USING PASSIONS AS DRIVING FORCES AND SPACES AS PRIMARY RESOURCES FOR SCIENCE EDUCATION WITH EMERGENT BILINGUAL STUDENTS IN MIDDLE SCHOOL

by

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(Under the Direction of Martha Allexsaht-Snider)

ABSTRACT

Much of the research on science education with emergent bilingual students has focused on using culturally relevant practices to enhance children's communication of science ideas. In this dissertation I studied how emergent bilingual students and their science teachers engaged in different processes to promote meaningful relations with space-student interactions and the integration of passionate activities in science learning.

Using assemblage theory as a guiding framework that emphasizes the elucidation of processes in which material and expressive elements interact, I studied: (a) What occurred during a teacher institute and summer student academy with secondary science teachers implementing science investigations and using material resources and spaces with their emergent bilingual students, and (b) an afterschool soccer program with a middle school science teacher/soccer coach where I collaborated in implementing a set of soccer with science activities with a group of emergent bilingual students.

Organized as three article-length manuscripts, the dissertation begins with an article focused on research with how science teachers promote and build science-learning environments with their emergent bilingual students in the classroom. The resources needed to accomplish this goal are discussed and the processes that allow science teachers to use cultural resources are considered. The second article examines emergent bilingual students' engagement in soccer with science practices in an afterschool soccer program with an 8^{th} grade science teacher who was also the soccer coach. Ways in which a passionate activity that is growing in popularity in the United States can be used with middle school students to engage them in thinking and communicating their science ideas are investigated. The final article provides an insight about my experiences as a teacher-researcher working with a middle school science teacher/soccer coach, two university researchers, and a group of emergent bilingual students and implementing a set of six soccer with science activities in a middle school afterschool program.

The overarching goals of this dissertation research were to find productive ways to integrate different cultural practices in science teaching and learning and to reimagine the physical spaces of the science classroom to support science teachers' work with emergent bilingual students in science education.

INDEX WORDS: Science Education, Middle School Education, Passions, Science Inquiry, Bilingual Activities, Learning Environments, Learning Territories, Soccer

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DEDICATION

To my little girl, Nina

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CHAPTER 1

EVOLUTION OF DISSERTATION: INTRODUCTION AND LITERATURE REVIEW

With the extent of student diversity and student backgrounds in the classrooms in the United States, the need for multiple strategies to teach them demands the use of every resource available to enhance science education. This is a dissertation about using different strategies to teach science to emergent bilingual students. The articles included here result from my experiences working in the Language-rich Inquiry Science with English Language Learners through Biotechnology (LISELL-B) project[1] during 2013-2015 that included a high school component in addition to the middle school science teachers, ESOL teachers, emergent bilingual students and their families. By collaborating with science teachers, the main objective of these projects was to experiment with instructional strategies that promote students' engagement in and communicating of science ideas. I worked very closely with the emergent bilingual students, their families, and the science teachers, especially from Bear Hill Middle School, in the different components of the LISELL-B professional framework. This professional framework consisted of a summer teacher institute, student summer academy, grand rounds classroom observations, bilingual "steps to college through science" workshops, and teacher exploration of students' writing workshops.

In chapter two, I use an architectural perspective to study how science teachers collaborated in designing science investigations in the LISELL-B teacher institute in

[1] The work has been supported by the National Science Foundation (award # DRL-1316398)

order to build and support science learning environments with the emergent bilingual students in the student summer academy. Chapter two is about the use of the classroom as a space and how science teachers facilitated the relationship between the students, especially emergent bilingual students, and the physicality of the classroom to support science learning. Research about the science classroom has focused mainly on topics like technology usage, such as smart boards (Martin, Shaw, & Daughenbaugh, 2014; Pourciau, 2015), computer-based environments (Van Laere, Agirdag, & van Braak, 2016), hands-on activities (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013), and discourse in the classroom (Nikula, 2015; Smart & Marshall, 2013), but has not yet systematically addressed the primary student-space interaction in which science learning occurs. In other words, the physical presence of the science classroom is most often viewed as an area limited by four walls with chairs, tables, and science and other equipment and is considerd a static accessory for the teaching-learning process. As a consequence, the promotion of innovative student-space interactions has not been fully explored, which creates the appearance that such interactions with the classroom are an innocuous given. This is not to say that students do not create environments or territories in the science classroom, because this is always a possibility (e.g., graffiti and tagging); however, the point is to consider how to purposefully work with students to create environments and territories that lead to, in this case, the learning of science.

Chapter two is meant to make visible the use of the space of the science classroom as a primary learning resource as well as explaining the process that turns such space into a learning territory. For this, I use an architectural perspective (De Landa, 2010) along with the Heideggerian (1975) explanation of making a house, which is inhabited, into a home, which is dwelled in, to study how students, including emergent bilingual students, benefit from this shift. Chapter two uses this theoretical and practical framework to analyze data from science teachers who constructed learning environments and glimpsed the possibility of building a learning territory during a two-week summer academy for emergent bilingual students, part of the LISELL-B project.

In chapter three, I focus on how science teachers can also use the LISELL-B pedagogical model and the emergent bilingual students' interests and passions for soccer to create meaningful science investigation practices in the classroom. The fact that families and students were relatively stable over time in their participation, especially in the Steps To College (STC) family science workshops, facilitated my relationship with them in and outside the research project. These relationships did not start with the intention to research about their interests and backgrounds but from the possibility of interaction in a situation in which they and I spoke Spanish and we were engaged in activities together through the science workshops. Many parents approached me because I frequently facilitated translations during science laboratory visits on university campuses and they had questions about something related to the activity or wanted to share something about the activity with me, such as the poultry science lab activity in which two parents approached me and talked about the children's excitement about watching a chicken laying an egg, an activity parents were familiar with since they were little kids. Often times, parents asked me about the research project goals or about the research consent and permission forms, which somehow lead to talk about our hobbies, jobs, places of origin, and favorite *fútbol* teams, among other things. Other times, they just wanted to talk to another person while transitioning from one activity to the next and I was there.

In addition, my interactions with science teachers in the STC family workshops and other LISELL-B professional learning activities also lead to conversations about other topics beyond our academic lives, such as sports. Of course, neither of these conversations with families and teachers was meant to fulfill my research interests at that time when I did not know about assemblage theory nor did I have a research topic for my dissertation. What I did notice was that all these interactions in the LISELL-B professional learning framework were providing many opportunities and environments for me to try new ideas using the LISELL-B pedagogical model structure and the theories I was reading about.

It was not until I was working on my doctoral comprehensive exam questions, specifically on assemblage theory, and I used a soccer example to explain the possibilities of *becoming* to my committee, that I realized that soccer was not only present in the students' daily activities but in their families' lives as well. I did not know if research about using soccer as a passion with emergent bilinguals in science education existed, and I began to document the research about this topic. Research on soccer and science is very popular indeed and it is very common to find topics about how science is used to make predictions and develop statistics in professional soccer leagues (Wesson, 2002), to understand the physiology, biomechanics, and psychology in soccer (Williams, 2013), to stress and develop programs to prepare staff for transdisciplinary dialogue about empirical results and soccer strategies (Figueiredo, Gonçalves, & Tessitore, 2014), and to improve the soccer players' performances (Akubat, Barrett, & Abt, 2014; Los Arcos et al., 2014). Although those research topics included a mixture of science and soccer, they are very specialized in content and the target population is professionals working in different fields, such as physicians, coaches, or players trying to improve their techniques, tactics, and physical performances. In other words, science is used to analyze the practice of soccer and improve it. Nevertheless, research about using soccer to learn science is nonexistent in English- and Spanish-speaking countries. This situation encouraged me to brainstorm and imagine my research activities: I had to find challenging soccer moves for the school soccer team along with a short video for each soccer move, to develop a sequence for all the six activities I created, and to balance the amount of science concepts and practices and the physical activity integrated into a short timeframe. Many questions arose as the possibility of combining these components increased: Should I use videos of Pelé or Maradona doing a soccer move or videos of Messi and Cristiano Ronaldo, in other words, new or old soccer stars? Would it be better to have each soccer with science activity in one or two divided afterschool sessions? Would it be better to design individual or group activities? As I explored these elements, I began watching so many soccer videos in YouTube trying to match science concepts with bodily movements and fit learning goals with soccer stars that I learned new names of soccer moves and soccer star careers and backgrounds. Of course, as a Mexican interested in our national sport, I was in constant interaction with soccer: Television and radio channels devoted to soccer analysis, the national Mexican team games, the World Cup, the Mexican League games every weekend, and soccer magazines and newspapers, were regular part of my daily life. In my community growing up in Mexico the soccer games between colleagues, soccer polls organized in my workplace, and the reunions to watch games after workdays, were also very common as there was a rivalry in the office between most colleagues. In my family, soccer was an every weekend activity to talk about it, to play it, to watch it. In addition to one's personal interest in soccer, there are many friends, the community, and the media that are constantly bombarding every child and adult with soccer, which is decisive in understanding the role of soccer not only as a cultural practice but also as a passionate activity. There is a big difference between a passionate activity and something that is cultural, although these are not exclusive. In my case, it was very easy to embrace the family soccer team, Cruz Azul, when I was very young and began my solidarity with those who also cheered for the team and my rivalry with those who did not. But I did not know the role of soccer for most of the students in my research project and with those participating in their school soccer team, was it just another activity for the day or a passionate one? As I carried on with this research project I better understood the role of soccer for my research participants.

In regard to my theoretical perspective, assemblage theory (De Landa, 2006; Deleuze & Guattari, 1987) required me to first elucidate relevant parts involved in this research to study how these interacted at macro and micro levels and then explore their historical process of becoming. At the micro level, for instance, my participants' use and practice of soccer was very important for it explained how soccer intertwined with the students' family lives, which has been studied in other social research in Latin America (Campomar, 2014; Nadel, 2014; Stavans, 2011). At the macro level, it was crucial to know the socioeconomic situation of the countries of origin and the status of soccer as a national sport at the time when focal participants, their parents, or both were there and decided to leave the country. For these investigations, I based my literature review on immigration research, national economic reports, and newspaper articles to understand the macro situation and contexts in the places of origin (Ho & Loucky, 2012; Marrow, 2011; Zong & Batalova, 2015) for my focal participants. But studying the participants from a historical perspective at macro and micro levels is just one aspect of assemblage theory; another part to plug into my research, specifically into the written activities for the students, was concepts and understandings of science education with emergent bilingual students.

Research about pedagogical strategies to teach emergent bilingual students is showing that obsolete models for teaching, like the *sink or swim* and the *pullout* models, are still used despite their poor results (García & Kleifgen, 2010). The *sink or swim* model consists of teaching the emergent bilingual student as a monolingual student, that is, not including any resource different from those used for mainstream students in the science classroom. Another is the *pullout* model that consists in removing the emergent bilingual student from the classroom to learn and/or improve his/her English language communication skills with an ESOL teacher. Nevertheless, there exist other models that work better for emergent bilingual students in which teachers use, in varying degrees, the emergent bilingual students' home language in the classroom. Bilingual approaches can be used to learn the science content using the student's home language as a support in the classroom (Buxton, C., Allexsaht-Snider, M., Kayumova, S., Aghasaleh, R., Choi, Y., & Cohen, A., 2015; Lee & Buxton, 2013). However, there is not just one correct way of using cultural and linguistic resources to support the teaching and learning processes in the classroom (see for instance, García & Kleifgen, 2010; González, Moll, & Amanti, 2005; Gutiérrez & Rogoff, 2003), which has lead me to study how the LISELL-B teacher and student participants used the physical space to enhance the learning of science.

