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Aprendiendo Ciencias: The Construction of a Community of Practice in a Fourth Grade Bilingual Classroom

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Aprendiendo Ciencias: The Construction of a Community of Practice in a Fourth Grade Bilingual Classroom

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Dedication

Por y para Nitse. Por ser la luz que ilumina mis días.

Para mi madre que ha sido un ejemplo de fortaleza.

To the amazing teachers that continue to make a difference every day.

To all the wonderful students who have inspired me to pursue this work.

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Aprendiendo Ciencias: The Construction of a Community of Practice in a Fourth Grade Bilingual Classroom

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Abstract: This was a qualitative case study focusing on one fourth-grade bilingual teacher and her students. Using theoretical and methodological tools from Communities of Practice and Sociocultural Learning research, I discuss how the teacher and her students co-constructed a community of practice during science. Additionally, this study provides first hand accounts of students' various oral, written, and visually represented stances related to complex issues in science, to describe how the teacher developed her students' linguistic and cultural resources through science. I used participant observation, video and audio recordings, and student classroom artifacts to document social interactions to understand what practices assisted in the co-construction of a community of practice in this particular fourth-grade bilingual classroom. Data analyses revealed that the teacher and her students engaged in practices that fostered the science identity of the bilingual fourth-graders. Further analyses revealed that through the integration of literacy practices with science, the students acquired ways to write, talk, and read, adopting scientific discourse. Important connections between home and school were present as a component of this community of practice. Finally, I found that the work of doing science within this particular classroom was accomplished by drawing upon linguistic resources in both English and Spanish. Engaging in the work of doing science bilingually became an essential characteristic of the co-construction of the community of practice. Implications for bilingual education and elementary science education include acknowledging the importance of utilizing all available linguistic resources to gain content-area knowledge and develop academic biliteracies. Implications for elementary teacher preparation call for training that focuses on the integration of content-area literacies, bilingualism, and home-school connections that value knowledge from home as a starting point for the study of science.

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CHAPTER 1

INTRODUCTION

My passion for science began many years ago when I worked as an instructional assistant teaching marine science in Spanish at a magnet school located in East San Diego. At that time, it was very difficult to find instructional materials in Spanish. I spent many hours researching suitable translations for reading materials, videos, worksheets, and lesson plans. Years later, when I became a certified teacher, I spent my summers immersed in professional development programs dedicated to science. The first of these professional development experiences took place at the University of California in Los Angeles and Catalina Island where I learned about integrating Marine Science into the elementary curriculum through the Leadership in Marine Science (LIMS) program. Throughout my teaching career I continued to foster and share my interest in science by continuing to participate in professional development and conferences related to science.

Subsequently, I joined the founding faculty at a brand new school site, the Science Center School. This elementary school emphasized science and technology as a result of the school districts' collaboration with the California Science Center. After two years at the Science Center School, I moved to Austin, Texas where I taught fifth grade science in English and in Spanish for two years. During the latter part of my career as an elementary school teacher, I struggled with teaching science as highly scripted curricula and high-stakes testing emphasizing reading and math were the norm. Among the many challenges that came with the growing standardization of teaching and learning was dealing with the inequities created and re-enforced by the standardized assessments[1]. As a bilingual teacher teaching emergent bilingual students[2], I felt compelled to explore how Spanish and English could be used within the content area of science to either promote or hinder student learning.

Research Questions

As an emerging scholar, I began to realize that the learning and teaching of science within bilingual classrooms is a complex process. The purpose of this qualitative case study was to document and analyze the ways in which one bilingual teacher and her students co-constructed a Community of Practice (CoP) during science. Additionally, by providing first hand accounts of students' various oral, written, and visually represented stances related to complex scientific issues, this dissertation describes how the teacher fostered her students' linguistic and cultural resources in and through science. The research questions that guided this study were:

1. How do a bilingual teacher and her students co-construct a community of practice in and through science within an elementary bilingual classroom?
    a. How does the teacher promote a sense of community in the classroom?
    b. How does the teacher cultivate this sense of community through and within science lessons?
    c. What specific scientific practices are constructed during science and how are they related to a larger scientific community?

[1] Standardized assessments present language challenges and cultural biases for students that are learning a second language and culture. These challenges have been documented by scholars such as Solano-Flores & Nelson-Barber (2001) and Solano-Flores & Trumbull (2003).

[2] Throughout this dissertation I will use the terms: Culturally and Linguistically Diverse (CLD) to refer to students from various cultural and linguistic backgrounds; Latina/o to refer to students from Spanish speaking backgrounds; Emergent Bilingual to recognize students' developing bilingualism (García, Kleifgen and Falchi, 2008); and English Language Learner (ELL) if the source refers to bilingual students as such. Some data sources use the terms Hispanic or Limited English Proficient (LEP) and will be noted when appropriate.

2. What are the language practices used within and across science lessons that support the co-construction of a community of practice?
    a. How are languages used within this classroom?
    b. How are languages used during the teaching of science?

Background

Beginning in the early 1960s, curriculum reform efforts in the United States have focused on the content areas of math and science to try to maintain pace with other nations:

> Policy makers worried that, without large numbers of well-prepared high school graduates to fill the science pipeline, the United States could lose ground to Soviet science, weakening its cold war position (Rudolph, 2002 as quoted by NRC, 2007, pp. 12-13)

Science education reform efforts have seen several iterations of curriculum reform, such as *A Nation at Risk, Benchmarks for Science Literacy, The National Science Standards,* and *No Child Left Behind Act of 2001*. Each of these has attempted to increase student achievement in science, science career enrollment, and science literacy. These curriculum reforms consequently led to the implementation of state and local standards, and the establishment of standardized state assessments (NRC, p. 16). More recently, students' achievement reported on the National Assessment of Educational Progress (NAEP) and the Program for International Student Assessment (PISA) provide the steam that drives current national science and more broadly in Science, Technology, Engineering and Mathematics (STEM) curricular reform. An integral part of the recent curricular reforms calls for increased measures of achievement and inclusion of culturally and linguistically diverse students in STEM areas. As a result, science education reforms have led to the establishment of content standards and standardized assessments, and an increased inclusion of science assessment results in accountability policies (Lee & Buxton, 2010, pp. 28-29).

The Standardization of Science

Curricular reform emphasizes the standardization of science teaching and learning in elementary schools. Unfortunately, "[b]y shifting emphasis from direct encounters with natural phenomena to test preparation, high-stakes exams [have] become a major factor alienating students from science and technology and turning science education back to pre-World War II, rote-learning modes" (King, 2007). The result is a decrease in experimentation, classroom and field-based projects, field trips and other hands-on, observational experiences, if they are present at all. Textbook-based learning takes priority through a scripted science instructional approach that aims for passing rates and performance incentives on standardized assessments (King, 2007). While teaching fifth grade science, I witnessed firsthand the detrimental effects of such standardization. One byproduct of standardization was a shift from students taking responsibility for learning science via problem-based inquiry to students practicing discreet skills-based information in a rote manner.

In California and Texas, standardized science assessments are administered in fifth grade. In my teaching experience in both states, fifth grade students' limited exposure to the specific language of school science creates problems for students as they encounter the language of the standardized science assessments. These difficulties often stem from a lack of school science-based experiences in previous grades due to the strong pressure on teachers to spend time preparing students for standardized assessments in reading, writing, and math. Such a strong emphasis on standardized assessment performance causes the quality of the science curriculum to suffer and become neglected (Texas SSI, 1999). My emergent bilingual, Spanish-dominant students faced an additional layer of language comprehension difficulty. When the assessment was in English, they might not have understood the questions completely, and if the assessment was administered in Spanish[3], the unknown academic vocabulary might have been at a higher cognitive level, thereby challenging their comprehension of the tasks presented in the multiple choice test items.

In addition to language assessment difficulties, Solano-Flores & Nelson-Barber (2001) argue that standardized assessments ignore the social and cultural backgrounds of bilingual and minority students because "[c]urrent approaches in assessment give little consideration to understanding how sociocultural predispositions influence student thinking" (p. 554). Thus, linguistic and socio-cultural biases in standardized testing marginalize bilingual and minority students (Solano-Flores & Trumbull, 2003). The movement towards the standardization of the science curriculum has led to the development of accountability assessments in elementary science classrooms that limit the potential for scientific learning for students who come from diverse cultural and linguistic backgrounds. More importantly, these standardized practices erase students' funds of knowledge, cultures, and languages from the dominant science curriculum (Warren & Rosebery, 1995, p. 301).

Currently, learning science is limited to the two goals of achieving a passing rate on a state assessment or becoming a scientist. However, learning science can have major implications for individuals' lives. As noted by the National Research Council:

> Major public policy issues, such as cloning, climate change, and alternative fuels, require a scientifically informed citizenry as never before. Underrepresentation of women and

[3] According to the Texas Education Agency (2011) students are able take the 5th grade science assessment in their native language if they had not transitioned out of ELL designation, or if they have been in the U.S. for less than three years. Ultimately, the Language Proficiency Assessment Committee (LPAC) at each school makes the decision for assessment language.

> minorities in the sciences is a widely recognized problem of increasing concern amid policy debates about the adequacy of the nation's scientific and technical workforce. Yet as scientific knowledge develops and grows, as new scientific tools and technologies emerge and work their way further into civic life, there is grave concern and debates about the quality of science education. (NRC, p. 1)

Scientific knowledge and the definition of scientific literacy includes the ability to make informed decisions in our daily lives, based on scientific information (NAEP, 2006, p. 22). This concept makes it important to consider *how science is enacted in everyday classroom practices for emergent bilingual students*, because it will directly affect how students relate science to their lives within and outside of the classroom.

Language and Culture in Science Instruction

To contribute to the understanding of science learning of emergent bilingual students, "[I]t is necessary to understand the nature and practice of science in combination with language and cultural experiences of students" (Lee & Fradd, 1998, p. 15). By taking a "language as a resource stance" (Ruiz, 1984), I sought to understand how language resources were utilized in a fourth-grade bilingual classroom during science learning and teaching. Research highlighting the use of language resources is needed, especially at the elementary level, and in bilingual classrooms where content area instruction may occur in Spanish or in another heritage language. More specifically, I sought to describe the linguistic and cultural resources utilized for the teaching and learning of science *within the context of a bilingual classroom community*.

Lemke (1990) argues that, "doing science is always guided and informed by talking science" (p. xi). Understanding the talk around science in bilingual classrooms helps us explore the language scaffolding[4] that is necessary to accomplish science teaching in elementary bilingual classrooms, and to "enable all students to develop advanced literacy skills" (Colombi & Schleppegrell, 2002, p. 14). For example, adopting scientific discourse practices may assist emergent bilingual students as they learn and practice the sometimes-unfamiliar grammatical structures of scientific texts (Halliday, 2006, p. 159). Learning and adopting these scientific discourse practices in turn affect the development of scientific literacy, which can have life-changing implications for students.

Talking and learning science is accomplished within classroom communities. As Lemke writes,

> Teaching, learning, and doing science are all social processes: taught, learned, and done as members of social communities, small (like classrooms) and large. We make those communities by communication, and we communicate complex meanings primarily through language. (p. xi)

Thus, through this study I sought to understand how the talk around, and about science assisted in building a community in a fourth grade bilingual classroom as a teacher and her students taught, learned, and did science.

Co-construction of a Community of Practice

Whether students are learning a language or a content area subject in school, learning is not something that is accomplished in isolation. As Vygotsky (1978) wrote, "[H]uman learning presupposes a specific social nature and a process by which children grow into the intellectual life of those around them" (p. 88). Understanding that learning occurs through social interactions

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[4] According to Wood, Bruner, and Ross (1976) *scaffolding* is the support provided to a learner, so that the learner can successfully accomplish a task that could not be performed independently and move towards new learning.

is the basis for the concept of community of practice or CoP. According to Lave and Wenger (1991), a CoP is a "set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice" (p. 98). Additionally, Wenger (1998) defines learning as taking place through engagement with others and in turn, engagement is described as a "more encompassing process of being active participants in the *practices* of social communities and constructing *identities* in relation to these communities" (p. 4). Finally, Wenger explains that we all belong to several communities of practice simultaneously, and that our communities of practice are fluid and exist everywhere. For example, we may belong to our family CoP while at the same time belonging to our work CoP or school CoP. Because each of these will change over the course of our lives, CoPs are dynamic and overlapping.

In essence, CoP is a framework that helps facilitate thinking about learning. This framework is useful in understanding how teachers and students co-construct their particular classroom community by allowing a focus on social practices and discourse within a specific group. In the case of bilingual classrooms, students' and teachers' use of language contribute to co-construction and maintenance of classroom communities. Additionally, languages and particular ways of talking signal membership in CoP. Looking closely at the relationships "between language and the other processes going on in interaction" (Tusting, 2005, p. 42) can guide us to better understand how languages are used during the learning and teaching of science.

Significance of the study

According to the U.S. Census Bureau, with a population of 53 million, Latinos are the largest ethnic minority group in the United States. As the Latino population in the U.S. grows, the use of Spanish at home has increased 117% since 1990 to a current number of 37.6 million

U.S. residents 5 and older. This makes Spanish the second most spoken language in the U.S. with 74% of Latinos speaking Spanish at home. As the Latino population in the U.S. continues to grow and use of Spanish increases, it is imperative that the STEM fields include both language and human diversity of Latinos in public education. The National Center for Educational Statistics (NCES), reported that during the 2008-2009 school year in Texas, only 6, 639 Hispanic or Latino students received post-secondary awards in STEM fields. In contrast, 14,351 White students received such awards (2011).

A recent educational agenda report by the U.S. Department of Education and President Obama's administration (2011), outlined the educational emergency Latinos face. The report states that Latinos are the fastest growing ethnic minority, yet hold the lowest education attainment levels (p. 2). While 13 percent of Latinos have a bachelor's degree, only four percent have completed a graduate or professional degree program (p. 2). Given the current trends in STEM education reform efforts to emphasize standardized assessments, the known limitations of such measures, and the educational urgency particular to Latino students, it is important to investigate how to best engage bilingual and Latino students in order to foster their interest in STEM involvement.

This study contributes to the research on teaching science to emergent bilingual students. While the CoP framework is rarely applied to studies in elementary bilingual classrooms, this study aims to understand the language practices used in elementary bilingual classrooms to co-construct a CoP. At the same time, because science and the STEM areas are of particular interest for current educational reform efforts, this study focuses on a bilingual teacher and the implementation of practices that foster science learning for a growing population of emergent bilingual students.

Although previous educational research projects have investigated the relationship between language use and science instruction, few have applied a CoP framework within elementary bilingual classrooms using qualitative case study methods. Kelly and Bretton (2001) explored how two elementary bilingual teachers used Spanish and English in delivery of instruction. The authors found that the teachers taught either all in Spanish or in Spanish and English (with a high degree of code-switching) and successfully engaged their students with science inquiry through specific "discursive strategies" (Kelly & Bretton, p. 1). Another study by Luykx, Lee, and Edwards (2008) explored how a monolingual-English elementary teacher, assisted by his bilingual co-teacher who provided concurrent translation, taught science to 3rd graders. The authors found that a lot of the scientific discourse and content was lost as the co-teacher provided translations, which were sometimes limited or incomplete because of a variety of classroom situations. While these two research studies explored how Spanish and English were used in the teaching and learning of science, they did not specifically explore how a CoP framework can be applied to our understanding of the co-construction of classroom communities in bilingual classrooms.

This investigation extends studies like the aforementioned by focusing on understanding the co-construction of a classroom CoP within an elementary bilingual classroom, and the "implications that the acquisition of scientific literacy has upon students' academic identities as learners of science" (Reveles, 2009, p. 195). Furthermore, understanding science in the everyday classroom can help identify and acknowledge the funds of scientific knowledge[5] that emergent bilingual students bring to the classroom, which can be valuable in developing and promoting science learning and teaching. Thus, this study is relevant not only to practicing teachers, but

[5] Funds of knowledge refer to the knowledge and practices that students bring from their communities and their families (Vélez-Ibáñez & Greenberg, 1992; Moll, et al., 1995).

also to pre-service teachers, researchers, and policy makers as we continue to find ways to engage our culturally and linguistically diverse students so that they continue to seek involvement in STEM areas as relevant to their lives and experiences.

Overview

To explore the questions outlined previously, I have provided a brief view of the professional experiences that lead me to this investigation, what the theories are that inform my work, and why the questions are worthy of investigation. I contextualize my research questions using relevant literature drawing upon sociocultural learning theory in Chapter 2. The Communities of Practice framework then complements these sociocultural theories of learning in order to understand the social practices within bilingual classrooms. I then explore literature explaining how language is specifically related to communities of practice within classrooms, in particular science teaching and learning in bilingual settings. Lastly, I situate this study within previous research on science teaching and learning.

I delineate the research methodology and describe the analysis framework in Chapter 3. Because I focused on one particular fourth grade class, case study methodology was best suited for this research. I include descriptions of the study site and participants. During data analysis, I drew upon ethnography of communication for discourse analysis methods to explore and explain the talk that occurred during the teaching and learning of science in this bilingual fourth-grade classroom.

I present my findings in relation to my focus on the practices that helped foster learning and identity development within the bilingual fourth-grade science classroom CoP in Chapter 4. I organized the findings as practices that became part of this community's way of learning and teaching science. These findings illustrate the ways in which the teacher, Ms. Lucero, fostered her students' development of scientific identities by integrating literacy practices within the learning and teaching of science. These literacy practices provided a scaffold for ways of talking, writing, and reading science. I also present findings gleaned from discourse analysis, students' illustrations, and students' writing.

Finally, I present a summary of the findings and a discussion of the conclusions in Chapter 5. I discuss the ways that this study contributes to the research literature in bilingual elementary science education, and teaching practices. I include important implications for bilingual education, elementary science education, and preparation of teachers. Lastly, I disclose the limitations inherent in conducting case study research in one classroom, and present future research questions for continued study on the teaching of science in bilingual elementary classrooms.

CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Introduction

This chapter presents the theoretical frameworks and related literature that informs the research reported in this dissertation. To understand learning as a social endeavor, I begin with a discussion of the two major frameworks that applied in my work, sociocultural theory and communities of practice. I then review research on the community of practice framework in science classrooms. Lastly, I review the research literature in terms of the development of classroom practices, student identities, and the mediating tools of languages and discourses within a classroom community of practice.

Sociocultural Theory

This research is grounded in sociocultural theory, which holds central that learning occurs in social interactions and that learning is mediated by tools, such as languages and discourses. Recognizing teaching and learning as social processes helps us better understand the social relationships that develop in classrooms as well as how learning evolves through interactions between students and students and their teachers. From a sociocultural perspective, learning is a constructive activity heightened through social interactions. That is, learning is a social endeavor that involves co-constructing perspectives, concepts, and new knowledge. Additionally, sociocultural learning theory recognizes the value of experiential knowledge in the learning process.

Learning therefore becomes the process of aligning a personal "previous history" (Vygotsky, 1978, p. 84) to new academic content. The co-construction of academic knowledge is influenced by previous individual and collective experiences that are conceptualized into a new social exchange. Classroom social interactions as well as behavior, planning, remembering, and problem solving are mediated through auxiliary means such as cultural signs and tools (e.g. languages and discourses) (Moll, 1990; Siegler & Alibali, 2005). To understand classroom interactions among students and teachers, it is important to examine languages, discourses, and the cultural and social practices that influence them.

In his book, *Thought and Language,* Vygotsky (1986) stated that learning scientific concepts consists of "an acquisition of new concepts and words that will be woven into the existing texture of the child's concepts" (p. 152). Vygotsky differentiated between scientific concepts and spontaneous or everyday concepts that children bring with them from home to school. From this perspective, teachers are charged with the task of creating learning contexts where children can weave the new concepts with concepts from their lives outside of the academic space. One way to accomplish this task is by providing children with opportunities to grow from their "actual developmental level" to the "zone of proximal development" or ZPD (Vygotsky, 1978, p. 85). The zone of proximal development is the distance between what the learner can do independently (actual developmental level) and what the learner can do with the guidance of a more capable peer or adult (Vygotsky, p. 86). In a classroom, the teacher or a more capable peer, could assist the learner(s) in solving a problem or task within their ZPD.

This process of learning within the ZPD can only occur through the scaffolding of learners. Bruner (1978) defined *scaffolding* as the support given to learners to assist them in solving problems or tasks they would otherwise not be able to solve on their own. To support students in moving from the actual developmental level to their ZPD, it is necessary for teachers to scaffold, or provide guidance. Scholars have researched how teachers scaffold the teaching of science writing and reading (e.g. Holliday, Yore & Alvermann, 1994), the instructional scaffolding of inquiry science (e.g. Lee, Maerten-Rivera, Penfield, LeRoy & Secada, 2008), and linguistic and discourse scaffolding in science classrooms (e.g. Moje, Collazo, Carrillo & Marx, 2001; Lee, Lewis, Adamson, Maerten-Rivera & Secada, 2008). Common among these research projects is the role of the teacher in assisting students within the ZPD in order for students to appropriate scientific ways of thinking, writing, and talking.

Moll (1990) suggests that, "a major role of schooling is to create social contexts (zones of proximal development) for mastery of and conscious awareness in the use of cultural tools" (p. 12). Indeed, teachers are instrumental in creating classroom contexts that are conducive to learning and that enrich the learning process. In turn, learning may also be negatively affected by the social learning context (Gutiérrez, Baquedano-López, & Alvarez, 2001), which is why it is important that learning contexts promote shared "material, sociocultural, linguistic, and cognitive resources" (Gutiérrez et al., p. 124). To describe how a bilingual teacher fostered an environment (social context) where her students practiced and learned the cultural tools and signs related to science, I observed how, over the course of a school-year, a classroom community was co-constructed in and through science learning, cultural signs, and languages.

Figure 1. Community of Practice

Drawing from a sociocultural theory of learning alone to explore how the language of school science in both Spanish and English presented some limitations in relation to the specific experiences of emergent bilingual learners. I incorporated the Community of Practice framework as it provided the missing lens to more thoroughly analyze and understand how fourth grade students in a bilingual classroom learn science.

Learning as Social Activity Within and Among Communities of Practice

Learning and knowledge "are closely tied to a community's values and what is useful in that community context" (National Research Council, 2012, p. 284). To understand how learning occurs during science in bilingual classrooms, I draw on the theoretical framework of communities of practice (CoP) based on the work of Lave and Wenger (1991) and Wenger

(1998). Wenger's (1998) proposed social theory of learning intersects with sociocultural theory and is based on the following concepts:

1) Humans are social beings;

2) Knowledge is related to meaningful activity;

3) Learning comes through participation, and

4) Learning produces meaning of our environment. (Wenger, 1998, p. 4)

Wenger emphasizes that the primary focus of this social theory of learning is on "learning as social participation" (p. 4). As these four concepts intersect, it becomes evident that Wenger proposed that both learning and knowing are a result of social interactions. That is, as humans interact, we create meanings, identities, communities, and practices, and through these, the social participation becomes a "process of learning and knowing" (p. 4).

Social interactions with others are central to communities of practice (CoP). Lave and Wenger (1991) define CoP as "participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities" (p. 98). Learning is the result of participating in certain practices and appropriating particular identities within a community of practice. Wenger (1998) elaborates CoP as collective learning leading to shared practices within a "shared enterprise" (p. 45). As members of a CoP engage together in a "common endeavor" or shared enterprise, "they develop a *shared repertoire* of common resources of language, styles and routines" that expresses belonging to the group (Barton and Tusting, 2005, p. 2).

Wenger (1998) describes "practice" not only as the result of learning, but also as "the source of coherence of a community" (p. 72). Practice has three dimensions:

1) *mutual engagement* through which *membership* is achieved

2) *joint enterprise* that is negotiated by the community

3) *shared repertoire* as resources for negotiating meaning.

Mutual engagement refers to the negotiation of the meanings of actions within a community through interactions and relations. *Joint enterprise* refers to the negotiated responses of individuals within a community. *Shared repertoire* refers to the activities, symbols, or artifacts that the community has adopted as part of its practice. These "dimensions work together to determine the practice, and the practice, in turn, works to refine the dimensions" (Aguilar & Krasny, 2011, p. 219).

A CoP framework "presents a theory of learning which acknowledges networks and groups which are informal and not the same as formal structures" (Barton & Tustin, p. 3). As such, CoP framework has been used and explored in many different areas, especially in business management (e.g., Botkin, 1999) and education. In education research, several domains have embraced this theory including: online education (e.g. Allan, 2004); writing instruction (e.g., NCTE, 2011); teachers' professional development (e.g., Lieberman & Miller, 2008); and mathematics learning (e.g., Siemon, 2009). Thus, a CoP framework has been useful for describing learning in a variety of contexts, including school settings.

Wenger (1998) explains that Communities of Practice remain fluid as individuals move in and out of several CoPs throughout daily life (p. 6). These CoPs may include family, school, and work. The notion of fluidity is an important consideration when analyzing classroom communities because students and teachers move in and out of classroom, neighborhoods, and family communities daily. By examining school communities through CoP theory, we can better understand the shared practices that develop within a school campus. In the same manner, individual classrooms can be considered a CoP as students and teachers are engaged together in a common endeavor, and share established practices to access the negotiated learning outcomes within their given classroom. By focusing on the linguistic and social practices of the classroom, a CoP framework is helpful in analyzing the learning process and furthermore, how identities are negotiated within classrooms. Thus, to understand how science is constructively taught and socially learned, one needs to consider the social interactions between students and teachers during the specific time frame and within the confines of the classroom space. We must analyze how *practices*, *identity negotiation*, and *tools (language and discourses)* mediate social interactions that occur during science instructional and learning time.

