and apply the necessary language. When I observed the 7th-8th grade “Diversity of Life,” lab that preceded the corresponding SVE, I saw pairs of students working together to observe an “unknown specimen” and attempt to determine whether or not it exhibited the

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5 Camphor gum shavings in water.
characteristics of life, thereby classifying it as a living organism. Susanne moved around the room and sat at each table for a few minutes to listen to the students converse about the specimen, probing as needed to elicit critical thinking. This was an example of close assessment. When students were unsure where to start, Susanne would refer them back to their notes on the characteristics of life by asking them, “Does it reproduce? Does it require water?” These prompts encouraged students to continue the dialogue themselves, using their notes as a scaffold to support their discussion. During the SVE that followed this lab, as described earlier, students were expected to match the English and Spanish translations of the characteristics of life and then recite one in Spanish as the final informal assessment of the day. This type of quick, short answer assessment would be considered an immediate assessment (Ruiz-Primo, et al., 2002). In this lesson, Susanne capitalized on several opportunities to promote student learning. She not only encouraged students to apply critical thinking to the unknown specimen before them, but also provided support in the form of strategic questions and references back to previous work. This type of inquiry-based approach was evidence of Susanne’s prior experience as a science teacher and her familiarity with the FOSS curriculum; she was able to facilitate not only discourse but also conceptual understanding.

In contrast, the corresponding SVE lesson for this unit illuminated missed opportunities for supporting academic language acquisition. The vocabulary from the FOSS “Diversity of Life” module emphasized the terms and phrases related to the functions of living things, i.e. taking in nutrients, getting rid of waste, and reproducing. The lesson began in English, with Susanne giving instructions to review packets handed out earlier in the week. About half way through the lesson, Susanne flipped the “Language of Instruction” sign from English to Spanish, and began speaking only in Spanish. Several students called
out, in English, “Why is it [the lesson] in Spanish?” and continued conversing with the teacher in English. For the most part, Susanne continued to respond and give instructions in Spanish. At this point in this lesson, the teacher handed out envelopes to each table, which consisted of a group of 4 or 5 students. Inside the envelopes were premade phrases, in both Spanish and English, describing each of the functions of life. Students were instructed to match the English phrase to the correct Spanish phrase. After a few minutes working in groups, the teacher called on each group to recite one of the English phrases and to provide its Spanish translation. As a final informal assessment, Susanne stood at the doorway of her classroom as she dismissed students. Before exiting, each student had to recite one function of life in Spanish.

In Susanne’s classroom, you could see that she provided multiple opportunities for students to read, hear, and speak the academic language related to the unit. As students began the activity, they discussed the vocabulary with their peers. For example, when identifying the Spanish translation for “All living things need water,” one student remarked, “See – agua – water.” However, one could argue that this type of activity required only rote memorization of the translated words and phrases, as students were simply reading the phrases, not creating translations in their own words. As students were sharing with the class, many were stumbling over the correct pronunciation for the Spanish phrases. In one instance, an English-dominant student became frustrated reading out loud in Spanish, and pushed the paper towards her Spanish-dominant partner to finish reading. Later in the class, in an effort to support one another, students would call out the correct word but would do so in English, such as “requirements” for “requisitos.” These student behaviors demonstrated an understanding of the vocabulary, but a preference for speaking in English. Throughout the class, Susanne did not correct students’ Spanish. These instances were missed
opportunities for Susanne to provide feedback on students’ use not only of academic language, but also of correct Spanish pronunciation.

In one of her hands-on labs, Susanne was continuing a sixth grade lesson on erosion from the FOSS “Landforms” kit. The hands-on materials for this lesson included a stream table, sand, and water for each small group. The students had used the materials before, and gathered the materials needed to conduct the lab from the workbook – comparing the flow of water from cups with two differently sized holes, and then observing the effect on the sand from these two water sources. Susanne began the lesson by asking students to recall any vocabulary terms used in the previous lesson. In English, students answered *delta*, *erosion*, and *streams*, words that Susanne wrote on the board. By writing these words on the board, Susanne provided students the additional opportunity to read and listen to the words being spoken.

Susanne used several opportunities to support students’ oral attempts to use academic language. For example, when she was first reviewing the word delta, she reinforced the meaning of it by gesturing and saying “a delta is like your hand.” There was one student who explained what occurred with the stream tables during the previous lesson using the term “wears away” to describe the impact of the water on the sand. Susanne rephrased his answer by using the vocabulary word *weathering*. At another point in the lesson, one student used the words “channels” and “canals” to describe the small rivulets of water running through his stream table. Susanne restated “canals” and asked the class if everyone understood this different term the student has used. Some students nodded yes, others mumbled in assent, and a handful of students did not respond at all. Susanne did not use this opportunity to explain the term in further detail.
During this hands-on stream table activity, Susanne did not ask students to produce any written work so that they could focus on the experiential nature of the lesson and the discussion with their peers. In fact, she made a point to announce that students would not be “filling anything out.” She did instruct the class to work in small groups with the prompt to “communicate about the stream table.” At the end of the lesson, she gave the groups a few minutes to discuss a plan for sharing their observations orally with the entire class. As students were sharing, they tended to state the vocabulary terms but not to use academic language to create more complex or descriptive sentences. For example, one group simply reported, “We saw a delta,” but did not offer any explanation of how the delta was formed, or details about how the delta looked. Susanne would check off the vocabulary words they mentioned but would not probe for further explanation or detail from their observations.

Again, the overall lesson provided multiple opportunities for students to interact with one another to discuss observations and draw conclusions, all the while using the language of science. However, there were missed opportunities for Susanne to encourage students to think more critically about the concepts. She could have rephrased students’ explanations using the academic language from the unit, or could have probed for richer detail from students’ observations.

By the end of the six weeks I worked with Susanne, I realized that I needed to understand how the school, and the teachers, defined academic language in the context of the dual language paradigm. I was curious if the definition were broad enough to include both Spanish and English usage; as a result, I added this inquiry as a sub-question to my original research questions. In Susanne’s case, the combination of the two “Diversity of Life” lessons, the hands-on lab and the SVE, demonstrated her comfort with a bilingual approach to academic language. She designed her lessons to complement one another, so
that the understanding of concepts and language in English could be transferred to the Spanish lesson. From what I observed, however, she assessed English academic language at a higher level, checking for conceptual understanding and application of critical thinking. Her Spanish assessment asked only for direct translation. Given that the Gómez and Gómez model only suggests one 20-minute class period per week for the opposite language, Susanne’s emphasis on English proficiency was to be expected. In executing the model as directed, her actions highlight an inherent disconnect between the goals of the dual language program and the time allotted to teaching both languages.

Teacher #2: Carla, Winter 2013

Whereas Susanne was the only science teacher for grades 6-8 during the school year 2011-2012, when I returned to Harbor Bridge Charter School the following school year, there was a 6th grade teacher, Gina, and a 7th-8th grade teacher, Carla. Carla was new to the school that year, but not new to teaching science. Prior to joining the faculty at Harbor Bridge, she had taught science for one year, and had taught language arts and history for three years before that. Carla had a master’s degree in education as well as BCLAD (Bilingual Crosscultural, Language, and Academic Development) authorization from the state of California. This credential meant that Carla was authorized to teach listening, speaking, reading, and writing skills in English for ELs; had received training in SDAIE techniques; and could provide content instruction in a primary language.

My observations in Carla’s classroom coincided with the beginning of a new unit on chemistry. I observed eight classes/labs and three SVE lessons over nine weeks. These lessons focused on states of matter and phase changes, i.e. solid, liquid, gas, melting,
evaporation, condensation, and freezing, as well as molecular movement in each state. These concepts represent only a fraction of the California Science Content Standards for Grade Eight (3d, 3e), yet Carla spent nine weeks – one quarter of the school year – focusing on these two standards in the “Structure of Matter” content area. This strand is one of eight content areas to be covered in eighth grade, the grade level that the California Department of Education names the “Focus on Physical Sciences” (California Department of Education, 2000). Additional concepts in the Grade Eight “Structure of Matter” content area include understanding atomic structure and subatomic particles, knowing how to use the periodic table, and understanding how atoms and molecules bond to create compounds. In fact, the content Carla covered during my observations more closely aligns with the Grade Three “Physical Sciences” standards 1e-i; these standards reinforce the principles of phase changes and states of matter that are first introduced in Kindergarten. A comparison of Grade Three standards and Grade Eight standards, highlighting which standards were covered during my observations, is included in Table 4.