Chapter four describes my experiences as a curriculum developer/science teacher/researcher collaborating at Bear Hill Middle School. In this collaboration, I put special emphasis on how we negotiated to make adjustments to the activities to address the interests of the emergent bilingual students, the goals of the soccer coach/science teacher, and the institutional requirements of the school. I emphasize the students' responses and feedback as they participated in the physical and written activities with the purpose to adapt them and enhance the student-activity interactions as we worked on this project. In addition, I include the language negotiations and adaptations that happened with those emergent bilingual students in English and Spanish. In this light, negotiations are a necessary part of developing innovations as well as establishing programs (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003), and design-based implementation research is a helpful approach designed to enhance processes and solve problems. In regard to the negotiation process, Penuel et al. (2013) argue for the use of the trading zone concept in which people agree on rules of exchange that will affect their collaborations to start a social practice. Since my theoretical framework is assemblage theory, I also extend the use of this concept to how the physical space, the weather, and other physical objects modified the activities. Thus, descriptions involving considerations of which soccer balls to use and how to arrange students, or the use of clipboards and what to do on rainy days, were not secondary to this analysis, for they directly affected the direction of this research process and as material aspects of the assemblages, participated in every activity.

In chapter four, I focus on the modifications I made with my research process as it was approved by the Institutional Research Board, my university advisors, and the science teacher/soccer coach at the Bear Hill Middle School. Then, I study the research process of implementing the soccer with science activities and the interviews and other conversations with participants that also affected the research investigation process.

In conclusion, the structure of this dissertation is as follows: the first chapter is an overview of my work in the LISELL-B project and how this work led me to each part of the dissertation. Chapter two starts with the science teachers as architects investigation that makes visible the student-space learning interactions and fostering of the students' learning territories. In chapter three, I placed the soccer and science article that discusses the engagement of emergent bilingual students in learning science by using their passion for the activity of soccer. The following article in chapter four describes my experiences as a science teacher/researcher/curriculum developer working with a science teacher/soccer coach and the emergent bilingual students implementing the soccer with science activities. The last part in chapter five includes discussion of conclusions, limitations, and further research.

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CHAPTER 2

SCIENCE TEACHERS AS ARCHITECTS:

BUILDING AND SUPPORTING SCIENCE-LEARNING ENVIRONMENTS WITH EMERGENT BILINGUAL STUDENTS[2]

[2] Vazquez Dominguez, M., Allexsaht-Snider, M., and Latimer, A. *Accepted by The Journal of Science Teacher Education.* Reprinted here with permission of publisher.

Abstract

This chapter focuses on the importance of including emergent bilingual students' cultural practices in the science learning process at a time when there is a growing diversity in schools, inadequate preparation for science teachers to address diverse students' needs, and a pressing demand for science, technology, engineering, and mathematics (STEM)-prepared professionals in society (Gordon & DeBard, 2014). We describe work that took place during a two-week student summer academy, part of the Language-rich Inquiry Science with English Language Learners through Biotechnology (LISELL-B) project. In this setting, science teachers, Latino/a emergent bilingual students, English for Speakers of Other Languages (ESOL) teachers, and university researchers collaborated to create and promote science investigation projects in an outside-of-school science learning environment. In addition, we address how science teachers are adopting and adapting these projects by incorporating the project's science investigation practices into their classrooms. We use an architectural perspective (De Landa, 2010) to study how these elements connected in order to provide a set of recommendations for future and current science teachers who are facing challenges and opportunities posed by demographic, policy, and curriculum changes in the schools.

Introduction

Science teachers play a crucial role in fulfilling societal goals for a better educated and prepared citizenry (Gordon & DeBard, 2014), but they face a range of challenges, such as policy reforms that narrow the curriculum toward what is most easily assessed (David, 2011), as well as the changes in racial, ethnic, linguistic, and socioeconomic demographics in the classroom (United States Census Bureau, 2014) and concerns about how emergent bilingual students[3] perform on standardized assessments (National Center for Education Statistics, 2014). In this light, as teacher educators in the Language-rich Inquiry Science with English Language Learners through Biotechnology (LISELL-B[4]) project we have collaborated closely with 50 middle and high school science teachers and teachers of English to speakers of other languages (ESOL) across 10 schools with 4000 students over the past two years. In this collaboration, we, a Mexican teacher educator now studying teacher education, a teacher educator with extensive experience in México and working with Latino/a families in the U.S., and an industrial scientist in the area of biotechnology now studying teacher education, functioned as part of a larger team of teacher educators, researchers, and teachers. The team co-constructed science materials and learning environments that integrated science and emergent bilingual students' language and cultural practices inside and outside school settings. The LISELL-B project's pedagogical practices are embedded in five professional learning contexts: A summer teacher institute, a student summer academy, 'grand rounds' classroom

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[3] In this chapter, we use the term *emergent bilingual students* to emphasize the positive attribute of having a home language that is a resource that we believe should be used, maintained, and strengthened.

[4] The work has been supported by the National Science Foundation (award # DRL-1316398)

observations, bilingual 'Steps to college through science' family workshops, and teachers' exploration of students' writing workshops. In this chapter we will discuss how the *Teacher Institute* and the *Student Summer Academy* were designed as interactive learning environments for science teachers and their emergent bilingual students and how these two contexts helped teachers meet the challenges posed by current policy related to standards, assessments, and teacher evaluation.

The Context of the Teacher Institute

The LISELL-B project works in middle schools and high schools where rapidly growing populations of emergent bilingual students, mostly of Latino/a descent, range from 30% to 50% of the total school population. In collaboration with two school districts, we identified participating schools and then invited science and ESOL teachers to participate in the project. Teacher participation in the teacher institute and in the student summer academy was voluntary; a total of 29 teachers participated. Of these 29 teachers, 24 were women and 27 were white (one was Latina and one male teacher was from China). These teachers then participated in the process of recruitment of the emergent bilingual students who attended the student summer academy. In this way we brought together students and teachers who had worked together in classrooms during the previous school year.

Teachers from the different schools began working in four teams: Earth science, middle school life science, high school life science and physical science groups, depending on what they taught in their home school. In collaboration with teacher educators and in preparation for the upcoming summer student academy, teachers began to design science investigations that incorporated one of the six LISELL-B *language of* *science investigation practices* (coordinating hypothesis, observation and evidence; controlling variables to design a fair test; explaining cause and effect relationships; applying general academic vocabulary in context; developing models to construct explanations and test designs; and owning the language of science).

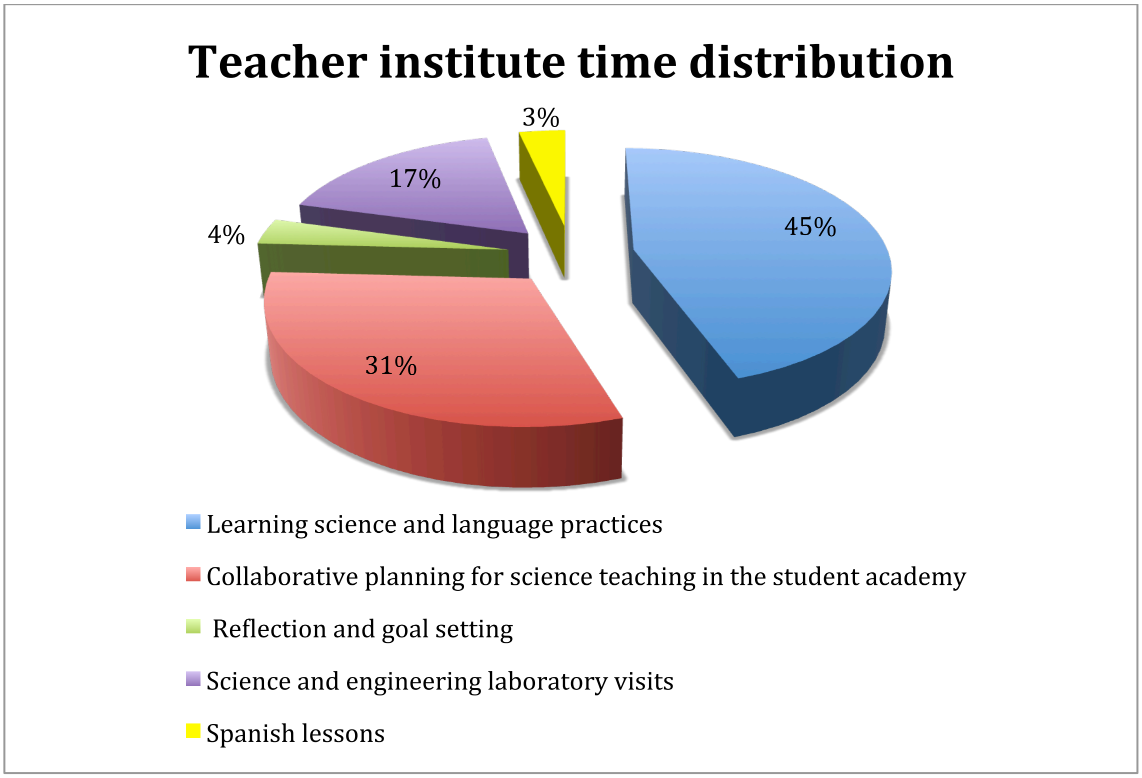

Figure 2.1 Teacher institute and the distribution of activities

Teachers in the institute, that included a total of 28 hours distributed across four days, took part daily in five major activities: Learning LISELL-B science investigation and language practices, collaborative planning for science teaching in the student academy, reflection and goal setting, science and engineering laboratory visits, and Spanish lessons, as shown in Figure 2.1.

The Context of the Student Summer Academy

The eight-day student summer academy was developed in conjunction with science teachers, ESOL teachers, and teacher educators. An average of 70 students attended the summer academy each day, spending four days on each of two different college campuses, which are located one hour away from each other. As we have noted, students in the summer academy came from schools with large and growing Latino/a populations. Between 70% and 80% of the total student population in these schools qualifies for free or reduced price lunch, and the National Assessment of Educational Progress (NAEP) scores for the participant schools is slightly below the national average.

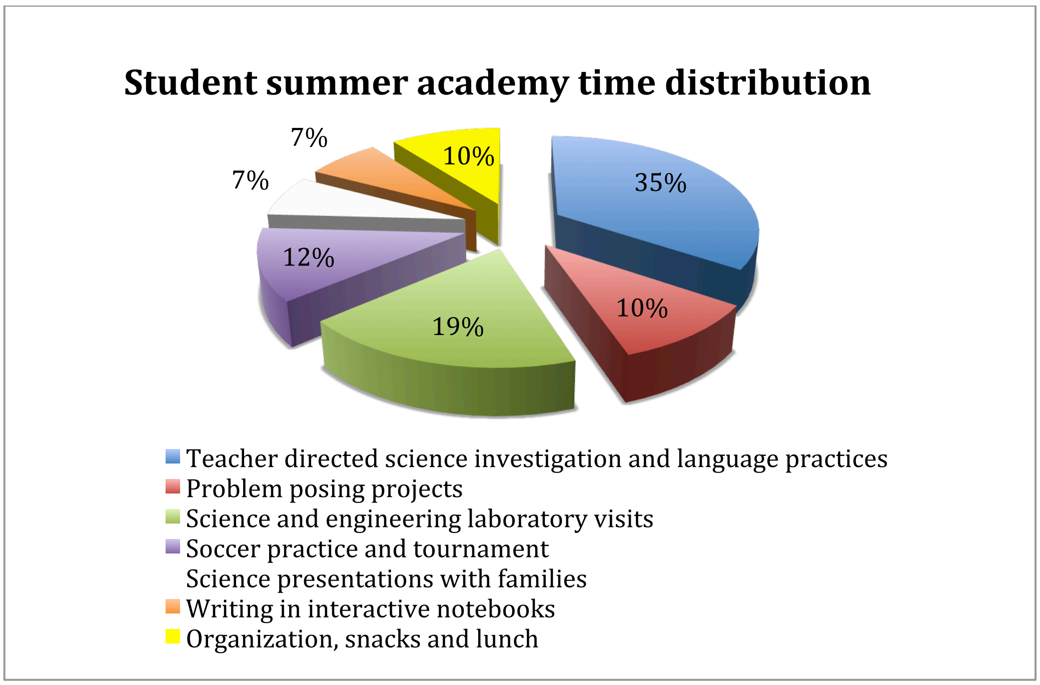

Figure 2.2 Student summer academy time distribution

The emergent bilingual students who participated in the student academy engaged in five types of activities distributed across 58 hours of the academy as shown in Figure 2.2. These activities were: Teacher-directed sessions incorporating LISELL-B science investigation and language practices (where students were grouped based on their grade level and science interests), problem posing projects, science and engineering laboratory visits, problem posing presentations with families, and a soccer tournament (in these other activities students were in mixed groups across grade level and school).