Practice within a Community of Practice

Participation in a CoP introduces learners to new ways of being. By documenting participation within CoPs, researchers can better understand how learning is co-constructed within particular classroom communities. For example, Aguilar and Krasny (2011) investigated particular social practices that led to the learning of science in three after-school environmental education clubs in coastal Texas. The authors interviewed seventh and eighth grade students, and collected qualitative data to determine instantiations of the three dimensions of CoP: joint enterprise, mutual engagement, and shared repertoire. The authors found that students were able to participate in the after-school activities as they took up different roles during the meetings such as leaders or translators. Taking up these different roles, assisted the students in making learning a relevant experience. The students were also able to connect the learning to their science classrooms and communities. Aguilar and Krasny also found evidence of the three dimensions of CoP at the different school sites while also finding that the three dimensions were unique to each of the sites. For instance, some students found that engagement in the after-school club led them to better understanding of science concepts. Others felt that they were more engaged during the after-school club than in their regular science classes as a result of various opportunities for participation. The authors concluded that much of the students' science learning was carried into their communities as they built peer networks, contributed to local communities and prepared for the future.

Employing a CoP framework, Hogan and Corey (2001) researched the ways that fifth graders responded to their teacher's and the researchers' attempts to implement a culture of science based on collective ideals. The researchers discussed how the school community was the dominant CoP to which students belonged. They found that students were more interested in school-based practices that encouraged knowledge reproduction than in knowledge building, which the larger scientific community values. The researchers found that the larger scientific practices that the teacher and the researchers presented, such as conducting collaborative investigations, engaging in peer reviews, and pooling class data, conflicted with the students' school-based value of individualistic work. Thus, instead of trying to impose a larger science CoP onto a classroom, Hogan and Corey suggested that educators learn about their students' cultural and epistemic perspectives to "work toward creating learning situations that give [students] the tools of a specialized community of practice, while respecting the vitality and priorities that they bring to the cross-cultural exchange" (p. 239). In other words, it is important for educators to understand students' *identities* in relationship with their membership in other CoPs.

Identity negotiation within a Community of Practice

A sociocultural stance defines *identities* as being socially constructed through social interactions and mediated by discourse within those social interactions. Wenger (1998) defines an identity as a "lived experience of participation in specific communities. What narratives, categories, roles and positions come to mean as an experience of participation is something that must be worked in practice" (p. 151). In a CoP, identity is "the constant work of negotiating the self" through participation in social interactions (Wenger, 1998, p. 149-151). Similarly, Gee (2001) suggests that identity is contextual and changing "moment to moment in the interaction" (p. 99). The work of negotiating the self is mediated by discourse[6]; people take on different identities through shared ways of representing reality. In short, identity negotiation is fluid, a byproduct of participation within a CoP, and mediated by discourse.

In schools, students' identities are negotiated through activities and interactions, and mediated by the discourse within classroom contexts. Brickhouse and Potter (2001), for instance, sought to understand how young African-American women developed scientific identities. The researchers framed the concept of identity in terms of participation in social activities and how others interpret this participation. The researchers followed two focal students across middle and high school years and observed them in a variety of science and computer classes. Brickhouse and Potter found that the young women's identities were influenced by marginalization and participation within their science classes. As the young women constructed their "ideal student" identities, which resembled White, middle-class identities, the researchers found that the young women were more successful in their science and computer classes. For instance, the young women "seemed willing to do the work deemed appropriate for those who wanted to take on the

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[6] In this instance, discourse (little "d") is defined as "representation through language [written or text], visual, and other media" (Ivanic, 1998, p. 17).

ideal student identities of the school," such as avoiding asking critical questions, while successfully memorizing formulas and procedures (p. 975). The successful or unsuccessful development of "ideal student" identities within science and computer classes depended on the young women's social interactions; the more diverse the social interactions, the more successful the young women became in their school academics. The researchers suggested that educators find ways to help students develop the competencies necessary to move across boundaries of race, gender, and class to construct school-accepted identities, while at the same time maintain the identities that are acceptable in their home communities.

Lemke (2002) states that language "plays a major role in identity development" (p. 77). The use of more than one language results in developing bilingual identities, and identities are negotiated through participation in a particular CoP. Achugar (2009) examined how participants in a creative writing graduate program developed and negotiated bilingual professional identities within the bilingual CoP. Achugar described how classroom interactions supported participants' use of both Spanish and English to develop their professional identities within the CoP. Through the analysis of the social interactions within the classroom, the researcher was able to detail the "complex ways in which language is used to construct and maintain professional identities in contexts where participants come from varied linguistic and cultural backgrounds but share a common purpose, that of becoming creative writers" (p. 82). This particular finding is relevant to this dissertation as it supports the notion that identities are negotiated through social interactions and through language in use.

Within a science context, Wheaton and Ash (2008) explored how two bilingual, 8th grade Latina students viewed science through participation in a bilingual summer science camp. The authors reported that although the two participants were siblings and had similar life experiences, they held differing views about science. This affected their participation in the summer camp activities. Through interviews and observations of interactions in the summer camp, the authors concluded that even though the participants held different ideas about science and what science was, their bilingual identities were reinforced. Both sisters stated that they felt valued and respected and that they had acquired content knowledge in Spanish, which was important to them. Additionally, both sisters expressed that their bilingual identities were important in maintaining their positive school identities as successful students. The participants viewed their bilingual identity as a valuable resource that could bridge the gap between school and home, and home and summer camp.

Langman, Hansen-Thomas, and Bayley (2005) researched how seventh-grade, bilingual students in a monolingual English-language classroom negotiated their participation during science class. The researchers described how the science teacher generally grouped students by assigning bilingual students to small groups that would help translating for each other during the class activities. Using classroom observations, the researchers found one of the small groups to be the most successful in achieving fruitful interactions during science class. The authors observed that within this particular group, linguistic identity, in this case signaled by speaking a common language, was one of the first identities aiding the success of the group. The second identity that facilitated the success of this particular small group was a shared social identity that allowed the students to socialize successfully by talking about *novelas*, sports, and other non-science topics. Further aiding in the success of the small group was the mutual interest among the students to succeed in the class. The authors also pointed out that the group was mixed gender. The authors explained that other groups that did not share linguistic or social identities were less successful in completing their tasks or withdrew from interaction altogether. The authors concluded that sharing identities within small groups served to guide successful negotiations of participation during science class. These identities were based on having a bilingual identity, engaging with the academic task, and willingness to interact with each other.

Central to the research studies presented above that utilize a CoP framework to describe the development of students' identity is the emphasis on language and linguistic resources. In *I Am My Language*, Norma González (2001) explained, "[I]t is through and by language (and discursive practices) that selfhoods are constructed, identities forged, and social processes enacted" (p. 173). Moreover, language and linguistic resources are used to "clarify emergent understandings of [a] task and its goals, to share knowledge, to assist one another, and to shift roles in the learning process" (Gutiérrez, Baquedano-López & Alvarez, 2001, p. 125). Thus, language and linguistic resources are tools that mediate participation, negotiation of identities, and ultimately, the learning of science. These concepts are important to this study as they provide the grounding to understand how linguistic resources are used as tools for the negotiation of the students' identities within a classroom CoP.

Language as a Mediating Tool

In bilingual classrooms, "a heteroglossic community where two or more language registers are in daily contact, meanings are mediated within and between languages and language varieties" (Fránquiz & Reyes, 1998, p. 215). In addition to the challenge of learning school and science discourses (e.g., ways of talking and writing), emergent bilingual students' academic success is related to access to the majority language of schools, English. Depending on the bilingual program implemented by school districts and particular schools, bilingual students may be placed in Immersion Programs where the goal is replacing their native language with the majority English language as quickly as possible. Other bilingual programs, such as Transitional

Programs, focus on the transition of emergent bilingual students into English only classes and instruction as they move along the elementary grades. On the other hand, Dual Language Programs aim to develop students' fluency in two languages simultaneously.

Unfortunately, Immersion and Transitional Bilingual Programs often ignore the students' home languages and cultural backgrounds in an effort to "mainstream" them, or transition them into English only classes. Although students may be orally fluent in English, they may not have the academic reading and writing language skills needed to succeed in science courses, where the academic language load can be greater. For example, vocabulary and grammar patterns specific to science, as well as "learning to communicate in the language of science and act as a member of the community of people who do so," all prove challenging for students learning English as a second language (Lemke, 1990, p. 1). Additionally, segregation by language ability and tracking, inequitable school funding, shortage of highly qualified teachers, and the lack of access to quality curriculum, compound the lack of access to effective science instruction (Valenzuela, 2002).

Some researchers have tried to understand how emergent bilingual students adopt and adapt to the demands of science while learning English as a second language (e.g., Ciechanowski, 2009; Ku et al., 2009; Moje et al., 2004; Pappas et al., 2002;). Other scholars have researched the practices of pre-service and in-service teachers that work (or will work) with emergent bilingual students. However, most of the research has focused on teaching science in English to emergent bilingual students (e.g., Akerson & Flanigan, 2000; Buxton, Lee, & Santau, 2008; Hart & Lee, 2003; Lee et al., 2009; Stoddart et al., 2002). Few studies have focused on science teaching and learning while taking advantage of students' first and second language resources. One foundational work in this area is the Chèche Konnen Project by Warren, Rosebery, and Conant (1989). The authors describe the first year of implementation of the project in which the researchers collaborated with teachers in developing and implementing an investigation-based approach for science. The project was implemented in two classrooms: (a) a 7th and 8th grade classroom where science was taught in Haitian Creole, and (b) a multilingual high school classroom. The researchers showed that through the implementation of a collaborative-inquiry model in the classroom, the middle and high school students who used their first and second language resources were able to participate in more authentic ways in the practices of the scientific activity. That is, instead of using a more text-based curriculum, the teachers in both classrooms planned and implemented investigations that arose from the students' queries. These queries led the students to participate in relevant scientific activities in which they were able to use their language resources to interact with each other and make sense of the scientific activities.

Examining the use of Spanish and English linguistic resources, Hampton and Rodriguez (2001) focused on analyzing the implementation of a hands-on, inquiry science curriculum with elementary emergent bilingual students. Their research project included pre-service teachers leading the hands-on inquiry science lessons. Topics included comparing animals, growing plants, exploring air and weather, and testing foods for fats, acids and sugars. The researchers documented how the elementary students responded to the curriculum. In half of the bilingual classrooms, science instruction was in English. The researchers found that the students talked to each other in Spanish to conduct the activities and clarify questions. In the second half of the bilingual classrooms, science instruction was conducted in Spanish. In this case, the researchers found the students increased their use of Spanish academic language. Hampton and Rodriguez suggested that a "language-sensitive inquiry science curriculum" is one way to ensure academic success for emergent bilingual students (p. 433).

A more recent study by Goldberg, Welsh and Enyedy (2009) described a middle-school classroom community. The researchers paid close attention to the classroom discourse and how Spanish was used within the classroom. The authors found that the bilingual teacher in this classroom community positioned her students and herself as co-inquirers through her "teaching practices and discourse choices" (p. 125). The researchers pointed out that many of these practices and choices included the use of Spanish as the language of instruction, even though it was not a designated bilingual classroom (p. 130). Goldberg, Welsh, and Enyedy presented several examples of how both Spanish and English were positioned as "legitimate tools for students to use to help explore science concepts" (p. 131). The authors explained how the teacher responded to the students' contributions made in Spanish not by translating, but instead focusing on the science content contributed to the discussions. The researchers also found that the students used more Spanish in their small group interactions, while English was used more during whole-class interactions.

Code Switching and Translanguaging

In bilingual classrooms where two or more languages may be spoken, the movement between languages can be identified as code switching. Fránquiz and Reyes (1998) write, "[W]here there is a confluence of linguistic and sociocultural influences, language choice and movement between languages becomes not only a possibility, but a likely probability" (p. 217). Code switching, as defined by Gumperz (1982), refers to the use of two or more languages in the same utterance or conversation. Zentella (1997) writes that "[c]ode switching is, fundamentally, a conversational activity via which speakers negotiate meaning with each other, like *salsa* dancers responding smoothly to each other's intricate steps and turns" (p. 113).

Many researchers have described the functions and purposes of code switching in bilingual or multilingual settings (e.g. Poplack, 1981; Zentella, 1997). For instance, code switching can happen at the *intrasentential level*, within the same sentence, and/or at the *intersentential level,* between sentences (MacSwan, p. 323, 2013). Few researchers have studied code switching in elementary bilingual classrooms during the teaching and learning of science. Okhee Lee (2005) cites two studies, one in Kenya (Cleghron, 1992) and the other one in South Africa (Setati, Adler, Reed, & Bapoo, 2002), that highlight code switching as a resource during the teaching and learning of science. The results of both research studies point to the importance of maintaining students' first language to access science content in English. A study conducted in the U.S. by Choi and Kuipers (2004) report on middle school students participating in a hands-on inquiry-based chemistry unit. The authors collected data in a middle school science class and focused on two emergent bilingual students working together throughout the curriculum unit. The researches found that the emergent bilingual students used Spanish as they worked together to make sense of the curriculum. The researchers explained that when students did not use the official language of the classroom, English, the students were perceived as being off-task. Choi and Kuipers highlighted the students' code-switching as a strategy for interacting with each other, and understanding assignments and the teacher. The authors also pointed out that a collaborative environment allowed for greater student-to-student interactions. Thus, a hands-on inquiry-based curriculum is conducive for students to draw from their linguistic resources.

In another study Hughes, Shaunessy, Brice, Ratliff, and Alvarez (2006) show that code switching is a potential indicator of giftedness and is used by youth appropriately and strategically to manipulate and mitigate the social discontinuities between home and school cultures. These scholars contend that students who can successfully code switch are performing a complex, rule-governed linguistic act while also demonstrating a keen perception of social situations and school culture.

While there are some studies using CoP theory in science classrooms and research literature on discourse during science activities, there is a paucity of research into the linguistic practices of teacher and students in bilingual elementary classrooms during the teaching and learning of science. Understanding how a bilingual teacher and her students utilize their linguistic resources during science is an important part of this dissertation for answering the second research question: What language practices are used within and across science lessons to support the co-construction of a community of practice?

Because code switching at the utterance or sentence level is not enough to help us understand the linguistic practices within a bilingual classroom, scholars such as Hornberger (2003) and García (2009, 2010) have defined the concept of translanguaging to describe more holistic language practices in bilingual and multilingual classrooms. García (2009) defined translanguaging as "the act performed by bilinguals of accessing different linguistic features or various modes of what are described as autonomous languages, in order to maximize communicative potential" (p. 140). For example, reading a text in one language and discussing the text in a second language. For García (2010) translanguaging includes code switching, but she relates translanguaging to "practices that go beyond a simple switch of code" (p. 45). Hornberger clarifies that translanguaging is more than the "concurrent use of two languages" (p. 82). Hornberger goes on to explain that translanguaging can involve "input (reading or listening)" in one language and "output (speaking or writing)" in another language (p. 82).

Hornberger went on to explain the advantages of translanguaging within the bilingual classroom as:

1) Providing deeper and fuller understandings

2) Supporting development of literacy in both languages

3) Helping facilitate communication between schools and homes

4) Assisting students in developing second language acquisition while developing content knowledge

In this dissertation, I define code switching at the micro level and translanguaging at the macro level. Micro-level code switching occurs when mixing languages at the utterance or sentence level, while translanguaging is language mixing at the macro level practices, e.g., read in one language, discuss in the second language. Gutiérrez, Baquedano-López and Alvarez (2001) describe "hybrid" language practices in similar ways to translanguaging. Gutiérrez, et al., write, "[H]ybrid language use is more than simply code-switching as the alternation between two codes. It is more a systematic, strategic, affiliative, and sense-making process among those who share the code, as they strive to achieve intersubjectivity" (p. 128). In the context of this study, I describe these "systematic, strategic, affiliative, and sense-making" language practices as translanguaging.

Although a scarcity of research exists about translanguaging, researchers like Creese and Blackledge (2010) explored how two or more languages were used concurrently within several heritage language schools in the U.K. Heritage language schools are designed to assist "minority students reclaim their ancestral tongues" (Crawford, 2004, p. 71). The researchers presented case studies of two schools: the first, Gujarati and the second one Chinese (Mandarin). The researchers observed and recorded teacher and student interactions during classes, breaks, and assemblies. Creese and Blackledge found that teachers and students engaged in flexible bilingual practices, and making the boundaries between languages permeable. For example, when reading and discussing a traditional folktale, the students and the teachers engaged in discussions by moving back and forth between languages. That is, at one point asking questions in one language, mixing first and second languages, and then clarifying in the second language. The authors argue that the teachers and the students in their study used all of their linguistic resources to perform certain identities (e.g., challenging the teacher), and to teach and learn the heritage languages. Most of the research within bilingual classrooms related to science, however, has focused on the development of the discourse of science in one language.

Discourse of Science

Lemke (1990) relates how communities are constructed through talk and as talk happens, a shared language and vocabulary emerges within the classroom communities. Similarly, Hicks (1995) posits that language is a social construct and that meaning is socially co-constructed, and established through membership and participation. Over the course of participation in a CoP, classroom interactions follow specific structures. Once a structure is learned, it becomes a shared "discourse structure" among students and teachers within the classroom community (p. 52). Accordingly, each classroom community develops its own ways of talking science, and this talk "is constructed through locally situated, everyday social interactions" (Hicks, p. 59). The language used to teach school science "has its own unique semantic patterns, its own specific ways of making meaning" (Lemke, p. 1). The language of the classroom includes certain structures that can be found in scientific text such as "casual relationships, relationships of taxonomy, precision and objectivity, and nominalizations" (Ciechanowski, 2009, p. 562). Thus, the way that science is represented in schools becomes unique to each classroom, while at the same time, sharing certain structures with the larger scientific discourse community.

The language of a CoP may also consider language *registers*. Register refers to the ways language varies according to situations or styles of language. For example, academic language is considered a *register* differing from informal language. As students move into classroom contexts "they gradually learn to vary the language they use according to the context in which they are using it" (Gibbons, p. 48, 2009). Many studies have documented how the language *registers* (Halliday, 1985) of schools and particular communities differ (i.e. Heath, 1983; Valdés, 2001; Delpit, 2006), and that this difference in *registers* is something that must be addressed when teaching children from linguistically diverse backgrounds. That is, researchers argue that school language *registers* must be taught explicitly for linguistically diverse students to be academically successful. However, for bilingual students, *registers* become more complicated as they not only have to learn academic *registers*, but they have to learn them in more than one language. For example, Rosebery, Warren and Conant (1992) conducted a pilot study to understand the ways in which Haitian middle-school students and high-school students that spoke Haitian, Creole, Spanish, Portuguese, Amharic, Tigrinya, and Cape Verdean Creole, appropriated "scientific ways of knowing and reasoning" (p. 61). The authors reiterated notions that language mediates social interactions and that science has its own linguistic structures that may not be familiar to students who are learning English as a second language or who are new to the communities of school.

Through the Chèche Konnen pilot program implementation, students from various linguistic backgrounds investigated their own questions through collaborative inquiry (Rosebery, Warren, & Conant). The researchers found that through the collaborative inquiry in which students, teachers, and researchers participated, the students' discourse changed in such a manner as to be closer to the discourse of the larger scientific community. The authors suggest that if students are to adopt the discourse of science, the communities of practice where they are learning must support the practices and discourse of science. At the same time, Rosebery, Warren, and Conant also suggest that in order for students to accept these new ways of scientific sense making, they must learn to accommodate the "purposes and values" brought from home, along with the scientific and school communities of practice (p. 92).

Herrenkohl, Palincsar, DeWater and Kawasaki (1999) investigated how specific science discourse strategies were explicitly taught. The authors designed and implemented a classroom intervention with the goal of improving science instruction. They investigated two elementary classes, a mixed third and fourth-grade gifted and talented class, and a fifth grade class. The researchers and teachers planned a unit covering the topics of floating and sinking. The researchers pointed out that different participant structures (whole class time, small group presentations, small group investigations and writing activities), intellectual tools (predicting and theorizing, summarizing results, comparing predictions and theories to results), and procedural roles (reporters and scribes), were explicitly taught and integrated into the unit. The participant structures, intellectual tools, and procedural roles were taught through very specific scaffolding activities that helped the students develop deeper understandings about science and made the learning public through classroom charts and available to all students. Herrenkohl et al. found that through the explicit teaching of the participant structures, intellectual tools and procedural roles, the students' discursive practices evolved and they developed more complex understandings of scientific problem solving through the use of tools or strategies.

In a different study, Kelly and Breton (2001) sought to understand how discourse practices affect science learning. The authors investigated the implementation of specific discourse practices in elementary bilingual classrooms with two bilingual elementary teachers. As part of a larger longitudinal study, the researchers presented data from two fifth-grade classrooms and one third-grade classroom. Kelly and Breton found that the bilingual teachers used specific discourse practices for a variety of purposes during the teaching of science. For example, the teachers positioned the students as scientists through explicit talk to students that communicated they would engage in the work of scientists. The researchers found that common understandings were developed over time, helping establish shared meanings that were significant for this particular classroom community. The researchers concluded that access to science was built over time within the classroom community through the discursive practices established, and utilized by the students in and through participation in scientific activities. This study is particularly relevant to this dissertation in its description of elementary bilingual classrooms and analysis of the discourse practices. The authors also identified the shared classroom practices that established a particular classroom community during the teaching and learning of science, which are also relevant to this dissertation.

Finally, Enyedy and Goldberg (2004) used a CoP framework to understand discourse and classroom interactions in two middle school science classes. The two classes studied implemented an inquiry-based, environmental science curriculum. The hands-on, collaborative program engaged students, teachers and scientists in working with environmental science over a three-month period. Enyedy and Goldberg specifically looked at how the classroom communities identified the common activity and how the classroom communities negotiated interactions and participation. The researchers found teachers instrumental in framing the common activities with the classroom communities. Enyedy and Goldberg also found the ways teachers used discursive practices to position themselves as either co-inquirer or as the holder of the right answers, also affected the classroom CoP. The authors suggested that the implementation of a particular type of curriculum may not be as important as creating a supportive CoP within classrooms.

The aforementioned research studies demonstrate how particular discourse practices during the learning and teaching of science develop particular CoPs in classrooms. Moreover, the research studies illustrate that the explicit instruction of scientific discursive practices provides students different ways of being that may be congruent with larger scientific CoPs. Roth, McGinn, Woszczyna and Boutonné (1999) argue that a CoP framework must be carefully analyzed when used to describe classrooms because the notion of participation will vary among individuals. Roth et al. used a CoP framework to investigate how discourse was influenced during science class by the use of different artifacts, social configurations, and classroom arrangements. The researchers argued that artifacts, social configurations, and classroom arrangements affect participation in a classroom CoP. Because participation is influenced by different variables (artifacts, social configurations, classroom arrangements) within a classroom CoP, differing discursive practices emerge based on these changing variables. Roth et al., suggested that scientific discourse increases to the degree students are engaged. The classroom variables they investigated provided different opportunities for exploring and practicing the new discourses being learned.

The previous research studies concerned themselves with discourse practices, generally defined as ways of talking and writing, during the doing of science. By limiting the discourse strategies that were explicitly taught to certain lessons and specific curriculum interventions, the researchers ignored the concept of Discourses (Big "D"). Gee's notion of Discourses integrates "ways of talking, listening, writing, reading, acting, interacting, believing, valuing, and feeling (and using various objects, symbols, images, tools, and technologies) in the service of enacting meaningful socially situated identities and activities" (Gee, 2001, p. 719). Discourses (Big "D") can be directly related to the "tacit" and "explicit" activities that make up the practice in CoP. Herrenkohl et al. explained that the explicit teaching of certain discursive structures, such as how to ask questions during small group presentations, helped the upper-level elementary students develop greater understanding of scientific concepts. However, the successful performance of a discursive strategy during the time of the study does not imply that the students were able to apply such a strategy independently and at other times within the classroom community. Sadler (2009) directly relates the concept of CoP and Discourses by explaining that "the criterion for learning is developing increasingly sophisticated Discourses within communities of practice of interest" (p. 5). In other words, competent practice within a CoP is developed as the Discourses particular to a CoP are being acquired.

In understanding school Discourses, Moje, Collazo, Carrillo and Marx (2001) acknowledged the importance of students' and teachers' practices in shaping classroom Discourses. The authors distinguished discourses (little "d") from Discourses (Big "D") as "[a]ny stretch of language (discourse) is always embedded in a particular way of knowing (Discourse)" (p. 470). Moje et al., discussed the disconnect students may find between their home Discourses (or ways of knowing) and the Discourses of school. The researchers also explained that some students may be unprepared for the expectations of science activities based on "authenticity, sustained inquiry and collaboration" as they would involve more than listening to a lecture or copying from a book. They added that the demands of "a classroom Discourse that may be unfamiliar or even contradictory to the Discourses to which students have become accustomed" may hinder students' participation (p. 472). Moje et al., suggested drawing from students' home

Discourses to develop awareness of school Discourses through explicit teaching of the science discourse genre to construct new knowledge (p. 489). Additionally, Moje et al. noted that the Discourse of science would be a greater challenge to students who are learning English as a second language, and may need instructional scaffolding to participate in more authentic and collaborative science activities. As Schleppegrell and Colombi (2002) explained,

> Learning to use language in ways that meet the school's expectations for advanced literacy tasks is a challenge for all students, but it is especially difficult for those who have little opportunity for exposure to and use of such language outside of school. (p. 3)

Through the work of this study I sought to uncover the practices within a bilingual elementary CoP that assisted in language scaffolding, as well as the practices that assisted the students in appropriating ways of talking about science and scientific identities.

Summary

The goal of this review was to frame the study within a sociocultural theory of learning that can be viewed through a CoP perspective to analyze the social interactions during the teaching and learning of science. Thus, to understand social interactions within classroom communities, a review of research that drew upon CoP framework helped clarify the advantages and shortcomings of utilizing this framework. For example, in researching the first question of this dissertation, "How do a bilingual teacher and her students co-construct a community of practice in and through science within an elementary bilingual classroom?" it is important to understand how a CoP develops in classrooms where two or more languages are used for teaching and learning science. As Reveles (2009) writes, "taking a sociocultural perspective on [science teaching and learning] implies the need to explore the dynamic relationship between students' and teachers' language use and its connection to the everyday co-construction of scientific knowledge" (p. 196).