When I first spoke with Carla about the resources she used for teaching, she said that she used a hybrid of FOSS modules, personally created materials, and the Holt, Rinehart, and Winston Interactive Reader and Study Guide for Physical Sciences. There were not enough workbooks for each student, therefore the students did not take the workbooks home. When I observed her lessons, I also saw that she used BrainPOP®, an online animated educational website for children. The BrainPOP® website offers interactive games and short videos that cover basic science, math, English, and social studies content. Carla would show some of the science videos to her students to reinforce concepts previously taught.

Similar to my work with Susanne the previous year, I went into Carla’s classroom with an eye for artifacts of research-based best practices for EL content-area instruction in
order to answer my first research question, “How do teachers incorporate language instruction into science content instruction?” I noticed that although Carla taught math, science, Spanish language arts, English language arts, advisory, and electives in her classroom, the overall learning environment of the room was geared towards science. There were large pieces of excellent student work from the previous year hanging above her cabinets. Her word wall had words from language arts and science, though the science words were in English only. The room, which had previously been the high school science lab, contained deep sinks and chemical-resistant counter tops. Throughout the chemistry unit, Carla would put up more recent student work, such as the states of matter posters. At the front of the room, Carla posted the learning objectives – in English – for the unit, which she based on the 5E Lesson Plan Format\(^ 6\) (Bybee, et al., 2006).

Carla designed lessons with a variety of student groupings. Within one class period, she would spend some time on whole class instruction, provide time for peer-to-peer discourse, allot time for progress on individual work, and assign work to table groups (four to five students each). In fact, collaborative group work was the primary mode of student participation in her class; I observed this activity in seven out of eleven observations. In accordance with the Gómez recommendations, Carla assigned seats to students based on language levels, though occasionally students would try to sit with friends instead. When this happened, Carla would address the students quickly so that they would return to their seats. Despite Carla’s awareness of the heterogeneous groupings, however, she allowed students to select their own partners when working on the “states of matter” poster project, with the result being that students did not necessarily pair with linguistically heterogeneous

\(^6\) Engagement, Exploration, Explanation, Elaboration, Evaluation
In terms of EL scaffolding techniques, Carla incorporated these strategies more explicitly than either Gina or Susanne. Specifically, she used the most visual aids out of the three teachers, employing them in six of the eleven observed lessons. It should be noted, though, that all of her visual aids were two-dimensional, e.g. posters, animated videos, and diagrams. Not using three-dimensional models, particularly for such abstract and complex concepts as molecular and atomic structure, represents a missed opportunity on her part to engage both the EL and English-only students in deeper learning. She began the chemistry unit by placing posters around the room for students to visit and discuss. There were posters depicting the periodic table, the structure of an atom, and different examples of solids, liquids, and gases. All of the posters were in English. She used this activity as a way to activate prior knowledge and to cultivate interest in the new unit. These posters, though small, remained on the walls throughout the entire unit. As students finished their own posters illustrating the states of matter, she would mount these as well. When she used the BrainPOP® videos during her SVE lessons, students had the opportunity to see the particle movement, in cartoon form, in each state of matter.

A frequent recommendation found in EL research is the use of a student’s primary language to explain or clarify a concept, also known as code-switching. Although she was bilingual, I never observed Carla using Spanish to restate or explain material to EL students during the Monday-Thursday English classes. That being said, I also never heard students initiating a question or a comment in Spanish. However, Carla would frequently code-switch from Spanish to English during her Friday SVE lessons. What follows are detailed descriptions of my SVE observations to illustrate Carla’s approach to incorporating language instruction into science content instruction.
My first observation of one of Carla’s SVE lessons was also the first one she had taught in over eight weeks. She faced school scheduling conflicts similar to those I observed the previous year; Fridays were often assigned for pupil-free days, district testing, assemblies, and field trips. In fact, even this first lesson was impacted by a scheduled fire drill; therefore the class began 10 minutes late. On this first day, Carla had to spend instructional time reviewing the norms for SVE, i.e. speaking only in Spanish and focus on reviewing key terms from the preceding week. When one student, asked aloud – in English – what was the point of SVE, Carla responded, in English, “Vocabulary. You already know this, now we’re learning it in Spanish.”

Despite the challenges to schedule these SVE class periods, Carla planned lessons that provided multiple opportunities for students to speak, read, and listen to Spanish academic language. For the first SVE I observed, Carla focused on the vocabulary associated with the states of matter and phase changes. She first asked the students, in English, to name the three states of matter\(^7\), then asked them for the Spanish translation. This was a good technique to activate prior knowledge, particularly since \(\text{solid}\) and \(\text{gas}\) are not only cognates, but also have multiple meanings apart from their scientific context. After this brief introduction, Carla then played a short BrainPOP® animated video, in Spanish, on the states of matter. In addition to the audio, the video was also closed-captioned so the students could simultaneously read and listen. The first time she played it, she instructed students only to watch, not to write. The second time, she told students to write down key phrases and terms. After two viewings, she activated the multiple-choice quiz at the end of

\(^7\) The fourth state of matter, plasma, is not introduced in the California Science Content Standards until Grades 9-12 Physics.
the video. Each student had his or her own small whiteboard on which to write the answer, then to hold up for her to see. One student specifically asked Carla to read the question in English. Instead, Carla slowly repeated the question in Spanish, emphasizing key words, and only translated _convierte_ (becomes). The student exclaimed “A-ha!” and wrote down his answer. This activity enabled Carla to quickly assess students’ understanding of the Spanish academic language.

Although this lesson gave Carla’s students opportunities to read and listen to Spanish academic language, there were few opportunities to write or speak in Spanish. During the first class period, for eighth grade, Carla began the BrainPOP® quiz with asking students to read the questions out loud. When the first student struggled with reading and declared, “I can’t read Spanish,” Carla took over reading all of the questions aloud. After Carla would read the question, she would patiently wait for students to write down their answers to the multiple-choice questions. She would look around the room at all of the answers, and then ask the students to chorally respond with the correct word or phrase. In a group setting such as this, it was difficult for Carla to provide individual feedback on students’ use or pronunciation of the Spanish academic language. In addition to watching the BrainPOP® video, Carla also had students copy notes from the board in Spanish. She recreated a diagram they had copied earlier in the week in English, which allowed students to anticipate which Spanish vocabulary terms would be used. Carla also used this time to focus on placement of accents when writing and speaking these Spanish words, such as _sólido, líquido_, and _energía_. Although this lesson provided some practice in speaking and writing, the opportunities were limited to one-word answers. Students were not expected to create complex sentences using the Spanish academic language, but instead focused solely on the vocabulary.
I observed Carla using a different instructional method for a later SVE lesson. She was teaching the same “States of Matter” unit so much of the vocabulary was the same, but the level of student participation increased, particularly with speaking complete sentences in Spanish. During this lesson, Carla passed out envelopes containing vocabulary words written on index cards. The words in the game were a mix of Spanish and English. Working as a table, students were to play a game similar to Password or Taboo, in which one person tried to get the others to guess the word with gestures or phrases that did not contain the word. This game encouraged students to speak and to create alternate methods of describing a known vocabulary word. To add a level of difficulty, each round of the game had different parameters, such as Spanish-only, or non-verbal gestures. At the end of the game, Carla asked students to make recommendations about which vocabulary words to retire and which new terms should be added. As I looked through the students’ suggestions, I noticed that 5 out of 6 groups wanted to remove all of the Spanish words, and offered English words in their place. I also noticed that students most often opted to retire the process words, such as condensation, evaporation, and sublimation. When I asked the students why, they told me that those words were too hard to explain in Spanish.

The best example of Carla’s approach to integrating language and science learning also exemplifies her comfort with hands-on science and classroom experiments in a lesson she called “The Candy Lab.” During this multi-day lesson, she also found opportunities to insert use of oral academic language into the instruction and assessment of her seventh and eighth grade classes. This entire lesson, including worksheets and expectations for student work, was conducted in English.

At the beginning of the lab, students worked with their table groups to follow the procedures on the worksheet from the FOSS “Chemical Interactions” module. The purpose
of the lab was to observe changes to an M&M® when exposed to different conditions: submerged in cold water, submerged in hot (near boiling) water, and placed above cold and hot water on a piece of aluminum foil, so that students could observe particle movement during the phase change from solid to liquid. Several students commented that they had completed this lab in the previous school year with Susanne, but Carla shrugged her shoulders and said she didn’t know that. As students were working, I walked around the room and listened to their discussions about the lab. I heard one group of students exclaim, “I can see the particles!” as they watched the candy dissolve in the hot water. Carla used this opportunity to connect students back to the worksheet, which posed the question, “What happened at the particle level when it melted?” As I continued to visit the different lab groups, I heard several students commenting on observing the M&M® dissolve. At this point in Carla’s unit, she had not discussed solutions and mixtures with the class, and therefore had not used the vocabulary term *dissolve*. Though both processes are physical changes, melting requires heat, while dissolving does not. This was a situation in which students were using the academic language incorrectly, yet I did not observe Carla correcting the students. This misunderstanding persisted even as the students were writing up their final lab reports on this experiment.