The Model of Professional Learning

The LISELL-B project team developed the professional learning model for the teacher institute linked to the student summer academy in recognition of the current contexts of the participating schools as well as broader aspects of the changing needs of students and teachers, both in U.S. schools, and internationally. The general characteristics evident in the educational landscape for Latino/a students are: (a) international assessments showing that Latino/a students continue to underperform in science (Organisation for Economic Co-operation and Development, 2013); (b) teacher workforce demographics showing that the majority of U.S. teachers (almost 77%) is White, non-Hispanic (U.S. Department of Education, 2004); and (c) research showing that most teachers feel unprepared to address different ethnicities in their classrooms as well as children from low socioeconomic status (Milner & Laughter, 2015), especially in science classrooms where many teachers consider science as culture-free (Lee & Buxton, 2011). As we imagined possibilities for teacher learning, we considered what we had learned in our initial LISELL project (Buxton, et al., 2015) about how these trends were both constraining and opening up opportunities for us as teacher educators and for the science and ESOL teachers and the emergent bilingual students in the schools where they taught.

In this light, we designed the *teacher institute* with two main goals: (a) to support teachers in learning how to engage emergent bilingual students in science by bringing language and cultural practices and LISELL-B science investigation practices into science learning environments, and (b) to increase and foster teacher experimentation using different teaching practices designed during the teacher institute to build learning environments with emergent bilingual students that could be adapted into teacher routines and activities in their own science classrooms during the regular school year. The *student summer academy* was designed to accomplish three main goals: (a) to foster teacher-teacher, teacher-student, and teacher educator-teacher-student collaboration; (b) to enact, adapt, and adopt the LISELL-B science investigation and language practices; and (c) to use the spaces of college campuses to construct learning environments that could be transformed into learning territories building on emergent bilingual students' language and cultural practices and fostering robust science learning[5].

Below, we begin with a description and analysis of the activities during the teacher institute followed by explication of the activities of the student summer academy. Due to space limitations, we will only include selected samples of the resources used during the institute and the academy, as well as samples of the teachers' and students' work. Both the teacher institute and the student summer academy can be conceptualized using an architectural metaphor consisting of learning environments that involved both *material* and *expressive* components (De Landa, 2006). For De Landa (2006), material components are the physical elements (e.g., bodies, science equipment, soccer balls) and

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[5] We use the term *space* to refer only to a physical setting; we use the terms *environment*, *context*, and *territory* to refer to the combination of a physical setting and the corresponding social elements (e.g., interactions between people, institutions, and larger social organizations). We further differentiate between territory and environment or context by claiming that the creation of a territory requires a different (and more intentional) relation between the space and the social settings than is the case for a context or environment.

expressive components are both the linguistic (i.e., language and symbols) and nonlinguistic elements (e.g., gestures, postures) in an environment. We used this architectural framework to consider what Didakis and Phillips (2013) (following Heidegger) have described as the difference between a house (which is inhabited) and a home (which is dwelt in), in conceptualizing the design of teacher and student learning contexts in the LISELL-B project. According to Heidegger, for a house to become a 'home' it needs to go through a process of additive interactions that serve to build an experience between the individual and the space until the architectural space "becomes an extension of the inhabitant, absorbing preferences, customs and rituals" (Didakis & Phillips, 2013, p. 308). We found this metaphor useful in conceptualizing our work in that we actively encouraged the consideration and incorporation of emergent bilingual students' language and cultural practices in both the teacher institute and summer academy contexts, seeking to foster a sense of teachers and students dwelling in these purposefully constructed and linked environments.

The daily interactions that took place in the summer academy on university campuses among the emergent bilingual students, their science and ESOL teachers, and teacher educators, typically started with an experience that supported the emergent bilingual students in contemplating the possibility of dwelling within these spaces as future university students. In order to reinforce our goal for the science teachers to think about how the emergent bilingual students might dwell in university spaces, we constructed learning environments that allowed science teachers and emergent bilingual students to explore science learning using the varied spaces around them. Thus, we provided teachers and students with the opportunity to turn indoor and outdoor spaces, i.e., classrooms, science labs, halls, conference rooms, and soccer fields, in these university contexts into learning territories.

In the following example, we explain how we came to see the conceptual difference between a learning environment and a learning territory. First, we consider the relationship between dwelling and constructing (Heidegger, 1975) as these concepts connect a learning process to a physical space. It is also important to know that a space, an environment, or a context becomes a territory only when an individual inhabits it and adds an expressive component to that space. The function of an expressive component is achieved when using and possessing the space so it has a signature of the possessor (Bogue, 2007). In general, expressivity consists of two elements, the nonlinguistic part and the linguistic one (De Landa, 2006; Deleuze & Guattari, 1987). In the case of science learning environments, these aspects of expressivity can take the form of meaningful written and oral communication such as reporting observational data, stating hypotheses, and explaining cause and effect relationships (linguistic elements); as well as in the creation of charts, diagrams, sketches, or models (nonlinguistic elements) to support scientific thinking and meaning-making.

To better support science learning and communicating in the student academy, we (both teacher educators and science teachers) also needed to consider the material component of how we worked with emergent bilingual students in the university classroom settings. Material and expressive components come in mixtures and are always embedded in processes (De Landa, 2006). For example, a written science lab report, when linked to a science investigation, includes both expressive and material elements.

We wished to question and explore how expressive components were reflected in the learning spaces of the LISELL-B student academy.

To continue with the example of a written science lab report, common in most science classroom settings, students are typically asked to respond to a previous activity they have completed by explaining their ideas or findings. In our classroom observations of LISELL-B teachers during the regular school year, we have typically seen teachers explain what needs to be included in the lab report to the whole class, then have students work individually or in pairs doing their written lab reports, and then either (a) the teacher gathers the reports to grade them, or (b) asks the students for answers to compare with the rest of the class. We wish to distinguish between viewing a written report as part of a learning environment, and viewing this activity as part of a learning territory in which students learn to express, construct, and dwell within the science classroom. In the first case, where the science teacher gathers the lab reports to grade them later, the student's expressive understanding of the lesson is not maintained in relation to the space around her, but has been shifted to a different relation in which the teacher now has a primary role and the space has a secondary role in regard to the student's learning process. In the second scenario, where the students compare their work with their peers, the social interaction is an additional linguistic element of support for students' learning process; however, the process still does not support students *dwelling* in the science learning space. For some students these learning practices are enough to support scientific meaning making, but for other students creating an additional relationship to the space might be necessary to support science learning. In the student academy we collaborated with teachers to consider what these additional relationships to the learning space might entail.

In order to improve the science learning process as well as to territorialize the learning environments in the institute and academy, we consider how the production of artifacts and the use of space may or may not allow emergent bilingual students to transform a space into a learning territory, and by extension, provide students with sufficient opportunity to dwell in these spaces. There cannot be a learning territory without a learning environment, but there may be a learning environment without a learning territory. Purposeful use of the space and creation of ways for students to communicate about their work and relate to it can facilitate the construction of a learning territory, which also depends on the teachers' promotion of the student-space interaction. We argue that by including cultural practices in the learning process, we can help emergent bilingual students to dwell within their science classrooms. For instance, including emergent bilingual students' home language in the written activities and in materials displayed throughout the science classroom can help link the students' learning process to the space and turn it to a learning territory by emphasizing the students' expressivity using language familiar to them. When activities that strengthen a learning territory are presented with sufficient frequency, they support students in domesticating the science activities and the space around them. As Didakis and Phillips (2013) suggest, domestication is an accumulative process of interactions between the space and the student that builds "meaning, affection and emotion" (p. 308). Science teachers can promote the domestication of science classrooms by increasing the space-student interaction through science activities using the emergent bilingual students' cultural resources.

In the following sections, we describe the implementation and the outcomes of the teacher institute and the student summer academy and how science teachers and emergent bilingual students went on to inhabit and glimpse these spaces as possible learning territories, where they might dwell.

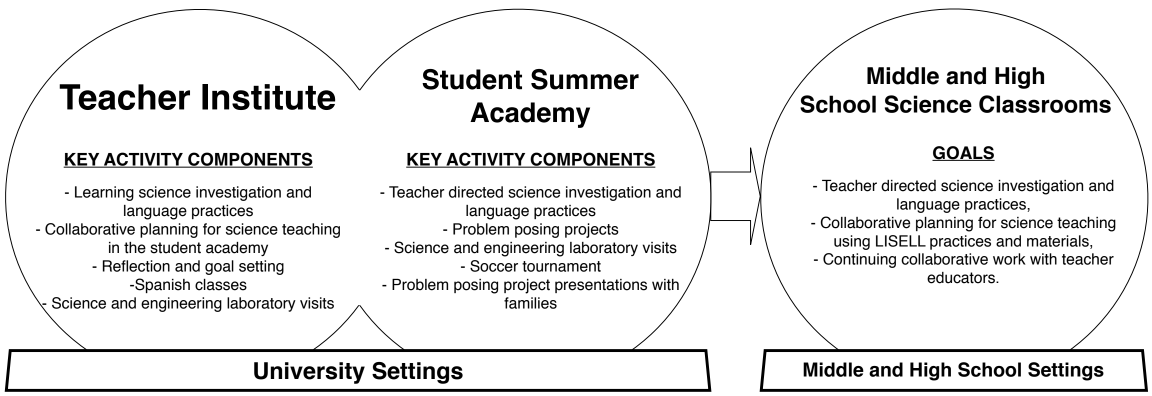


Figure 2.3. Constructing possibilities of learning territories for emergent bilingual students

We conceptualized the process of dwelling in these spaces as only possible if the inhabitants (teacher and students) domesticated them. We considered that incorporating cultural practices, such as home languages (García & Kleifgen, 2010) and family and community practices (González, Moll, & Amanti, 2005; Gutiérrez & Rogoff, 2003), that have proven to promote learning with emergent bilingual learners, could facilitate this process of domestication for LISELL-B participants. The cultural practices we incorporated in the LISELL-B project were based on activities that our Latino/a students practiced regularly; for example, the use of Spanish language and connections to soccer as a communal practice. This theoretical framework that we have described led us to two driving questions:

1. What are the lessons learned from utilizing an architectural perspective to make sense of science and ESOL teachers' work in an outside-of-school learning environment for emergent bilingual students?
2. How can those lessons be adapted by science and ESOL teacher educators designing dynamic learning opportunities for current and future teachers committed to language-rich science learning for all of their students, including their emergent bilingual students?

Implementation of the Teacher Institute and Student Summer Academy

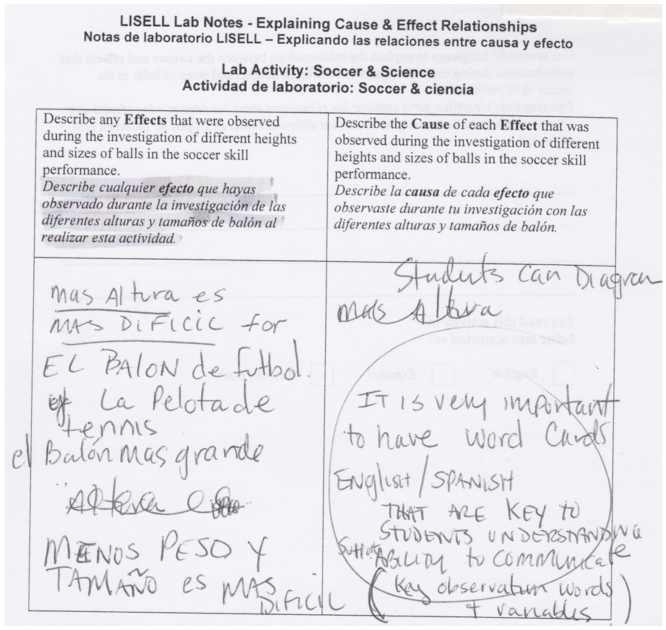
How to start this process of constructing supportive teacher professional learning contexts promoting language-rich science learning environments for middle school and high school emergent bilinguals? After observing a number of our project teachers' science classrooms in these past two years we found that many teachers are already using, to varying extents, some of the practices needed to build productive learning environments for their emergent bilinguals. We have also noticed that teachers' use of these practices often focuses more on the content of the lesson than on the students' cultural practices and strengths. If science is not culture-free, as Lee and Buxton (2011) suggested, then science content along with the science standards can be linked to students' cultural practices. To this end, we begin by describing the science investigation practices and resources developed in the teacher institute, that were later utilized in the student summer academy, that included the emergent bilingual students' language and cultural practices. Figure 2.3 shows the relationship between the activities and goals of the teacher institute and the student summer academy in which science teachers and

ESOL teachers worked together to use the resources and practices necessary to create learning territories.