To answer the second question, "What languages practices are used within and across science lessons that support the co-construction of a community of practice?" I reviewed relevant research in the areas of identity development and language use. These areas helped ground this research in sociocultural theory that understands languages and identity negotiation as factors that mediate learning in social contexts. Other factors that may have an effect on science learning and teaching, such as learning particular discourses and Discourses, were also evident in my review of the literature concerning studies conducted with emergent bilingual students. Because translanguaging and code switching in bilingual elementary classrooms during the teaching and learning of science has not been the focus of researchers, the second question regarding language practices is extremely relevant as the results make an important contribution to the current research literature.

CHAPTER 3

METHODOLOGAL FRAMEWORKS AND RESEARCH DESIGN

A sociocultural framework is helpful in understanding how meaning and practices are co-constructed within classrooms. The purpose of this study was to understand how a teacher and her students in a bilingual classroom use “material and symbolic objects” (Scribner, 1990) and cultural tools, such as language, to co-construct meaning and practices during the teaching and learning of science. Furthermore, from a Communities of Practice (CoP) perspective, learning is not only understood as an inherently social endeavor, learning occurs through *participation* within a community. Thus, to understand how meaning and practices are co-constructed within a CoP, it is important to study the ways language and culture mediate such co-constructions.

Context of the Study

Reflecting my interest in bilingual education and science, I began my search for a bilingual elementary teacher who taught science in Spanish at either the fourth or fifth grade level. I chose to focus on fourth or fifth grade because I was an upper elementary teacher and my experiences would allow me to better describe the experiences in such a classroom. Many schools make decisions about language of instruction at the elementary level that affect what languages teachers use to teach many content areas because of various issues related to standardized assessments. This issue is very evident in the major urban city in the Southwest where this study took place. Even though many schools have implemented transitional bilingual programs, science is taught in English at most of those schools in the upper elementary grades. This limited the pool of teachers eligible to participate in my study. Fortunately, I was very close to a specialized Bilingual Master’s Program at a local university, and I was able to find a few teachers who had taught science in Spanish in the past. However, I found many of them had moved to a different grade level, or would be required to teach science in English the following year. Ms. Lucero[7], the teacher participant in this study, had just moved to a different school, and would be assigned as a bilingual education fourth-grade teacher. After having an informal conversation with her, Ms. Lucero told me that she would be teaching science in Spanish and agreed to participate in this research project.

Research Methodology

From a socio-constructivist stance that knowledge and meaning are socially co-constructed (Mertens, 2005), as the researcher, I sought to understand how knowledge and meaning were co-constructed in this particular bilingual fourth grade classroom during the teaching and learning of science. To do this, a qualitative research methodology was best suited because, as Denzin and Lincoln (2005) noted,

> It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. (p. 3)

Conducting educational research in elementary classrooms requires that the researcher be attentive to the complex activities and social interactions that take place. Considering the time limitations related to standardized assessment preparation in the spring semester, a true ethnography was not possible in this study. Merriam (1998) wrote that ethnographic methods or

[7] Teacher's and students' names are pseudonyms.

techniques “are the strategies researchers use to collect data” (p. 14). Ethnographic methods in educational research are useful in describing and interpreting the social interactions within classrooms. Because the goal of this study was to make the practices of a fourth-grade bilingual classroom visible so that the co-creation of a science community of practice could be understood, I utilized ethnographic strategies such as interviews, observations, discourse analysis, etc. More specifically, case study research design allowed me to learn about this particular classroom and the interactions that I sought to describe (Stake, 1995; Merriam, 1998).

Case Study

Although there are several definitions of a case study, I was guided by Merriam (1998), who described it as “an intensive, holistic description and analysis of a bounded phenomenon” (Merriam, p. xiii). In this research, I sought to describe the participant structures and interactions that made this fourth grade bilingual classroom a community of practice being co-constructed by the teacher and her fourth-grade students during the teaching and learning of science (the phenomenon) (Merriam, p. 29).

Case studies allow the researcher to “seek out both what is common and what is particular about the case [...] drawing all at once from its physical setting and those informants through whom the case can be known” (Stake, 2005, p. 447). Additionally, utilizing a case study design supported “thick descriptions” (Geertz, 1993), to clarify those descriptions, to provide interpretations, and to provide the reader with enough material to make generalizations (Stake, 1995, p. 102). In this sense, a case study design allowed me to attend to student-student interactions, student-teacher interactions, lesson plans, how classroom roles were negotiated, and classroom expectations, to name a few micro-level instances of how the community of practice was co-constructed. Through a case study design, I also considered the macro-level contexts, such as the school-wide bilingual program, which also aided in accurately framing the case study.

Research Setting

The research setting was an urban elementary school, Mesa Elementary. I define "urban" as being within city limits, deliberately moving away from the more politically charged use of "urban"[8] to define schools where minority and/or poor students attend (Watson, 2011, p. 49). In the large urban district that includes Mesa Elementary, 64% of students are identified as Economically Disadvantaged, 27.8% of students as English Language Learners (ELL), and 60.5% of students are identified as Hispanic (TEA, 2011)[9].

Mesa Elementary is situated in the southern part of a fast-growing city in Southwestern United States, rapidly changing in terms of demographics and socio-economic development, which has brought many Latinos to the area. Mesa Elementary is located at the boundary of East and West, which in this particular city, indicates ethnic and socio-economic divisions; East represents the lower socio-economic groups, while West represents the higher socio-economic groups. At Mesa Elementary, 7.8% of the student population was identified as African American, 77.8% as Hispanic, 10.2% as White, 0.5% as Native American, 1.7% as Asian, and 2.0% as Mixed Race. 79.6% of the students were identified as Economically Disadvantaged, 36.1% were identified as ELL, while 32.5% of these students were enrolled in the Bilingual/ESL Education program (TEA, 2012). The Texas Education Agency Accountability Rating System's

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[8] I clarify this term because the language we use to talk about students and schools has an impact on how students are perceived. For example, Watson, Charner-Laird, Kirkpatrick, Szczesiul, and Gordon (2006) conducted a study with novice teachers, and found that the term "urban" was fraught with deficit meanings when used to describe students.

[9] The Texas Education Agency used LEP to identify English Language Learners and Hispanic to identify Latina/o students.

latest available data ranked Mesa Elementary as Recognized in 2011[10] (TEA, 2012). This meant that Mesa Elementary, although not at the highest ranking, was a very desirable school for teachers and families. For example, there were no beginning teachers during the 2011-2012 school year, and all the teachers were highly qualified (TEA, 2012).

Mesa Elementary implemented a Spanish-English one-way dual language program in the primary grades, in which teachers utilized Spanish and English as languages of instruction on alternating days (Dual Language Training Institute [DLTI], 2013). The one-way dual language classrooms began with mostly Spanish instruction and introduced English as the students moved up to the upper grade levels. The fourth and fifth classrooms at Mesa Elementary were very different. These upper grades had two classes in fourth grade and two classes in fifth grade designated as late-exit bilingual classrooms. In late-exit bilingual classrooms or programs emergent bilingual students are "moved in stages from native-language instruction to content-based ESL to mainstream (or English Only) classes" as they move up the grades and their English proficiency improves (Crawford, 2004, p. 45). Thus, most of the instruction in the fourth grade bilingual classrooms was conducted in Spanish, while the teachers in the fifth grade bilingual classrooms would use more English during instruction to prepare students for middle school.

The district adopted the Gómez and Gómez model for dual language implementation (DLTI, 2013), which provides options for one-way dual language or two-way dual language education programs. As mentioned above, Mesa Elementary followed the one-way dual language program. One of the components of this program is the Language of the Day (LOD), which

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[10] Texas' state rankings were as follows: Exemplary (the highest ranking), Recognized, Academically Acceptable, and Academically Unacceptable (the lowest ranking). The Texas Education Agency did not rank districts and schools in 2012 and revised the ranking criteria and rating labels in 2013.

requires that schools prominently display signs coded in red for Spanish and in blue for English (DLTI, 2013). Thus, walking into the school, there would be a sign indicating what the language of the day was. I also recognized that both Spanish and English were used on all wall displays created by the school.

The school was brightly decorated and murals greeted visitors. Often, one of the walls in the main hallway would be decorated for special occasions reflecting the multiculturalism of the school. For instance, I saw Día de los Muertos altars, Thanksgiving posters, African-American History highlights, and during assessment weeks, posters encouraging the students. In various hallways, I observed posters in Spanish and English that stated the vision, the mission, and the beliefs of the school.

Research Participants

Ms. Lucero. Following *purposeful* sampling procedures to select a case that would yield rich information for this dissertation (Patton, 1990), I met Ms. Lucero through one of her professors as in a specialized Master's Program for bilingual teachers. Ms. Lucero identifies herself as Mexican-American, born and raised in Austin, Texas. At the time of the study, she had been teaching for seven years. Ms. Lucero began her teaching career as a second grade teacher, later taught fourth grade for four years, fifth grade for two years, and during the 2012-2013, when this study took place, she was teaching in fourth grade.

Throughout her teaching career, Ms. Lucero has continually participated in various professional development workshops that focused on literacy, writing, and science. Many of these workshops focused on the integration of literacy practices and science. Several professional development series were taught at the local and neighboring universities. Ms. Lucero stated that participating in the National Writing Project professional development in 2011 had a strong impact on her practice (Interview, May 2013).

During the 2012-2013 school year, there were seven fourth-grade classes at Mesa Elementary. Ms. Lucero's class was one of two designated bilingual classes in her grade level. Ms. Lucero explained that she tried to have a truly bilingual class, and she strived for all the texts and conversations to be in both languages. From initial observations, I noticed that she asked students to copy notes from the charts in both languages during science, but the students were free to choose which language to use to write their observations and their reports throughout the day, including science and language arts.

The fourth graders. In this particular fourth grade class, there were 24 students: 11 girls and 13 boys. All of the students were identified as Latina/o and their family origins included Mexico, Venezuela and Honduras. The students' English Language Development levels were identified as follows: 2 Beginning, 6 Intermediate, 9 Advanced, 6 Advanced-High, and 1 English Only (as reported by the Texas English Language Proficiency Assessment System [TELPAS] results). During my visits, I observed all students speaking Spanish at some point during the school year. A new student moved to the classroom in January, but she was not a participant in the study and none of her work is included in the findings.

Permissions

I presented the research proposal to Ms. Lucero during an individual and informal meeting with her. I explained the purpose of the study, and the following general overview of the project was explained: The classroom teacher will teach her science lessons as usual, while the principal investigator observes (videotape and voice record) the activities. After she agreed to participate, I followed up with Ms. Lucero's principal and requested permission to observe the science lessons in Ms. Lucero's fourth-grade classroom. I explained to the principal that I would be observing how languages were used during the teaching and learning of science and how the classroom community was developed during science lessons. To obtain district permission, I submitted a research proposal that included the research questions presented in this dissertation, a brief summary of the research design as a qualitative case study, and a concise description of the data analysis methods.

I also obtained students' assent to participate in this research study and I presented an overview of the project in both English and Spanish. The overview of the project was as follows: "I am here to ask for your participation in a project I'm working on for school. I attend the University of Texas at Austin and I am working on a project that is related to observing how teachers teach science to their students. I will be here to observe while your teacher teaches science to you. I will also be here while you participate in activities related to science. I will be recording with a camera in the back of the class and I will be taking pictures of your work."

Institutional Review Board permissions were obtained from the school district and the university to assure confidentiality and safety of all participants. Sample parent consent and student assent letters are included in Appendix A.

Data Collection

Fieldwork began on the first day of the 2012-2103 school year continued through the end of May, 2013. Observations took place four days per week during the Fall 2012 semester. I began observations from the very first days of school because important to get a sense of the routines and expectations that would set the tone for the rest of the school year (Emmer, Evertson, Anderson, 1980). After about a week, I started conducting observations only during the science class period. During the Spring 2013 semester I observed approximately four lessons per month. The range of the observations allowed me to get a sense of how the community of practice evolved over an extended period of time.

I used ethnographic data collection techniques that included writing field notes; recording lessons with video and audio; taking photographs of the classroom environment; collecting various artifacts (teacher's lesson plans, a variety of students' multi-modal texts, e.g., journals, illustrations, and digital products such as videos and posters); and interviewing the teacher and students. The various data sources supported the "thick descriptions" and provided depth to help with "*holistic* description and analysis characteristic of a case study" (Merriam, p. 134). Table 1 presents a matrix of the research questions outlining the data collection procedures and the timeline.

Table 1: Data collection procedures and timeline

Question #1: **How do a bilingual teacher and her students construct a community of practice in and through science within a bilingual classroom?**			
Question	*Examples*	Data to be collected	Time frame for data collection
1.1 How does the teacher promote a sense of community in the classroom?	*Classroom environment, letters to parents, student work*	• Letters to parents from teacher • Photographs of classroom environment • Interview with teacher • Interviews with students • Lesson plans	• Collection of artifacts (letters, lesson plans, photographs) – August • Interviews (students, teacher) – August
1.2 How does the teacher cultivate this sense of community through and within science lessons?	*Science lesson plans, science work samples* *Event mapping*	• Science lesson plans • Classroom discourse • Students' science notebooks • Students' work samples	• Ongoing – August until December, 4 times per week

Table 1: Data collection procedures and timeline

1.3 What specific scientific practices are constructed during science and how are they related to a larger scientific community?	*Science activities, scientific vocabulary Event mapping*	• Classroom discourse • Lesson plans • Material resources • Literature selections •	• Ongoing – August-December, 4 times per week
Question #2: **What language practices are used within and across science lessons that support the co-construction of a community of practice?**			
Question	*Examples*	Data to be collected	Time frame for data collection
2.1 How are languages used within this classroom?	*Choice of texts, classroom environment, teacher and student discourse*	• Photographs of classroom material resources • Interviews with teacher and students • Lesson plans, letters home, handouts • Materials selection	• August 2012 – May 2013
2.2 How are languages used during the teaching of science?	*Curricular choices, choice of texts, classroom environment, teacher and student discourse – all during science*	• Audio/video recording of classroom discourse • Interviews • Science lesson plans • Observations of science activities	• Classroom discourse during science time August 2012 – May 2013

Participant observation

To collect the data in a naturalistic manner, my role was that of a participant observer (Spradley, 1980). This meant that I entered the classroom with "two purposes: (1) to engage in activities appropriate to the situation and (2) to observe the activities, people, and physical aspects of the situation" (Spradley, 1980, p. 54). I took the roles of *insider* and *outsider*[11] at the same time, as well as, sometimes acting only as a participant and sometimes acting only as an observer (Spradley, p. 57). I tried to approach research with a wide-angle lens. As the teacher and the students became comfortable with my presence in the classroom, I widened my lens for examining the classroom events (Spradley, p. 55-56). As a participant, I would walk around the room asking the students questions and if needed, acted as a facilitator in small groups focusing my lens on small group interactions and talk. When conducting whole-class lessons and discussions, Ms. Lucero would ask the students to sit at the rug with her. As an observer, I would sit behind the students and I was able to observe the whole class and Ms. Lucero.

During the observations in the classroom, I kept a fieldwork journal to record condensed accounts that I expanded after the observations were completed for the day (Spradley, p. 69-71). As the school year began, I spent most of the day in the classroom during the first week of classes. I kept field notes, and audio recorded most of the classroom talk. As the second week progressed Ms. Lucero began following her daily schedule. Science was taught after recess and before lunchtime. During the second week and third week of classes, I would arrive before the class went out for recess and I would go outside with the class. After recess I would start keeping field notes and recording the science lesson. Some times, if the science lesson had to be continued after lunch I would stay. As the semester continued, I would arrive just as the students came back from recess when the science lessons began.

[11] I refer to Banks' typology of crosscultural researchers and identify myself as both, an indigenous-insider and indigenous-outsider (Banks, 1998).

Interviews

Interviews yielded information that helped me understand the teacher's and students' "cultural knowledge and beliefs, and description of practices" (LeCompte and Schensul, 1999, p. 128). That is, through interviews I was able to understand how the teacher and her students utilized their cultural knowledge, beliefs and practices to co-construct knowledge within the classroom (Ginsburg, 1997). Thus, through semi-structured interviews with the teacher and a few selected students, I acquired first hand perspectives of how teacher and students understood their classroom community. By using semi-structured interviews I asked questions to explore specific choices or practices, and asked questions that emerged from our conversations.

At the initiation of the dissertation research, an interview with the teacher provided a sense of her goals and thoughts for her science teaching in two languages. The guiding questions for the interview are included in Appendix A. I consulted with Ms. Lucero to select the students to be interviewed. I was interested in interviewing students from English and Spanish speaking backgrounds and different genders, to explore their interpretations on how their linguistic and cultural resources were recognized and utilized within the classroom community. I asked the students a few questions about the teaching and learning of science, as well as questions regarding their understanding of community and use of language during science. The guiding questions for the interviews are included in Appendix B. As the research progressed, I conducted additional unstructured interviews with the teacher to gain a better understanding of her teaching practices, her choices for materials and how she thought her students were responding. All the interviews were audio recorded and I took observational notes as needed.

Data Analysis

The data collected were coded regularly. My field notebook initially served two purposes. First, it assisted me in maintaining field notes of classroom activities. Second, I utilized my notebook to keep notes about ideas, questions, and reactions to my observations. During data analysis I used these notes to begin searching for emerging ideas, themes, and practices that I had highlighted.

I began by reading and coding field notes. For field notes and artifacts, I used *open coding* to "identify and formulate any and all ideas, themes, or issues they suggest" (Emerson, Fretz and Shaw, 1995, p. 143). For instance, one of the early themes I found was the theme of <u>building community</u>. As the school year began, Ms. Lucero and her students were involved in activities that set the tone for the rest of the year and assisted in building community. Some of these activities included reading literature related to community, such as *Quinito's neighborhood/Quinito y su vecindario* (Cumpiano & Ramirez, 1995), and establishing classroom community guidelines. Additionally, Ms. Lucero asked the students to bring a few artifacts from home to design individual exhibits for a class museum. These individual exhibits were shared with their families during Back to School Night. Creating the classroom museum was an important event in the class as it allowed the students to work closely together in the creation of the exhibits, as well as creating a sense of belonging to the classroom community. Two other larger themes that emerged from the open coding were <u>doing science</u> and <u>talking about science</u>.

As these larger themes emerged I conducted more fine-grained *focused coding* to "elaborate interesting themes…by connecting data… and by delineating subthemes and subtopics that distinguish differences and variations within the broader topic" (Emerson, Fretz & Shaw, p. 160). Within the larger theme of talking about science, some of the interrelated subthemes that emerged from the data were related to literature connections. As Ms. Lucero integrated literature with science, a lot of scientific terms were discussed. “Scientific terms” was then a subtheme that emerged, and one that I was further able to categorize into related subthemes such as science topics, and language, Spanish or English, that was used to present the scientific topics.

Related to the larger theme of doing science, the subtheme of inquiry activities emerged. Within the subtheme of inquiry activities, I was able to categorize into further subthemes hands-on activities, observational activities, and research activities. Other interrelated subthemes that emerged had to do with how the organization of the science activities. Some activities were accomplished as a whole class, some in small groups, others in pairs, and others individually.

To answer the research questions, I further categorized the themes that emerged from field notes and artifacts according to the community of practice framework. That is, I categorized the data to find out how the *practices* in this fourth grade bilingual classroom fall within its three dimensions: 1) *mutual engagement* through which *membership* was achieved; 2) *joint enterprise* that was negotiated by the community, and 3) *shared repertoire* as resources for negotiating meaning (Wenger, 1998). The questions that guided the exploration of the three dimensions of *practice* within this fourth grade CoP are presented in Table 2.

Table 2: Practice dimensions and related questions (adapted from Aguilar & Krasny, 2011)

PRACTICE DIMENSIONS	DATA
Mutual Engagement • Membership • Engagement • Participation • Roles	1. How do the students and teacher participate in science activities and discussions? 2. In what roles are the students engaged? 3. What does membership look like?
Joint Enterprise • Evolution of Practice • Purpose of Practice	1. What is the goal/purpose and common practice of the community? 2. Who initiates and/or maintains goal/purpose of practices? 3. How are goals/purposes and practices signaled or marked in the discourse?
Shared Repertoire • Tools • Language	1. What artifacts/tools/symbols/words are used to convey meaning in this community?

Discourse Analysis. Moreover, to understand the *practices* within this classroom I conducted discourse analysis, which consists of analyzing how language, either spoken or written, is used (Gee, 2011). I transcribed selected lessons from the audio and video recordings, and I read and coded each of the transcripts with the goal of identifying practices particular to this bilingual, science community. More specifically, I relied on ethnography of communication, an approach used to analyze discourse that is helpful in understanding the communicative practices and patterns of a particular community (Hymes, 1972). Hymes argues that speakers of a language in a particular community have the ability to communicate by using shared linguistic codes, rules and norms. In this sense, ethnography of communication is well suited to understand how the teacher and her students developed and learned the language patterns particular to this classroom community.

In considering Ms. Lucero's bilingual fourth-grade classroom as a "speech community" which Hymes (1972) defines as "a community sharing rules for the conduct and interpretation of speech, and rules for the interpretation of at least one linguistic variety" (p. 54), it became important to focus, not on the grammar at the utterance level, but instead on the context-appropriate use of language. Within speech communities, Hymes defines "speech situations, speech events, and speech acts" (1972). *Speech situations* are socially-contextual situations such as "activities which are in some recognizable way bounded or integral" (Hymes, p. 56). A *speech event* occurs within *speech situations* or "activities, or aspects of activities, that are directly governed by rules or norms for the use of speech" (Hymes, p. 56). A *speech act* is the individual utterance that forms the *speech situation*. In analyzing discourse, a speech act is regarded, not at the level of grammar, but rather it is regarded within the context of the utterance and the participants involved. For example, within Ms. Lucero's classroom a *speech situation* was the science period, while a *speech event* was a particular lesson on types of energy, and the talk that occurred during that *speech event* was made up of several *speech acts* or utterances.

Hymes' developed the model of the SPEAKING grid to aid in analyzing discourse. The eight components of the SPEAKING grid are:

> (S) Setting including the time and place, and physical aspects of the situation such as arrangement of furniture in the classroom; (P) participant identity, including personal characteristics such as age and sex, social status, relationship with each other; (E) ends, including the purpose of the event itself as well as the individual goals of the participants; (A) act, sequence or how speech acts are organized within a speech event and what topic/s are addressed; (K) key, or the tone and manner in which something is said or written; (I) instrumentalities, or the linguistic code [i.e. language, dialect, variety and

> channel i.e. speech or writing]; (N) norm, or the standard socio-cultural rules of interaction and interpretation; and (G) genre, or type of event such as lecture, poem, letter. (Farah, 1998, p. 126)

The SPEAKING grid was helpful in opening up the potential meanings within the fourth-grade bilingual classroom. For instance, when describing an exchange between students in a small group, it was helpful to understand the participants' identities within the group to analyze and understand particular discourse segments. By utilizing the SPEAKING grid as a guide, I was able to make the interpretation of particular *speech events* more evident in the findings section of this dissertation.

I supplemented discourse analysis with micro-ethnography techniques when appropriate. Luis Moll (1981) describes how micro ethnographic analysis can be helpful in understanding "the social organization of lessons or other educational events by describing in detail the interactional work of the participants that assemble these events" (p. 430). Furthermore, because "ethnographic microanalysis of interaction illustrates the dialectical co-construction of activity" (Collins, Palincsar, & Magnusson, 2005, p. 204), I was able to move from the fine-grain discourse analysis to understanding the larger context of the lessons *across time* which helped me answer the questions of how the community of practice was co-constructed during science activities and how languages were used within and across science lessons. Micro ethnography analysis was helpful in analyzing not only the discourse across lessons, but also artifacts such as lesson plans, students' science notebooks and work samples, and other texts (science texts, literature texts, etc.) to answer the question of how the CoP was co-constructed across time.

I did not evaluate the science discourse for content accuracy, instead, I analyzed the scientific discourse to understand what Lemke (1990) calls organizational and thematic patterns.

Organizational patterns refer to the "organization of [the] social interaction, [the] *activity structure,*" that is, how discourse is organized during a social interaction exchange (Lemke, p. 13). An example of an organizational pattern, or organization of social interactions, is the IRE model, which is a structure for questioning to elicit student information – teacher Initiation, student Response, and teacher Evaluation (Mehan, 1979). Thematic patterns refer to how words and other symbols are combined to "construct complex meanings about a particular topic" (Lemke, p. 13).

By organizing the science discourse into organizational patterns and thematic patterns and using ethnography of communication to explore how particular speech communities develop common linguistic norms, I was able to understand how discourse is a tool being used in "learning to communicate in the language of science and act as a member of the community of people who do so" (Lemke p. 1). Furthermore, discourse analysis of the science lessons permitted analysis of the social co-construction of knowledge taking place over time in and through the classroom interactions. As Saville-Troike wrote, "The ethnography of communication[…] seeks always to discover the general from the particular, and to understand the particular in terms of the general…" (2002, p. 141). In this manner, I was able to understand the commonalities that arose from the individual participants, such as language choices, and participation patterns. At the same time, I moved from the micro-analysis of speech acts to understand the co-construction of the speech community during science in the fourth grade bilingual classroom. To accomplish this, it was important to maintain a holistic approach for the analysis of the data so that the general was not emphasized over the particular or vice versa.

The process of data analysis was inductive, reflective and recursive (Merriam, 1998). "The primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data, without the restraints imposed by structured methodologies" (Thomas, 2006, p. 2). The reflective nature of data analysis was imbedded throughout the project, as I kept ongoing reflection notes throughout the entirety of the fieldwork. The recursive process of data analysis took place from the beginning of the research until the end of the research report; thus, the data analysis will be ongoing and continuous from the beginning of the project until I completed the dissertation (LeCompte & Schensul, 1999a, p. 13).