Carla used this lab as a springboard to further inquiry. Once students had completed the procedures outlined on the worksheet, she then encouraged students to design their own experiments based on this one. She suggested students think of different variables to test, such as using different types of candy, or different liquids, or even building protective coverings for the candy. Carla modeled some example questions, saying, “What if I did *this*? What if I changed *that*?” She consulted with one group about their idea, suggesting that they could use a thermometer to record changes in temperature. Carla then tasked the students
with developing a new question, determining which materials they required, and writing a procedure. Students began discussing their ideas, but wondered aloud if they would have the opportunity to actually perform the experiments. Carla assured students that she would be purchasing the additional materials they requested so they could conduct the experiments later in the week. The outcome of this activity provided Carla with proximal assessment information (Ruiz-Primo, et al., 2002); she could assess not only students’ interactions, but also their critical thinking as they planned and conducted their own experiments.

This example of proximal assessment begins to answer my second research question, “How do teachers monitor and/or assess students’ use of academic language?” though additional examples of Carla’s methods add depth to this answer. Carla used lab reports, a quiz, and posters as opportunities to assess her students’ use of academic language. The quiz she created covered the first week and a half of the chemistry unit on states of matter and phase changes. The quiz consisted of five multiple-choice questions, in English. For extra credit, students could write longer explanations to answer the questions. The final question on the quiz was a fill-in-the-blank diagram with a word bank. The diagram was identical to a diagram the students had previously drawn in their science notebooks. When I asked Carla how the students had done on the quiz, she did not give me any specifics other than “they did well overall.”

In addition to the quiz, Carla gave students another opportunity to demonstrate their learning. Students worked in pairs or small groups to create posters that illustrated the states of matter. Although the Gómez model specifies that students should be heterogeneously paired based on language fluency, i.e. a Spanish dominant student with an English dominant student, Carla allowed her students to select their own partners. When I asked her about this choice, she said, “I had them do that [choose their own partners] so they would do it
“[the project], basically.” She recalled that she did provide some parameters for choosing partners, telling students, “what I’m looking for is behavior and I think I told them language. I don’t remember.” The students spent several class days creating the posters. One group chose to draw the Volkswagen van featured in music videos by the pop band “One Direction.” The girls’ choice to incorporate a pop culture reference was a strong example of Calabrese Barton’s hybrid learning spaces in action (2008). The students were able to make a connection between academic science and their own interests. When I asked the girls about their poster, they explained that the van represented a solid, and that they would draw a gas station “for the gas.” Although the girls were misusing the word gas on this project, neither they nor the teacher corrected this mistake for the final poster.

Some students used this poster project as an opportunity to put in extra effort, and also included the phase change vocabulary, i.e. evaporation, condensation, sublimation, freezing, and melting. Still others also drew diagrams representing the molecular movement in each state of matter. Carla created a rubric for this project that awarded points for this extra effort as well as attention to spelling, grammar, and punctuation. Overall, Carla noted that the eighth grade class did not put as much creative effort into their posters as the seventh grade class. Only seventh graders had included the process vocabulary, and a few even included plasma. None of the eighth grade posters included this information. When I asked her why she thought this was so, she reflected on the students’ experience at Harbor Bridge Charter School: “The seventh graders, most of them have gone through the [school], like started in Kinder or third… Most of them have been here for a while so they’re used to the dual language. The eighth graders… a few of them joined really late…some of them joined this year.”
The best example of Carla’s formal assessment of academic language was the final lab report required for “The Candy Lab.” The required headings for the lab reports included question, hypothesis, materials, procedure, data, analysis, and conclusion. Students spent over a week writing these formal lab reports, going through rough drafts, edits, and rewrites. Some students chose to write their rough drafts in Spanish, and then rewrote their final drafts in English to hand in. Carla noted that the students who wrote in Spanish first had been recently reclassified as English proficient (RFEP); when we discussed this, she felt that these students were more comfortable writing in academic Spanish. Carla graded the lab reports using a rubric she downloaded from the Internet (Appendix E) but when asked, offered more detail about her grading practices that reflected her emphasis on academic language: “I marked them off for the conclusion, if they didn’t summarize their results and give me a logical reason for supporting or rejecting their hypothesis.” These lab reports reflected more advanced academic language, as demonstrated by phrases such as “I accept the hypothesis.” Many of the students put in extra effort to write an introduction to the lab report, such as one student who wrote, “Through this science lab, we’re better able to understand the movement of the particles in the 3 states of matter and what can exacerbate the change.” One explanation for the higher level language used by these students could be the language composition of the class: this eighth grade class had only one true EL student; the rest had either become RFEP or were English-only. During my observations of this particular class, I noted that students conversed with one another in English, and only used Spanish during the SVE lessons. This was also the class that had several students who asked for help reading aloud the BrainPOP® Spanish questions.

Overall, Carla’s teaching practices demonstrated a comfort with both the process of science and the language of science. She provided multiple opportunities for students to “do
“science” and discuss this work with their peers. She held students accountable for their learning through a variety of assessments, from posters to quizzes to lab reports. Though she created engaging SVE lessons to reinforce vocabulary in Spanish, when it came to the formal assessments her expectation was that students would use academic English. This discrepancy indicates that her definition of academic language, or at least her interpretation of the administration’s definition, only focused on English and did not include Spanish. The imbalance in accountability between the two languages highlights an inherent disconnect between the goals of the dual language program and the expectations for student achievement in both languages.

**Teacher #3: Gina, Winter 2013**

The third teacher I observed at Harbor Bridge Charter School was Gina, who taught sixth grade science. Gina was a second year teacher who had taught Kindergarten the year before. She had begun as a teaching assistant and then took over the Kindergarten class to cover the teacher’s maternity leave. Her experience in Kindergarten included teaching a year-long science curriculum. Gina had her Bachelor’s degree and a California multiple subject teaching credential. She received EL training as part of the multicultural emphasis for her credential.

At the beginning of the 2012-2013 school year, Gina was responsible for teaching math to 6th-8th grade. Midway through the year, in late December 2012, the site director had asked Gina to swap her eighth grade math class for Carla’s sixth grade science class. I first met Gina just a few weeks after she had transitioned to teaching science. When I started my observations, Gina was finishing a unit on density that Carla had started with the sixth grade.
She then began a new unit, “Plate Tectonics.” I observed five classes/labs and one SVE lesson in Gina’s classroom.

During my first interview with Gina, I asked her about the materials and resources she used to design her lesson plans. She mentioned the FOSS modules as well as a new textbook set. Another school had generously donated the textbooks to Harbor Bridge Charter School, but there were not enough for each student. At the time of the interview, Gina had been teaching sixth grade science for three weeks; when asked about the new textbook set, she replied, “I haven’t checked it out yet.” When I interviewed Gina at the culmination of my observations, she shared her frustration that the FOSS modules were incomplete, with “lots of lessons missing and the teacher binders are incomplete.” She informed me that the faculty member responsible for reordering materials had left the school the previous year, therefore the science storage room and FOSS modules were “all over the place.” To supplement her lesson plans, Gina had been looking on Pinterest, an online social media and bulletin board site, for lesson plan ideas.

Gina’s classroom environment reflected an emphasis on dual language learning. She had many classroom objects and tasks labeled in both languages, i.e. the class schedule, the calendar, and student jobs. She would use Spanish to communicate classroom management and instructions, such as “collect the scissors” or “push in your chairs.” Gina adhered to the Gómez recommendation of heterogeneous linguistic pairs, and had even posted the color-coded pairs’ names at the front of her classroom. Although students were never out of their assigned seats, they were also rarely given time to dialogue with peers. In this instance, the teacher was implementing the Gómez model recommendations, but did not use the construct as an opportunity for students to practice language and support one another’s learning.
To answer my first research question, “How do teachers incorporate language instruction into science content instruction?” I was looking for targeted language instructional strategy for EL students such as code-switching, or using the students’ primary language to help explain new content or language. Gina was the only teacher I observed who used Spanish somewhat frequently in her classroom to interact with students on the English-only days. However, I only heard her use Spanish one or two times to support the academic learning, i.e. restating “placas que flotan” after discussing the plates of the Earth’s crust. The other instances in which she used Spanish were for classroom management.