Daily sessions at the ***Institute*** provided teachers with opportunities for learning about the LISELL-B model for developing the language of scientific investigation practices and how this model and its practices support national and state science standards (Buxton et al. (forthcoming) describe these practices in detail). For our purposes, it is enough to say that these practices help teachers to engage all students, and particularly their emergent bilingual students, in developing the process of thinking scientifically and communicating scientific ideas using the language of science. Teachers also learned how their current teaching in the science classroom could be adapted to this model to better meet the needs of their students while still addressing curricular standards.

As a first step, teachers took part as students in a science investigation activity where directions and explanations were in Spanish with bilingual language supports such as concept cards (explained below), general academic vocabulary cards, and talk moves/language frame guides that provided relevant sentence stems to be used orally and in writing to articulate understandings using the language of science (illustrated in Figure 2.5 below).

The goal of this activity was to help teachers empathize with their emergent bilingual students while considering how to balance existing science curriculum requirements with students' linguistic needs and the supports they could make available in their classrooms. The teachers in the Institute were asked to write their ideas and answers in Spanish as they collaborated with other science and ESOL teachers during the soccer and science investigation[6] titled 'Explaining cause and effect-Ronaldinho controlling the soccer ball' science investigation as shown in Figure 2.4.



LISELL Lab Notes - Explaining Cause & Effect Relationships
Notas de laboratorio LISELL – Explicando las relaciones entre causa y efecto

Lab Activity: Soccer & Science
Actividad de laboratorio: Soccer & ciencia

Describe any **Effects** that were observed during the investigation of different heights and sizes of balls in the soccer skill performance. *Describe cualquier **efecto** que hayas observado durante la investigación de las diferentes alturas y tamaños de balón al realizar esta actividad.*	Describe the **Cause** of each **Effect** that was observed during the investigation of different heights and sizes of balls in the soccer skill performance. *Describe la **causa** de cada **efecto** que observaste durante tu investigación con las diferentes alturas y tamaños de balón.*
mas Altura es MAS DIFICIL for EL BALON de futbol. ~~ef~~ La Pelota de tennis el Balón mas grande ~~Altura~~ MENOS PESO Y TAMAÑO es MAS DIFICIL	Students can Diagram mas Altura IT IS very important to have word Cards English/SPANISH THAT ARE KEY TO STUDENTS UNDERSTANDING Support ABILITY to communicate (Key observation words + variables)

Figure 2.4 Teacher's second page of the soccer with science activity

In this activity, teachers read an investigation guide and looked for clues as they highlighted the Spanish text that helped them understand and carry out the investigation and record their ideas (see Figure 2.4). Figure 2.4 also shows how a White non-Hispanic female science teacher wrote a note on the second column of the table she filled out as part of the investigation that reads, "It is very important to have word cards English/Spanish that are key to students' understanding," and "support ability to communicate," as she was finishing recording her notes in Spanish about the investigation. As they experienced learning in a second language, similar to the situation in which many emergent bilinguals are placed, teachers recognized the need to use

[6] These investigations were co-developed with a science teacher who was also the soccer coach at one of our participant schools. Most students on the soccer team were emergent bilingual students of Latino descent.

cultural practices such as home languages in their classrooms. They also saw the utility of specific resources, such as *concept cards* with important concepts written in both English and Spanish, explanatory graphics, and carefully crafted student-friendly definitions, and *general academic vocabulary cards* with non-discipline specific academic vocabulary, to support their emergent bilingual students in their learning process. These cards are just two of the scaffolding resources within the LISELL-B science investigation kits (see Buxton et al. forthcoming) that also include language booster texts, lab materials, scaffolded science investigation guides, role cards, and talk move/language frame guides.

In the second type of session in the teacher institute, *the collaborative planning for science teaching in the student academy*, science teachers from different schools who teach the same grade level and ESOL teachers gathered together to brainstorm ideas about adapting their current practices and lesson plans and constructing new ones using the LISELL-B pedagogical model. This exercise helped teachers to incorporate the LISELL-B language of science investigation practices into their planning, and to share their experiences working with emergent bilingual students in the science classroom while considering students' academic strengths, cultural and language practices as resources, and challenges. During the institute, teachers co-designed science investigation activities planned for the student academy using classroom resources such as posters that described language frames for communicating their scientific ideas through the six LISELL-B language of science investigation practices (coordinating hypothesis, observations, and evidence; controlling variables to design a fair test; explaining cause and effect relationships; owning the language of science; using models to construct explanations and test designs; see Figure 2.5 for examples). Two additional posters were designed to highlight classroom norms for supporting a culture of science investigation and talk moves for promoting productive science discourse.

Language frames for Explaining Coordinating Hypothesis, Observation, and Evidence

Teacher Language Frames

- Based on your knowledge of science and other life experiences, what do you think will happen? Why?
- What observations could you make to test that idea?
- What evidence would support your hypothesis?
- What evidence would disprove your hypothesis?
- How can you use your observations as evidence to judge your hypothesis?
- Based on your observations and evidence, can you make a new hypothesis?

Student Language Frames

- Based on my experience with ______, my hypothesis _______.
- I can observe/measure ____ to find out _____.
- Evidence that would support my hypothesis is _______.
- Evidence that would disprove my hypothesis is _______.
- Based on my observations that ____, the evidence supports/does not support my hypothesis because _______.
- Based on the evidence from my observations, a new hypothesis I have is _____.

Explicando la Coordinación entre la Hipótesis, Observación, y la Evidencia usando marcos de lenguaje

Marcos de lenguaje para los maestros y maestras

- Basándose en tus conocimientos de ciencias y otras experiencias de vida, ¿qué crees que va a pasar? ¿Por qué?
- ¿Qué observaciones podrías hacer para probar esa idea?
- ¿Qué evidencia apoyaría tu hipótesis?
- ¿Qué evidencia refutaría tu hipótesis?
- ¿Qué te dicen tus observaciones acerca de tu hipótesis?
- ¿Cómo puedes utilizar tus observaciones como evidencia para juzgar tu hipótesis?
- Basándose en tus observaciones y la evidencia, ¿puedes hacer una nueva hipótesis?

Marcos de lenguaje para los Estudiantes

- Basándose en mi experiencia con ________ mi hipótesis es __________.
- Yo puedo observar/medir _________ para encontrar que __________.
- La evidencia que apoya mi hipótesis es __________________________.
- La evidencia que refutaría mi hipótesis es ________________________.
- Basándose en mis observaciones que son ____________, la evidencia apoya/refuta mi hipótesis porque ______________________________.
- Basándose en la evidencia de mis observaciones, la nueva hipótesis que tengo es ____.

Figure 2.5 Example of Language Frames posters in both English and Spanish

The third activity in the teacher institute, *reflection and goal setting*, provided opportunities for teachers to think about the knowledge, practices, and resources they were learning about; and then consider how these could be included in spaces such as the student summer academy and their regular science classrooms. Through this reflective process, the teachers were coming to see that the science learning spaces that they control can evolve into learning territories, if they become an extension of their emergent bilingual students' learning processes, that is, if the classroom captures the affectivity, emotions, and interests of the students who inhabit it (Didakis & Phillips, 2013).

The *science and engineering laboratory visits*, the fourth activity in the teacher institute, supported the teachers in thinking about the connections between the LISELL-B pedagogical model, the middle and high school science curriculum, their emergent bilingual students' pursuit of college and career pathways, and the student summer academy. These teacher laboratory visits also provided previews for the laboratory visits that the students in the summer academy would participate in; the specific goals for the student lab visits are described in the next section regarding the Student Summer Academy.

The fifth activity in the teacher institute, daily *Spanish language lessons*, functioned as a language support and as an informal bonding experience for both the science teachers and the ESOL teachers. Here, teachers, according to their personal experience and needs, learned basic Spanish words and phrases with the goal of communicating with and building stronger relationships with their emergent bilingual students and their students' families.

The activities of the teacher institute were co-designed and put into practice by a group of teacher educators and teachers who emphasized collaboration and group work. Not only did this collaboration between science and ESOL teachers and teacher educators enhance the richness of each activity by incorporating different perspectives, but it was also an opportunity to share and learn from each other's experiences working with emergent bilingual students as lessons were collaboratively planned. As a consequence, the design of the student summer academy was based on enriching science content knowledge, supporting curricular requirements, and validating emergent bilingual students' linguistic and cultural practices connected to the local context, at the same time as it incorporated the LISELL-B pedagogical practices. The student summer academy offered teachers a more flexible space to try new activities and approaches when compared to that of their regular school year science classrooms.

In the ***Student Summer Academy****,* one central activity was the *teacher-directed science investigation sessions*, designed to put into practice the language of science investigations that the teachers planned during the teacher institute. An additional purpose was to evaluate the materials, directions, resources, and procedures they had developed so they could be further modified for classroom use. Many of these activities were developed into science investigation kits for teachers to check out and use in their own classrooms during the school year.

In the *problem posing project activity*, each student brainstormed three possible research/problem interests and posted them on the board (see Figure 2.6). After collecting and categorizing all the research/problem interests, students chose one to work on with one or two other students during the summer academy.

Figure 2.6 Students' problem posing project ideas

Students worked collaboratively, with support from teachers and mentors and using the LISELL-B language of science investigation practices, to set guiding questions, search for information about possible relevant causes and effects and variables, elaborate on findings, and construct presentations to share with families.

The goal of the *science and engineering laboratory visits* was to increase the emergent bilingual students' perspectives on science and engineering practices and professions as they participated in guided visits to different university laboratory facilities. These visits also helped students and teachers to connect current science research with science learning taking place in the summer academy. The group visited research labs in the departments of kinesiology, public health, and animal sciences; the college of engineering; and a microbiology research center.

After lunch, students went to the athletic fields to play soccer for 40 minutes a day. Boys and girls played soccer in mixed teams and some of them played soccer matches, while others just kicked the ball around the field. On the final day of the student academy we had *a soccer tournament* in which students, teachers, and teacher educators participated. The ambiance in the tournament, incorporating an important informal cultural practice for local Latino/a communities, further encouraged the bonding process between teachers and students in the student summer academy.

At the end of each week, students had the chance to *present their problem posing projects to their families* before a shared dinner with teachers, students and families, as shown in Figure 2.7. In university classrooms, students used the language of science as they explained to the assembled families, peers, university researchers, and teachers their research/problem topic of interest, relevant causes and effects and variables they had identified, and ideas about next steps in their inquiry. Emergent bilingual students' audience engaged in conversations and asked the presenters about their topics and findings using their posters as support.

Figure 2.7 Emergent bilingual students presenting their science projects to family members

The Teacher Experience of Building Science Environments for Emergent Bilingual Students

A learning territory is in the process of construction when participants take active part in and collaboratively build the activities that occur in a particular space. As Heidegger (1975) suggests, we can dwell in these spaces only when we construct them and when we domesticate them. From this point of view, an architectural perspective allowed us, as teachers and teacher educators, to identify, conceptualize, and enact the processes incorporating material and expressive elements that became relevant for constructing learning territories where science and ESOL teachers supported emergent bilingual students in learning language-rich science investigation practices. Two crucial questions arise: How can teachers in different contexts work collaboratively with emergent bilingual students to build these learning environments? And, how can emergent bilingual students make the school classrooms their learning territories? Although each of these questions is framed from a different perspective, they both refer to activities that happen in the same space: the location where the learning occurs. The location is a necessity, that is to say, no learning happens without a location. However, the relation we have with a location depends on whether we use it as a learning resource or as something distinct from or extraneous to the learning process.