Trustworthiness

Qualitative research relies on credibility, dependability, transferability, confirmability, and authenticity of the data (Mertens, 2005). To ensure credibility I conducted member-checking with the teachers and the students when appropriate, to ensure that my understandings and interpretations were the ones intended. When appropriate, I consulted with colleagues (other doctoral students and professors) in the areas of bilingual education and elementary science instruction to help provide feedback and trustworthiness of analysis interpretation. To ensure the dependability of my study I conducted triangulation of the data to verify interpretations as much as possible. First, I collected multiple sources of data such as field notes, classroom artifacts (lesson plans, students' notebooks) and audio/video recordings. I used multiple methods to analyze the data such as discourse analysis, and micro-ethnographic analysis, making sure that the data were as holistic as possible and that the data sources provided multiple ways to corroborate interpretations (Merriam, p. 204).

To address the issue of transferability I provided detailed descriptions of the case study to ensure that my interpretations were consistent with the data collected and described, in this manner, the reader would have enough information to "determine the degree of similarity between the study and the receiving context" (Mertens, p. 256). Furthermore, to ensure that confirmability and authenticity were met, I provided detailed accounts of data collection, analysis categories, and how decisions were made throughout the research process.

Results/Interpretation

The results of this case study research are thus presented in narrative form that includes the description and analytical examples that provided results for the research questions of this case study. How these results can be applied to improve science instruction in bilingual education programs and in the field of teacher education will constitute the final chapter of this dissertation.

Chapter 4

ANALYSIS OF THE CO-CONSTRUCTION OF A COMMUNITY OF PRACTICE

This chapter presents the ways a community of practice was co-constructed in a fourth-grade bilingual classroom during science. Discourse and activity analysis make visible how the teacher, Ms. Lucero, and her students established their classroom practices in a bilingual CoP. Ms. Lucero fostered science learning and facilitated the co-construction of the CoP within this classroom by establishing opportunities for participation in activities and appropriate roles that promoted meaning-making across the science curriculum. This chapter details the discursive practices and science activities that were established from beginning of the school year. Additionally, I explore how they became part of the ways this CoP did science. As the students participated in the science activities, they had opportunities to take up identities that were related to science. This chapter also presents analyses of the ways that Ms. Lucero and her fourth-grade students capitalized on their linguistic resources during science. Although the analysis mainly focuses on the teacher's contributions to the whole-class discussions, I did not analyze the classroom discourse in terms of the quality of its scientific content. Instead, I explored the classroom interactions that created or hindered opportunities for student learning.

Establishing the Practices

From August – December 2012, the first half of the school year, the teaching and learning of science was framed by student participation in an activity known as the "Worm Investigation." This investigation was the first instance during the school year of an inquiry-oriented approach to science. The project began the second week of school (See Appendix D: Timeline of science activities during the first half of 2012-2013 school year). During the Worm

Investigation, Ms. Lucero and her students participated in literacy and science activities. These activities would serve as the foundation for practices that students would draw from throughout the year. For example, Ms. Lucero began the Worm Investigation by providing a link to literature as she read a fiction book about worms titled *Diary of a Worm* by Doreen Cronin (2003). After reading the book to the class, Ms. Lucero asked the students to write down what the facts they had learned about worms. Additionally, she asked them to separate the fiction from non-fiction information in the book.

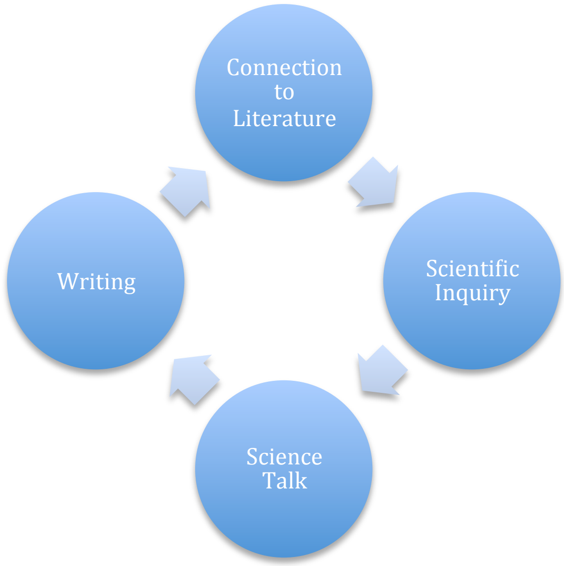
The following day, the students engaged in direct observation of earthworms and used tools (measuring tape, rulers, hand lenses) to collect data about the earthworms. Ms. Lucero asked them to record their observations. Ms. Lucero provided a laboratory sheet for students to record their observations, questions, sketches, predictions, results, and conclusions. The next day, the class came together to share their recorded observations. It was through their discussions together, that Ms. Lucero introduced new concepts such as noticing behaviors and describing the physical properties of worms.

The investigation was concluded when the students wrote a "scientific conclusion." Ms. Lucero asked that the students' scientific conclusions included any new concepts they had learned throughout the investigation. Ms. Lucero explained the purpose of writing scientific conclusions as a way for scientists to share their findings. Ms. Lucero facilitated a discussion about the types of observations the students had conducted to guide their writing. As a class, the students classified their observations into the categories: behavior, physical properties, and comparisons. Using whole-class discussions, Ms. Lucero scaffolded scientific concepts such as decomposition and observations, and scientific language such as mass and texture. After the whole-class discussion, the students wrote their scientific conclusions and were asked to include labeled sketches.

After the inquiry activity and completion of writing the scientific conclusion, Ms. Lucero integrated Language Arts by conducting a writing workshop and using science-based poetry. This particular investigation ended with the students writing poems about the earthworms. This integration between Language Arts and science mirrors what some scholars have suggested as key to improving science teaching practices and learning disciplinary literacies (e.g., Akerson & Flanigan, 2000). Additionally, the recently adopted Common Core Standards for English Language Arts advocate for content area literacy skills to be taught as an integral part of English Language Arts (NGACBP & CCSSO, 2010).

To summarize, the Worm Investigation began with connections to literature, a hands-on scientific inquiry, engagement in scientific talk, followed by writing scientific conclusions, and finally ending with further connections to literature. Figure 2 illustrates the succession of activities for this investigation and how they were interrelated and one leading to the next, going back to the integration of literature where the investigation began. This succession of activities continued throughout various units of study in science.

Figure 2. The Worm Investigation



Co-constructing the Classroom Community of Practice

Mutual Engagement

Mutual engagement is the negotiation of actions through interactions and relations within a CoP. As described previously, the class established certain practices that assisted the co-construction of the science CoP. Ms. Lucero explained that as students doing the work of scientists, they would be engaging in scientific practices together. As the students engaged together in these scientific practices, they had to negotiate their actions as they participated in small group activities. For instance, during the Energy unit (see Appendix D), the class first explored how they could light a light bulb. For the initial inquiry activity in this unit, Ms. Lucero handed out a battery, wire, and light bulb to the students and asked them to determine how to make the light bulb shine.

1054	Ms. Lucero:	Your mission today,
1055		with your table,
1056		is to use the materials in the bag

1057		to try to make
1058		light.
		(Students move from the rug to their table groups and begin to take out materials from bags)
1059	Paco:	Let me see.
		(Asking his peers to allow him to handle the materials)
1060	Lisa:	Wait.
		(Lisa takes the materials out of the bag and starts connecting cable to the battery)
1061	Paco:	OK, Let me see.
1062		Let me try.
1063	Lisa:	This
1064		and then this over here.
		(Lisa connects one side of the cable to one side of the battery and tries to connect the other end of the cable to the other end of the battery)
1065	Paco:	Yeah, but it won't fit in there.
1066		Let me see.
1067	Lisa:	Wait.
		(Still trying to connect the cables by herself)
1068	Paco:	Let me…
		(Lisa and Claudia continue exploring with how to connect the cables and the light bulb)
1069	Paco:	Let me see.
1070		Let me try.
1071		Let me try.
		(Lisa hands the materials to Paco)
1072	Paco:	I don't know how to do this thing.
		(Connecting the cable to the battery and holding the light bulb, but the light bulb did not light)
1073	Lisa:	Maybe this goes over here.
		(Grabbing one end of the cable)
1074		Come on!
1075		Connect it!
		(Telling Paco to connect the other end of the cable to the battery)
1076	Claudia:	No, nothing.
		(Observing Lisa and Paco)
1077	Lisa:	It's getting hot!
1078	Ms. Lucero:	Is it?
1079		I wonder why?
1080	Claudia:	Really?
1081	Lisa:	Yes!
		(Claudia touches the cable)
1082	Lisa:	¡Te dije!

This exchange provides an example of how participation within small groups was negotiated. In this instance, Lisa took charge of the materials for her group and Claudia assisted her. At the same time, Paco was interested in handling the materials and trying to connect the cable to the battery and the light bulb. He tried early on to participate when he saw the girls taking out the materials and saying, “Let me see” (line 1059). However, Lisa was not persuaded; subsequently, Claudia became an observer when Lisa tried to connect all three objects by herself (lines 1063 and 1064). Lisa eventually handed the materials to Paco, but he became frustrated rather quickly (line 1072), and Lisa pressured him (lines 1074 and 1075). Paco then assisted Lisa to hold the cable and light bulb, while Claudia continued to observe. Lisa maintained the lead in her group as she discovered that the cable was becoming hot and exclaimed, “It’s getting hot!” (line 1077).

As legitimate peripheral participants within this science CoP, the students’ negotiated their participation within their small group. When Lisa took the lead, she departed from many stereotypes about girls doing science, especially when “[science] classes are dominated by boys who tend to take charge, manipulate the equipment, and leave [the girls] to play the role of scribe” (Brickhouse et al., p. 441). Lisa quickly took charge of the materials to decide who would have a turn handling the materials and the timing for taking turns (line 1060). In telling Paco to wait (lines 1060, 1067), she established her identity as the leader of the group, and she confirmed her identity as a girl who is confident in her abilities to do science work.

Grammatical analysis of this exchange reveals that as Ms. Lucero handed out the small bag containing the materials, she did not refer to them by name (line 1056). The students in this small group began their inquiry by handling the materials, and they used object pronouns (e.g. line 1063) and demonstrative pronouns (e.g. line 1064) to describe the objects. For example, as

Lisa tried to assist Paco in connecting the cable to the battery, she explained "Maybe this goes over here" (line 1073). Lisa was referring to one end of the cable connected to one end of the battery. In line 1072 Paco explained his frustration in not being able to light the light bulb, "I don't know how to do this thing." As Lisa and Paco held the cable to the battery Lisa noticed that the cable was heating up. She said, "It's getting hot!" (line 1077) maintaining the use of pronouns to refer to the materials they were working with. As the students continued working, they continued with the same pattern of pronoun use. When another small group was able to light their light bulb, they shared their new knowledge with other small groups.

In their exchanges, Lisa, Paco, and Claudia demonstrated they were still novices through their use of indexical statements and expressed doubt as to how to connect the cable, the battery and the light bulb (line 1072). As novices who were unsure of the technical vocabulary, the students referred to the objects as "it" and "this." Additionally, Paco expressed his frustration by saying he did not know how to do "this thing" (line 1072).

Another example of how Ms. Lucero and her students engaged together in meaning making included shared readings. These shared readings occurred around informational or scientific texts that helped the students acquire scientific information. When the class began their Light investigations, Ms. Lucero assigned an informational text in Spanish as homework. The text was related to colors and vision, and as the class came together to discuss it, the students shared in pairs what they learned from the reading and also what they already knew from the reading. Ms. Lucero asked the class to read the text aloud in unison. Ms. Lucero sensed a teachable moment when she asked the class to re-read two sentences about what types of animals can see colors as humans do.

1612 Ms. Lucero: Let's read it together, right here from "los perros."

1613	Class reads:	"Los perros, gatos, ratones, conejos, y muchos otros lo ven todo en blanco y negro o gris. Los animales que tienen colores vistosos, casi siempre ven los colores."
1614	Ms. Lucero:	OK.
1615		¿Qué significa la palabra colores vistosos?
1616	Students:	(several students talking at the same time)
1617	Ms. Lucero:	Algo con la vista
1618		¿por qué?
1618	Rafael:	Porque algunos animales ven como,
1619		como…
1620		no me acuerdo, como…
1622	Ms. Lucero:	Vamos a ver, a ver si hay pistas.
		(Directs class to read in unison to try to find context clues)
1623		Right here.
1624	Class reads:	"Los animales que tienen colores vistosos casi siempre ven los colores."
1625	Ms. Lucero:	You have a clue already?
1626	Johnny:	Casi siempre ven los colores.
1627	Ms. Lucero:	Casi siempre ven los colores.
1628		OK.
		Ms. Lucero recognizes Juan.
1629	Juan:	(8s)… the colors, they could see the colors
1630		and they could see the same thing.

Ms. Lucero gave directions to the class to read together in English (line 1612), and the class then read the text in Spanish aloud in unison (line 1613). This was an instance where translanguaging was used to move between two languages (Spanish and English), and two modalities of language (reading and speaking). As discussed in Chapter 2, translanguaging refers to the use of bilingual discourse practices, and it focuses on the linguistic practices that can help "mediate understanding, co-construct and construct meaning… and to show knowledge" (García, 2009a, p. 34). Ms. Lucero then asked a question in Spanish to check for students' understanding of the words "*colores vistosos*/bright colors" (line 1615). After this question, the class engaged in a discussion that moved between Spanish and English in trying to understand what *colores vistosos* meant. In line 1617, Ms. Lucero restated the students' answers and agreed that it has to do with "*la vista*/eyesight." To guide the students on how to search for context clues, Ms. Lucero said, "*Vamos a ver, a ver si hay pistas*/Let's see, let's see if there are clues" (line 1622). She then pointed to the sentence and told the class where to start reading aloud with her (1624). Ms. Lucero asked the class if they had an idea of what *colores vistosos* meant (line 1625). This question, "You have a clue already?" (line 1625) is noteworthy because it followed the reading aloud of the Spanish text and it was followed by Johnny's response in Line 1626 in Spanish, "*casi siempre ven los colores*/they almost always see colors." This exchange and move between modalities – speaking, reading, speaking – is another notable example of how the practice of translanguaging became part of the repertoire within this fourth grade CoP to talk about science.

As the students struggled to understand context clues and the meaning of *colores vistosos*, Ms. Lucero asked the class to continue reading to try to find more context clues.

1640	Ms. Lucero:	OK.
1641		So let's figure out what it means.
1642		¿Qué es un color vistoso?
1643		Let's keep reading.
1644	Class reads:	Este es el caso de las aves, las mariposas, serpientes,
1645		lagartos y otros reptiles, así como las abejas y muchos
1646		peces.
1647	Ms. Lucero:	Si estos son los animales que tienen esos colores
1648		vistosos,
1649		¿qué tienen en común?

Ms. Lucero strategically modeled the application of reading strategies with informational text. By asking her students to try to "figure out" what the words meant (line 1641), and by telling them to keep reading (line 1643), Ms. Lucero signaled to her students that clues within the text would assist them in understanding the term "*colores vistosos*." This literacy strategy applied to an informational text during science modeled reading strategies are transportable into different content areas. Furthermore, Ms. Lucero modeled strategies that the fourth graders will need when encountering more difficult science texts that include more specialized vocabulary and higher content density. Cervetti, Jaynes, and Hiebert (2009) suggest that an approach in which "reading skills and strategies are taught and learned in a context that supports the development of disciplinary knowledge and skills with high level of integrity" (p. 93) will assist students in developing deep scientific understandings. In this manner, Ms. Lucero supported her students in *reading to learn* about science.

Although, when guiding students to comprehend scientific texts, Ms. Lucero used the IRE[12] pattern (lines 1625-1628), once the students began discussing the coloring of birds, butterflies, snakes, alligators, reptiles, bees and fish, she did not evaluate some answers by restating the students' answers or by saying "O.K." Instead, Ms. Lucero followed students' answers with another question, for instance:

1659	Ms. Lucero:	They are not talking about animals.
1660		Right here. (pointing to the text)
1661		Colores vistosos.
1662		Cuando dicen vistoso estánn hablando de los colores, no de los animales necesariamente.
1663		¿De qué color son estos animales?
1664		[reading from the text] Aves, mariposas, serpientes, lagartos, reptiles, abejas peces.
1665	Francisco:	Oh, reptiles can be yellow, green, black.
1666	Students:	(several students calling out)
1667	Ms. Lucero:	What about mariposas, butterflies?
1668	Students:	(several students calling out)
1669	Ms. Lucero:	So what did you notice when I said, "What colors are they?"

As Ms. Lucero initiated a question (line 1663), the students called out the answers (lines 1665) and she followed with another question, "What about mariposas, butterflies?" (line 1667). Ms. Lucero began an IRI – Initiation, Response, and Initiation – pattern, and this pattern continued as the students answered the question about butterflies (line 1668). Ms. Lucero asked a

[12] IRE model – teacher Initiation, student Response, and teacher Evaluation (Mehan, 1979) – a structure for questioning to elicit student information.

question to establish the commonality among the coloring of the animals mentioned, “So what did you notice when I said, ‘What colors are they?’” (line 1669). This IRI pattern helped the fourth graders make the connections among the animals and their bright colors, thus helping them understand what “*colores vistosos*” means. Furthermore, as Ms. Lucero and her students moved from reading the text in Spanish (line 1644), to talking about animals’ colors in English (lines 1665 and 1668), they demonstrated that the practice of translanguaging was an important tool to share understandings around reading to learn and scientific talk.

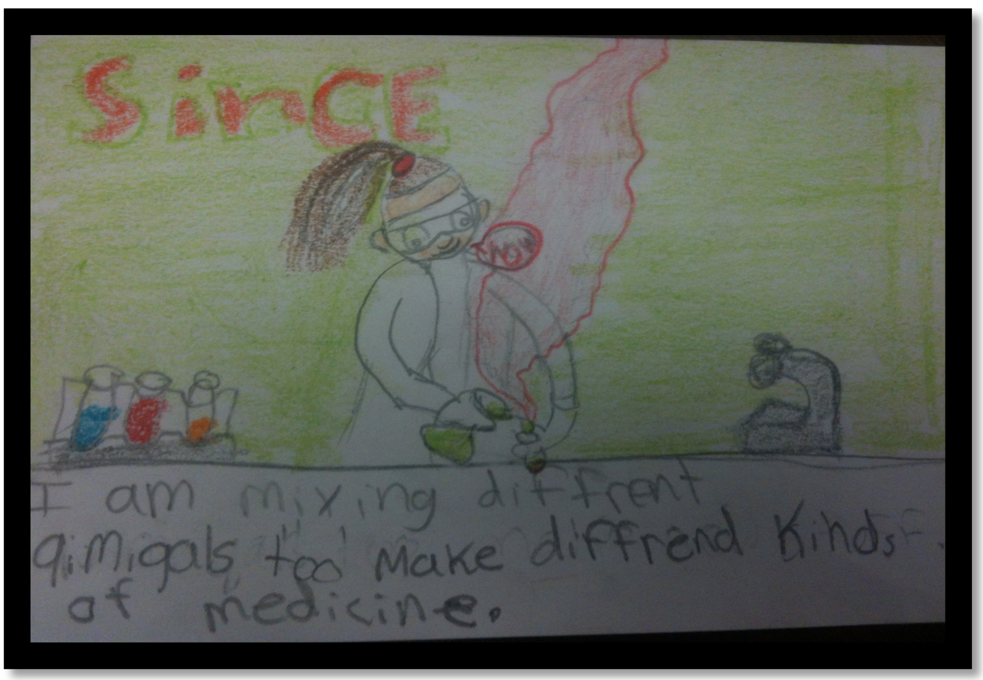
An important component of the excerpt above, is the use of scientific technical vocabulary. Fang and Schleppegrell (2008) distinguish two types of scientific technical vocabulary, “specific words unique to science and everyday words with technical meanings” (pp. 21-22). These two types of technical vocabulary are challenging because the first type are not words that students would encounter on a daily basis out of the context of science class. The second type of everyday words with technical meanings are also challenging as students may encounter the same word within different content area contexts. In the case of “*colores vistosos*” the technical vocabulary falls under the “everyday words with technical meanings” as both words could be encountered in different contexts. However, the students were not familiar with the word “*vistosos”* and although they could relate the word to visual recognition of colors (e.g., line 1618), they could not relate the term to the reading stating that brightly colored animals can usually see bright colors. For bilingual students learning science in two languages like the students in Ms. Lucero’s class, learning these technical words adds another layer to the challenge of learning the scientific discourse. Ms. Lucero integrated all these layers through translanguaging and her students followed her lead. Through translanguaging, these bilingual fourth graders made sense of scientific technical terms by capitalizing on their linguistic resources.

Ms. Lucero continued to provide guidance for the students to read with strategies and purpose. Moreover, she modeled questioning while reading an informational text to find meaning through context clues. She pushed her students' thinking to make the connection between the coloring of certain animals and their ability to see color. As shown through the excerpts discussed above translanguaging demonstrated Ms. Lucero's and her students' ease in moving between linguistic resources for reading and oral communication. In other words, Ms. Lucero and her students engaged in translanguaging for different modes of communication: reading and speaking through the use of a scientific text. Additionally, translanguaging aided Ms. Lucero in scaffolding her students' thinking so that they would comprehend technical vocabulary in Spanish, such as *colores vistosos*.

Joint Enterprise

Joint enterprise within a CoP refers to the engagement in a common endeavor. In general, the fourth-grade class was engaged in the common endeavor of learning science. However, analysis of science events revealed how this joint enterprise was accomplished. One of the artifacts that were adopted early in the school year was the scientist illustration. At the beginning of the school year, Ms. Lucero asked the students to illustrate themselves doing the work of a scientist. Figure 2 demonstrates how one student in particular, Rosa, perceived herself as a scientist, doing the work of a scientist. In this activity, students were provided the opportunity to visualize themselves as active participants in the discipline of science. In her drawing, Rosa explained how she is mixing chemicals to make different kinds of medicine. She drew herself at the center of scientific activity. At the top of her drawing she wrote "Since [*sic*]", an approximation of the spelling of the word science. At the bottom of the drawing she wrote, “I am mixing different qimiqals too make diffrend kinds of medicine [*sic*].” She included laboratory equipment such as test tubes, flasks, and a microscope. Rosa drew goggles on herself and illustrated what could happen during a chemical reaction by drawing smoke and labeling it as “Hot.” Rosa drew herself with a ponytail, wearing a lab coat, and speaking English. She utilized her knowledge of English phonetics to spell words such as “qimiqals [*sic*]” and “diffrend [*sic*].” Although she did not use standard spelling, the meaning of her sentence is not obscured. In her illustration, Rosa is interpreting and doing science, and appropriating the identity of a scientist.

Figure 2. Rosa as a scientist



This activity, known as the Draw A Scientist Test (DAST) (Chambers, 1983) is used to investigate students’ images of a scientist through drawings. When Rosa and her peers took up the activity of drawing themselves as scientists they generally demonstrated a positive relationship with science. Most of the students identified particular activities they thought they would engage in as scientists: these included mixing chemicals, investigating germs, animals and plants, observing insects, and making/constructing robots and trampolines (See Appendix E). Almost all students drew themselves alone, mirroring stereotypes that are held in popular culture about scientists working in isolation. Traditionally the DAST asks students to draw a scientist, however, Ms. Lucero asked her students to draw themselves as scientists. This departure from presenting the students with more traditional illustrations of scientists as White men with crazy white hair may have contributed to the positive self-identifications with science as visible in student illustrations. Appendix E shows that eighteen students described themselves in the first-person. For instance, Lalo wrote, "*Aqui soy un cientifico investigando un germene* [*sic*]/Here I am a scientist investigating germs." In this sense, the students envisioned themselves as doing the work of scientists.

Reveles (2009) found that third-grade students who illustrated a scientist held some stereotypical images of scientists: working alone, handling lab equipment, and scientist as male. In contrast to Reveles' findings, the students in Ms. Lucero's fourth grade bilingual class drew themselves as scientists participating in scientific activity. Although Reveles interpreted that some of the lab and safety equipment included in the third-graders' illustrations as stereotypical images, I argue that the bilingual fourth-graders brought their previous experiences related to school-based science. In the case of my study, six students in the class drew themselves wearing goggles, glasses and/or gloves and lab coats demonstrating their knowledge of lab safety, which is one of the standards taught in the elementary school science curriculum in Texas (e.g., TEKS[13] 3.1A, 3.4B[14]). In their illustrations, the fourth-grade bilingual students demonstrated their past experiences learning about science tools and equipment, expressing knowledge of another

[13] I will reference the science TEKS unless otherwise noted. Texas Essential Knowledge and Skills (TEKS) are the "state standards for what students should know and be able to do" (TEA, website).
[14] TEKS 3.1A: demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations, including observing a schoolyard habitat.
TEKS 3.4B: use safety equipment as appropriate, including safety goggles and gloves.

standard to be taught in Texas. Half of the students illustrated themselves handling laboratory equipment such as test tubes, flasks, microscopes or hand lenses (e.g., TEKS 3.4A[15]).

The students' writing evidenced that they identified themselves as scientists, indicating their appropriation of the Discourse of science. As discussed in Chapter 2, Gee (1990) described Discourses as a "sort of 'identity kit' which comes complete with the appropriate costume and instructions on how to act, talk, and often write, so as to take on particular social role that others will recognize" (p. 142). The illustrations and grammatical choices to place themselves at the center of the scientific activity, grounded most of the students in Ms. Lucero's class in their identities as scientists. In other words, they were appropriating the Discourse of science as they illustrated themselves in science labs, wearing a lab coat, or placing themselves as active participants in science. However, one particular student, Laura, did not identify herself or illustrate herself as doing the work of a scientist. Laura's identity kit at the beginning of the school year did not include the particular role of a student who actively participates in science. Instead, she self-identified as a good student paying attention to the Ms. Lucero because the teacher was talking about science. Figure 4 demonstrates how Laura drew herself sitting at her desk, listening to her teacher.

[15] TEKS 3.4A: collect, record, and analyze information using tools, including microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, wind vanes, rain gauges, pan balances, graduated cylinders, beakers, spring scales, hot plates, meter sticks, compasses, magnets, collecting nets, notebooks, sound recorders, and Sun, Earth, and Moon system models; timing devices, including clocks and stopwatches; and materials to support observation of habitats of organisms such as terrariums and aquariums.