Another frequently recommended EL scaffolding strategy is the use of visual aids and models. During Gina’s unit on plate tectonics, she would incorporate diagrams of the Earth’s layers and the plate boundaries into her Power Point presentations. She would photocopy similar diagrams for students to color and label and add into their science notebooks. Gina did try to incorporate a hands-on demonstration for the students: she gave each student a piece of dried spaghetti and compared it to the Earth’s crust, explaining that it can withstand some stress, but that too much stress will break the noodle. Despite this inaccurate model, there were no additional three-dimensional models to help students understand the complexity of plate movement and boundaries.

A key component not only from the Gómez Dual Language Enrichment Model, but also from numerous other EL recommendations and best science teaching practices, is the value of peer discourse. However, Gina did not build time into her lessons for students to discuss their learning. Instead, she would begin the lesson by projecting her Power Point presentation on the board and reading the title slide to inform the class of the content objective for the day. The lesson would then continue with Gina reading each slide, in English, while students copied the material into their science notebooks. When students
would speak, Gina would reprimand them and remind them to be silent. During one lesson, Gina became so frustrated by students speaking that she turned off the projector and instructed students to get a textbook off the shelf to take notes from the chapter. She declared that the “Power Point lesson is not working [for the class],” and that the homework would be learning material they could have covered in class. When I asked Gina about this class in our follow-up interview, she chalked up their talkative behavior to the fact that it was the first day back at school after the long Presidents’ Day weekend, and that “any little change that you do in the schedule, it’s just like it throws them off completely.” It should be noted that this was also the same class period during which Gina passed out the dried spaghetti as a model of the Earth’s crust. Students were excited to have an object to hold, but as she struggled to explain the connection between the pasta and the tectonic plates, the students lost focus and as a result she had a difficult time regaining the class’ attention.

In my quest to answer my research questions, I was looking for examples of how each of the teachers incorporated language instruction into science content instruction. In Gina’s case, I realized that her own lack of science content knowledge made it difficult for her to integrate the two. She expressed to me that she felt overwhelmed when she took over the sixth grade science class from Carla:

Carla has a lot of things from her old school… binders that she did for science already. So she incorporates a lot of that stuff into her own teaching. I had nothing, right? I was moved from Kinder to middle school – big switch. So I’m working with what I have.

What Gina did have experience with was language. As a result, her lessons were more linguistically demanding and placed less emphasis on the experience and process of
actually doing science. She told me that she emphasized writing with academic language based on the Gómez recommendation, “They do that in the DLE model. It’s a lot of writing so they have to write in their journals every day.” She explained that she would often start the day with a journal prompt she would write on the board that “has a lot of the words that we’ve used the previous day.” Gina would also photocopy diagrams for students to color, label, and add to their science notebooks as away to reinforce vocabulary. In addition to journal writing, Gina noted how much the students enjoyed working cooperatively, “Give them a paper to write and tell them it’s going to be in partners and they love it.”

To target language instruction for her struggling students and her ELs, Gina described how she would pull out these students to front-load vocabulary for upcoming lessons. While front-loading is a research-based strategy recommended by many EL curricula, i.e. CALLA, SIOP, SDAIE; interestingly it is not specifically included in the Gómez model. Despite her detailed description of her targeted language instruction, however, I only observed her communicate the language goals to the class two out of six observations. I never observed her actually using the front-loading techniques she described.

The best example of Gina’s language and science instruction was in the form of a formal assessment. Her sixth grade class wrote lab reports based on an experiment they had conducted in December while Carla was still their teacher. This lab, called “The Rainbow Lab,” was an activity designed to find the relative densities of different liquids, e.g. dish soap, salt water, fresh water, and isopropyl alcohol. Many students chose to draw the items for the materials section. Some even drew cartoons to detail the procedures. Overall, the language students used in the sixth grade “Rainbow Lab Reports” was more conversational and less academic. For example, one student who was classified as English-only wrote:
In conclusion, I would say this is a pretty cool experiment. I even learned some new things from this experiment. It was really hard for us to pull off this experiment.

One of the EL students wrote in an equally non-academic tone:

My conclusion was a little bit of wrong and at the same time right. My group was so excited [sic] to get the first time right but they got it wrong.

When I asked Gina how she intended to score these lab reports, particularly when students were using non-academic language such as “weird” and “ugly” to describe their observations, she referred to the same rubric Carla had downloaded for “The Candy Lab.” (Appendix E). Although the rubric is organized by the lab report headings, points are deducted not for quality but for lack of information. For example, a student would earn a low score if the procedures are not detailed, but only described with generalities. The lab report does not address academic language, and Gina even added, “a lot of the spelling we don’t look at because they’re spelling non-conventionally and that’s part of the school’s model.”

From my observations and interviews with Gina, I realized that her definition of academic language was limited to vocabulary, rather than broadly encompassing both oral and written registers of language. The assessments she used were all written, e.g. lab reports, journal prompts, or multiple choice tests. When specifically asked for her definition of academic language, she provided a literal explanation: “The academic language that we use is anything… a lot of academic language comes from the textbook. Academic language is different from what they’re learning. It’s a completely different ballgame.” She went on to explain that with the increased district oversight, one area of focus for the school-wide
improvement was vocabulary: “In science what we do is reinforce a lot of the vocabulary… because that’s a strand on the CST that they do poorly on.” This emphasis on vocabulary, to the exclusion of discourse, highlights Gina’s lack of comfort and familiarity with teaching science content. Without a deeper understanding of the concepts, she defaulted to the literal instruction of the vocabulary and terms found in the textbook – instructional methods with which she felt more confident.

Section III: Contextualizing the Findings

Academic language is used less frequently than everyday or non-scholastic uses of language even by teachers in the classroom, and is often less familiar than conversational language; therefore academic language requires targeted instruction and monitored practice so that students can fully comprehend content and incorporate discipline-specific language into the expression of their learning. In a science classroom, the academic language moves beyond vocabulary and syntax; it also encapsulates the process of thinking displayed in the scientific method. Students should not only be able to use correct terminology, but should also be able to apply the scientific method when exploring new ideas and questions. For these reasons, I developed research questions that focused on teachers’ perceptions of the role of academic language in science content instruction, and their own practice when teaching science to linguistically diverse students. Each of the three preceding case studies addresses my findings related to the first question and its two sub-questions: how do teachers incorporate language instruction into science content instruction, and how do teachers monitor and assess students’ use of academic language in the science classroom. The key findings were:
1) Teachers targeted language instruction in isolation from science content instruction, at the expense of engaging students in the “doing of science.”

2) Teachers practiced inconsistent monitoring and assessment of students’ academic language acquisition.

3) The stakeholders did not hold a shared perception of academic language or the role of academic language in the science classroom; while the administration held a holistic view of academic language, the teachers narrowly focused on vocabulary and assessed only this aspect of academic language.

In this section, I will illuminate how these findings present an overall picture of how academic language is addressed in a dual language school.

Perceptions of Academic Language

I entered into this study with certain research questions in mind about the role of academic language instruction and the assessment of academic language in middle school science classrooms. As discussed in Chapter 2, researchers have broadened the concept of academic language to include far more than just discipline-specific vocabulary (Bailey, 2012; Bunch, 2006; Cervetti, et al., 2008). Particularly in the domain of science, this more holistic definition includes academic discourse, the specific syntax of science texts, and words with meaning outside of science (Fang, 2004; Lemke, 1990; Shanahan & Shanahan, 2008). After initial interviews and observations at Harbor Bridge Charter School, a new question emerged: what were the stakeholders’ perceptions of academic language? Given the school’s sudden adoption of the new Gómez Dual Language Enrichment model and its structured language instruction guidelines, I was curious to learn if teachers and administrators shared an understanding of academic language. How did teachers and administrators differ in their
understanding of the role of academic language? At a dual language school, was the definition of academic language broad enough to include both Spanish and English academic language? Understanding the teachers’ and administrators’ perceptions gave me deeper insight into the role of academic language in the Harbor Bridge Charter School curriculum and pedagogy, and helped me make sense of what I learned from observing the three different classrooms.

I wanted to know if a shared definition of academic language translated into shared pedagogy, or if differences would be reflected in individual classrooms. In order to learn about teacher’s perceptions of academic language, I simply asked them the question, “What is academic language?” The responses voiced similar concerns about students’ grasp of academic language, but reflected each teacher’s different frame of reference. Susanne, the teacher who had the most experience working at Harbor Bridge Charter School, shared her opinion of academic language through the lens of lack of exposure: “It’s more challenging for them [the students]…it’s not words that they use all of the time and they’re always exposed to… words where they’re, ‘Oh, I’m not sure what that means.’ Ideally, you’re getting them up on your word while they’re being exposed to it.” In this quote, Susanne expresses her opinion of academic language along the traditional lines of BICS and CALP (Cummins, 1981). She felt that academic language is something that students do not encounter in their everyday lives, and that this lack of exposure to academic language makes it challenging for students to learn and apply it. Carla, the teacher with the most science teaching experience, discussed academic language in the context of science, saying, “words that are specific to a content but explain concepts. There’s a complexity to it, too… and within that shades of meaning. You could have one word that could work but an even more specific term to describe a color or to describe a situation.” In contrast to Susanne’s view of
academic language as “unfamiliar” to students, Carla describes academic language not as inherently unfamiliar, but rather as discipline specific (Fang, 2004; Shanahan & Shanahan, 2008). She notes the specificity required to accurately describe or explain scientific concepts.