During the teacher institute and the student summer academy, three important processes were emphasized that supported the creation of learning territories. The first process was the importance of including students' home language as a resource for their learning, to which one science teacher reflected,

> I think that the LISELL[-B] program brings that ELL perspective that I am not familiar with. I didn't grow up, I didn't move to any state, I didn't move anyways… or I don't know anybody and I've never been to an area where they don't speak my language. […] So I've never been in a situation where I cannot bridge a way of communicating and I think this program really brings this perspective that allows me to see how to bridge that gap and what strategies I can use to help those students, that are ELL students, to feel more comfortable in the classroom.

The second process in the teacher institute that was important for creating learning territories emphasized the use of science inquiry along with the structure of the LISELL-B pedagogical model to design science investigations for teachers' own classrooms, to which one of our teacher participant shared,

> I think the [LISELL-B] practices are really great because they provide that inquiry-based learning to the kids… As a teacher, to highlight those practices within the units has been very helpful, so I know that when I do a lab that has variables, and then I make sure to highlight those practices, which are now incorporated throughout our lessons. Cause and effect is a topic that I am now more intentional when I use those words, so being through this program has

> allowed me to think more about my planning and how I am going to phrase the lesson and use the wording in the lesson, make sure I highlight, for example, the cause and the effect nicely, because sometimes they get those two switched easily.

The third process we stressed in the institute for creating learning territories was the use of the particular learning space as a key element to the learning process, especially for the emergent bilingual students, with the purpose of supporting students in domesticating the space they inhabit. In this light, another teacher shared that, "The communication component is the most important for me. The sentence starters that you showed in the posters are very useful for me. I think I can use them in my classroom." Another example is the general academic vocabulary and concept cards as mentioned by the science teacher in Figure 2.4. This shows teachers thinking about how to prepare the classroom learning space to be ready to interact with and be used by students, but this material element has to be systematically included and utilized in the activities in the class so that students domesticate their use and the location where the material elements are being provided. Another science teacher added,

> I think that participating in the LISELL-B project has helped with pushing a focus on the vocabulary that it didn't necessarily happen before, so, understanding the importance of breaking down vocabulary into the root words, showing students how to interpret phrases or modeling that, using the Spanish-English interpretations, and focusing on particular vocabulary words instead of the majority of it, because in science we have a very large vocabulary to be able to focus on maybe six of the most [important], I think it has really encouraged me in my classroom to take those tools and skills and make sure that I am always thinking with my ESOL hat on or think about my ELLs that I don't necessarily… I didn't have that on before I entered into this program.

With these three processes, science and ESOL teachers had the chance to collaborate in learning, designing, and enacting the LISELL-B language of science investigation practices with other middle and high school teachers and teacher educators and to plan for integrating those practices into their own classrooms. When teachers design and put into practice the different elements of the LISELL-B pedagogical model, they go through a similar process to that of the students when they build a learning environment, one that will allow them to support all students and especially emergent bilingual students in their learning process, a necessary step to building a learning territory. As one teacher mentioned, “So what we are doing is translating this very dense language not just only for newcomers but for everybody. And to me all the LISELL-B [activities] are very sound educational practices for all, regardless of the language ability. It is good teaching,” and he continued, “It’s just like the soccer activity in Spanish… I get that now.”

Results and Implications

Our research with the professional learning components of the LISELL-B project confirms and expands on the assertion that educators committed to equity for all of their students do not and cannot work in isolation (Allexsaht-Snider & Hart, 2001). It also shows that science teachers can play a critical role in designing and implementing the use of science investigation activities, group work, bilingual materials, and resources for supporting their emergent bilingual students. This approach serves to structure the classroom setting to promote science thinking, the use of the language of science in communication about science learning through investigations, and science collaboration with other peers. In this light, science teachers especially benefited from using the LISELL-B pedagogical model with the emergent bilingual students in the summer academy, as this model aided teachers in building a bridge that provided continuity in applying the practices in their classrooms during the school year. For instance, a 6th grade earth science teacher shared that,

> I think these investigations are really beneficial for these students because they have to be engaged and do things in the classroom […] so we are constantly taking what we learned and using these investigation practices in our classroom, whether it is the language boosters, or practices like cause and effect and the variables. Practices that we put together within the activities that we do in the classrooms.

Moreover, this model helped both the emergent bilingual students and the science teachers to connect their science knowledge, interests, and practices to the laboratory visits and industrial practices in science. In regard to how teachers think about connecting and enacting these practices in higher education institutions where this student academy took place, one participant noted,

> We are seeing them [the emergent bilingual student population] staying and hanging on because they know that, one, they are intelligent, and two, they see their peers going to college. This program we all are involved in, it is one of the best things that shows them that there are many colleges and I think these kids realize that there are more opportunities available to them and there is a lot of opportunities in science, technology. And a lot of our kids are good at, I mean, we do a lot of labs and a lot of our ELLs are really good at doing things, making things… nonverbal communication. And I think as they learn the language of science they realize that, man, I am good at this, I can do this, I can make a living in this. I think that opens up more opportunities.

In order to understand and work toward change in the current educational landscape, the use of an architectural perspective can provide the tools for science teachers who are looking to balance their students' educational needs with curricular demands by strengthening connections between secondary and postsecondary educational institutions and other resources in the community.

Too rarely do emergent bilingual students have purposeful experiences that involve visiting a higher education setting such as a university or a science or engineering laboratory under the guidance of science teachers and university educators. We recommend that science teachers continue to build stronger connections to post-secondary institutions and organize visits for all their students, but in particular for their immigrant and emergent bilingual students, to higher education settings and laboratories. An architectural perspective highlights how such experiences benefit science teachers by supporting the propagation of inclusive science learning environments for all students, while also offering a richer experience to continue learning about industrial and other career sectors where employees with STEM expertise are in demand.

When science teachers actively participate in programs where they bring and use their knowledge, ideas, and experience to design and implement new educational practices in safe spaces, the chances of adopting and adapting these practices in their school classrooms increase. This finding is supported by the current high demand for the LISELL-B science investigation kits in the school classrooms. At the same time, when emergent bilingual students experience these science practices using their language and cultural practices as learning supports, the chances of incorporating new knowledge also increase. The purposeful university and laboratory visits also reinforce the possibilities of students dwelling in these higher education spaces while linking science learning to career practices. That is, the purposeful visits link an idea, an experience, and a practice to a space where those experiences are used and valued.

Challenges still exist in creating and sustaining initiatives that support science teachers in better meeting the needs of emergent bilingual students. These challenges include: coherent integration of out-of-school experiences with the regular science classroom settings, collaborating in the implementation and elaboration of science investigation kits for classroom use, engaging and supporting families in science learning and college preparation, connecting middle and high school science education to college and science careers, and promoting the use of both English and Spanish to support powerful science learning for emergent bilingual students who speak Spanish. More research and development work is needed, in a wide range of contexts across the United States and in other countries educating multilingual populations. We hope that what we have learned along with the teachers and students in the LISELL-B project can help others to construct viable and sustainable models for supporting current and future science teachers towards these goals.

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CHAPTER 3

"I KNOW HOW TO PLAY SOCCER SINCE I LEARNED HOW TO WALK": CONNECTING LATINO MIDDLE SCHOOL STUDENTS' PASSION TO SCIENCE LEARNING IN ENGLISH AND SPANISH[7]

[7] Vazquez Dominguez, M., Allexsaht-Snider, M., and Buxton, C. Submitted to *Journal of Latinos and Education,* 4/12/2016.

Abstract

Building on a pedagogical model designed to support the teaching and learning of the language of science investigation practices with middle school emergent bilingual learners, we developed a series of soccer and science investigations to promote interest and engagement in science learning. We used assemblage theory to study how students made sense of their experiences and acted within this bilingual curriculum situated in an afterschool soccer practice context. We found that soccer, a passion for many Latino students, can be used as a cultural tool for science teachers to support emergent bilingual students' learning process. Implications for educators and researchers considering ways of integrating diverse students' cultural practices and passions with culturally sustaining pedagogies for science teaching and learning are discussed.

Introduction

Latinos/as are playing an increasing role in the social dynamics contributing to the growth of cultural and linguistic diversity in the United States, both in the workforce and in classrooms (Zong & Batalova, 2015). This is especially true for regions like the 'Deep South' where the ethnic composition was relatively stable until the late twentieth century (Levine & LeBaron, 2011). This panorama converges at a time when societal demands for science knowledge and skills are reflected in the current reform initiatives in science education (NGSS lead states, 2013; NRC, 2012), and are paralleled by calls for new science skills in the industrial sector (Gordon & DeBard, 2014). However, curricular changes in education have had only limited success in helping Latino/a students to succeed in learning science, at least in part because Latino/a cultural practices are rarely addressed in frameworks that continue to view science "as culture-free" (Lee & Buxton, 2013a) For this reason, in the research described here, we[8] (the three authors of this chapter) focused on cultural practices that have played an important role in the sociohistorical contexts of most Latin American countries.

Building on the pedagogical model we developed as part of a larger project to support the teaching and learning of the language of science investigation practices with middle school emergent bilingual learners (Buxton et al., 2015), we developed a series of soccer and science investigations to promote interest and engagement in science learning. The soccer and science investigations curriculum drew upon and extended the work of

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[8] The word "we" is used in this chapter to refer to the three authors who collaborated in designing the study and analyzing and interpreting the data. The lead author for this chapter, Max Vazquez, conducted the research in the field. At points where the experiences in the field are being described he uses the term "I" to refer to himself.

other educators who have argued for the importance of incorporating powerful cultural practices (Gutiérrez & Rogoff, 2003) such as the use of students' knowledge of Spanish (de Atiles & Allexsaht-Snider, 2002; Gutiérrez & Rogoff, 2003) and interests in sports like soccer (Bavoni Escobedo, 2014; Nadel, 2014) to develop culturally sustaining pedagogies (Paris, 2012). We used assemblage theory (De Landa, 2006) to study, embody, and give voice to a new form of science teaching and learning as it unfolded over a seven week time period in a middle school serving high numbers of Latino/a immigrant students situated in a small city in the southeastern United States.

The goals for this research were to answer the following questions: (a) How did Latino[9] students engage in a project that integrated their cultural practices and passions for soccer with science learning in an afterschool program? And (b) In what ways might we as educators and researchers explore the potential for deepening understanding of material and expressive elements interacting in disruptive and homogenizing processes in the context of science learning situated in soccer practice?

Theoretical Framework

Drawing from De Landa (2006), and the readings he does from Deleuze and Guattari's work (1987), we use assemblage theory to experiment with and make sense of the connections between the diverse elements and processes in a complex landscape: Latino middle school students, science, English and Spanish, educational policies, soccer, science practices, parents' sociohistorical processes, and Latino/a cultural practices, among other features. For De Landa (2006), relations of exteriority characterize

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[9] We use the term *Latino/a* throughout the paper to include both males and females who identify as and are identified as of Latin American or Mexican cultural heritage and Spanish linguistic heritage, but when discussing the research, I use the term *Latino* because the context for the research was our work with a boys-only soccer team.

assemblages, in other words, assemblage theory allows the study of complex interactions between different elements of the assemblage, such as the sociohistorical contexts for the Honduran and Mexican parents of our participants, without essentializing or considering the system as closed. Assemblage theory provides the tools to explain and work with each of the elements combined in this landscape and the processes involved in these interactions. Moreover, assemblages facilitate the study of interactions among macro and microstructures, such as the links between the seemingly disparate elements of soccer practice outside of school and the science and English language learning goals that occur during the school day.