Figure 4. Laura as a scientist

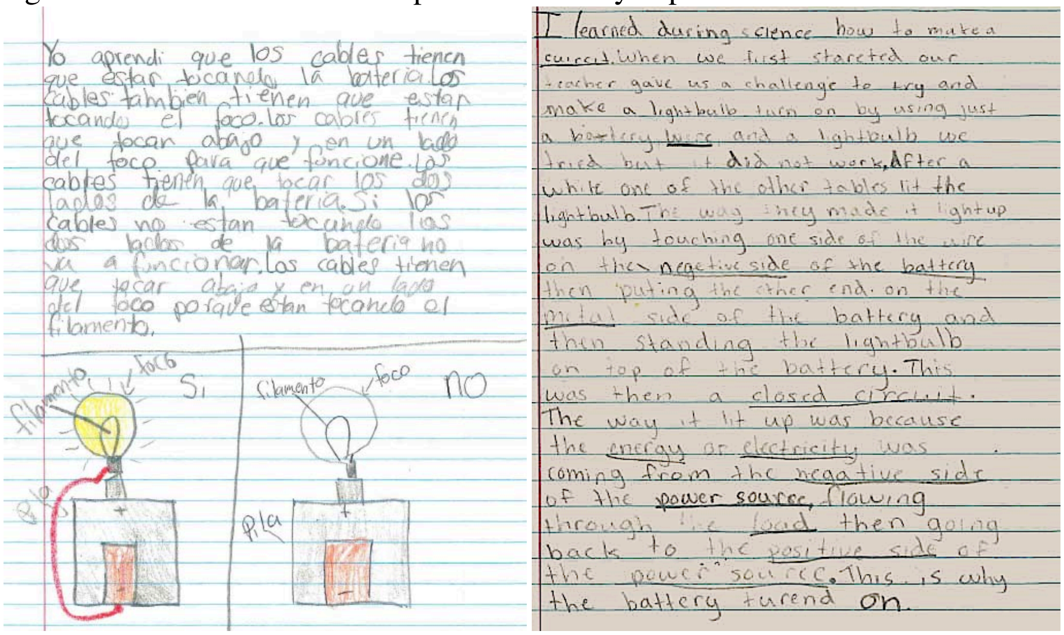
Laura wrote, "*Estoy poniendo atencion a la maestre porque esta hablado de sciencias* [*sic*]/I am paying attention to my teacher because she is talking about science." As may be the case in some science classrooms, being a good student that pays attention when the teacher is talking is one of the valued identities by teachers and schools (Brickhouse, Lowery & Schultz, 2000). Additionally, Laura's drawing reflects how she thought of herself as a good science student, by listening attentively to the teacher as opposed to actively participating in science inquiry. Brickhouse, et al. described how girls' engagement in science depends largely on how the girls view their identities "and whether or not they are the kind of person who engages in science" (p. 441). Although all four focal students in the Brickhouse study expressed they were good at science, the teachers only recognized one student as fitting the "good student identity" – quiet, attentive, organized – for the Honors track. In this same manner, Laura's illustration of herself sitting and paying attention demonstrates that her "good student identity" had perhaps been recognized as successful in science.

Early in the school year, another practice that fostered the joint enterprise of learning science was established through the Worm Investigation. Ms. Lucero and her students established the practice of writing to share learning. In this classroom, sharing the results of investigations became an important part of how the CoP did science. For instance, during the Worm Investigation, before the students made direct observations of the worms the class brainstormed facts (nonfiction) about worms. As the students shared their ideas, Ms. Lucero charted the students' contributions. When it was time to transition to the inquiry activity, Ms. Lucero stated:

> This is not all we know about worms. *Ustedes tienen cosas en sus papeles que yo no he escrito y está bien. Los científicos comparten todo y después podemos compartir más.*/You have more things on your paper that I have not written and that's fine. Scientists share everything, and later on we can share more. (Transcript, 9-13-12)

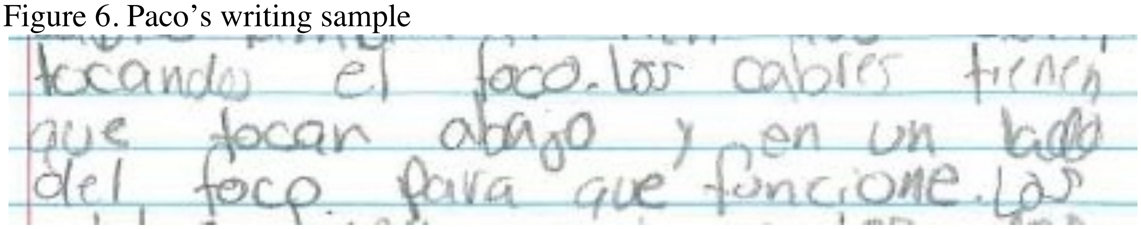
The practice of sharing information via observational notes and illustrations within the classroom science CoP continued throughout different units. The practices of sharing observations and learning with others were fostered through various inquiry activities, for instance, Ms. Lucero asked her students to write scientific responses to summarize their observations. The students were asked to include "evidence from the investigation" to support their response and "appropriate scientific vocabulary" (Criteria for Scientific Response, 10.29.12). Two samples of Scientific Responses are presented in Figure 5; one in Spanish and one in English. These samples were written at the conclusion of the Battery Investigation in which the students explored different circuit configurations to light a light bulb.

Figure 5. Students' scientific responses to battery experiment



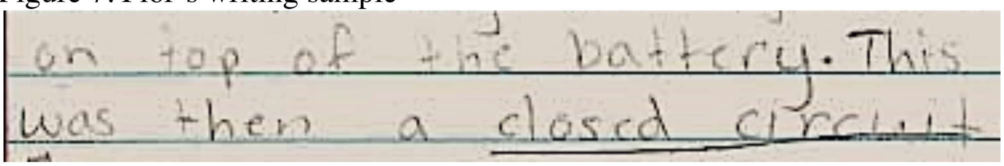
These two samples demonstrate students' appropriation of scientific talk in Spanish and English. Paco, the author of the Spanish sample wrote, "*Los cables tienen que tocar abajo y en un lado del foco para que funcione*/The cables have to touch the bottom and the side of the light bulb for it to work." Paco explained how he noticed that to make the light bulb light, one cable has to touch the side of the light bulb's metal base, and the other cable has to touch the bottom of the light bulb's metal base to make sure the circuit is complete. Figure 6 shows that Paco did not use indexical statements to refer to the cable, the battery and the light bulb.

Figure 6. Paco's writing sample



Flor authored the English sample in Figure 6 and also demonstrated her understanding of circuits and her emerging appropriation of the scientific talk introduced during the whole-class discussions and readings. Figure 7 presents Flor's writing demonstrating how she underlined key terms throughout her writing signaling to her readers that she was capable of integrating scientific vocabulary. Flor explained how connecting a wire, battery, and light bulb completed a closed circuit, “This was then a closed circuit,” demonstrating her emerging appropriation of scientific concepts and talk.

Figure 7. Flor’s writing sample

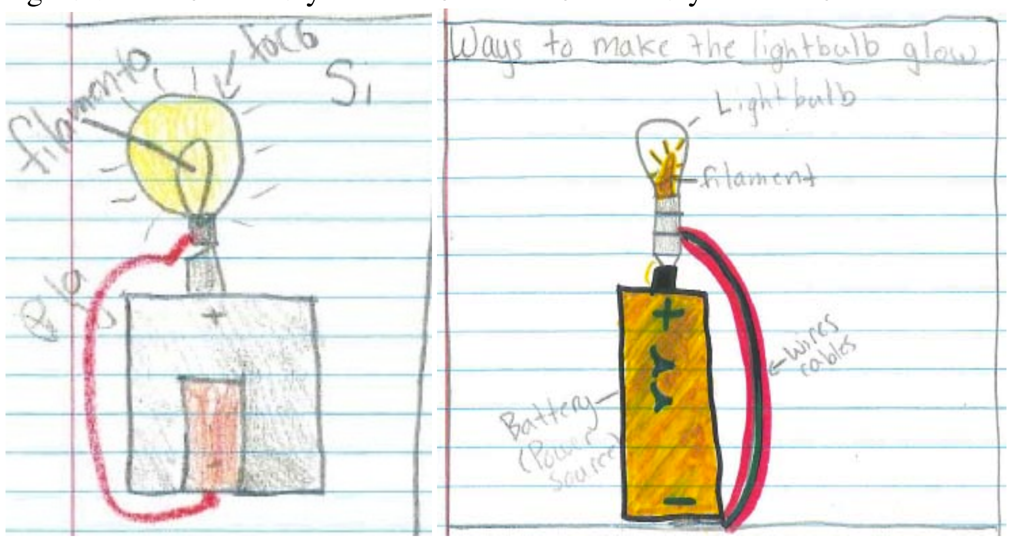


The visual representations of their observations supported their scientific responses and further demonstrate Paco’s and Flor’s understanding of circuits. Paco demonstrated his understanding of the battery circuit through his illustration. Figure 8 represents his understanding as he carefully drew a cable touching one side of the light bulb and the bottom of the light bulb touching the positive side of the battery. Additionally, Paco carefully labeled the filament inside the light bulb, reminding his readers that the placement of the cable and the light bulb on top of the battery is such because the energy has to flow through the light bulb’s filament. Paco’s drawing also demonstrated his fluency with a different type of mode of scientific text, diagrams (Lemke, 2002). Paco drew a detailed diagram that not only expressed his understandings of circuits, but also his understanding of the scientific genre (Lemke, 2002). Paco’s diagram was clear and labeled, mirroring labeled diagrams that are often included in science informational texts such as research reports (Lemke, 1998).

Flor’s diagram demonstrated her fluency with labeled diagrams. Her diagram is very clear and it illustrates how to connect a wire, battery, and light bulb to make the light bulb shine.

Flor also included a title for her diagram, “Ways to make the lightbulb glow,” mirroring the presentation of diagrams in informational texts that include a title and labeled components.

Figure 8 – Paco’s battery illustration and Flor’s battery illustration



The fourth graders’ scientific responses represented their understandings in two modalities, writing and diagrams. Additionally, the students’ multimodal texts signaled emerging understandings of, and fluency in the scientific genre, as they mirrored the practices of the larger scientific CoP. Airey and Linder (2009) argue that for students to “experience disciplinary ways of knowing[,] they need to become fluent in a critical combination of modes” within the particular discipline (p. 43). Together, the writing and the diagrams represent the fourth graders’ holistic understanding of circuits. Of course, these understandings were demonstrated at a novice level, but nonetheless important for the students’ development of scientific knowledge and perspectives.

The practice of writing to share learning and knowledge within this bilingual fourth-grade science CoP was established early in the fall semester as Ms. Lucero explained to the students that scientists observe and share their findings. The practice of sharing knowledge individually through writing, in small and whole groups served two purposes within this CoP. Sharing was accomplished through informal talk without the accuracy of scientific terms as well as through whole-class discussions where Ms. Lucero scaffolded content and introduced specific scientific terms in Spanish and English. The fourth-grade students also shared their understandings and observations by authoring multimodal texts.

Being aware of the multimodal nature of science representation, Ms. Lucero asked students to write their scientific conclusions integrating various ways to represent their learning. Hand, Alvermann, Gee, Guzzetti, Norris, Phillips, Prain and Yore (2003) identify two approaches to writing in science. The first approach they explain deals with learning how to reproduce the discourse of the larger science CoP. The second approach they describe as writing to communicate in various settings and making connections among various CoP. Hand et al., suggest merging both approaches through a multimodal representation of science that includes writing. In this same manner, Ms. Lucero prepared her students to meet the demands of scientific texts' various genres by asking them to reproduce the discourse of the larger science CoP while at the same time, utilizing a multimodal representation to communicate findings.

Shared Repertoire

Shared repertoire refers to the common resources such as language or artifacts that are adopted as part of the CoP. Initiating science inquiry activities through children's literature within this fourth grade bilingual CoP became an established practiced. Examples of literacy integration were seen in incorporating the book, *Diary of a Worm* during the Worm Investigation and opening discussions about what scientists do by reading *The Day-Glo Brothers: The True Story of Bob and Joe Switzer's Bright Ideas and Brand-New Colors*. Later on in the semester, the practice of literature integration continued and was eventually taken up by the students as they contributed literacy connections to the science content being shared in the classroom.

Intertextual connections

During the energy unit, the class viewed a short video about nuclear energy. As the class was discussing nuclear energy and bombs, the following exchange took place:

1912	Ms. Lucero:	I am going to give you an example
1913		of when nuclear energy was used
1914		that we have learned in class.
1915	Sts:	Oh! Oh!
		(students raising their hands)
1916	Ms. Lucero:	What are you thinking about?
1917		You tell the class.
		(pointing to Damian)
1918		Which bomb have we learned about?
1919	Damian:	The one in *Sylvia and Aki*!

As the class discussed nuclear energy Ms. Lucero drew on the students' recent discussions in language arts after they read *Sylvia and Aki* (Conkling, 2011). Through the story of eight-year olds Sylvia Mendez and Aki Munemitsu, the author relates the case of Mendez vs. Westminster (1947) that ultimately ended school segregation of Mexican-American children in California schools. Sylvia's story is intertwined with Aki's story, as Sylvia's family leased Aki's family farm when Aki's family was sent to a Japanese internment camp. During the course of the story the U.S. dropped the nuclear bombs in Hiroshima and Nagasaki. As the class read the book, they engaged in discussions about how the bombs affected the people in Japan, as well as the effects of the news on the Japanese internees in the United States. This historic-fiction literature book allowed students to make a connection between nuclear energy and the nuclear bombs they had read about in the book (line 1919).

As the short video continued and presented information about the process of breaking up uranium atoms, the students found another connection to a literary text they were reading in class.

1925	Ms. Lucero:	What kind of energy do we get from there?

1926	St:	Heat
1927	Ms. Lucero:	Heat.
1928		Calor.
		(plays video)
1929	Video:	La energía calorífica convierte el agua en vapor.
1930	Ms. Lucero:	(pauses video) Oh! So then what happens?
1931	Sts:	Se convierte en vapor.
1932	Ms. Lucero:	Causa cambios en la materia
1933		¿verdad?
1934	Video:	El vapor hace girar las turbinas de los generadores que producen electricidad.
1935	Ms. Lucero:	(pauses video) Hm.
1936	Carlos:	Oh!
1937		It's
1938		el que está en el de *City of Ember*.
1939	Ms. Lucero:	Yeah!
1940		Good connection.
1941		So they have a generator in the *City of Ember*.
1942		También tienen un generador.

During the lesson, Ms. Lucero reviewed other types of energy the class had studied in previous weeks (line 1925-1927). In lines 1927 and 1928, Ms. Lucero provided the terms for heat in English and Spanish. In reviewing information that had been covered before in class, Ms. Lucero asked what happens to water as it is heated (line 1930). In line 1931 the students responded that it changes into vapor. Ms. Lucero rephrased the students' contribution by stating, "*Causa cambios en la materia ¿verdad?*/It causes changes in matter, right?" (lines 1932-1933). This strategic rephrasing served to reinforce the concept that heat causes changes in matter, or water in this case.

When the narrator in the video stated that water vapor turns the generators' turbines, Ms. Lucero paused the video and said, "Hm," (line 1935) inviting students' contributions. One student was able to immediately make the connection to *The City of Ember* (DuPrau, 2003). In this story, an underground city is running out of supplies and depends on a huge electrical generator that is also failing. Ms. Lucero chose to read this fictional book during Language Arts and became a complement to the class' study of energy during science. Carlos, upon listening to the words "*generadores*/generators" (line 1934) was able to make the connection directly to the book and contributed, "Oh! It's… *el que está en el de* city of Ember/the one that's in the city of Ember" (lines 1936-1938). Ms. Lucero recognized Carlos' contribution (lines 1939-1940) and to reinforce the concept of generator in Spanish, restated "*También tienen un generador*/They also have a generator" (line 1942).

Through these connections, the students were able to situate the science concepts they were learning within a context that made sense for them. These connections between literature and science made by students were *intertextual connections*. An intertextual connection, as defined by Bloome and Egan-Robertson (2004), "must be interactionally recognized, be acknowledged, and have social significance" (p. 17). In the case of the excerpts above, the intertextual connections were proposed, recognized, and acknowledged by other members of the CoP, and had social significance. For instance, Ms. Lucero invited the intertextual connections by asking the students for an example of nuclear energy they had previously read about. The students demonstrated they recognized the connections by raising their hands to offer contributions. Ms. Lucero then acknowledged the connections by prompting Damian, "You tell the class" (line 1917). The social significance in this exchange is reflected in the way Damian acted, taking on the role of knowledge authority as recognized by Ms. Lucero. These intertextual connections contributed to the development of a classroom community, reflecting the social nature of intertextuality and became an important part of the practices of doing science within this CoP.

Varelas, Pappas and Rife (2005) documented intertextual connections that contributed to children's acquisition of science and literacy. Varelas et al., explained that intertextual connections are ways in which teachers and students "attempt to build common knowledge as a community" and that they allow for students and teachers "to make sense of ideas, develop understandings, and further expand and elaborate them" (p. 141). In this same way, Ms. Lucero used the opportunities afforded through the intertextual connections to expand and elaborate understandings about matter and energy. Intertextual connections also assisted in the co-construction of the CoP by establishing common knowledge as Ms. Lucero and her students integrated literature and science.

Reformulating Discourse

When the fourth-grade class began the exploration of mixtures and solutions, the students made lemonade using water and a powder-based lemonade mix. After reviewing the differences between mixtures and solutions, Ms. Lucero asked the class to make observations about the lemonade solution that the fourth graders had left on Petri dishes a few days earlier. Ms. Lucero brought the Petri dish to the document camera to project the image on the screen for the whole class to see.

809	Ms. Lucero:	¿Cómo…
810		a comparación del principio y el final,
811		¿Cómo ha cambiado
812		el polvo de la limonada?
813		Talk to your partner.
814		(Students talk in pairs)
815	Ms. Lucero:	Look at your diagrams of the lemonade,
816		How is it different from this? (pointing to the Petri dish)
		(Students talk for about 30 seconds)
817	Ms. Lucero:	Fernando,
818		What happened?
819		What did you notice?
820	Fernando:	The water dried up.
821	Ms. Lucero:	The water dried?
822		OK.
823		In scientific terms,
824		how would you say
825		the water dried?

826		El agua se secó,
827		¿Cómo lo digo de una manera científica?
828	Danny:	The water evaporated.
829	Mark:	The water evaporated.

In the excerpt above, Ms. Lucero asked the students to compare how the lemonade powder mix had changed since they made the lemonade solution (lines 809-812). As the students were sharing their observations in pairs, Ms. Lucero directed them to use the diagrams they had drawn when making the lemonade to compare the before and after (lines 815-816). In line 817, Ms. Lucero asked Fernando to explain what he noticed about the lemonade mix. In line 820, Fernando answered that he noticed the water "had dried up." Ms. Lucero restated Fernando's answer (line 821), and pushed the students for a more scientific term, asking them, "*¿Cómo lo digo de una manera científica?*/How do I say it in a scientific manner?" (line 827). Ms. Lucero signaled to her students that to talk about their observations, they could refine their descriptions by using more scientific terminology; thus, she was orienting the students to move from an informal discourse to a more precise way to describe scientific concepts.

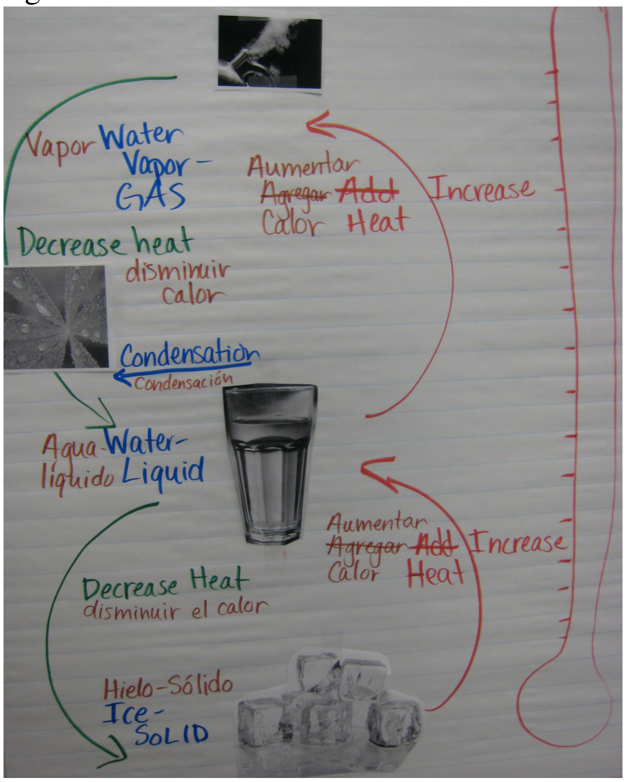
When the students stated that the water had evaporated from the lemonade mix, Ms. Lucero asked the students to recall information that had previously been covered in class when learning about states of matter (see Appendix D).

830	Ms. Lucero:	El agua se evaporó.
831		What caused the water to evaporate?
832	Students:	The sun!
833	Ms. Lucero:	We didn't leave it in the sun.
834	Students:	The condensation!
835		Heat energy!
836	Ms. Lucero:	OK.
837		I'm hearing condensation,
838		I'm hearing heat energy.
839		What caused this evaporation?
840		Talk with your partner.

(Students talk for about 30 seconds)

In line 830, Ms. Lucero restated Danny's and Fernando's answers (lines 828-829) in Spanish, *"El agua se evaporó."* Following this, Ms. Lucero asked the students what had caused the water evaporation (line 831). As several students started calling out answers about the sun (line 832), condensation (line 834), and heat energy (line 835), Ms. Lucero realized that although this information had been covered previously in class during the states of matter unit, the students were still not clear about what caused the water to evaporate in this particular case. To clarify how water changes states, Ms. Lucero quickly revisited a chart that the class had previously discussed. This time, Ms. Lucero added a thermometer, as shown in Figure 9. As Ms. Lucero talked about how water changed from solid to liquid state, she asked her students how that happened. Having the thermometer on the chart aided the students in understanding that a change in temperature was needed for water to change states. Ms. Lucero, with the assistance of her students, wrote on the chart, "*Agregar Calor*/Add Heat" (Figure 9). However, as the class talked about "*Disminuir Calor*/Decrease Heat" (Figure 9), Ms. Lucero stated to the class that a better word for "adding" would be "*aumentar*/increase." As seen on Figure 9, Ms. Lucero crossed out the words "*agregar*/add" and wrote instead "*aumentar*/increase." Ms. Lucero signaled to her students how language can be reformulated to be more precise and more subject-specific.

Figure 9. States of water



Translating. In the discussion above Ms. Lucero strategically translated some terms. For example, at first Ms. Lucero asked, “In scientific terms, how would you say the water dried?” (lines 823-825). Ms. Lucero translated immediately after (lines 826-827to make sure the whole class understood her question. Ms. Lucero translated again to make sure that the whole class understood Danny and Fernando’s answers when she translated, *“El agua se evaporó”* (line 830). In this discussion, Ms. Lucero utilized translation for the purpose of restating information and translating it for the benefit of the whole class. Additionally, another function of the translations above can be considered in terms of reinforcing scientific terms in Spanish, such as “*evaporó*/evaporated” (line 830).

Thematic patterns. Thematic patterns refer to how words and other symbols are combined to “construct complex meanings about a particular topic” (Lemke, p. 13). The excerpt relating to the lemonade solution presented a unique challenge for the fourth-graders as the concepts were not related in a traditionally taxonomic relationship. According to Halliday (1989/2006) taxonomies are typically either “superordination”: a is a kind of b; or “composition”: c is part of d (p. 164). In this case, neither the superordination nor the composition taxonomic relationship between the concepts was clear for the students. The concepts’ relationships may be illustrated as follows:

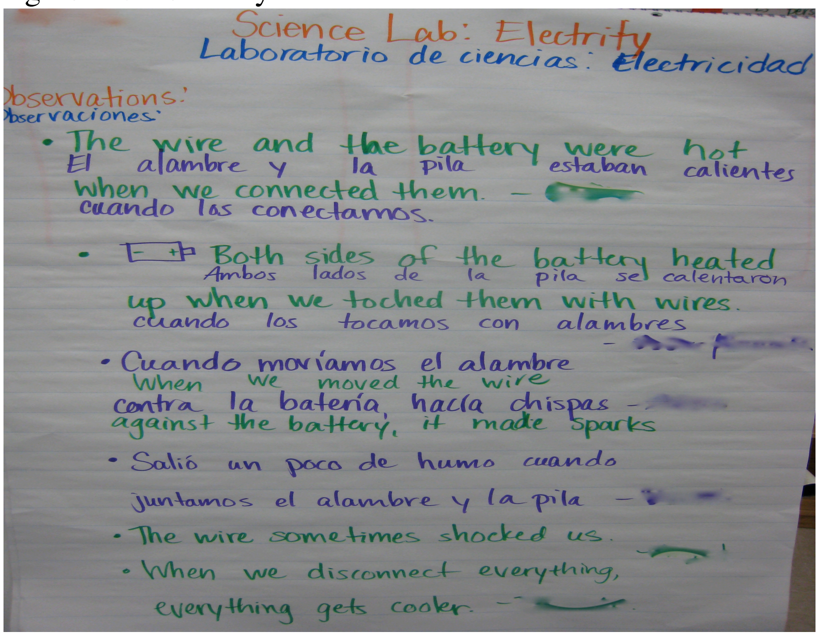
Solutions → Some solutions can be separated through evaporation
→ States of matter

As the students were learning about mixtures and solutions, they had to recall that evaporation is related to states of matter, and in particular, that water evaporation necessitates a change in temperature. Finally, the fourth-graders had to incorporate these concepts to their observations of water evaporation in the lemonade mixture that lead to the separation of the solution. Ms. Lucero facilitated this level of complexity when she guided the students back to the chart (see Figure 9) to clarify abstract ideas such as how a change in the state of water would affect the separation of the lemonade solution.