Gina, the teacher with the least science experience, provided the literal explanation that “academic language come[s] from a textbook. It’s a lot of work. Some of them have heard the words, some of them are like ‘¿Qué es esto?’ (‘What is this?’)” Note that she did not include discourse in her definition, an omission that aligns with the lack of discourse and emphasis on reading text that I observed in her classroom.

From my observations of the students’ work at Harbor Bridge Charter School, I could see that students struggled the most with writing academic language. They also struggled when tasked to use academic language to communicate orally, which is likely connected to the few opportunities they had to practice this skill. When I asked the teachers how they perceived their students’ abilities with academic language, they shared the following insights with me. Carla shared that, “a lot of kids struggle with that [academic language]. They don’t have that language.” I probed her for more detail and learned, “I do have a few eighth graders who are not completely bilingual and fluent in Spanish so their work is limited.” Gina felt that her sixth graders “are understanding and they get the concept more than they can show you… but not using the terms.” She referenced the linguistic diversity in her class when she commented, “It [academic language] is hard. You’ve seen how many ELs we have… a lot of the kids don’t even know what I’m talking about if I use big technical words.”

8 47% English-only, 30% EL, 20% RFEP, 3% unclassified
Whereas the teachers focused on vocabulary as the heart of academic language, the two head administrators at the school, Maricela and Christina, both seemed to understand academic language in a broader context that included discourse as well as discipline-specific literacy and vocabulary. For example, Maricela described academic language in contrast to conversational language, “our students’ English oral language proficiency may be deceptive because you may think, ‘I can talk to José pretty easily and he seems to be pretty on the ball,’ but then you look at his written work and it’s not going to be on the level of his oral English.” In this example, Maricela made a distinction between written and oral academic language use, noting that she perceived students’ oral use to be more proficient than written. Christina’s view of academic language was that, “it’s not cognitively demanding if you start an early enough age. It’s just developing those CALP [skills] that are certainly cognitively demanding and require good instruction.” Though their definitions are rooted in Cummins’ (1981) original work, both administrators made reference to using language in conversation and discourse as a component of language acquisition, which demonstrates a more holistic view of academic language as defined by more recent studies (Bailey, Butler, & Sato, 2007; Bunch, 2006; Cervetti, et al., 2008). This emphasis on discourse was not shared between administration and the faculty, and therefore not translated into classroom instruction as evidenced by each teacher’s focus on learning decontextualized vocabulary as the main method of Spanish language acquisition.

Yet rather than blame the administration for failing to communicate their vision with faculty, I see this disconnect as more of an issue with the selection of the Gómez Dual Language Model as the school’s language acquisition model. As mentioned in previous sections, the major vehicle for targeted academic language instruction at Harbor Bridge Charter School was the Specialized Vocabulary Enrichment lesson. The idea behind SVE
was to reinforce vocabulary previously taught, but to do so in the opposite language. At Harbor Bridge Charter School, this meant that English science vocabulary was reviewed in Spanish. As a method to practice applying and using academic language contextually, the SVE lessons I observed at Harbor Bridge Charter School provided limited opportunities for students beyond memorizing vocabulary terms. This pedagogy was at odds with the administration’s view of academic language – a misalignment that the administration either ignored or overlooked. Based on my SVE observations, the majority of student participation centered on reading academic language and listening to the teacher use academic language (both vocabulary and syntax). Students were not expected to create full written or oral discourse, but rather to answer questions with one-word answers or short phrases, as in the case of Carla’s multiple choice quiz or Susanne’s direct translations of the functions of life. Though this limited scope of academic language as vocabulary does not align with current research or with the administrators’ stated perceptions, these lessons did adhere to the Gómez Dual Language Enrichment Model guidelines for SVE (Appendix F). To the teachers’ credit, they were following the model as directed, even though ultimately the model was not serving the mission or vision of the school leaders.

Given that the Gómez DLE model so heavily emphasized Spanish vocabulary in the science SVE lessons, it was surprising that teachers rarely assessed students’ use of it. Susanne was the only teacher who explicitly assessed students’ writing and speaking in Spanish, but she told me that she only did the writing assessment for my benefit so that I could have written work to analyze. During the last week of school, June 2012, when I asked Susanne if the administration expected her to assess Spanish academic language, she had this to say: “Not really. The way I’m understanding it [SVE] is just to reinforce how they [the vocabulary words] use the roots and then how they [English and Spanish words]
are connected.” She went on to share that the SVE scheduling made it challenging to focus on Spanish vocabulary, “it [SVE] is once a week for 20 minutes, so it’s been hard… and then when they’re short and for different reasons if we’re not here… no, 20 minutes doesn’t seem like enough.”

Because of the natural connection between SVE and my study on academic language in science, I was eager to see more of these lessons when I returned to Harbor Bridge Charter School in Winter 2013. Unfortunately, I saw that the SVE lessons continued to be negatively impacted by the school’s schedule. The schedule for the 2012-2013 school year designated 30- and 35-minute time slots for SVE on Fridays (Appendix G). Carla’s comments about the administration’s low or non-existent expectations for Spanish academic language assessment mirrored Susanne’s from the previous year. In the school year 2012-2013, each teacher submitted a weekly lesson plan to Christina for review, but Carla said, “They look at our Weeks at a Glance and they know exactly what the Spanish activities are… I haven’t been asked ‘how are you assessing’ so I figured I’ll just leave it alone for now.” When several of Carla’s own students wrote rough drafts of their “Candy Lab Reports” in Spanish, they asked her if they would receive extra credit. She responded, “Yeah, I’ll give you extra credit if you do it in both languages. In the future you will be required to do both.”

**Monitoring and Assessing Academic Language**

As well as observing academic language instruction, I was also interested in learning how teachers monitored and assessed students’ use and mastery of academic language in science. However, the guidelines provided to the school from the Gómez DLE only address
K-5 assessment (Appendix F). In these younger grades, it is recommended that students be assessed in the language of instruction for science, regardless of their language dominance. Furthermore, the guidelines suggest primarily assessing conceptual understanding with a secondary focus on use of language of instruction. The guidelines offer no specific recommendations on academic language assessment. However, since research shows that ongoing assessment is a critical component of a successful dual language program (Lindholm-Leary, 2005), I continued to look for assessment in order to answer my research question. In fact, I did see a variety of formal and informal assessments from the three different teachers I observed. The assessments emphasized different uses of language, i.e. oral, written, or reading comprehension. Though each teacher did incorporate some forms of immediate, close, and proximal assessments (Ruiz-Primo, et al., 2002), overall there was a lack of consistency not only between teachers, but also within each teacher’s assessment practices.

**Oral Assessment**

Two of the three teachers I observed at Harbor Bridge Charter School built time into their lessons for students to dialogue with their peers about the scientific concept being explored, and then conducted informal assessments of students’ oral use of academic language by observing students’ interactions or asking short answer questions. These assessments would be considered close assessments (Ruiz-Primo, et al., 2002). Such peer-to-peer discourse was also a recommendation from the Gómez model, specifically the use of bilingual pairs and bilingual groups for instruction. The target of these assessments was students’ understanding of the meaning of the terms, not pronunciation or syntax. This focus on definitions and strict English-Spanish translation made the learning goals and
success criteria very evident to both teacher and student (Bailey, Huang, & Escobar, 2011). The third teacher did not allow time for students to participate in academic discourse with their peers, nor was there time for students to engage the teacher in academic discourse.

While I was observing these classes, I was looking for examples of best practice for conducting formative oral assessments. Specifically, I was looking for evidence of teachers setting learning goals for oral use of language, making success criteria explicit to students, and evoking a variety of evidence of student learning, because these practices “work together to create a continuous feedback loop that informs teaching” (Bailey, et al., 2011, p. 146). For Spanish language assessment, Susanne and Carla both set the intention for learning direct translations of science vocabulary and phrases, and these goals were shared with students. However, Susanne only asked her students to repeat one phrase each, and Carla only required multiple-choice answers or one-word answers. There was not an expectation that students demonstrate their learning with a variety of evidence. In contrast, both teachers provided a variety of platforms for students to demonstrate English oral language use. With both languages, however, there was little to no feedback on students’ oral use of language. Without such feedback, neither students nor teachers were receiving information to inform future teaching and learning; the continuous feedback loop did not exist.