De Landa (2006) suggests that assemblages consist of the expressive-material axis and the territorialization-deterritorialization axis. Both dimensions are important for this study: The former defines the different roles of the expressive and material elements in the assemblage. In our case, these encompassed cultural practices such as an interest in soccer and the use of Spanish language for students, as well as the science educational contexts where students worked to develop language skills (e.g., reading, writing, and communicating) along with understanding and manipulating with science materials (e.g., bodies, soccer balls). The territorialization-deterritorialization dimension aids in the interpretation of the processes in which these elements participated, either by: (a) defining the limits of actual territories or (b) stabilizing or destabilizing the homogeneity of the system (De Landa, 2006). In the research presented here we apply only the second meaning and will refer to this function as stabilizing/destabilizing the homogeneity of the assemblage. In other words, along this axis, some of the expressive and material components of the assemblage may work to maintain its homogeneity while others may do the opposite by disrupting the equilibrium of the assemblage. In fact, according to De Landa (2006), the same component may exercise capacities to both disrupt and homogenize the assemblage. For instance, soccer and science activities can disrupt the way Latino students and science teachers approach science by enhancing their teaching-learning process, and, at the same time, the activities can reinforce soccer's' importance as part of Latino families' and communities' cultural practices outside of school. Here, because of the national origins of the families in our research, it is crucial, when constructing and interpreting this assemblage, to analyze how soccer plays a major cultural role in some Latin American countries like Honduras and México, but not necessarily in other countries like Puerto Rico and Cuba, where baseball is culturally more important. Therefore, cultural practices must be studied as historical processes, both broadly for each self-identified national and cultural group, and then specifically for each individual and family in order to avoid over-generalizing and stereotyping.

Assemblage theory also emphasizes experimentation to find critical thresholds for productive interactions, such as by connecting the learning of science with soccer activities with Latino students across different in-school and out-of-school learning environments. To this end, we built on the available research on curricular and professional development to support emergent bilinguals in learning science (Buxton & Lee, 2014; Janzen, 2008) and the research on cultural practices (Gutiérrez & Rogoff, 2003) and culturally sustaining pedagogy (Paris, 2012) to develop our soccer with science activities.

In regard to teaching science to emergent bilinguals, Buxton et al. (2013) suggest active, multi-modal, inquiry-based activities as strategies to support and enhance comprehension of science content and English proficiency. For this research, I mixed a variety of gestural, oral, and textual modes in the soccer with science activities to foster communication of students' knowledge and skills. This distribution between the gestural, oral, and textual modes allowed us to diversify the linguistic burden for Latino students and reinforced exposure to science across contexts (Buxton et al., 2013).

In order to identify thresholds for productive interaction, I used De Landa's (2006) notion that such thresholds depend on extensities and intensities, that is, zones that consist of extensive properties (e.g., area of a classroom, the volumes of soccer balls) and intensive properties (e.g., the passion of students for soccer and their experiences of soccer as a cultural practice). Following Deleuze and Guattari's (1987) claim that any society is defined by the ways in which people or institutions capture desire and incorporate that desire into social structures, I looked for different ways of directing desire into the learning structure of our project. To this end, I conceptualized the extensive and intensive properties of the research context to address how cultural aspects, passions, and educational goals might be connected and used in the soccer with science assemblage to promote different ways of approaching the learning of science and soccer for middle school students.

Methodology

Participants

Data gathered for this qualitative research comes from a seven-week study in which I collaborated with one eighth-grade science teacher who was also responsible for coaching the school's male soccer team of 24 students. He and I developed a series of 40-minute activities, where twenty minutes were spent in academic exploration, and the other twenty minutes were used to practice the soccer move and write the results. In addition to retrospective fieldnotes taken by the instructor/researcher (first author; referred to as *I*) following the activities, and the collection of student writings that were incorporated into the activities, initial and final interviews were conducted with four focal students, and interviews were also conducted with the fathers of those students. Interviews with students were recorded and transcribed verbatim and I took notes with the interviews with fathers for analysis. These interviews were used to learn more about the participants' backgrounds, hobbies, and interests in education. The second and third authors were co-researchers in analyzing the data and writing up the study (their voices are represented when the pronoun *we* is used). This paper reports on four focal students whose cases proved to be generative for our understanding of the range of material and expressive elements, as well as disruptive and homogenizing processes that were operating in the assemblages that emerged. In the discussion of the soccer with science activities, in several cases we quote the writings and talk of other participants, as they help to give a broad sense of the ways students were making sense of these activities. Information gathered from the interviews with the four focal students and their fathers was used to study the micro and macro historical processes that trace participants' reasons to migrate and histories with education and soccer.

The focal students were 14 years old at the time of the research. Each student was the first generation in the United States; their parents spoke Spanish at home; none of their parents had post-secondary education; soccer was a very important part of their lives in multiple ways (e.g., watching soccer leagues on TV, playing in local soccer leagues). These students were interested in science; but only Israel indicated an interest at the time of the study in going to college. Focal participants spoke and read in both English and Spanish during the interviews and soccer and science activities; due to space limitations we have only included the English or English translations in this paper.

The middle school was located in the northeastern part of Georgia in a small urban setting. According to ProPublica (2013) the socioeconomic condition of the student population and their families is such that 84% of students were eligible for free/reduced price lunch. The ethnic composition of the 640 students in the school in 2014 was: 52% African-American, 2% Asian, 33% Hispanic, 3% Multi-racial, and 10% White. The ethnic composition of the middle school soccer team was: 21 students of Latino descent, one African-American, one Asian American, and one Anglo student.

Data Collection

Students involved in the school soccer practices participated in six *soccer with science* activities, which followed a format derived from the classroom materials that we developed for the broader project focused on science teaching and learning. These six bilingual and multimodal lessons were structured around activities such as watching videos that showed famous soccer players performing soccer moves, students trying to learn the moves kinesthetically, and then working to understand the science behind those soccer moves.

All materials were prepared in English and Spanish to facilitate students' utilizing bilingual language practices as they made sense of the language of science. Students worked with partners to discuss the videos, read and talked about passages describing the underlying science concepts, practiced performing the physical activity, and then wrote their results. Students were encouraged throughout to use the full range of linguistic resources and to indicate when they had used English, Spanish, or a combination of both languages. Working with the science teacher/soccer coach and the researchers, students used these activities to learn about the following science investigation practices: coordinating hypothesis, observation and evidence; controlling variables to design a fair test; explaining cause and effect relationships; using general academic vocabulary in context; and owning the language of science. (for more details on the practices see Buxton et al., 2015; and, "LISELL-B," 2016).

Data Analysis

In this qualitative study, we analyzed data using methods that helped us code the different connections between the elements and interactions in the assemblage. For this, we used two different categories: predesigned and emergent codes. The former ones refer to the preexisting categories in the science activities (e.g., science practices), and the latter focus on the process of this study, for example, the interactions and modifications to the activities and the materials involved (e.g., the sequence and amount of questions in the activities and number of written responses requested). We describe these deductive and inductive analytical processes as we discuss our findings and elaborate on the implications.

Findings

We divide this section in three parts that will help to explain the chronology of the events and how they affected the process. The first part addresses the conversations with fathers and focal students and delves into the macro and micro forces that shaped our participants' sociohistorical understandings. In these interviews we were particularly interested in addressing topics like soccer, education, and fathers' and focal students' backgrounds (e.g., places of origin, education, work). The second part focuses on the analysis of some key excerpts from the *soccer with science* inquiry-based activities that were conducted during the team soccer practices. Finally, the last section of the findings addresses the conversations with focal students about their participation in these activities. In this third section we analyze focal students' feedback on what they liked and things they would modify on the *soccer with science* activities.

Sociopolitical Forces Impacting México and Honduras in the 1990s and Beginnings of XXI Century

The history of migration between México and the U.S. can be traced back much further than the last decade of the twentieth century, when these students' parents decided to migrate, but for the purposes of this paper it is enough to describe the social, political, and economic situation of México and the United States during the specific period between the North American Free Trade Agreement (NAFTA) and the 9/11 attacks, a significant time frame for the participants in our study.

Carlos Salinas de Gortari, the Mexican president, signed the NAFTA agreement among México, the U.S., and Canada in 1992 with the explicit goals of boosting the Mexican economy and reducing migration to the U.S. Nevertheless, things worked differently than expected in regard to agriculture and each country had a different agreement with the other two. Mexican agriculture was not able to compete against the industrialized agricultural sector of the U.S., and the Mexican rural workers could not do anything in the countryside to stop U.S. subsidized products from invading the Mexican markets. The combination of NAFTA's failure to improve rural working conditions in México, and México's economic crisis in 1995, resulted in the exacerbation of emigration from México during the 1990s and the beginning of the 21st Century (Blecker, 2014). Large numbers of people living in the Mexican states with a long history of migration and with social ties in the U.S. (e.g., Michoacán, Guerrero) decided to migrate to the U.S. in search of new opportunities after NAFTA (Durand & Massey, 1999). But the causes of migration also include the social ties between people living in México and those in the U.S. who often helped as links between the companies in need of workers and immigrants (Consejo Nacional de Población, 2001). Trade between the U.S. and México increased along with the migration process: "the estimated number of unauthorized Mexicans in the United States rose from 2.5 million in 1995 to 4.5 million in 2000" (Martin, 2005, p. 449), and then to 11 million in 2005 (Passel, 2005). The general characteristics of Mexican people migrating to the U.S. during this period can be described as people from rural places with low income and low education (Consejo Nacional de Población, 2001; Ho & Loucky, 2012).

Honduran people also started a process of steady migration beginning in the last decade of the twentieth century (*Sueños truncados: La migración de Hondureños hacia Estados Unidos*, 2003), as opposed to their neighbors in El Salvador, Guatemala, and Nicaragua who were in political conflict in the 1980s and started migrating to the U.S. during that period. The main reason behind the Honduran undocumented immigration process is the level of poverty in the country: 71% of the population is classified as low socioeconomic status and, according to Blanchard et al. (2011), 66% of those who decided to migrate can be characterized as having low levels of education, low income, and very little English ability.

Another aspect of the Honduran migration happened when hurricane Mitch struck the country in 1998, leaving approximately 700,000 people without homes, and 4.2 million people (70% of the country's population) without safe water (United Nations, 1999). Mitch destroyed the livelihood in both lowland rural and urban areas: tobacco and banana crops were devastated, the land was left useless, and animals were killed and lost (Reichman, 2011; United Nations, 1999); in urban areas small businesses lost their goods, the infrastructure was damaged, and the tools to maintain sustainability were disrupted (United Nations, 1999). This natural event added another reason for Hondurans to migrate to the U.S. (*Sueños truncados: La migración de Hondureños hacia Estados Unidos*, 2003; United Nations, 1999).

It is important to add the effect of the 9/11 attacks to the history of Latinos in general (Amnesty International, 2012). As Alden (2012) reported, "the attacks transformed border control from what had been essentially a public order issue into a national security issue. […] The creation of the DHS [*Department of Homeland Security*] institutionalized the link between border security and terrorism" (p. 111). This repositioning of immigration issues had the consequence of a hardening of both the U.S. borders and the processes of granting permission to enter the country. This event also affected how Latinos were perceived and in many cases treated by officials, portrayed on TV, seen by regular citizens, and in some cases discriminated against by governmental institutions (e.g., Alabama HB56, Arizona SB1070). In Georgia there have been efforts to pass similar anti-immigration bills and now the five major universities in the state require students to prove they are 'legally' in this country in order to be qualified to apply (Brown, 2010, October 14).

This rising social resistance to Latino/a immigration exists in parallel with an economic climate that has created new centers for immigrantion other than the traditional immigrant gateways like California, Florida, Illinois, New Jersey, New York and Texas. New destinations for Latino immigrants have expanded in the 'Deep South' (Levine & LeBaron, 2011; Marrow, 2011), comprising the states of Georgia, South Carolina, Mississippi, Louisiana and Alabama. This region became very attractive for transnational companies (e.g., poultry farms and carpet mills), given the economic investment and government incentives that triggered the need for a large workforce, ready to take low-wage jobs (Amescua, 2013).