Scientific Language

After the inquiry activity of trying to make a light shine, the class discussed their observations as a whole group. Through this discussion, Ms. Lucero began the work of scaffolding concepts and academic language. For example, as one student, Lola, described that “things were hot” (Transcript, 10.23.12), Ms. Lucero rephrased her answer and asked “Do you mean the wire and the battery?” (Transcript, 10.23.12). As Ms. Lucero recorded the students’ contributions to the discussion, she continued to rephrase and rename the students’ contributions. In this manner, she guided her students to refine their science vocabulary by moving away from using indexical statements to name the materials and observations. Figure 10 presents the chart that the class created after the hands-on activity.

Figure 10. Electricity chart



Through this whole-group discussion, Ms. Lucero continued to foster the practice of “sharing observations as scientists do” (Ms Lucero, Transcript, 10.23.12). Additionally, the chart also represents how Ms. Lucero recorded the science talk, by giving both Spanish and English equal status. This became an essential practice within this fourth grade classroom, as I will discuss later in this chapter.

On the following days after the first exploration with the battery, the students had an opportunity to work with additional wires, a light bulb and battery to determine what would be the best way to make the light bulb shine. Ms. Lucero also presented non-fictional texts (e.g., *Usar la electricidad*, [Royston, 2006]) during the course of the unit to support the students’ understanding of batteries, circuits, and electric energy.

Utilizing linguistic resources. To help her students make important connections among science concepts, Ms. Lucero used Spanish and English in various pedagogical ways. Through the use of both language resources, Ms. Lucero was able to clarify concepts and increase understanding by favoring the use of her and her students' linguistic repertoires. Ms. Lucero often moved between Spanish and English strategically to help students further understand a specific question or concept. One instance of note occurred during the reading whole-group reading of a short text related to electrical circuits. The class read the following segment in English: "Electrical circuits have a source of power and a closed path." After the class read this sentence together, Ms. Lucero checked for understanding by using Spanish to assist her students in connecting concepts:

1103	Ms. Lucero:	What was the source of power
1104		that we just talked about?
1105	Lalo:	Potential energy.
1106	Ms. Lucero:	Potential energy.
1107		But what is it called
1108		in this case?
1109		What is our power source?
		(Students struggle to answer)
1109	Ms. Lucero:	¿De dónde saca la energía para prenderse el foco?
1110	José:	Circuito.
1111	Ms. Lucero:	Does it come from the wires?
1112	Students:	The battery!
1113	Ms. Lucero:	The battery.
1114		So, the battery has what kind of energy inside?
1115	Students:	Potential.
1116	Ms. Lucero:	Why is it potential?
		(Several students talking at the same time)
1117	Ms. Lucero:	Está almacenada la energía, no se está saliendo,
1118		hasta que
1119		lo conectan ¿verdad?
1120		So the source of power
1121		that they are talking about is what?
1122	Students:	Power.
1123	Ms. Lucero:	We just talked about it.
1124	Students:	[inaudible]
1125	Ms. Lucero:	What has potential energy?
1126	Students:	The battery! (in unison)
1127	Ms. Lucero:	So what are they talking about when they say

1128		"the source of power"?
1129	Students:	The battery!

When Ms. Lucero checked for comprehension (lines 1103 and 1104), she asked the students to identify the source of energy for the circuit, which they had just read about. In line 1105, Lalo, did not provide an answer to Ms. Lucero's question, but he successfully marked old information by answering "Potential energy" (line 1105). Responding to Lalo's answer (line 1106), Ms. Lucero asked again for the students to identify the source of energy (line 1109). The class continued to struggle. As Ms. Lucero paused for an answer, she noticed that the fourth graders did not understand the question. Ms. Lucero shifted to Spanish and asked, "*¿De dónde saca la energía para prenderse el foco*?/Where does the light bulb get the energy to light up?" (line 1109). Ms. Lucero's shift to Spanish was not a direct translation of the first question she had posed, but it was a question that came from the students' experience in connecting the battery, wire and light bulb.

Following Ms. Lucero's move to Spanish, José answered "*Circuito*!/Circuit!" (line 1110). In noticing that stating the question in Spanish still did not help the students make the connection, she shifted back to English and asked, "Does it come from the wires?" (line 1111). Making the connection between potential energy, the circuit and the battery, several students answered, "The battery!" (line 1112).

Once the students identified the battery as the source of energy for lighting the bulb, Ms. Lucero returned to the Lalo's previous contribution (line 1105) to strengthen the connection between potential energy and the battery. She did this in line 1114 by asking what kind of energy was stored in the battery, and in line 1116 when she asked the students why they thought it was potential energy. These questions were used to check for understanding. When the students started calling out answers, they did so in Spanish and Ms. Lucero summarized their contributions in Spanish, "*Está almacenada la energía, no se está saliendo, hasta que lo conectan, ¿verdad*?/It is stored energy, it is not leaving until it is connected, right?" (lines 1117-1119). Returning now to the original question, Ms. Lucero asked, "So the source of power they are talking about is what?" (lines 1120-1121).

Ms. Lucero's fluid moves between Spanish and English in lines 1117-1121 summarize students' answers, to check for understanding, and to recall the students' previous answer to the original question, "What was the source of power that we just talked about?" However, the fourth graders did not comprehend the question, and answered "Power" (line 1122). As Ms. Lucero understood the students' confusion, she asked, "What has potential energy?" (line 1125) and the students were able to answer, "The battery!" (line 1126). Ms. Lucero asked the original question again, "What is the source of power?" (lines 1127- 1128) and the students were finally able to make the connection to the battery as the source of power for the circuit (line 1129).

Translanguaging. In the excerpt discussed above, Ms. Lucero used translanguaging to mediate the fourth graders' comprehension of informational text. For instance, when she realized that her students could not name the power source from the reading, she asked *"¿De dónde saca la energía para prenderse el foco?"* (line 1109) referencing the previous inquiry activities. When the students recalled what they had learned about potential energy, Ms. Lucero summarized their answers in Spanish (line 1117-1119) and then asked the original question (lines 1120-1121) in English.

At the utterance level, the moves between Spanish and English are considered code switches. However, in considering the exchange holistically, I observed Ms. Lucero use translanguaging to help her students in making connections between the concepts of potential energy, source of energy, and circuits. For example, at the beginning of the exchange, Ms. Lucero asked what the source of power was referenced in the reading,

> 1103 Ms. Lucero: What was the source of power
> 1104 that we just talked about?

Because the informational text was in English, Ms. Lucero followed the text's language. Upon noticing that the students may not have understood the question, she rephrased it in Spanish,

> 1109 Ms. Lucero: ¿De dónde saca la energía para prenderse el foco?

Later on, as the fourth graders began to make the connections between the concepts of circuits and source of power, Ms. Lucero restated the question,

> 1117 Ms. Lucero: Está almacenada la energía, no se está saliendo,
> 1118 hasta que
> 1119 lo conectan ¿verdad?
> 1120 So the source of power
> 1121 that they are talking about is what?

In lines 1117-1121 Ms. Lucero's shifts between Spanish and English rephrase the students' contributions to connect the students' responses to the question posed about a power source. In other words, translanguaging helped mediate the fourth graders' understandings of the relationships between circuits, batteries, and light bulbs. Williams (2002) writes, "[T]ranslanguaging entails using one language to reinforce the other to increase understanding and to augment the pupil's ability in both languages'' (as cited in Lewis, Jones, & Baker, 2012, p. 644). In this sense, Ms. Lucero's translanguaging was a strategic move to guide her students' understandings of the concepts and the informational text.

The fourth graders also engaged in translanguaging to try to make sense of the reading and Ms. Lucero's questions. The reading was in English, and as they tried to make sense of the connections between the science concepts, and as the students responded to a topic they had already studied, potential energy, they moved to Spanish. When Ms. Lucero asked the students to recall old information, "Why is it potential?" (line 1116), the students answered in Spanish and, because they already knew what potential energy was, several students answered at the same time. Ms. Lucero picked up on this, and maintained Spanish when summarizing their answers (lines 1117-1119). As the fourth graders translanguaged to mark old information (i.e. line 1110), they did so to try to understand the connections between the scientific concepts and the meaning of Ms. Lucero's initial question. García and Kleifgen (2010) explained translanguaging as bilingual practices that "go beyond a simple switch of code, such as when bilingual students read in one language and then take notes, write, or discuss in another" (p. 45). As shown in the excerpt above, Ms. Lucero and her fourth graders engaged in translanguaging as they read an informational text in English and made sense of the reading in both Spanish and English.

Organizational and thematic patterns. Further analysis of this excerpt highlights the organizational and thematic patterns (Lemke, 1990). Organizational patterns refer to the "organization of [the] social interaction, [the] *activity structure,*" that is, how discourse is organized during a social interaction exchange (Lemke, p. 13). An example of an organizational pattern, or organization of social interactions, is the IRE model – teacher Initiation, student Response, and teacher Evaluation (Mehan, 1979) – which is a structure for questioning to elicit student information. In the previous excerpt, Ms. Lucero used the IRE pattern to help the students make sense and understand the informational text they were reading.

The previous excerpt follows the IRE <u>organizational pattern</u> of questioning where the teacher asked a question, the students responded, and the teacher evaluated the responses. Ms. Lucero's use of the IRE pattern supported the fourth graders' comprehension of a science text and assisted them in making connections among the concepts related to electrical circuits. For example, in lines 1103-1104, Ms. Lucero initiated the question, in line 1105 Lalo responded, and in line 1106, Ms. Lucero evaluated the response as being somewhat correct when she restated Lalo's answer: "Potential energy". However, Ms. Lucero continued her questions signaling that it was not the correct answer by saying, "but what is it called in this case?" (lines 1107-1108). This IRE pattern continues as Ms. Lucero transitions to Spanish to help the students connect the concept of potential energy to the battery as an energy source in line 1109. José provided his response in 1110, and Ms. Lucero asked in line 1111, "Does it come from the wires?" evaluating the students' response as incorrect. Ms. Lucero ended the exchange by continuing the IRE pattern in line 1126, and the fourth graders responded in line 1127, "The battery!" The IRE pattern was repeated as the class finished reading the science text, and assisted the students in their understanding that circuits have an energy source, which in this particular case was a battery.

In the excerpt above, the thematic pattern began when Ms. Lucero asked where the energy in a circuit comes from. The students remembered that they had already discussed the concept potential energy. Finally they responded with that knowledge in line 1105 and in line 1115, by saying that potential energy was stored in the battery. Ms. Lucero signaled the thematic pattern as the concepts of energy, potential energy, circuits and batteries were discussed. This relationship can be notated as:

BATTERY → ENERGY →POTENTIAL ENERGY →CIRCUIT

Even though Ms. Lucero did not make this relationship explicit, she successfully marked old information as she asked the students, "So, the battery has what kind of energy inside?" (line 1114), indicating that the "thematic item" of potential energy had been reviewed before (Lemke, p. 34). As the students recalled prior knowledge, they struggled to transfer that knowledge to an abstract context as presented in the informational text. However, with Ms. Lucero's guidance, the students signaled that they knew how to talk about energy as Lalo answered in line 1105, "Potential energy," and José answered in line 1110, "*Circuito*/Circuit," which were two terms the class had discussed after the inquiry activity of how to light a light bulb with a wire and a battery.

As shown in the analysis of the excerpt above, through their shared readings and whole class discussions, the fourth graders were "learning to communicate in the language of [school] science and act as member[s] of the community of people who do so" (Lemke p. 1). The previous excerpt demonstrates how Ms. Lucero and her fourth graders took up the practice of translanguaging to mark previously learned concepts and vocabulary, as well as to make sense of the connections among those concepts. Additionally, by using the IRE organizational pattern, Ms. Lucero was able to guide her students' comprehension of a scientific text that was related to the thematic pattern of energy.

The shared repertoire in this bilingual fourth-grade classroom developed over time and included several practices that became part of the CoP. First, talking about science utilized Spanish and English linguistic resources to participate in inquiry activities and conversations about science. Secondly, translanguaging, by both Ms. Lucero and the fourth-graders, was a practice that assisted in the sense making of scientific concepts and relationships. Thirdly, talking about science meant learning to refine/reformulate informal discourse towards a scientific discourse. Finally, talking about science meant working together within the CoP to engage in learning and doing science.

Larger Scientific Community of Practice

The appropriation of scientific identities continued throughout the semester as students engaged in discussions and inquiry practices that required doing the work of scientists. Ms. Lucero planned lessons that facilitated the development of scientific identities such as making observations, inquiring, researching and taking notes. One example of the way Ms. Lucero structured science instruction occurred at the beginning of the school year. Ms. Lucero introduced the book *The Day-Glo Brothers: The True Story of Bob and Joe Switzer's Bright Ideas and Brand-New Colors* (Barton & Persiani, 2009), which presented the story of two brothers who discovered daylight fluorescent paint or Day-Glo, mostly by accident. Before reading the book, Ms. Lucero shared a PowerPoint presentation with the students that introduced tools the brothers used as they tinkered with different hobbies and interests that led them to discover and develop Day-Glo colors. "What do scientists do?" was the question posed by Ms. Lucero to her students. During the reading of the book, Ms. Lucero took notes with the students about the practices depicted in the book. She also asked whether the practices were part of the larger scientific CoP. As they discussed what the Glo-brothers did in the story, the students helped Ms. Lucero brainstorm ideas about what scientists do.

During the discussion about what the Day-Glo brothers did and how their practices related to the larger scientific community, Ms. Lucero asked her students how the brothers noticed that certain colors would glow when they shined a black light:

511	Ms. Lucero:	They did this
512		kind of by accident right?
513		Did they mean
514		to shine it
515		and make something glow?
516	Sts:	No!
517	Ms. Lucero:	No,
518		but

519		did they notice it?
520	Sts:	Yes. (only about three students answered)
521	Ms. Lucero:	¿No lo notaron?
522	Sts:	Yes!
523	Ms. Lucero:	Yeah they were looking at it.
524		So scientists do this all the time.
525		We do this all the time.
526		We look at things.
527		Does anybody know the scientific word for looking at things?
528	Sts:	Observation, observe.
529	Ms. Lucero:	Observing.
530		So we need to add
531		that scientists
532		all make observations.

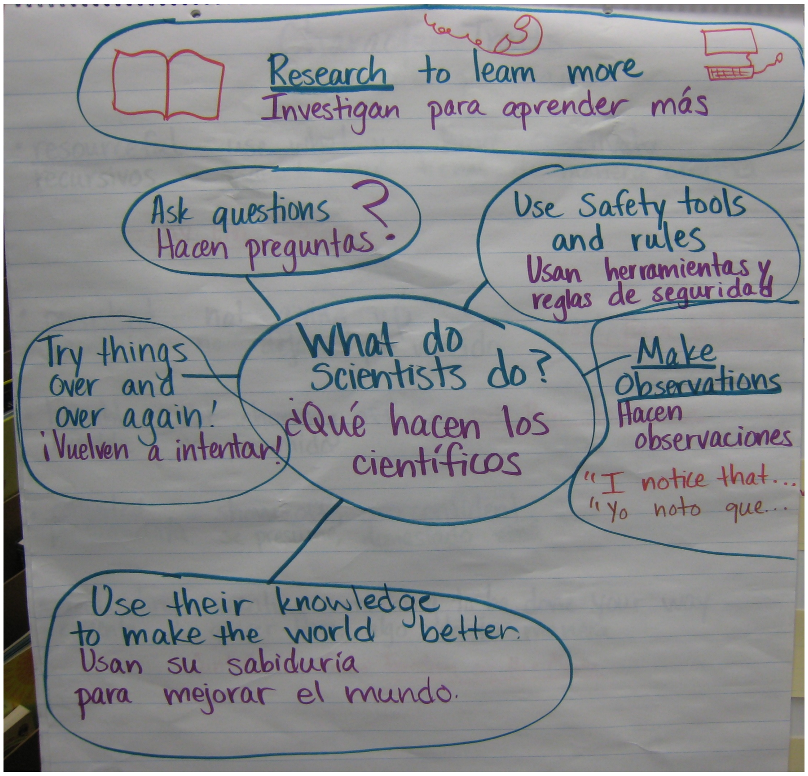
(Ms. Lucero writes on chart) [See Figure 11]

As Ms. Lucero asked the students how the brothers came upon their discovery of fluorescent colors, she checked the students' comprehension of the story by asking them if the brothers meant to make the colors glow (lines 513-515). When the students confirmed that the brothers did not mean to make the colors glow as they shone the black light (line 516), Ms. Lucero asked the students if the brothers had taken notice of the phenomenon (lines 517-519). When only a few students responded positively Ms. Lucero restated the question in Spanish (line 521). As noted in line 522, more students answered in English, "Yes!" The code switch in this exchange served to emphasize Ms. Lucero's focal point in this conversation: noticing. When only a few students answered her original question (lines 517-519) she emphasized her question by asking it in Spanish (line 521). The students recognized the emphasis and more students answered Ms. Lucero's question (line 522). Ms. Lucero then asked for the scientific word for noticing (line 527).

The excerpt above is notable because it would set the stage for the subsequent Worm Investigation, which would require the students to make close observations (see Appendix D). At the same time, Ms. Lucero associated the scientific practice of observation to something "we" do all the time (line 525). By associating what scientists do and what "we" do all the time, Ms. Lucero brought the students into scientific practices while at the same time, bringing the practices of the larger scientific CoP into the classroom (lines 524-525). Finally, the students demonstrated their previous knowledge of this practice by telling Ms. Lucero that the scientific word for noticing was "observation" (line 528).

During the whole-class discussions Ms. Lucero guided students in thinking about the work of scientists. The excerpt noted above demonstrates two purposes. First, the exchange relates science content to the development of the students' scientific identities as they identified practices from the larger scientific CoP as what they would be doing in the classroom. Second, Ms. Lucero scaffolded science talk. When Ms. Lucero asked her students if they knew the scientific word for noticing, she was asking students to recall knowledge that may have learned in previous school years. As she wrote on the chart, Ms. Lucero wrote in Spanish and English that scientists "Make Observations" or "*Hacen observaciones*" thereby reinforcing the term and the practice in both languages. The conversation continued in this manner as Ms. Lucero and her students created the chart documenting the answer to the original question, "What do scientists do?" (see Figure 11).

Figure 11 – What do scientists do?



Science from home. As a beginning activity for the unit on states of matter, Ms. Lucero asked her students to take home an assignment that required family participation. The students were to ask their families for the definitions of solids, liquids, and gases and examples of each. When the students came back to class, Ms. Lucero asked them to share their homework first with a partner and then with the whole class. As students shared with the whole class, they stood at the front of the class, and projected their papers, Ms. Lucero charted their statements. This action validated the knowledge her students contributed to the class.

306	Ms. Lucero:	Esto es lo que ya sabemos
307		¿Verdad?
308		por que ya hablaron de esto con sus padres,
309		o con alguien
310		algunos, escuché,
311		que lo hicieron solos porque no estaba nadie en la casa.
312		That's OK too.
313		But I really want you to try talk to your family
314		about these things.

As Ms. Lucero began to record the students' contributions, she stated that the responses she would record was information that the students already knew (line 306) because they had talked about it with their parents (line 308). When the students shared in pairs, Ms. Lucero listened to students talk about completing the assignment without assistance because their family members were not present (lines 310-311). Ms. Lucero acknowledged that this was an acceptable way to complete the homework (line 312). However, Ms. Lucero insisted that it was important for the students to talk with their family about the states of matter (lines 313-314). This last statement, "But I really want you to try to talk to your family about these things" (lines 313-314), demonstrates Ms. Lucero's stance in relation to scientific knowledge from home – it is important and contributes to the co-construction of the classroom CoP.

Of the eight students who shared their homework with the whole class during this science lesson, seven did so in Spanish. As Ms. Lucero and her students reviewed and recorded the contributions, they moved between speaking and writing in Spanish and English.

349	Ms. Lucero:	¿Cuáles son
350		algunas palabras
351		que podemos agregar aquí que
352		nos dio Celso?
353	Yesenia:	¿Cómo fluidos?
354	Ms. Lucero:	Yeah,
355		Where does the fluid go?
		(asking about how to categorize the word)
356		Fluido.
357	Claudia:	En sólido.
358		I mean…
359		en líquido.
360	Ms. Lucero:	Liquid,
		(writing on chart)
361		Yeah.

Ms. Lucero made sure that the contributions were recorded in both languages, for instance, when Claudia stated that "fluid" would go under the category of liquid, she did so in

Spanish (line 359). Ms. Lucero rephrased Claudia's contribution in English (line 360), and wrote it in both languages on the chart. In this exchange, Ms. Lucero moved between languages stating the terms she wanted the students to relate as scientific terms in both languages. For example when she asked, "Where does the fluid go?" (line 355) she only translated the scientific term to Spanish, *"Fluido"* (line 356). When Claudia stated that fluid should go in the liquid category, "*En líquido"* (line 359), Ms. Lucero only translated the scientific term to Spanish and said "Liquid" (line 360). By translating the scientific terms, Ms. Lucero signaled the importance of maintaining both languages during science.

As the semester progressed, Ms. Lucero sent additional homework assignments that invited the students to bring scientific knowledge from their homes. The connections that Ms. Lucero established through homework assignments were recognized and became part of the collective CoP's scientific knowledge. As shown in the previous exchange, Ms. Lucero facilitated these intertextual connections by proposing the connection between home and school by asking the students to bring definitions and examples of solids, liquids, and gases. The connections were taken up by the families and the students, and shared with the classroom CoP. Ms. Lucero facilitated the recognition of the intertextual connections as she incorporated and recorded the definitions and examples of solids, liquids, and gases on the classroom chart. The social significance for this intertextual connection lies in the relevance given to families and home as sites of scientific knowledge.

When I asked Ms. Lucero for her rationale in assigning homework assignments that required family involvement in science she stated,

> "I wanted them [the students] to see that science is everywhere, and that their families know a lot about science that they can pass on. And validating and bringing in their

families into all conversations, and it seemed easier to do in science. Maybe because anything is scientific." (Interview, May 2013)

As an example, Ms. Lucero explained that during Family Reading Night, parents chose to read poems the students had written during science time. This was also an important connection between home and the classroom scientific CoP.

Moje, Ciechanowski, Kramer, Ellis, Carrillo and Collazo (2004) refer to the integration of knowledges from different spaces, such as merging home knowledge with school knowledge, as the "construction of 'third space'" (p. 41). By facilitating the connections between home and school, Ms. Lucero and her students fostered the construction of such a "third space." Moreover the construction of a "third space," the merging of home knowledges and school knowledges, became part of a practice in the CoP as Ms. Lucero and her students continued to integrate home and school knowledges during science through homework assignments. Moje et al. explain that the students in their research project were bilingual (Spanish and English), while the teaching and learning of science was conducted in English. In contrast, the CoP in this study constructed a "third space" by using linguistic resources in both Spanish and English.

Conclusion

In this chapter I analyzed how science-oriented identities were fostered within this fourth-grade bilingual classroom. At the beginning of the school year, Ms. Lucero asked her students to illustrate themselves as scientists. In this way, the fourth-grade students began the school year by identifying themselves as students who do science. Later on, the Worm Investigation served to establish literacy practices within science teaching and learning that were carried out throughout the school year. Ms. Lucero started the Worm Investigation by introducing a fictional text about worms. From the reading of the book, the class discussed facts about worms. The students then moved on to an inquiry activity in which they observed, took notes, discussed, and shared their findings. Ms. Lucero facilitated whole-class discussions and reinforced and introduced scientific vocabulary and science-oriented practices. As the students finished their inquiry they were asked to write in different genres (report and poetry) about their work. Finally, Ms. Lucero made another literature connection as they moved to reading poetry related to science.

Throughout the rest of the year, these science-oriented identities were fostered by various activities that developed their fluency in science discourses. Moreover, sharing through oral and written modes became the practice of conducting science talk within the science CoP. Furthermore, as students participated in the inquiry activities to discover how to light a light bulb and form a complete circuit, they negotiated participation within their small groups. This was exemplified by Paco and his group as they developed their emerging scientific talk, as well as their identities as students who do and talk science.

The co-construction of the CoP through shared practices was accomplished through its three dimensions: mutual engagement, joint enterprise, and shared repertoire. Mutual engagement within this CoP meant that students negotiated meanings of actions through their interactions and relations in small groups. As described in the sample transcripts, students negotiated roles within their small groups, such as who would handle materials, or who would be the leader of the group. The joint enterprise meant that the students engaged in a common endeavor, such as reading to learn from various texts and writing scientific reports. The shared repertoire developed within the classroom CoP was co-constructed through intertextual connections and connections to home, and through translanguaging.

Finally, by facilitating the integration of new knowledge and understandings, appropriation of scientific discourses and values, and engagement in inquiry activities, Ms.

Lucero and her students established practices that lead both to the acquisition of scientific knowledge and scientific habits of mind as suggested by Lee and Fradd (1998) and shown in Table 3. Lee and Fradd explain that in promoting science teaching practices, and science learning for bilingual students, "[I]t is necessary to understand the nature and practice of science in combination with language and cultural experiences" (p. 15). Based on previous science standards documents (AAAS, 1983, 1993; NRC, 1996), Lee and Fradd suggest several components of science learning:

Table 3. Science learning

Scientific Knowledge	**Scientific Habits of Mind**
Knowing science (scientific understanding): • Building on prior knowledge • Using appropriate science vocabulary • Understanding concepts and relationships	Scientific values and attitudes • Manifesting generic values and attitudes • Appropriating culturally mediated values and attitudes
Doing science (scientific inquiry) • Engaging in inquiry • Solving real-world problems	Scientific world view • Recognizing scientific ways of knowing
Talking science (scientific discourse) • Participating in social and academic discourse • Using multiple representational formats • Appropriating the discourse of science	

Note: Adapted from Lee and Fradd (1998, p. 16).

Through literature connections, inquiry-based investigations, engaging in scientific talk, and literacy practices such as reading and writing, Ms. Lucero promoted science learning. These practices in turn, aided in the co-construction of this bilingual classroom's science CoP. Furthermore, through their participation in these practices, the fourth graders fostered their scientific identities as students actively participating in scientific activity.