**Reading and Writing Assessments.**

Each teacher I observed incorporated reading and writing assessments into her instruction, but with different levels of difficulty, and targeting different languages. Not all assessments were explicitly designed to assess academic language; several were purely content-based, such as Carla’s multiple-choice quiz. However, even this quiz assumed a certain level of academic language literacy, as the questions were phrased in academic
English. The assessments varied among posters, short written responses, formal lab reports, and multiple-choice tests. Such written work would be close assessment of students’ learning (Ruiz-Primo, et al., 2002). The teachers would give students class time to work on their written responses, lab reports, and posters since the school had a “no homework” policy. My observations of Susanne’s classroom overlapped with two weeks of the CSTs. Because students were taking these high-stakes tests, Susanne purposely conducted only quick informal assessments in her class. After several weeks focusing on the characteristics of life in both Spanish and English, Susanne had students write one of the characteristics on a note card, using their own words, in both English and Spanish. Susanne told me that she intentionally included this assessment for my benefit, and would not normally have assigned this task. We reviewed the cards together, and noticed that the vocabulary in English was more discipline-specific than the Spanish vocabulary. For example, one student wrote a simple Spanish sentence to say, “non-living is when they never lived or died,” but then his English writing included the phrase, “respond to stimuli.” Overall, Susanne noted that all of her students, whether EL or English-only, struggled with scientific terms as well as abstract concepts. In her opinion, these challenges stemmed not as much from linguistic issues as from the students’ lack of exposure to science and scientific language, and feeling “not quite sure how it [science] relates to them in everything.” She went on to describe her students’ reluctance to speak using academic Spanish during student-led parent conferences:

It’s hard to even get them to use it [Spanish], so when they’re up there [presenting], you’re like, ‘I need you to practice. I want to hear what you have to say.’ They could write it down. They could read it and pronounce it and all of that, but they won’t actually say it. That’s what takes a little bit more of a push.
In the end, I think that Susanne saw value in conducting this close assessment, even though she would not normally have incorporated this activity into her lesson. Reviewing the students’ work gave her further insight into her belief that her students struggled with “their scientific reasoning, or just connecting it to their own lives” and that this disconnect negatively impacted their level of content comprehension.

Although I did not have the opportunity to observe Gina’s students taking a test, she told me about the process she used to create the multiple-choice assessments for her students. She used an online software tool called OARS, created by Red Schoolhouse Software. OARS stands for Online Assessment Reporting System. OARS was a software program that the entire Harbor Bridge Charter School had license to use, although neither Susanne nor Carla had received training to use this tool. Gina found the program easy and user-friendly because she was able to quickly create assessments based on the California Content Standards. This software had pre-written questions that addressed each strand of the content areas, which Gina could select to make the quiz as long or as short as she liked. She could print the tests directly from the website, with the bubble-in answer sheet, and then run the answer sheets through the school’s machine to read and score the quizzes and automatically generate reports on student performance. Gina found the OARS assessments to be good practice for the CSTs, since she felt that her students “understand while they’re listening, and the visuals, but when it comes down to taking a test they’re not good test takers.” Gina was the only one of the three teachers who consistently used the OARS assessment program to review and test her students on their science content. Her reliance on the OARS tests may have been related to her role as the first semester 6th-8th grade math teacher, a subject very closely monitored by the district, and one for which she used OARS weekly.
The Role of Academic Language in a Dual Language School

The teachers and administrators at Harbor Bridge Charter School had an awareness of academic language and its prominence in today’s educational landscape; each teacher spoke easily and confidently when asked about academic language showing her familiarity with the phrase, if not the meaning. However, based on my findings, these teachers did not seem to hold a shared meaning of academic language, nor did they seem to understand the richer meaning of academic language beyond vocabulary. In turn, each teacher held a different view on how her perception of academic language should be incorporated into instruction and assessment at a dual language school. As a result, each classroom I observed addressed academic language in very different ways. Despite the differences, three common themes emerged from my observations. First, the teachers’ perceptions of academic language were narrowly focused on vocabulary. When I did observe scaffolded instructional strategies, they were solely focused on Spanish vocabulary rather than English. However, Spanish academic language was rarely assessed; English academic language was assessed more frequently and more formally but only in terms of grammar and syntax, not use of scientific language. This seems like a mismatch between instructional goals and measurable outcomes, making it difficult to assess what is actually being taught in the classrooms.

Second, in the attempt to follow the guidelines set by the Gómez model, teachers were focusing more on targeted language instruction at the expense of the “doing of science,” and therefore missing opportunities to embed language learning into science content learning. In short, the dual language model became counter-productive to effective science teaching at the middle school level. Third, there was a discrepancy between the administration’s goals and expectations communicated to teachers, a gap that was exacerbated by the construct of the newly adopted Dual Language Enrichment model and the variability between each
teacher’s professional experience. Without adequate training, classroom materials or support from the administration, each teacher was interpreting her role as language and science content instructor differently. As a result, English language instruction, Spanish language instruction, and science content instruction were at odds with each other, rather than working in concert towards deeper student understanding. Overall, the school’s execution of the dual language program met some of the criteria for effective dual language programs (Lindholm-Leary, 2005), but there were major needs to address in order to exemplify all seven characteristics of success. In the next chapter I will discuss recommendations for meeting these criteria.
Chapter 5: Discussion and Recommendations

Introduction

When California passed Proposition 227 in 1998, bilingual education all but ended in the state. The law limited EL instruction to one-year structured English immersion programs; however, research shows that children require several years of scaffolded instruction in order to become fluent in another language (Collier, 1987; Cummins, 1981). Although early proponents of Proposition 227 claimed to see increases in EL academic achievement, in April 2013 the American Civil Liberties Union (ACLU) filed a lawsuit against the California Department of Education for inadequate English instruction for EL students. The ACLU claims that EL students are being held back in school or maintain low proficiency scores. Despite varied attempts to equalize the learning landscape between English and non-English speaking populations, EL students continue to struggle to attain academic achievement on par with their native English-speaking peers. As noted in Chapter 2, an increasingly popular method of closing this achievement gap is via dual language immersion programs in which 50% of the students are EL and 50% are English only, but both groups are learning in two languages. This study adds to the growing body of literature on dual language programs, with a much needed focus on middle school classrooms.

In this chapter I reflect on implications of this study’s findings and recommend ways school leaders and teachers can more effectively target academic language acquisition in a dual language program. The recommendations are organized as advice for teachers, administrators, and providers of professional development. Furthermore, I detail this study’s limitations, possible effects on policy, and opportunities for future study. I close by
reflecting on this study’s import and impact.

**Summary of Research and Findings**

I embarked on this study to learn more about academic language instruction in science for EL students in middle school. Middle school presents particular difficulties for students in science, as motivation and achievement in math and science tend to decline for both genders at this stage (E. M. Anderman & Machr, 1994; L. H. Anderman & Midgley, 1997; Eccles, et al., 1993; Osborne, et al., 2003; Roeser, et al., 2000). The focus of my study was a K-8 dual language charter school in an urban, low-income, predominantly Latino area of a Southern California metropolis, referred to in this study as Harbor Bridge Charter School. Through qualitative analysis of classroom observations and interviews with teachers and administrators, I attempted to answer several research questions. First, I wanted to learn how teachers incorporate academic language into science content instruction. I found that teachers’ perceptions of the meaning of academic language influenced their execution of this integration. The teachers’ own definitions of academic language were narrowly focused on vocabulary, rather than encompassing the written and oral discourse needed to effectively navigate in a school environment. This emphasis on language instruction came at the expense of the “doing of science,” and therefore teachers missed opportunities to embed language learning into science content learning. Second, I wanted to learn how teachers monitor their students’ use of academic language. I found that teachers were inconsistent in their monitoring and assessment of students’ academic language acquisition, often missing opportunities to provide feedback for students learning the language of science. Finally, I was curious how academic language is addressed in a dual language school. Would there be an emphasis on learning academic language in both languages? I found that there was a
discrepancy between the administration’s goals and the expectations communicated to
teachers; the administration spoke of prioritizing bilingual learning and biliteracy, but
selected an instructional model that emphasized teaching academic Spanish, but assessing in
English. As a result, each teacher was interpreting her role as language and science content
instructor differently, with some emphasizing one language only, while others targeted both
languages. These three findings characterize how English language instruction, Spanish
language instruction, and science content instruction were at odds with each other at Harbor
Bridge Charter School, rather than working in concert towards deeper student
understanding. In short, the dual language model became counter-productive to effective
science teaching at the middle school level.