A Brief History of *Fútbol* (Soccer) in Mexico and Honduras

In most parts of the Central and South American continent soccer has been part of the countries' identity formation and consolidation as nations (Nadel, 2014). In general terms, soccer has been present in Latin America since the late 1800s and 1810s when British investment moved into the new Latin American territories and soon trade was established between these two regions. Besides encouraging economic exchange, the interaction between Englishmen and locals also promoted the practice of soccer and clubs as organizations began to emerge (Campomar, 2014). At first, soccer started its popularity in the southern countries of the American continent and then eventually became popular very fast in other Latin countries, like México and Honduras, where baseball had been dominant given the proximity and influence of the U.S. with these countries. Multiple reasons increased the popularity of soccer, but one is decisive, according to Goldblatt (2008), "football [soccer] is available to anyone who can make a rag ball and find another pair of feet to pass on" (p. xiv). Its uncomplicated rules and practicality added to its success. After clubs were founded around the globe and the *Fédération Internationale de Football Association* (FIFA) created in 1904 and started regulating soccer rules, leagues, and international tournaments like the World Cup that started in 1930 in Uruguay.

In Mexico, soccer was introduced in the late XIX century with the arrival of British miners. At the beginning, English people mostly formed Mexican teams, but in the 1920s the first Mexican team formed by Mexicans started playing in the national league. México participated in the first World Cup and from that moment the popularity of the sport continued until today where there are 18 teams that play a total of 344 official games played on the *Ascenso MX* league in a year (Federación Mexicana de Fútbol Asociación, 2011). In 2012, CNN reported that México is the fourth country in the world, only after Germany, England, and Italy with more fans coming to the stadiums.

Honduran soccer also started in the late nineteenth century, but in this case French people who were interested in the banana trade introduced the sport that gained support from the local people very fast (Nadel, 2014). Honduras' *Liga Nacional* (national league) hosts 10 teams in its professional tournament. Honduras, after a slow process of economic growth, joined FIFA in 1951, and attended its first world cup in 1982 (Goldblatt, 2008). Also, and as a note importance of sport in this country, Honduras and El Salvador were involved in the so-called 'Soccer War' in 1969 (Goldblatt, 2008; Nadel, 2014).

As Villoro (1995) argues, everybody can play soccer, short and chubby, tall and thin, poor and rich, young and old. Soccer, then, is more than just a sport: It is intertwined with politics, culture, identity, history, economics, technology, media, and poetry. According to Eduardo Galeano (1995),

> In soccer, ritual sublimation of war, eleven men in shorts are the sword of the neighborhood, the city, or the nation. These warriors without weapons or armor exorcize the demons of the crowd and reaffirm its faith: in each confrontation between two sides, old hatreds and old loves passed from father to son enter into combat.

The Cases of the Focal Participants and Their Families

Participants' backgrounds are briefly described in this section. Using an open-ended questionnaire, I focused on the places where they were born, education, job experiences, family and sport activities. I usually started the conversations with parents and then, on a different occasion, with the focal students. I only talked to participants' fathers since they were responsible for picking up their children from soccer practice.

Enrique's Case

Enrique's father, Fernando Ojeda, was born in 1975 in Los Caracoles, Michoacán, where he grew up with his two younger brothers and sister. He remembers that most people in Los Caracoles worked in the logging and carpentry businesses and some others grew avocados, which is still very popular. But his case was different; Fernando's family had a small piece of land where his parents grew corn with the help of their children and, in order to support the family, his father also worked as a night guard in one of the logging stations. Fernando graduated from the local elementary school and pursued the path most of the adolescents in Los Caracoles followed: to help and work with their parents and older siblings as there was not any local middle school. Fernando added that there is now a Telesecundaria in Los Caracoles where children can finish their middle school education.

Fernando's family lived at his grandparents' house with his extended family and it was very hard for him when he and his wife decided in late 1994 to migrate to the U.S. He recalls that earlier than 1994 many of his friends came to visit for the holidays from the U.S. to Los Caracoles with new trucks and nice clothes. They shared about their own experiences living in the U.S. in regard to the availability of jobs for everybody in construction and farming and encouraged him to go with them. He and his wife agreed; in 1994, when they had only one child, they decided to go and meet their friends in Georgia. The 'coyote' took them as far as Atlanta and Fernando's friends picked them up and brought them to a medium sized city in, Georgia, where they still live. In 2001, Fernando's second son, Enrique, was born and Estela, the youngest of the family, was born in 2007.

When I asked Fernando about his favorite sports, he said that he enjoyed playing soccer and basketball. He played in the local soccer leagues in Los Caracoles as a forward. Nowadays he does not play any sport but watches the Mexican soccer league and sometimes the Spanish league because his son, Enrique, watches it a lot.

Both Fernando and his wife work at a local business to support their children as they want their children to go to college 'to be someone in life'. However, Enrique's older brother just graduated from high school in Spring 2015 and already has a job and, according to Enrique, he is not interested in attending college. Enrique, on the other hand, is very interested in going to college to study engineering or business at the local state university. His favorite subject is science, "physical science and earth science, and anything that has to do with space stuff," he added. Enrique has been interested in science since he was 5 years old, when he started learning about space and watched a documentary on TV; he is also interested in earth science because he likes "learning about natural disasters like earthquakes." Other interests includes soccer; he was part of the middle school soccer team where he played the same position for two years as a forward, like his father. Enrique adds, "I remember when I was 5 or 6… I didn't really want to go to play soccer but my father signed me up and made me go. My father goes to every game I have and coaches me on how to play." He predicted during this interview that he will continue playing soccer for the local high school team. Enrique's favorite team is Barcelona from Spain, *Las Chivas* from México, and Bayern from Germany and he adds, "My favorite soccer player is Messi but everything in my room is about *Las Chivas*."

Jose's case

Jose's parents are from one of the largest coastal cities in Honduras, where they got married in 1995. Jose Sr. graduated from elementary school but did not finish middle school because he had to support his family and reported, "The thing I missed the most when I left school was playing soccer with my friends." Jose's mother Silvia graduated from middle school and worked in the tourist business cleaning rooms in local hotels. Jose Sr. and Silvia worked in the tourist sector in Honduras before 1998 when Hurricane Mitch hit the country and left them "with almost nothing." Then, they decided to migrate to the U.S. where they had relatives who helped them to start again. They decided to move to Georgia where they had friends working in the poultry farms. They started a family when they moved to Georgia, with Jose Jr. and two younger brothers.

Jose Jr. does not want to go to college, "I want to get a job when I graduate from high school," and he added when I asked why, "Because I don't need to [go to college]."

I asked Jose Jr. about his conversations with his parents about education and he answered, "I only talk to them about school when we have parent-teacher conferences," which is once or twice a year, and, "The only thing they tell me is to keep my grades up."

When I asked Jose Jr. about the day he learned how to play soccer he answered, "I know how to play soccer since I learned how to walk." Jose Jr. is a Barcelona fan and thinks that Messi is the best soccer player. He adds, "He's short and fast and he is never scared. He's won almost everything."

Israel's case

Israel's case is different from Jose's, who was born in the U.S. and will not, therefore, face the restrictions on undocumented immigrants in postsecondary education imposed by the state of Georgia. Israel was born in a little town 30 minutes from Morelia, Michoacán, where his parents were also born, grew up, and met while they were in their mid-twenties. Israel has two maternal half-siblings whom he has never met in person. Israel added, "My mother's ex was never there at all, so she came over here and met my dad." Israel's parents, Juan and Sonia, migrated to the U.S. to work in Texas with some relatives; when Sonia was pregnant with Israel they returned to their hometown in 2000 to give birth to Israel and to settle for a year before leaving again to live in Georgia with Sonia's older siblings. They have been in Georgia since then and now Israel has a little sister. Israel and his family are very involved in their Catholic church, in which they have meetings almost every day. Israel goes with his parents but he stays outside with his friends playing soccer. I asked him about his favorite soccer team and he responded, "It is a family thing, Cruz Azul." He continued, "We do *quinielas* [soccer pools] with all my family at the beginning of the Mexican league." I also asked him about his participation in soccer teams to which he answered, “Honestly, this is my first time on a team. But I have always played soccer, like street soccer.” After a brief pause he added, “Last year I wanted to play soccer but I wasn’t as fit, I was very chubby, but I realized that I could make it to the team. So I started pushing myself and running around. I always played soccer with my friends in the neighborhood since I was 7.”

In school, Israel said that his year has “been good… not perfect but not bad.” I asked him for the reasons to which he responded, “I really hate writing” and he added, “90% of the topics I have to write about are very boring.” He continued, “It is not that they are hard, they aren’t interesting to me.” He paused and then added that, “I like science a lot. All kinds really, 6th grade is earth science and I liked it a lot; 7th grade is biology and I liked that a lot too; and right now, physical science, which I like too.” I asked him what he liked about science and he answered, “I like science because when I have a question about how some thing works or why it’s there I find out… I just don’t like using things and not knowing how it is made and I like to know that.” If he has the opportunity to go to college he would like to study civil engineering because, “I want to design bridges and roads.” His father wants him to graduate from high school, go to college, and have a good life.

Esteban’s case

As mentioned before, I never had the chance to talk to Esteban’s parents. They never went to watch him play or to the school for the parent-teacher conferences. We know very little about their backgrounds, education, and activities in México and now in Georgia. Esteban was born in México but does not know the town or city’s name. Michoacán sounds familiar to him but he is not sure. I know his mother works night shifts and his father works all day, which explains in part why none of them could come to the soccer games to watch him or to pick him up. He has four siblings and Esteban is the oldest of them. He also told us that because of his father he is playing as a goalie and as a forward in the two teams he is playing for. His favorite team is *Real Madrid* from Spain, and *Las Chivas* from México.

In regard to education, Esteban failed the first science benchmark with a score of 43 points. He said that the science teacher "does not teach much, he only wants us to answer stuff on the computer. I wish [the class] was hard." He also shared that his favorite subjects are gym, Spanish, and art. I asked him about science and he responded, "I like science a lot but I like doing real experiments. I don't like that stuff [the science teacher] teaches. That's boring and he gets mad like that [snaps fingers] if you say something."

He mentioned that he was arrested for shooting cars on the highway with his friends using a BB gun and was having a trial. "I want to change, my mom says I am a bad role model for my little siblings," so I asked him what he needed to do to make that change, and Esteban answered, "I don't know." I offered him our support after this conversation.

The *Soccer with Science* Inquiry-Based Activities

These inquiry-based activities were intended to create opportunities for the development of the following science investigation practices that are a focus of the broader project of which this study was one part: (a) coordinating hypothesis, observation and evidence; (b) controlling variables to design a fair test; (c) explaining cause and effect relationships; (d) using general academic vocabulary in context; and (e) owning the language of science (Buxton et al., 2015).

In this section we briefly describe key examples from the six activities and how these were structured, and then complement the descriptions with a range of students' written responses to give readers an idea of the exploratory work with students with the soccer and science activities. In the following examples we mainly use the focal participants' responses but also include some examples from the secondary participants. These activities were:

First activity-Kick/spin/air resistance

The kick-spin-air resistance-different balls activity used a Roberto Carlos two-minute video showing the Brazilian player curling the ball and scoring against France. Students tried this activity with different balls as shown in figure 3.1. Science practices addressed in this activity were: Coordinating hypothesis, observation and evidence; and using academic vocabulary in context.

Figure 3.1 Student about to test his hypothesis

Question 1

You want to conduct an experiment in which you want to find out about different types of balls and if they curl like a soccer ball when kicked with the proper spin. Imagine that you ask Roberto Carlos (the one who scored a goal in the video) to repeat the same free kick with all the options you will try. What ball will curl the most and why?

> Jose answered, "My hypothesis is that the plastic ball will curl the most because it is less dense than the soccer ball." His observation was, "I need to kick the balls and curl them to see which one curls the most." His evidence was, "The weight is less in plastic."
>
> Esteban's answer was, "My hypothesis is the plastic ball." His observation was, "You need the soccer ball and the balls." And for his evidence he wrote, "if going around the wall (ball)."
>
> Enrique stated, "The regular size 5 soccer ball will bend the most because it will have more density so it will have the weight to go with more power." For his observation he wrote, "You will need to do the experiment and see which one bends the most." He added as his evidence that, "My evidence would be the ball going around the wall and going into the goal."
>
> Joe, the Asian student, answered, "I think the plastic ball will curl the most because it is light and when you kick it the ball spins a lot faster." He did not state anything for his observation, but added this for his evidence, "The plastic is light than the rest."