In the following chapter I provide an overview of this dissertation study and a summary of the findings as they relate to the research questions presented in previous chapters. I also discuss the findings as they relate to the CoP theoretical framework. I conclude with implications for bilingual education, and elementary science education. Finally, I discuss the limitations of the study and recommendations for future research.

CHAPTER 5

CONCLUSIONS

In this chapter I present an overview of the case study of a fourth-grade bilingual classroom and the co-construction of the CoP during science instruction. I then describe the findings as they relate to the research questions. The discussion of the findings is organized based on the CoP framework. I end the chapter with a discussion about the implications for bilingual education, elementary science education, and teacher preparation. Finally, I discuss the limitations of this study and provide recommendations for future research.

Overview of the Study

The purpose of this qualitative case study was to understand how a bilingual fourth-grade teacher and her students co-constructed a CoP during science. The study focused on the development of academic and linguistic resources during the teaching and learning of science. I conducted a case study in a bilingual fourth-grade classroom, where the bilingual teacher taught science in Spanish and English. The practices in the CoP manifested themselves through talking (discussing and negotiating meaning), writing (observations, conclusions, and reports), and reading (exploring academic content) about science.

In order to understand how Ms. Lucero and her students co-constructed a CoP, I analyzed the discourse and practices (and resulting artifacts) during the teaching and learning of science. First, data analysis revealed that Ms. Lucero fostered practices that assisted in developing the science identity of her fourth-grade bilingual students. Secondly, the integration of literacy practices during the teaching and learning of science supported the students in acquiring scientific ways of writing, talking, and reading. Thirdly, Ms. Lucero strategically welcomed important connections between home and school in order to bring in science knowledge from home to school, and vice-versa. Through these various science literacy practices the fourth-graders engaged and appropriated scientific discourses. Finally, the co-construction of the CoP was accomplished by drawing upon linguistic resources in both Spanish and English. Engaging in the work of doing science bilingually became an essential characteristic of the co-construction of this fourth-grade bilingual CoP.

Research Questions

The first question, "How do a bilingual teacher and her students co-construct a community of practice in and through science within an elementary bilingual classroom?" guided this study. In order to understand how a fourth grade bilingual teacher and her students co-constructed a CoP I first explored how the community was fostered in the classroom through the following questions:

1.1 How does the teacher promote a sense of community in the classroom?

1.2 How does the teacher cultivate this sense of community through and within science lessons?

1.3 What specific scientific practices are constructed during science and how are they related to a larger scientific community?

A second question, "What language practices are used within and across science lessons that support the co-construction of a community of practice?" assisted me in exploring how Ms. Lucero and her students utilized their linguistic resources during science. Two areas of focus were,

2.1 How are languages used within this classroom?

2.2 How are languages used during the teaching of science?

These questions helped me understand the ways languages were used to make sense of scientific vocabulary and practices that assisted students in appropriating identities as scientists.

I organized the following summary of the findings as they apply to each of the previous research questions. After presenting these research questions, I discuss the findings in relation to the CoP framework.

How does the teacher promote a sense of community in the classroom?

The development of the CoP began from the very first day of the school year as Ms. Lucero fostered a community within the classroom through multiple means. Although the description of how Ms. Lucero promoted a sense of community was not the focus of this study, it is important to understand as it set the stage for how the community developed in other areas such as the science "period." As described in Chapter 3, Ms. Lucero engaged her students in thinking about a community through the reading of various literature pieces, including *Quinito's neighborhood*/*Quinito y su vecindario* (Cumpiano & Ramirez, 1995). In this story, Quinito describes members of his community and how they are connected to each other. After discussing the story, Ms. Lucero led a discussion about working in a classroom community and the class brainstormed their community guidelines. The guidelines included, "Encourage each other and believe in each other/*Apoyarnos y creer en nosotros mismos*." These guidelines were referenced throughout the year as students shared, worked, and learned together.

Ms. Lucero also began fostering a sense of community when she would encourage students to listen to each other. For instance, she would ask, "*¿Cómo podemos mostrar respeto a nuestros compañeros?*/How can we show our classmates respect?" (Transcript, 8.30.12). She would also request, "Let's practice being a respectful community and listen" (Transcript, 8.30.12). Soon, the students began to encourage each other to become part of the community. For example, when Danny came to the front of the room to share the illustration of himself as a scientist, he became embarrassed and did not want to share anymore. His classmates soon encouraged him by saying, “We are not going to laugh at you. Don’t be embarrassed” (Transcript, 8.31.12). Danny was indeed encouraged by his classmates and able to share his illustration. The following week, when Ms. Lucero told the students that she was waiting for everybody to listen, Omar clarified, “The community” (Transcript, 9.4.12). Omar demonstrated that he understood that everybody in the class was now “the community.”

Also during the first few days of the school year, Ms. Lucero introduced a project to the class and explained how they would all be creating a class museum to share with their families. The students brought in personal artifacts and wrote information cards for each of their artifacts. This project began with Ms. Lucero sharing a pencil drawing she had made of her sister and explaining to the class why it was meaningful to her. As students brought in their own artifacts they had various opportunities to share with partners and small groups the personal meaning of their artifacts. As they wrote their cards and organized their personal exhibits, the students developed a sense of pride and were eager to share with me. The students finalized their projects and during Back to School Night, they shared their exhibits with each other’s families.

These first instances of how Ms. Lucero began to foster a community demonstrate her instructional decisions to structure a supportive and safe space for her students. These decisions had a notable effect as the students began to internalize this sense of community and reminded each other that everybody was part of the classroom community. At the same time, by encouraging the students to create their personal exhibits, Ms. Lucero recognized her students’ backgrounds and histories as important and relevant to the classroom community.

How does the teacher cultivate this sense of community through and within science lessons?

Ms. Lucero continued to foster the co-construction of community not only during the language arts period, but during the science period as well. In order to have a sense of the students' backgrounds in science, Ms. Lucero asked the students to illustrate themselves as scientists. As explained in Chapter 4, these illustrations allowed the students to visualize themselves as doing the work of scientists. Additionally, through sharing their illustrations, the students were able to learn more about each other and their experiences or ideas of science.

The CoP was also fostered through intertextual connections during the teaching and learning of science. As the community shared literature in language arts and social studies, Ms. Lucero or her students made intertextual connections during science. As detailed in Chapter 4, these intertextual connections were proposed, acknowledged, and given meaning and importance within the CoP. These connections were significant in the sense that it provided a common experience for the community and served to strengthen it as the CoP built common knowledge. The intertextual connections also assisted the students in making sense of new information, and to frame this content within contexts that they were familiar with such as the literature texts they were reading in language arts.

Another way Ms. Lucero facilitated the co-construction of the CoP was through homework assignments that helped the students connect with their families' knowledges. Ms. Lucero assigned homework assignments that required the students to interview their parents, such as asking for their definitions and examples of gases, liquids, and solids. When the students came back to class and shared their definitions and examples, they were strengthening their knowledge of the science content, but they were also enhancing the common scientific knowledge of the CoP. For instance, as students shared their examples with the class, some of them brought up vocabulary that was added to the classroom chart that would be kept throughout the unit. Some of those words included "*fluido*/fluid" and "*transparente*/transparent," and they were discussed as a whole class establishing common meanings.

What specific scientific practices are constructed during science and how are they related to a larger scientific community?

Ms. Lucero also facilitated scientific practices and strategically tied them to the larger scientific CoP. Early in the semester Ms. Lucero integrated literature that would serve as a springboard for discussions and practices that were related to the larger scientific community. One of these pieces of literature was *The Day-Glo Brothers: The True Story of Bob and Joe Switzer's Bright Ideas and Brand-New Colors* (Barton & Persiani, 2009). This story was the beginning point for the discussions about what scientists do in the larger scientific community. Ms. Lucero utilized these discussions to make the connections between the larger scientific CoP and the classroom CoP. For instance, through her choice of discourse, Ms. Lucero signaled that scientists conduct observations and that "we" (the classroom CoP) do this all the time as well.

Another way Ms. Lucero facilitated scientific practices related to the larger science CoP was through reformulating discourse and explicit teaching of scientific language. First, Ms. Lucero frequently asked students to reformulate or restate terms to a more "scientific manner." In this manner, she signaled to her students that within the larger science CoP there were specific ways of describing scientific practices such as observing. Ms. Lucero also demonstrated how to refine scientific terms such as "increase" and "decrease." As demonstrated in her discourse, Ms. Lucero frequently asked her students, "How do would you say that in a scientific way?" This type of question made the reformulation and refinement of scientific language very explicit for the students.

Ms. Lucero also explained to her students that sharing findings was something that scientists do all the time. As students doing the work of scientists, she indicated to her students that they too would be sharing their findings with each other through writing. Ms. Lucero introduced the Scientific Response early in the semester as the students completed their first inquiry activity, the Worm Investigation. Chapter 4 detailed an example of a Scientific Response, and my analysis revealed how the students acquired important discourse practices that were reproduced through writing. At the same time, the students demonstrated their understanding of multimodal texts by merging writing and diagrams, mirroring scientific texts.

How are languages used within this classroom?

During our initial conversations, Ms. Lucero indicated that she wanted to foster a bilingual space where Spanish and English were both given equal importance. In the course of my time spent in the classroom I observed students speaking Spanish and English. Some students favored Spanish, and some students favored English, and during my observations I noticed that all students were bilingual. Ms. Lucero always used different colors to differentiate languages. For instance, text in Spanish would be purple while English text would be green.

Throughout the school year I observed various texts being utilized in both Spanish and English. Although not everything was translated, Ms. Lucero utilized resources in both languages, informational texts, fiction pieces, historical fiction books, videos, websites, and powerpoint presentations, would be in either language or in both Spanish and English. When students asked about taking notes, Ms. Lucero indicated that they could write in both or in either Spanish or English. The availability of both languages allowed for students the freedom to choose what language to write notes in, and to move fluidly between the two.

How are languages used during the teaching of science?

Many of the practices summarized above such as refining discourse or writing to share findings were done bilingually and through various modes. A lot of the science work in this CoP was accomplished through what García (2009b) calls the work of languaging. Sometimes the class discussed important themes and ideas in English, sometimes in Spanish, and sometimes in both languages.

Translanguaging was an important practice within this fourth grade science CoP. Reading an informational text in one language, discussing it in another language, and making sense of newly acquired knowledge in the first language was a common practice that Ms. Lucero and her students engaged in. Ms. Lucero also used translanguaging in order to guide her students to new understandings of science concepts and texts. The fourth graders also translanguaged in order recall information they had already processed and apply it to new understandings.

Although code switching at sentence level (intrasentential) was not a common practice within this CoP it nevertheless occurred at the intersentential level. For instance, Ms. Lucero utilized code switching to emphasize a question or to make sure that her students understood her original question. The students also engaged in code switching as they would talk with each other. In some cases, code switching served to emphasize or make a point, and to try to convince each other.

The practice of translating was prominent within this CoP during science. As Ms. Lucero asked the students to refine their scientific language she would ask them to refine it in both languages. Ms. Lucero would ask her students to translate any terms or concepts they were discussing to make sure that all students had access to the scientific discourse in both languages. The classroom charts created with students' input were in English and Spanish as well.

In short, all three languaging practices, translanguaging, code switching, and translating, were fundamental in accomplishing the work of learning and doing science in Ms. Lucero's fourth grade bilingual class.

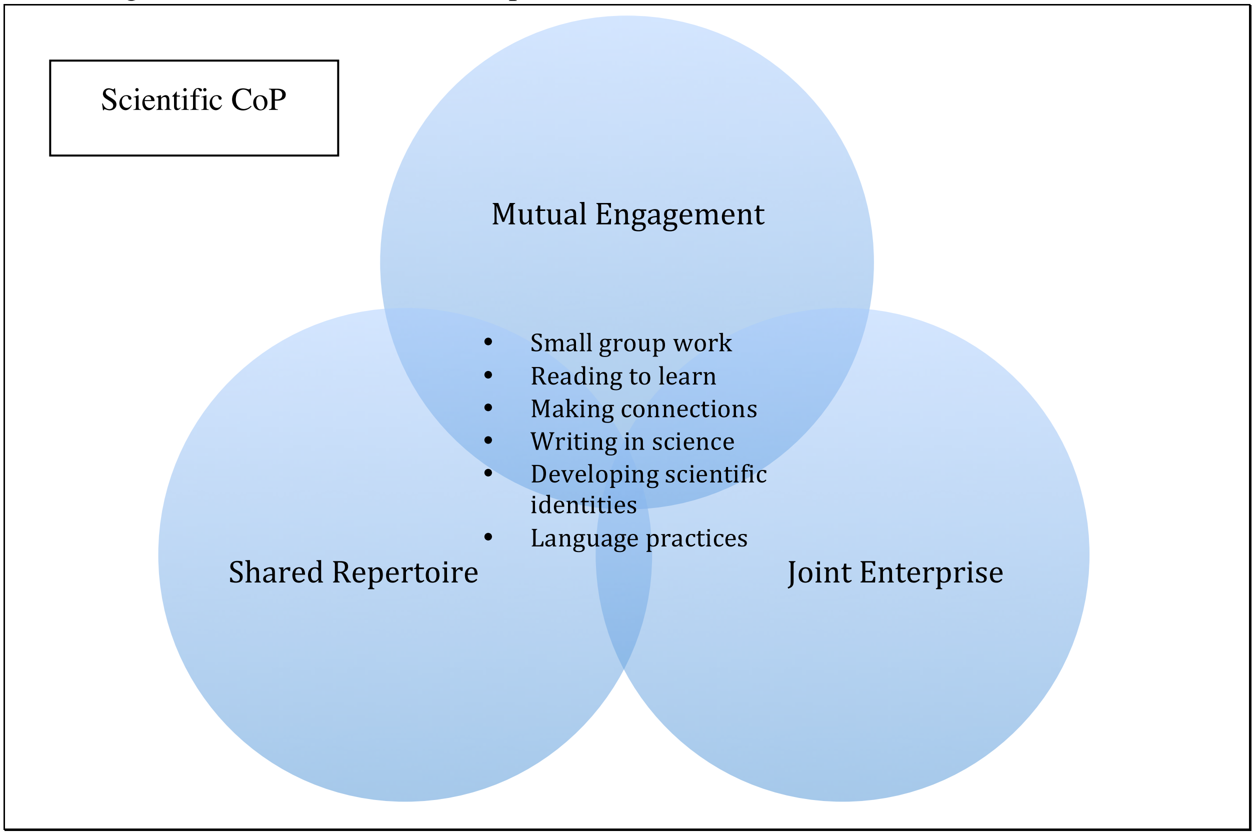
Discussion

Learning in a CoP integrates practice, identity, and meaning (Wenger, 1998). As demonstrated in this dissertation, language as a mediating tool is also important for learning within a CoP. The findings presented in Chapter 4 focused on the three dimensions of practice, mutual engagement, joint enterprise, and shared repertoire. This discussion focuses on practice, identity, and meaning as mediated by language.

Practice within a Community of Practice

The linear organization of the dissertation made it difficult to demonstrate how the practices fostered by Ms. Lucero and her students are connected to all three dimensions of practice. As shown in Figure 12, the CoP practices discussed in the findings can be classified within all three dimensions of a CoP. For instance, through participation in small group work, the fourth graders were engaged with each other (mutual engagement), negotiated their participation in a common endeavor (joint enterprise), while at the same time developed together common ways of talking about science (shared repertoire). Another example of how a practice was composed of all three dimensions is the work of reading informational texts to obtain new information. Ms. Lucero and her students were engaged in a joint enterprise as she guided the readings during class time. As the students participated in guided reading, they were engaged with each other and with Ms. Lucero to make sense of the readings together. And it was through this making sense together that the CoP continued to co-construct their shared repertoire.

Figure 12. Three dimensions of practice



As Ms. Lucero and her students engaged in the practices that assisted in the co-construction of the CoP during science, they were also engaging in practices that could be applicable and relevant within the larger scientific CoP. For example, as Ms. Lucero encouraged her students to write their scientific conclusions, she was encouraging her students to adopt scientific practices, such as sharing findings, writing, and using scientific vocabulary, that mirror practices scientists utilize as they participate in various scientific CoPs. Through such practices, Ms. Lucero assisted her students in adopting new scientific Discourses. As Moje et al. (2001), wrote, "science knowledge production and learning are also embedded in particular ways of knowing, doing, reading, and writing, or Discourses" (p. 471).

Having access to these scientific Discourses has implications that function beyond the school setting, because without access to these practices, "youth may not have opportunities to develop rich repertoires of science knowledge and practices for engaging in the world in empowering terms" (Calabrese, Basu, Johnson, & Tan, 2011, p. 11). By fostering these scientific Discourses, Ms. Lucero was not only providing access to scientific practices, she was also helping the fourth-graders develop their scientific literacies, which in turn, provide students with fundamental skills to participate in society in meaningful ways.

Aikenhead (1996, 2006) suggests that learning school science is a cross-border experience in which students may encounter ways of knowing that ignore knowledges they bring to school. Moje et al., explain,

> Funds of knowledge research indicates that although youth have ample stores of knowledge about the natural world available in their everyday interactions, the Discourses that they use to make sense of and communicate this knowledge are often distinctly different from those valued in science and in science classrooms. (p. 473)

Ms. Lucero sought ways to help her students build a bridge between home knowledges and the school science curriculum by assigning homework assignments that required family involvement. These homework assignments, as she explained, were her way to guide students to see science as part of their daily lives. This was an important practice that related the fourth-graders' home experiences with science to be integrated into the required school science curriculum.

Ms. Lucero facilitated the border crossings between home and school knowledges through the co-construction of the science CoP. As students participated in various science practices and incorporated new Discourses, they co-constructed the CoP, and together were learning how to cross borders between their classroom science-CoP and home CoPs. At the same time, they were explored practices and Discourses congruent with larger scientific CoPs.

Identity negotiation within a Community of Practice

From the beginning of the school year Ms. Lucero fostered the development of her students' scientific identities. Wenger (1998) defines identity as "negotiated experience" through participation in communities, where we bring our "learning trajectory" (p. 149). Additionally, Wenger defines learning as a "process of transforming knowledge as well as a context in which to define an identity of participation" (p. 215). In other words, learning is not only a process of acquiring knowledge; it is also a process of learning new ways of being through participation in CoPs.

> A CoP becomes a place of cultivating identity through participation by:
>
> 1) incorporating its members' pasts into its history – that is, letting what they have been, what they have done, and what they know contribute to the constitution of its practice
>
> 2) opening trajectories of participation that place engagement in its practice in the context of a valued future. (Wenger, 1998, p. 215)

Ms. Lucero began the work of establishing the science CoP where identities would be negotiated through participation by encouraging her fourth-graders to incorporate previous learning experiences in current science activities. Through the self-illustration activity, where the students incorporated previous academic knowledge of scientific practices, science tools, and safety rules, they were afforded the opportunity to identify themselves as active participants in science. In this way, this fourth-grade bilingual community began the work of appropriating scientific identities from the beginning of the school year.

Brickhouse, Lowery, and Schultz explain, "If students are to learn science, they must develop identities compatible with scientific identities" (1998, p. 443). As the semester progressed Ms. Lucero organized learning experiences in small groups to ensure various opportunities for student participation. Small group activities afforded students opportunities to "try on" different identities such as that of a leader. Other small group activities fostered the fourth-graders' identities as budding scientists who participated in various investigations.

Writing about science gave students further opportunities to practice the Discourses associated with scientific identities. Through the work of writing, Ms. Lucero promoted the integration of scientific language, informational texts, and modes. Through writing the students began the practice of mirroring scientific texts (Lemke, 1998), which assisted them in the development of scientific identities as they wrote to share their findings. As they mirrored the multi-modality and the Discourse of scientific texts, writing also aided the fourth-graders in deepening their fluency with such texts.

Aikenhead (2006) warns against school science identities replacing and erasing students' identities brought from home. However, Moje et al. (2004), point out that the identities that students develop within their classrooms "have consequences for how their performances in and out of school will be valued" (p. 68). Thus, the work of teaching students to move between home and school CoPs, encompassing home and school Discourses, and home and school identities, is imperative. In other words, expanding students' repertoires of practices (Gutiérrez & Rogoff, 2003) will assist them not only with school success, but will also help empower them to make decisions as to how and when they engage in certain practices in the world beyond the classroom.

Language as a Mediating Tool

Scholars like Delpit (2006) advocate for the explicit teaching of the discourse of power in schools without dismissing students' funds of knowledge in order to expand their repertoires of practice. Ms. Lucero's teaching was very explicit about expanding, refining, and practicing scientific language. For example, when the students began the Worm Investigation, Ms. Lucero asked for the "scientific word for noticing." This practice continued throughout the year as the students learned about plants and animals, and they were able to appropriate scientific talk about habitats and insect behaviors.

Translation played an important role alongside the practice of expanding and refining scientific language. Ms. Lucero's translations of important scientific terms provided access for all students to science talk. As Lemke (1990) pointed out, learning science involves talking about science with others, and engaging in this talk necessitates having access to the particular disciplinary register. As Ms. Lucero encouraged her students' scientific talk in both languages she provided "meaningful input and opportunities to engage with texts and tasks in purposeful ways" (Schleppegrell, 2004, p. 153).

Ms. Lucero was also very explicit in teaching her students cognates. These cognates aided the students in developing their vocabulary. Learning scientific vocabulary and terminology is an essential building block in acquiring science knowledge as "[t]he lexis of school-based texts is often technical and abstract" (Schleppegrell, 2004, p. 52) which may present a challenge for students. By providing explicit instruction of cognates in science, Ms. Lucero supported the fourth-graders' development of scientific academic vocabulary in both Spanish and English. As discussed previously, this is a challenge for many emergent bilingual students as they may not be familiar with the scientific vocabulary in either language. A list of sample cognates found in the data is presented in Appendix G.

Similarly, the work of translanguaging within the fourth grade class was a significant practice that guided meaning-making as Ms. Lucero and her students co-constructed the scientific CoP. As discussed in Chapter 4, translanguaging assisted the students in making meaning when reading, writing, and talking about science. Hornberger's (2003) continua of biliteracy offers a way of thinking about translanguaging in terms that encompass a multitude of contexts, development, contents, and media, as learning in bilingual/multilingual settings occurs. That is, translanguaging is fluid and not necessarily dichotomized, it involves "criss-crossed, hybrid mixes, and languaging practices" (Hornberger & Link, 2012, p. 267).

Figure 13. Continua of biliteracy

traditionally less powerful <------------> traditionally more powerful

Contexts of biliteracy

micro <--> macro

oral <---> literate

bi(multi)lingual <--> monolingual

Development of biliteracy

reception <---> production

oral <---> written

L1 <--> L2

Content of biliteracy

minority <---> majority

vernacular <--> literary

contextualized <---------------------------------> decontextualized

Media of biliteracy

simultaneous exposure <-------------------------> successive exposure

dissimilar structures <------------------------------> similar structures

divergent scripts <------------------------------> convergent scripts

For instance, Ms. Lucero provided simultaneous exposure in Spanish and English to the discourse of science while supporting the reading (literate) of scientific texts. At the same time, Ms. Lucero encouraged the students to move between the oral and written forms of languages through discussions and scientific writings. Another example of the criss-crossed, hybrid mixes in this fourth-grade CoP occurred when students would read an informational text in Spanish, and the discussion would occur in English or in both languages as Ms. Lucero and the fourth-graders moved comfortably between the two.

The work of translanguaging is significant in the sense that it moves away from using two languages or codes separately to accomplish learning and encompasses the languaging capabilities of emergent bilingual students. As Hornberger and Link (2012) write,

> [I]t becomes clear that these multiple continua are interrelated dimensions of highly complex and fluid systems; and that it is in the dynamic, rapidly changing and sometimes contested spaces along and across multiple and intersecting continua that most biliteracy use and learning occur. (p. 264)

This has tremendous implications for students who have traditionally been marginalized out of traditional Western science as it opens up the possibilities to expand students' repertoires of practices and border crossings.

Implications for Bilingual Education

Lee, Penfield and Buxton (2001) explain how a professional development and curricular intervention proved limited for ELL students at the beginning and intermediate levels of English proficiency. My dissertation contributes to this finding by understanding that science learning and teaching can be accomplished in two languages so that students are successful in learning content knowledge while at the same time developing their academic biliteracies. Hornberger and Link (2012) define biliteracy

> along reciprocally intersecting first language-second language, receptive-productive, and oral-written language skills continua; through the medium of two or more languages and literacies ranging along continua of similar to dissimilar linguistic structures, convergent to divergent scripts, and simultaneous to successive exposure; in contexts scaled from micro to macro levels and characterized by varying mixes of monolingual-bilingual and oral-literate language practices; and expressing content encompassing majority to minority perspectives and experiences, literary to vernacular styles and genres, and decontextualized to contextualized language texts. (p. 265)

Traditional dual language program implementations advocate for the separation of languages, even though scholars have demonstrated that bilinguals do not adhere to language separation during interactions with other bilinguals (e.g., Zentella, 1997; Martínez, R. A., 2010). The major significance of understanding translanguaging as a practice that moves away from the dichotomies of using two languages or codes separately is that it can help foster the development of important academic biliteracies.

Implications for Elementary Science Education

There are meaningful implications for elementary science education that relate to the co-construction of a CoP within the time dedicated to the teaching and learning of science. By developing practices that foster the co-construction of a science CoP in elementary classrooms provide opportunities to engage all students that afford them access to the scientific Discourses, which lead to the attainment of scientific literacy. Through participation in their classroom science CoPs, students also develop practices that will expand their repertoires of practices giving them the skills necessary to engage in meaningful ways in the world beyond their classrooms.

Another relevant implication for elementary science education is that through the practices of fostering intertextual connections between content area subjects, such as language arts, social studies, and science, and home and school knowledges, meaningful science learning can take place. These intertextual connections assist students in making sense of scientific knowledge by making significant connections to other areas. It is also through intertextual connections that students may discover the relevancy of science involvement in their lives.