Before exploring the recommendations based on these findings, it is important to
pause and take stock of the issues facing the school at the time of this study. The
administrators were at odds with each other, lenders were demanding money, and teachers
tried to do their jobs with little support from school leaders. In the chaotic scramble to meet
the district’s curricular and financial demands, administrators were reassigning teachers to
roles for which they were not equipped. Gina was a prime example of this: a teacher
without content expertise or experience teaching middle school who was thrust into a sixth
grade science classroom – midyear – without textbooks, curriculum, or supplies. Yet even
when faced with strict district oversight including threats of takeover and mandated
curriculum, teachers and administrators were passionate about improving student
achievement at Harbor Bridge Charter School.

The findings from this study provide negative evidence to support the research that
science instruction for EL students should offer high challenge, but with a high level of
linguistic support as well (Gibbons, 2003). In the case of Harbor Bridge Charter School, we
see students with low achievement scores on the standardized tests. When we trace those scores back to the classroom, we see a learning environment that is providing some, but not enough, targeted English language support for academic language. Recall the sixth grade classroom with text-heavy Power Point slides, copied verbatim from the science textbooks, read aloud by the teacher without any visual aids, checking with students for understanding, or providing time for students to discuss, interpret, or ask questions. In the seventh and eighth grade classrooms, we saw content that was not at grade level for students; nine weeks were spent covering standards that represent a small fraction of the Eighth Grade Science Content Standards. Referring back to Vygotsky’s Zone of Proximal Development (1978), students acquire new knowledge when they are challenged with material that is just beyond their range of competence within a supportive, cooperative learning environment. The students’ scores on state achievement tests reflect the absence of challenging content and adequate scaffolding at Harbor Bridge Charter School.

**Significance of Findings**

When examined through the lens of the key features of highly effective dual language programs (Lindholm-Leary, 2005; Stanford Graduate School of Education, 2013), the findings from this study support the need for schools to be mindful and purposeful in their execution of each feature. Furthermore, these findings and the subsequent recommendations tell a cautionary tale for any school undergoing major changes and facing the pressures of high stakes accountability.
Implications for Practice

Although these findings provide an unsettling explanation for low academic performance, there are several lessons learned from which this and other schools can benefit. I have framed these recommendations as advice for the teachers and administrators of Harbor Bridge Charter School, as well as potential providers of professional development and teacher education.

Recommendation One: Authentically Embed Language in Science Learning

In the current era of high stakes accountability, much emphasis is placed on the annual math and language arts standardized tests. With science only tested in fifth grade, eighth grade, and tenth grade, there is the implication that less time is allotted for science and science academic language. The research on dual language models and sheltered instruction recommends targeting language that students will need to fully comprehend content-area concepts, with front-loading as a key strategy (Chamot & O'Malley, 1996; Echevarria, et al., 2008). However, more recent dual language research actually supports moving away from decontextualized, discrete lessons that target academic language (Lindholm-Leary, 2005; Quinn, et al., 2012; Stanford Graduate School of Education, 2013). The Gómez model adopted by Harbor Bridge Charter School is at odds with this more recent research; therefore I would recommend that rather than focus on vocabulary, the teachers purposefully embed vocabulary and focus on discourse, or ways of talking about science. Kelly and Breton (2001) found that teachers can guide students through an inquiry-based science curriculum while simultaneously teaching them the specific discourse needed to frame problems and make observations. Learning and using scientific discourse is critical
to developing deeper knowledge of scientific concepts and understanding the nature of science (Lemke, 1990; Moje, et al., 2001; Rosebery, et al., 1992). Evidence-based talk and argumentation will become increasingly important as California moves to adopt the Next Generation Science Standards developed as part of the Common Core; these standards emphasize the practices and processes of science much more than the content. Harbor Bridge Charter School teachers have the opportunity to design lessons that encourage students to make sense of science phenomena through peer conversations, such as Carla’s collaborative “Candy Lab” lesson. Her students were able to observe the candies melting and discuss their observations as she circulated the room, facilitating conversation and probing for more detail. In contrast, Gina was so focused on content instruction that she did not create time or space for students to dialogue about science concepts, or for collaboration in general. As students gain confidence sharing observations with and questioning their peers, then teachers can support this dialogue with appropriate academic language. Strategies like this empower the students to take responsibility for their learning, and also relieve the teacher of the role of “sage on the stage.”

**Recommendation Two: Provide Challenging and Engaging Academic Content**

As I stated in Chapter 2, the collaborative nature of an inquiry-based science classroom promotes the social and emotional development of students as well as their conceptual understanding of science (Kluger-Bell, 1999). The self-directed nature of inquiry-based science learning can increase academic achievement for ELs, girls, and students of color (Amaral, et al., 2002; August, et al., 2009; Geier, et al., 2008; Marx, et al., 2004; Patrick,
et al., 2009). When students engage in developing their own questions, they challenge themselves to learn. Susanne observed this with her own students, “They’re ready. They want the challenge.” Participating in hands-on science experiences is a noted method of engaging EL students in meaningful science inquiry (Chamot & O'Malley, 1986; Lee & Fradd, 1998; Rosebery, et al., 1992). Two out of the three teachers at Harbor Bridge Charter School incorporated hands-on learning into their lessons; these were also the teachers who encouraged peer-to-peer scientific discourse. When reviewing student work from the three classes, students in these two teachers’ classes demonstrated the most mastery of academic English. This finding strongly suggests that the teachers at Harbor Bridge Charter School should spend more time planning lessons that incorporate hands-on activities and labs. Teachers like Gina, who lacked science teaching experience, would greatly benefit from administrative support in the form of content-specific professional development. The administration should be aware that placing faculty in positions without the skills or support to execute their jobs well sets unrealistic expectations for both teachers and students.

Another way to engage students in science learning is to make science relevant to their lives (Ladson-Billings, 1995). Making science culturally relevant honors students’ prior experiences, funds of knowledge, and cultural assets (Moll, et al., 1992). An excellent example of culturally responsive pedagogy in practice was one student’s disagreement with another on living versus non-living things: “No, it [yogurt] is living, dude. My mom grows it. She makes yogurt.” Acknowledging and encouraging students to express their diverse cultural backgrounds results in deeper academic engagement and achievement (Ladson-Billings, 1995). Susanne noted that for her students, science “is pretty challenging when they’re not quite sure how it relates to them.” She encouraged students to make connections to their lives, Carla echoed this sentiment, “As long as there’s that real world connection or
that connection to something they’re interested in, then they can buy into it a little bit more.” The hands-on activities presented in the FOSS modules provide one method of introducing culturally relevant experiences, such as the “Candy Lab.” However, by the second year I was working with the school, the FOSS materials were decimated and curriculum guides were missing. Since the school had already made the initial investment in this curriculum, I would recommend that they continue to maintain this resource so that teachers would have access to engaging, research-based science activities. Specifically, the administration should commit the financial resources needed to restock the kits with materials and student workbooks, and the school should set a priority for translating key materials into Spanish.

**Recommendation Three: Conduct Consistent and Useful Assessments**

Both Lindholm-Leary (2005) and Understanding Language (2013) point to the importance of conducting systematic formative assessments to measure students’ content knowledge and academic language competence. Administering consistent assessments, then providing useful feedback to students, not only allows teachers to adjust their instruction as needed but also encourages students to reflect on their own learning.

Ruiz-Primo et al (2002) recommend conducting multi-faceted assessments that measure student learning at different distances from the curriculum: immediate, close, proximal, distal, and remote. In the classroom, teachers have many opportunities to assess student achievement from immediate and close ranges, such as through science notebooks, oral presentations, unit tests, lab reports, and listening to student dialogue. In order to maximize the effectiveness of such assessments in a dual language program, it is important
that teachers measure achievement in both languages (Lindholm-Leary, 2005).

Results from this study indicate that consistent feedback on students’ written lab reports enabled students to make improvements to their written academic English. Students were given the rubric at the beginning of the assignment, and then submitted a rough draft for the teacher’s feedback. Through this exercise, students were aware of areas for improvement and expectations for the final draft. In a 50:50 dual language school with the goal of creating bilingual and biliterate students, the same attention should be paid to similar assessments in the target language. Instead, in the case of Harbor Bridge Charter School, the scant amount of time spent on Spanish academic language instruction resulted in equally scant Spanish assessment. In order to honor the commitment made to the 50:50 dual language model, the Harbor Bridge Charter School teachers should hold students accountable for their learning in both languages with equal emphasis on each.

In addition to written assessments, it is equally important to conduct assessments of students’ oral use of scientific language. As recently detailed by Bailey et al. (2011), systematic, formative oral assessments require setting learning goals, making success criteria explicit to the student, and evoking a wide range of evidence of student learning. Looking back at the lab report assessment, the school had these measures in place for written assessment; the same could not be said for oral assessments. Because discourse includes both written and oral registers of language, consistent, systematic assessment of both is key to students’ mastery. Skill in communicating with others is a key feature of the Next Generation Science Standards (NGSS), the most recent best practices in science education developed by the National Research Council (2013). Particularly, the Science and Engineering Practices dimension of the NGSS focuses on asking questions, constructing explanations, engaging in argument from evidence, and communication information.
**Recommendation Four: Conduct On-Going Program Evaluation**

During times of major school changes, effective leadership is particularly critical to the success of new programs (Castellano, Stringfield & Stone, 2002). The leadership at Harbor Bridge Charter School definitely acted as advocates for dual language immersion which ensured that all faculty were aware of the school’s mission and ready to implement the dual language program. However, with the limited time available for SVE, it was obvious to me that the administration had done little to evaluate the effectiveness or fidelity of the Gómez DLE model, at least at the middle school level. Had administrators been closely monitoring the implementation of the model, they would have been aware that the time scheduled for SVE was routinely used for other school business instead. With methodical program evaluation, administrators can gain more accurate insight into what is actually occurring in their school.

It is interesting that Harbor Bridge Charter School, and its local district, agreed to adopt the Gómez Dual Language Enrichment Model when such differences exist between the ideal model and the model in practice. Many of these differences are beyond the school’s control, such as when state-wide standardized tests are scheduled. However, given that the district almost shut down this school for low achievement scores, one would think that adopting a model that promised success under very different circumstances would not be the best solution for the school.

In addition, there was little instructional oversight at the school, an omission that allowed for a wide disparity between science classrooms; there were differences in assessment practices and amount of hands-on and inquiry-based science instruction.
Furthermore, resources and materials were not maintained. Hands-on science relies heavily on supplies and equipment, yet teachers such as Carla mentioned feeling limited by the lack of materials, “Materials? I ask the kids, I ask the kitchen. I try to make it as basic as possible.” Without administrative support for acquiring curricular resources and instructional materials, teachers were equipped only with prior experience or materials they brought to the classroom themselves. Administrative support can take the form of dual language program advocacy, supervising instruction and managing resources, and facilitating staff development and collaboration.

**Recommendation Five: Provide Professional Development in both Language and Science**

Science teachers in linguistically diverse schools must be equipped not only to teach science content, but also language development. Particularly for middle school science teachers, the Transformative Professional Development model (Johnson and Marx, 2009) is an effective strategy to empower teachers to create more effective classroom learning environments that address these needs. Transformative Professional Development builds collaborative relationships among faculty, creating a safe space to share ideas and feedback, which is then incorporated into a continuous cycle of learning known as a positive feedback loop (Kauffman, 1980). The curricular goals of Transformative Professional Development include making science culturally relevant and establishing procedures and routines for participation in science classrooms and high expectations for success. A model such as Transformative Professional Development requires a commitment from both administrators and faculty to make time for collaboration. I would strongly recommend that the faculty of
Harbor Bridge Charter School participate in a professional development program such as this. Not only would it build individual teachers’ capacity, but also it would unify the faculty in a time of crisis.

For professional development providers targeting middle school teachers, programs must be designed with both content objectives and language objectives in mind. It is no longer enough to quiz students on vocabulary; teachers must be trained to facilitate peer discourse and evidence-based argumentation. Engaging in these activities will not only immerse students in the practices of scientists, but will also empower students to take responsibility for their own learning and sense-making. When reflecting on Gina’s lessons on plate tectonics, students were expected to listen to and read the science content. As students blurted out questions while attempting to make sense of the content, such as “Has anybody ever been to the core [of the Earth]?” their questions went unanswered. The resulting effect was that science was something that was being done to them, e.g. lectured, rather than being experienced first-hand.

Limitations of the Study

Several limitations of this study deserve attention. First, the interview data comes from a small sample of similar teachers. Each of these Latina teachers had less than five years teaching experience, and each one had some level of training in EL instruction. It could be argued that this small sample size diminishes the generalizability of this study’s findings. However, I purposefully executed my research as a nested case study in order to gather data about more than just the teachers; through interview transcripts, student work, and classroom observations, the school itself began to tell a story. Although the story is
unique to the school, charter schools across the nation are facing similar district mandates. The interpretation of this school’s challenges and successes meeting those district goals is the generalizable information.

The second limitation presented by this study was ever-changing landscape of the school. When I began the study, the school had only been using the Gómez model for three months. When I returned the following year, not only were the teachers different, but also one of the teachers had only begun teaching science a few weeks earlier. These constant structural shifts could be interpreted as the school not having enough time to settle in to the new models and instructional style, therefore I was not observing the teachers and the school when it was operating at its best. I would argue that many schools face changes such as this, and that teachers are always adapting to new mandates, revised schedules, and myriad other variables that impact the operation of a school. Also, observing a school at the onset of program implementation can be a valuable resource for other schools hoping to introduce similar programs.

Implications for Future Research and Policy

This study adds to the growing body of research on teaching science to linguistically diverse students by describing how teachers teach and monitor learning in their own classrooms. Without introducing a my own structured intervention or a new curriculum, I was able to “investigate a contemporary phenomenon within its real-life context” (Yin, 1994, p. 13). However, there continues to be a need to study the unique nature of middle school science classrooms, particularly those with a large percentage of EL students. Much of the research focuses on K-6 education; perhaps this is because by eighth grade, many EL
students have been reclassified as Fluent English Proficient, and schools do not focus as much on language. However, EL, RFEP, and English-only students all face the challenge of learning more complex academic language in middle school content areas. Further research on academically challenging, linguistically supportive teaching will provide teachers with additional resources and strategies to teach at this level.

Although these circumstances are specific to Harbor Bridge Charter School, the pressure for schools to perform is universal. Charter schools across the nation face similar financial and academic challenges, often turning to research-based programs such as dual language immersion that promise academic achievement. The findings from this study can be applied to similar situations, that is, schools looking to improve student success and accountability for a linguistically diverse population.

In terms of policy, this area of research makes a strong argument for continuing education and professional development for teachers in linguistically diverse science classrooms. Not only do middle school teachers require deep knowledge of the content, but also should understand the most effective methods to teach science, i.e. inquiry-based, culturally relevant, and with consistent assessment. In addition to understanding science, teachers must then layer instructional strategies for varying levels of EL students. Professional development should target the special needs of middle school teachers and include research on adolescent development and psychology. Districts should require that middle school teachers have or receive training in content area as well as EL instruction. Policy should reflect this commitment to high-quality, highly qualified teachers in specialized content areas.
Reflection and Conclusion

I began this study to learn about middle school science instruction in linguistically diverse classrooms representative of California’s student population. What I discovered was that the world of bilingual education is a controversial, ever-shifting paradigm. Christina, the co-founder of Harbor Bridge Charter School and a bilingual educator for many years, shared her common sense approach to bilingual education:

The kids who had had English-only spoke English well but had low literacy… They didn’t have any cognitively grade-level appropriate language. They had been learning English while everyone else was learning content… The kids who had had Spanish-dominant instruction also spoke English well and could read and write both, so I’m not a rocket scientist.

She is right – teaching science does not have to be separate from addressing language. In fact more and more recent research supports integrating the two needs (Fathman & Crowther, 2006; Lindholm-Leary, 2005; Quinn, et al., 2012; Stanford Graduate School of Education, 2013). However, it should be acknowledged that this type of teaching requires work. It is challenging to simultaneously consider content, academic language, and English language. The teachers in these kinds of classrooms require support and encouragement from their colleagues and administrators. Seeing the teachers strive to meet these goals at Harbor Bridge Charter School reinforced my thoughts on collective efficacy. This idea builds on Bandura’s (1977) early theory of self-efficacy to include the beliefs of group members concerning “the performance capability of a social system as a whole” (Bandura, 1997, p. 469). For schools, collective efficacy implies that teachers must not only hold an
outcome expectation that the school’s work will have an impact on student success, but that each teacher at the school believes in the entire faculty’s ability to contribute positively to that goal (Goddard, Hoy, & Hoy, 2004). Collective efficacy instills a sense of accountability to something greater than the individual.

Belief in our students, belief in our teachers. These beliefs are the foundation of success. As Carla expressed, “Here, let me give you a task that you can accomplish and you’ll be successful. Then maybe that will get you to try because you know you’re going to succeed.”
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