Implications for Teacher Preparation

Implications for elementary teacher preparation call for training that focuses on the integration of content-area literacies, bilingualism, and home-school connections that value knowledge from home as a starting point for the study of science. Quinn, Lee, and Valdés (2012) explain how teachers can foster science and language learning. These recommendations include five areas: "(1) literacy strategies with all students, (2) language support strategies with ELLs, (3) discourse strategies with ELLs, (4) home language support, and (5) home culture connections" (p. 7).

Literacy strategies. Through various reading and writing activities and connections, Ms. Lucero supported science learning. As students read science texts, historical-fiction literature, and fiction picture books, they were able to make intertextual connections to their science learning. Furthermore, Ms. Lucero supported the integration of various science genre texts as she asked her students to write scientific conclusions that included labeled diagrams. During reading, Ms. Lucero guided her students through various reading strategies such as utilizing context clues to understand the meaning of technical terms.

Language support strategies and home language support. As Ms. Lucero and her students wrote, read, and talked about science, Spanish and English were intertwined. Ms.

Lucero made sure that whole-class created charts included both languages signaling the importance of both. Additionally, when discussing science concepts, Ms. Lucero provided translations to make sure the fourth graders were familiar with the concepts in both languages. Within this CoP the students had the freedom to choose what language they used to write and talk about science, while Ms. Lucero provided reading texts in both Spanish and English. As such, Spanish and English were utilized to support the learning and teaching of science. The practice of using both languages to learn and teach science became the established way this CoP wrote, read, and talked about science.

Discourse strategies. Through the development of discourse practices in science, Ms. Lucero guided her students to transition from their "everyday" register to the science register during the teaching and learning of science. As she frequently asked her students, "How do you say that in scientific words?" Ms. Lucero she was asking her students to attend to their use of scientific register. These discourse practices were developed in both Spanish and English and translanguaging and code switching became important scaffolding practices that assisted in the teaching and learning of science.

Home culture connections. Through various homework assignments, Ms. Lucero built connections between science at school and science at home. As she stated, her objective was to demonstrate to her students that science was everywhere. The families happily responded to the connections as they participated in whole-school activities by contributing science-based resources. Furthermore, these connections were also a way to bridge the language of home with the language of school-science. As the students shared their homework assignments they brought knowledge that became part of the shared knowledge within the science CoP.

Although this research and findings were based on the practices of a bilingual teacher who was fluent in both Spanish and English, practitioners who are not bilingual or do not share the same linguistic resources as their students can support their emergent bilingual students in the above-mentioned areas. Some suggestions for practitioners are:

1. Emergent bilingual students can provide support for each other.
2. Find and provide resources for students to support their primary languages.
3. Reach out to families and communities to provide support and resources for students.
4. Find bilingual or multilingual science mentors that can assist in providing resources for the students, as well as being role models.

Limitations

There are some limitations inherent with case studies, as the findings are not generalizable. The characteristics of the participants and the classroom situation do not exist elsewhere, making this study unique. While this dissertation focused on one teacher and one bilingual classroom, educational research would benefit from studies of similar and dissimilar CoPs with bilingual students.

Although I utilized ethnographic methods for data collection, a comprehensive ethnography would require a holistic portrait of practices and activities. Then, the impact of the CoP would not be limited to observations during the teaching of science, but could be observed across space and time. In this way the possibility of migration and/or integration of scientific practices across the disciplines could be examined.

Lasting effects of newly acquired identities in a CoP must not be limited to one semester or one year. Rather, the benefits of a longitudinal examination of students across years of science learning may yield robust findings on better ways to educate children in general, and emerging bilingual students in particular.

Future Research

> In an increasingly global society, and in a nation that is linguistically and culturally diverse, it behooves us to build on our linguistic capacities to understand ways to optimize what immigrants and their children bring. A valuable role for research would be to document and develop further insight into successful community initiatives that can amplify linguistic diversity. (Hakuta, 2011, p. 172)

In order to engage emergent bilingual students in the areas of science, it is necessary to investigate further the following areas:

1. As Hakuta (2011) suggests, further research is necessary to investigate linguistic diversity in order to consider its role in the learning and teaching of science in the U.S. Although English is considered the language of science it is necessary to explore emergent bilingual students' access to the Discourse of science in varied linguistic terms.
2. Further explore how teachers work to construct CoPs within the constraints of imposed curricula.
3. Professional development for pre- and in-service teachers that focuses on content knowledge and how teachers' content and pedagogical knowledge affect their teaching strategies.

4. Longitudinal studies to explore if translanguaging and literary practices integration prove a long-term advantage for emergent bilingual students as they continue their education.

Appendix A: IRB Permission Forms

Student Assent Form
Teaching Science in a Fourth Grade Bilingual Classroom

I agree to be in a study about my bilingual class when we learn and participate in activities related to science. This study was explained to my (mother/father/parents/guardian) and (she/he/they) said that I could be in it. The only people who will know about what I say and do in the study will be the people in charge of the study.

In the study I will be observed while doing normal work while I learn. The things I say and do might be video recorded. I may also be asked what I think about the activities we do together in class.

Writing my name on this page means that the page was read (by me/to me) and that I agree to be in the study. I know what will happen to me. If I decide to quit the study, all I have to do is tell the person in charge.

____ __________________
Child's Signature Date

____ __________________
Signature of Researcher Date

Formulario de Consentimiento

Enseñando Ciencias en un Salón Bilingüe de Cuarto Grado

Estoy de acuerdo en participar en una investigación cuando participemos en actividades relacionadas con las ciencias. A mi madre/padre/guardián legal le explicaron de que se trata esta investigación y el/ella está de acuerdo que yo participe. Las únicas personas que conocerán lo que diga y haga en la investigación serán las personas encargadas de la investigación.

En este estudio me observarán mientras hago trabajo normal mientras aprendo. Las cosas que haga y diga pueden ser grabadas en video. Tal vez se me harán preguntas de lo que pienso acerca de las actividades que realicemos en la clase.

Escribiendo mí nombre en esta página significa que leí este formulario o que alguien me lo leyó y que estoy de acuerdo en participar en la investigación. Entiendo lo que haré en la investigación. Si cambio de parecer y decido que ya no quiero participar en la investigación solamente tengo que decirle a la persona encargada de la investigación.

_____________________________________ __________________
Firma del niño/a Fecha

_____________________________________ __________________
Firma de investigador Fecha

PARENTAL PERMISSION FOR CHILD PARTICIPATION
THE UNIVERSITY OF TEXAS, AUSTIN

You are being asked to allow your child to participate in a research study. This form provides you with information about the study. The person in charge of this research will also describe this study to you and answer all of your questions.

Title of the study: Teaching science in a fourth grade bilingual classroom.

Principal Investigator:
Maria-Antonieta Avila
Doctoral Student in Curriculum and Instruction
University of Texas at Austin

You are being asked to allow your child participate in a research study. This form provides you with information about the study. The person in charge of this research will also describe this study to you and answer all of your questions. Please read the information below and ask any questions you might have before deciding whether or not to take part. Your participation is entirely voluntary. You can refuse to participate without penalty or loss of benefits to which you are otherwise entitled. You can stop your participation at any time and your refusal will not impact current or future relationships with UT Austin or your child's school. To do so simply tell the researcher you wish to stop participation. The researcher will provide you with a copy of this consent for your records.

The purpose of this study is to learn how science lessons are taught in a bilingual classroom, and the activities related to the teaching of science.

If you agree to be in this study, we will ask your child to do the following things:

- Your child will participate in his/her normal classroom instruction. Your child will participate in various activities within science. As part of the research, the investigator will observe the interactions between the students and their teacher three times a week. These observations maybe be video and audio recorded.
- The researcher may collect and make copies of your child's work such as foldables, PowerPoint presentations, and science notebooks.
- Additionally, your child may be selected for a 15-minute interview related to themes of the project. These interviews will be audio taped.
- If you do not agree for your child to be in the study, your child will still receive normal instruction. The instruction and the grades your child receives will not be affected by your decision. Your child will not be observed, his/her classroom work will not be collected, and will not be asked to be interviewed. While recording audio and video the investigator will take care to not include your child in the recording by pausing the video or audio if necessary.

Total estimated time to participate in study

- The study will take place from August 2012 until May 2013.

Risks of being in the study

- This study may involve minimal risks that are currently unforeseeable. At this time no physical or psychological risks are anticipated.
- Participation in this study is completely voluntary and you can refuse participation and can withdraw permission at any time. Any participant can also refuse to answer any question for whatever reason. It is possible that persons who participate in interviews may feel uncomfortable if they do not know an answer to a question. In this case the researcher can change the question or reassure the participant that they do not have to answer all the questions.
- There is a possible risk for loss of confidentiality.
- If you wish to discuss the information above or any other risks your child may experience, you may ask questions now or call the Principal Investigator listed on the front page of this form.

Benefits of being in the study

- There will be no direct benefit toward participants that result from participation in the study. However, your child's participation will help us make contributions to the fields of elementary science and bilingual/bicultural education.

Compensation:

- Participants will not receive monetary compensation.

Confidentiality and Privacy Protections:

- The data resulting from your child's participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data will contain no identifying information that could associate your child with it, or with your participation in any study.
- With regards to audio and video recording:
    - (a) observations will be audio and video taped;
    - (b) tapes will be coded so that no personally identifying information is visible on them;
    - (c) tapes will be kept in a secure place (e.g., a locked file cabinet in the investigator's office);
    - (d) tapes will be heard or viewed only for research purposes by the investigator;
    - (e) the investigator will retain the recordings to make possible future analysis.
- The records of this study will be stored securely and kept confidential. Authorized persons from The University of Texas at Austin, members of the Institutional Review Board have the legal right to review your child's research records and will protect the **confidentiality** of those records to the extent permitted by law. All publications will exclude any information that will make it possible to identify you a s a subject. Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study.

Contacts and Questions:
If you have any questions about the study please ask now. If you have questions later, want additional information, or wish to withdraw your child's participation call the researchers conducting the study. Their names, phone numbers, and e-mail addresses are at the top of this page. If you have questions about your child's rights as a research participant, complaints, concerns, or questions about the research please contact **Jody Jensen, Ph.D., Chair, The University of Texas at Austin Institutional Review Board for the** Protection of Human Subjects at (512) 232-2685 or the Office of Research Support at (512) 471-8871.or email: orsc@uts.cc.utexas.edu.

You will receive a copy of this consent form.

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. If you later decide that you wish to withdraw your permission for your child to participate in the study, simply tell me. You may discontinue his or her participation at any time.

____
Printed Name of Child

_________________________________   _________________
Signature of Parent(s) or Legal Guardian   Date

_________________________________   _________________
Signature of Investigator   Date

FORMULARIO DE CONSENTIMIENTO PARA LOS PADRES/GUARDIANES LEGALES
LA UNIVERSIDAD DE TEXAS, AUSTIN

Le estamos pidiendo que permita a su niño/a participar en una investigación. Este formulario provee a usted información sobre la investigación. La investigadora principal, describirá esta investigación a usted y contestará todas sus preguntas.

Título de la investigación: La enseñanza de las ciencias naturales en un salón bilingüe de cuarto grado.

Investigadora Principal:
Maria-Antonieta Avila
Estudiante de doctorado, Curriculum e Instrucción
Universidad de Texas en Austin

Se le pide su permiso para la participación de su hija/hijo en un estudio de investigación. Esta forma le da información acerca de esta investigación. La persona a cargo de esta investigación también le explicará el estudio y contestará todas sus preguntas. Por favor lea la información que sigue y si tiene preguntas, hágalas antes de decidir si quiere participar o no. Su participación es enteramente voluntaria. Usted puede negar participar sin castigo o pérdida de beneficios, que aparte de esto, merece. Puede dejar de participar en cualquier momento y su negación no afectará sus relaciones con UT Austin o con la escuela de su hija/hijo. Para dejar de participar solo tiene que avisarle a la investigadora. La investigadora le dará una copia de esta forma para sus archivos.

El propósito de esta investigación es observar cómo se enseñan las ciencias naturales, y las actividades relacionadas con la enseñanza de las ciencias naturales.

Si esta de acuerdo con esto, le pediremos a su hijo/a que haga lo siguiente:

- Su hijo/a participará en sus actividades normales en el salón. Su hijo/a participará en varias actividades relacionadas con las ciencias naturales. Como parte de este estudio, la investigadora principal observará las interacciones entre los estudiantes y su maestra tres veces por semana. Estas observaciones pueden ser grabadas con audio y video.
- La investigadora puede recoger y hacer copias del trabajo de hija/o como organizadores, presentaciones PowerPoint, y cuadernos de ciencias naturales.
- Adicionalmente, su hijo/a puede ser seleccionada/o para una entrevista corta de 15-minutos relacionada con los temas de este proyecto. Las entrevistas serán grabadas.
- Si no quiere que su hija/o participe en la investigación, su hija/o recibirá la enseñanza normal. La enseñanza y las calificaciones que su hija/o reciba no se afectarán por su decisión. Su hijo/a no será observada y su trabajo no será recolectado, y no se le pedirá una entrevista. Mientras la investigadora graba video y audio, se tendrá cuidado para no incluir a su hija/o y se detendrá la cámara de video y audio si es necesario.

Tiempo aproximado de participación en este proyecto

- Este proyecto tomará lugar de agosto del 2012 a mayo del 2013.

Riesgos de participar en este estudio

- Este proyecto puede presentar riesgos mínimos que no se han previsto. No se anticipan riesgos físicos ni psicológicos por ahora.
- La participación en este proyecto es completamente voluntaria y puede rehusar su participación y revocar su permiso cuando quiera. Cualquier persona que participe puede rehusarse a contestar cualquier pregunta por cualquier razón. Es posible que las personas que participen en las entrevistas se puedan sentir incómodas por algunas preguntas si no saben la respuesta. En este caso la investigadora puede cambiar la pregunta o asegurar a la persona que participa que no tienen que contestar todas las preguntas.
- Hay un posible riesgo de la pérdida de confidencialidad.
- Si quiere discutir la información que aquí se provee o cualquier riesgo que si hijo/a pueda sufrir, puede hacer preguntas ahora o contactar a la investigadora principal con la información que se provee en la primera página de esta forma.

Beneficios por participar en este proyecto

- No hay ningún beneficio directo a los participantes como resultado de su participación en este estudio. Sin embargo, la participación de su hijo/hija nos ayudará a contribuir a el entendimiento de la enseñanza de las ciencias naturales a nivel de primaria y la educación bilingüe/bicultural.

Compensación:

- Los participantes no recibirán ninguna compensación monetaria.

Confidencialidad y Protecciones de Privacidad:

- Los datos que se den con la participación de su hija/o se podría compartir con otros investigadores para propósitos de investigación que aquí no se detallan. En estos casos, los datos no tendrán ninguna información que pudiera identificar a su hija/o con los datos, o con su participación en este estudio.
- Respecto a las grabaciones de audio y video:
    - (a) las observaciones serán grabadas con audio y video;
    - (b) las grabaciones serán marcadas de manera de que no se vea ninguna información personal;
    - (c) las grabaciones se guardarán en un lugar seguro (por ejemplo, en un archivero cerrado con llave en la oficina de la investigadora);
    - (d) las grabaciones serán escuchadas o vistas solo para propósitos de investigación por la investigadora;
    - (e) la investigadora guardará las grabaciones para análisis a futuro.
- Los archivos de este proyecto se guardarán en un lugar seguro y se mantendrán confidenciales. Personas autorizadas de la Universidad de Texas en Austin, miembros de la Mesa de Revisión Institucional tienen el derecho legal de revisar los archivos de investigación de su hijo/a y se protegerá la **confidencialidad** de estos archivos conforme lo permita la ley. Todas las publicaciones excluirán cualquier información que permita la identificación de los participantes. Durante todo el proyecto, la investigadora le notificará si hay alguna información nueva que se le pueda dar y que pueda afectar su decisión de

participar en este proyecto.

Contactos y Preguntas:
Si tiene alguna pregunta acerca del proyecto por favor pregunte ahora. Si tiene preguntas después, si necesita información adicional, o si quiere que su hijo/a no participe más, puede llamar a la investigadora que realiza este estudio. Su nombre, teléfono y dirección de correo electrónico esta al principio de esta forma. Si tiene preguntas acerca de los derechos de su hijo/a como participante en este proyecto, quejas, dudas o preguntas acerca del proyecto por favor contacte a **Jody Jensen, Ph.D., Chair, The University of Texas at Austin Institutional Review Board for the** Protection of Human Subjects al (512) 232-2685 o a la Office of Research Support al (512) 471-8871 o correo electrónico: orsc@uts.cc.utexas.edu.

Usted esta tomando la decisión de permitir a su niño/a que participe en esta investigación. Su firma significa que ha leído la información en este formulario y está de acuerdo en permitir que su niño/a participe en la investigación. Si luego decide negar la participación de su niño/a por favor comuníquese conmigo. Pueden negar su participación en cualquier momento.

Nombre de mi niño/a: ____

Firma del padre/madre/guardián legal: ____

Firma de Investigador/a Principal: _____________________

____
Fecha

TEACHER CONSENT

Aprendiendo Ciencias: The construction of a community of science practice in a fourth grade bilingual classroom.

Conducted By: Maria-Antonieta Avila
The University of Texas at Austin
Department / Office: Curriculum & Instruction

You are being asked to participate in a research study. This form provides you with information about the study. The person in charge of this research will also describe this study to you and answer all of your questions. Please read the information below and ask any questions you might have before deciding whether or not to take part. Your participation is entirely voluntary. You can refuse to participate without penalty or loss of benefits to which you are otherwise entitled. You can stop your participation at any time and your refusal will not impact current or future relationships with UT Austin or participating sites. To do so simply tell the researcher you wish to stop participation. The researcher will provide you with a copy of this consent for your records.

The purpose of this study is to observe the teaching of and activities related to science in a fourth grade bilingual classroom.

If you agree to be in this study, we will ask you to do the following things:

- Complete a basic background information form
- Participate in 15-20 minute audiotaped interview
- Be observed during the teaching of the book(s)
- Provide researcher with copies of lesson materials and student-produced artifacts

Total estimated time to participate in study is more or less 120 minutes of instructional time per week, plus interview. The researcher will take copying responsibilities.

Risks of being in the study:

- The risks associated with the study are no greater than everyday life. If you wish to discuss the information above or any other risks you may experience, you may ask questions now or call the Principal Investigator, *Maria-Antonieta Avila*.
- There is a possible risk for loss of confidentiality.

Benefits of being in the study:

- There will be no direct benefit toward participants that result from participation in the study. However, this study will make contributions towards the field of science education and bilingual/bicultural education.

Compensation:

- There is no monetary compensation for participation in the study.
- Educators participating in the study will get a final copy of the findings.

Confidentiality and Privacy Protections:

- The data resulting from your participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data will contain no identifying information that could associate you with it, or with your participation in any study.
- With regards to audio and video recording:
    (f) interviews will be audio taped; observations will be audio and video taped;
    (g) tapes will be coded so that no personally identifying information is visible on them;
    (h) tapes will be kept in a secure place (e.g., a locked file cabinet in the investigator's office);
    (i) tapes will be heard or viewed only for research purposes by the investigator;
    (j) the investigator will retain the recordings to make possible future analysis.

The records of this study will be stored securely and kept confidential. Authorized persons from The University of Texas at Austin, members of the Institutional Review Board, and have the legal right to review the research records and will protect the confidentiality of those records to the extent permitted by law. All publications will exclude any information that will make it possible to identify you as a subject. Throughout the study, the researchers will notify you of new information that may become available and that might affect your decision to remain in the study.

Contacts and Questions:

If you have any questions about the study please ask now. If you have questions later, want additional information, or wish to withdraw your participation call the researchers conducting the study. Their names, phone numbers, and e-mail addresses are at the top of this page. If you have questions about your rights as a research participant, complaints, concerns, or questions about the research please contact Jody Jensen, Ph.D., Chair, The University of Texas at Austin Institutional Review Board for the Protection of Human Subjects at (512) 232-2685 or the Office of Research Support at (512) 471-8871 or email: orsc@uts.cc.utexas.edu.

You will be given a copy of this information to keep for your records. **Statement of Consent:**

I have read the above information and have sufficient information to make a decision about participating in this study. I consent to participate in the study.

Signature: ___________________________________ Date: __________________

Signature of Investigator: __________________________ Date: __________________

Appendix B

Guiding Questions for Semi-Structured Teacher Interview

- How do you establish a sense of community in your classroom?
- How do you carry that sense of community through science?
- How do you think your students feel during the science lessons?
- How do you make science relevant for your students?
- What are your goals for your students in science?
- How do you use Spanish and English during science lessons?

Appendix C

Guiding Questions for Semi-Structured Student Interview

- What language do you speak the most during science class? ¿Qué idioma hablas más durante la clase de ciencias?

- How do you think you learn science best? ¿Cómo crees que aprendes mejor las ciencias?

Appendix D

Timeline of science activities during the first half of 2012-2013 school year

August 2012	September 2012	October 2012	November 2012	December 2012

- What is science?
  - Myself as a scientist
  - What do scientists do?
    - Worm Investigation
      - Matter
        - States of matter
          - Mixtures and Solutions
            - Energy – Electric
              - Mechanical Light Thermal
                - Force and Movement
                  - Weather

Appendix E

Students' Illustrations of Themselves as Scientists

Student	Gender	Verbalization Spanish English	Social Context Self With others	Actions	Equipment
Nieve	Female	I am mixing chemicals to make a medicine.	Self	Mixing Make	Microscope Test tubes Flasks Table Goggles/glasses Lab coat
Ofelia	Female	En este dibujo estoy viajando a la luna y estoy experimentando algo con quemicos.	Self	Viajando Experimentando	Rocket Flasks Table
Rosa	Female	I am mixing different qimiqals to make diffrend kinds of explotions.	Self	Mixing	Test tubes Flasks Microscope Goggles
Lisa	Female	Para mi, la electricidad es importante porque con ella, puedo ver mejor y leer mis libros. La electricidad es parte de las ciencias.	Self	Reading	Lamp Plug Book
Andrea	Female	En el experimento yo pongo vinagre y carvonato en partes iguales. El carvonato ace que el vinagre aga una erupcion de burbujas.	Self	Pongo	Flasks Graduated cylinder Microscope Goggles Table
Miguel	Male	Arqueologo	Self		Bones Shovel
Lalo	Male	Aqui soy un cientifico investigando un germene	Self	Soy Investigando	Microscope Table Glasses Computer Chair
	Male	Los sintificos usan estos metales	Self	Usan	Hand lens (?)
Eduardo	Male	Estoy asiendo quimicos y estoy estudiando los volcanes y el mundo	Self	Haciendo Estudiando	Flasks Volcano models Tables Earth model (?)

Juan	Male	Yo estoy mesclando liquidos para hacer medecinas	Self	Mezclando Hacer	Flasks Test tubes
	Male	Yo estoy estudiando animals	Self	Estudiando	Zoo
	X	Yo estoy experimentando en como haser forrmiula en tomando las cosas con mi compañero.	With partner	Experimentando Hacer Tomando	Test tubes Hand lens Tables
Angela	Female	I am mixing things to make more new matirials.	Self	Mixing Make	Test tubes Goggles Lab coat Gloves Table
Fernando	Male	En este dibujo estoy asiendo un expirimento	Self	Haciendo	Classroom Board Table Goggles Lab coat Gloves Test tube Flask Cylinder
Jorge	Male	Yo estaba espirimiento a las estrllas que brillas. Me gust alas estrellas porque brilla y esta bonimo como unos tiene. Como puedo ver las estrellas la Luna.	Self	Experimento Ver	Telescope
Jazmín	Female		Self		Color blocks Stone statue
Margarita	Female	Yo estoy viendo una mariquita en un arbol con mi lupa.	Self	Viendo	Hand lens Table
	Female	Yo estoy haciendo siencias con mi maestra en la escuela	Self	Haciendo	Test tube Hot plate Flask Table
	Female	Studying different types of flowers.	Self	Studying	Table
Carlos	Male	Aqui estoy siendo un robot	Self	Haciendo	Table Pencil Paper Ruler Tools
Rafael	X	Yo soy asiendo un tranpolin	Self	Haciendo	Table Ruler Trampoline

Danny	X	Estoy investigando en un telescopio jermenes insectos	Self	Investigando	Telescope
Laura	Female	Estoy poniendo atencion a la maestra porque esta hablando de sciencias.	Self	Poniendo atención	Desk

Appendix F

Conventions of Transcriptions

(Wells, 2001)

Layout	The stream of speech is segmented into tone units, with each tone unit starting on a new line. Speakers are indicated by their pseudonyms.
--	Incomplete utterances or self-corrections are shown by a hyphen on the end of the segment that was not completed.
.	One period marks a perceptible pause. Thereafter, each period corresponds to approximately one second of pause.
? !	These punctuation marks are used to mark utterances that are judged to have an interrogative or exclamatory intention.
< >	Angle brackets enclose segments about which the transcriber was uncertain.
X	Passages that were insufficiently clear to transcribe, with one for each word judged to have been spoken.
_____	When two participants speak at once, the overlapping segments are underlined and vertically aligned.
[ ]	Enclose descriptions of other relevant behavior.

Appendix G

Sample of Cognates Provided by Ms. Lucero

Spanish	English
Nerviosa	Nervous
Dramática	Dramatic
Masa	Mass
Color	Color
Comparaciones	Comparisons
Textura	Texture
Sólido	Solid
Líquido	Liquid
Gas	Gas
Fluído	Fluid
Transparente	Transparent
Invisible	Invisible
Materia	Matter
Molécula	Molecule
Demostración	Demonstration
Predicciones	Predictions
Húmedo	Humid
Temperatura	Temperature
Vapor	Vapor
Electricidad	Electricity
Conclusion	Conclusion
Diagrama	Diagram
Condensación	Condensation
Soluciones	Solutions
Evaporación	Evaporation
Energía	Energy
Nuclear	Nuclear
Filamento	Filament
Conductor	Conductor
Mecánica	Mechanical
Potencial	Potential

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