Second activity-Ronaldinho controlling the ball

We watched a one-minute video of Ronaldinho controlling a ball after a defender rejected it. Science practices addressed were: Coordinating hypothesis, observation and evidence; explaining cause and effect relationships; and using academic vocabulary in context.

Question 3

In pairs, each one will toss the soccer ball at different heights and the other person will try to control the ball just like Ronaldinho in the video. You will try kicking the ball vertically, reaching these heights measured from the ground: 10 m 20 m, 30 m, and on the last one you and your partner come up with a different measurement. Then, you will describe what happened, explaining causes and effects in the following table:

> Israel answered in the effect column, ”At 10 m the ball was easy to control; at 20 m the ball was slightly harder, it moved away three inches; at 30 m the ball was even harder, it moved like a foot away; at 40 m the ball moved around 2 feet away; at 70 m the ball was very hard to control.” As a cause he wrote, “The higher the ball the harder to control.”

> Enrique responded, “At 10 mts it was easy to control; at 20 mts it went higher but it was still easy; at 30 mts it was harder to control.”

> Jose put, “The 10 mts it was easy - its low,” “the 20 mts it bounced - its medium,” and “the 30 mts I didn’t nail it - its high.”

> Joaquin wrote, “At 10 meters it was easy to control,” “at 30 meters it was harder because it was coming down fast.”

Question 4

Use scientific language to explain the relationships between the causes and effects that you observed during the experiment:

> Israel wrote, “I think the cause of the ball being higher it determined how hard it was to control the ball (effect).”

> Enrique wrote, “The cause was how high you threw it each time and the effect was how well you were able to control it.”

> Jose answered, “The *causa* was it was high and the effect was I didn’t control it.”

> Joaquin wrote, “”When the cause is 10 mts it was very easy which is the effect [;] When the cause is 20 mts it was just easy which is the effect [;] When the cause is 30 mts it was kind of hard [;] When the cause is 40 mts it was very not easy.”

Third activity-Everybody is the goalkeeper

The third one, titled everybody is the goalkeeper, started with a two-minute video in which several professional goalies were the focus of attention. After watching the video students worked in teams to design a reflex activity to test their skills as goalies.

Science practices addressed were: Controlling variables to design a fair test; and using academic vocabulary in context.

Question 1

Imagine you are the goalie and the forward kicks the ball thirty feet from the goal. Take a minute to think and describe the different variables that are involved so you are able to stop the ball:

> Enrique stated, "Speed of the ball, field conditions, curve of the ball, power of the shot, agility."
>
> Jose answered, "The power, speed and curve of the ball, the field conditions and the mass of the ball."
>
> Joe, the Asian student, wrote, "Strong, speed, power, curve, distance, forces, field conditions."
>
> Arturo said, "Power, movement, agility."

Question 2

Now, in groups of three design a reflex experiment using tennis balls. Describe the components of your experiment:

> Joe answered, "Maybe the goalie face the wall and you throw the ball against the wall. It can bounce in different direction. So the goalie body have to react. The goalie is at the goal and other person in the PK spot and throw it toward the goal with 5 tennis balls."
>
> Enrique said, "One person stands on the line and the other throws tennis balls at the goalie who has to block them."
>
> Israel wrote, "Two people have to throw the balls from 15 feet away from the goal keeper. The goal keeper have to stop the ball with there feet. You only get 5 balls each."
>
> Arturo answered, "Throwing tennis balls at the goal keeper and they have to at least touch the ball. They have to be ten feet away fro the goal keeper and five balls."

Fourth activity-Kicking the ball/energy transfer

Kicking the ball-energy transfer was the fourth activity; the science practices used were: Coordinating hypothesis, observation and evidence; explaining cause and effect relationships; and using academic vocabulary in context. We used two pictures of Messi to ask students to think about how potential and kinetic energies work.

Question 1

If Lionel Messi is <u>about</u> to kick the ball, then the kinetic energy of his leg

______________ and the potential energy of his leg ____________________.

> Jose answered, "The kinetic energy is at is peak" and the potential energy, "is at 0."
>
> Enrique answered, "The leg is moving about to kick the ball is kinetic energy because kinetic energy is energy in motion" and the potential energy, "is when his leg is at his peak."
>
> Israel answered, the kinetic energy of the leg "will transfer to the ball. The leg store energy and release it to the ball. The ball now zero kinetic energy."
>
> Joaquin said, "The leg is moving so it is at its max." and the potential energy, "is when he kicks the ball."

Question 2

If Lionel Messi <u>is</u> kicking the ball then the kinetic energy of the leg ____________ and the potential energy of the ball ___________________.

> Jose answered, "the energy is 0" and the potential energy of the ball "is at it's peak."
>
> Enrique's answer was, "The speed of the ball is kinetic energy" and the potential energy of the ball "is when he impacts the ball and is max."
>
> Israel said, the kinetic energy "zero" and the potential energy of the ball "max."
>
> Joaquin shared that, "the kinetic energy is transferred" and the potential energy is growing."

Question 3

Who kicks the ball harder, shorter or taller people? Who do you think kicks the ball harder in your team? Why?

> Israel said, "I think Ricardo kicks the ball harder because he is more stronger than and he is easy to kick the ball. When you are tall it is not easy to kick the ball."
>
> Joaquin answered, "Taller people kick harder because they have longer legs."
>
> Jose added, "I taller people kick harder because the store more energy in the taller foot when they are about to kick."
>
> Joe said that, "I think short people shot harder because tall lose their balance when they kick."

Fifth activity-Shooting precision

The fifth activity, the shooting precision exercise, consists of watching a one-minute video of Neymar scoring from the corner kick. Students tried to score from the corner. This activity deals with explaining cause and effect relationships and using academic vocabulary in context.

Question 1

Can you score a goal when kicking the soccer ball from the corner kick spot? Many soccer players have scored goals from that spot even though it is very difficult. Have you tried to do it? Write your hypothesis about the difficulty of scoring an Olympic goal:

> Enrique said, "My hypothesis is that to score an olympico you have to hit it with good pace, placement so I can do it! But it will take more than 1 try."
>
> Jose answered, "my hypothesis is that is kind of hard because I can curl it sometimes."
>
> Joe, said "My hypothesis is I can score a goal in the middle not the corner because I can score easy. At the corner I can't curl the ball at all. Neymar can kick from the corner and made a goal."
>
> Joaquin said, "My hypothesis is that I won't score because I can't kick that well."

Question 2

On Tuesday, when you try this activity you will be able to see all the different things that affect your shots from different angles to the goal. Before you try this please name at least 4 variables that may affect your shot:

Enrique said, "Wind, speed, curve, power."

Jose put, "Wind, speed, curl, power."

Joe said, "The wind, the curl, power, speed."

Joaquin answered, "Power, accuracy, wind, and curve."

Sixth activity-Controlling the ball

The last activity showed the Brazilian national team controlling the ball in a four-minute video. Students competed against each others' time, controlling the ball. The science practices used in this activity are: Coordinating hypothesis, observation and evidence; and using academic vocabulary in context.

Question 1

List three good characteristics a player must have in order to control the ball:

Enrique answered, "Speed, quick feet, balance, and ball control."

Jose said, "Ball control, reaction, balance."

Joe said, "Strong legs, balance, reaction."

Esteban answered, "Ball control, balance, skills (jugling), strong legs, reactions."

Question 2

Write a hypothesis that predicts for how long you or one of your soccer mates can control the ball without touching the ground:

Enrique wrote, "I think I can control the ball for one minute because I have tried."

Jose said, "A 1 min."

Joe answered, "I think [Jesus] can control the ball for 30 seconds. I think [Sean] can control the ball for 10 second. I think I can control the ball for 25 second because I am a little good than [Jesus] but not a lot [unintelligible]."

Esteban said, "Probably around 10 seconds because of my balance."

Final Conversation with Focal Students

Enrique, Jose and Israel were in the final conversation. Esteban approached me constantly to talk at the end of each of my classroom observations. Esteban talked about multiple topics: His problems with teachers, new soccer videos he watched the day before, his girlfriend or friends, his activities the day before. When he was suspended from the soccer team because he cheated on one science assignment, he went to me to talk about it. He was very worried because soccer was his favorite thing to do and the science teacher/soccer coach expelled him; he wanted me to advocate for his return to the team. I told him that he needed to work on his assignments and his behavior in and outside school for one or two weeks so his science teacher could reassess his decision. He improved his behavior and participation in class and this time he asked questions in relation to the content they were studying in class. I did not mention any of the conversations I had with Esteban to the teacher until three weeks later when the teacher approached me during a soccer practice. This happened because the second goalie just failed to save a goal (Esteban was the first goalie); the teacher said that he was surprised how Esteban has improved in science class. I told him that he was doing that to be put on the soccer team again; the next day the they talked and Esteban was back on the team with the condition that he had to behave in all classes and do his work. He agreed and, at the end of the school year, he passed the science class but he failed other two classes.

After these activities and the soccer tournament, finished I had a final conversation with the focal students. I asked them about these activities, their participation, and their opinions on what to change with the practices and activities. According to Enrique, “ I enjoyed the activity where we tested each other’s reflexes as goalies, […] and the one where we curled the ball and tried to make it with different balls like tennis, the plastic ones and the soccer ones.” Since we are interested in the reasons why an activity was interesting to a particular group of students, we asked him about this, to which he answered, “Because it was hard to do them.” Jose also said that the Roberto Carlos (Kick-spin-air resistance-different balls) activity was his favorite in which we “worked with hypothesis and cause and effect.” Israel said he remembered the Ronaldinho one and added,

> We worked with the cause and effect and hypothesis. And I thought it was impossible to bring the ball down but I tried and it is not easy, and then when we did the tennis balls I though it was harder with smaller balls because people who play soccer, you know? The ball size is bigger and you see the ball coming like and they curl different. So I learned that balls are different, they are different to control.

Both Enrique and Israel enjoyed participating in the soccer and science project because “it was fun.” However, Jose said, “I liked the activities but didn’t like that we had to fill out the papers” and he continued explaining that it was too much for him after a school day full of classes. In Jose’s words, “I liked soccer in these activities, I want to see a ball and I want to play, but it is too much writing. Less questions would be better.” Although I did not have a previous interview with Jose, I approached him right after the fourth activity to talk about his animosity towards the activities and he mentioned something similar about the excess of writing. I decided to address this issue by modifying the last two activities.

Interpretations

Our findings show clear evidence that science teachers who use their students' sociohistorical process (De Landa, 2006) attending to the social, political, material, cognitive, and linguistic backgrounds (Gutiérrez, Baquedano-López, & Tejeda, 1999) as a classroom resource are able to elucidate important cultural practices and passions that can be used to engage students in science. In this research, data showed that these bilingual and multimodal lessons with videos showing soccer stars performing a soccer move (a) helped Latino students to engage in thinking, reading, and writing scientific ideas in both English and Spanish in different environments, and (b) challenged them to perform the soccer move while testing their scientific ideas. This research experimented with some elements from the assemblage shown in figure 3.2, such as students, the science teacher, and the researchers collaborating to modify the activities according to the interaction between them and the intensities involved (engagement in the soccer activities, ludic or playful competition between participants). As we mentioned earlier, some intensities were productive (e.g., the students' passions for soccer) and some other intensities were counterproductive (e.g., some students' resistance to participate due to what they perceived as excessive writing requirements), but the collaboration between the teacher, researchers, and students changed the process and the assemblage as it unfolded in ways that became productive. In the beginning, we were utilizing these activities more as an extension of the classroom than as activities that took advantage of the material and expressive aspects and processes of the unique soccer learning context out on the soccer field, which from the students' perspective was not destabilizing the homogeneity of the classroom-type environment. There is a crucial difference between these two contexts: At the soccer field, the environment is competitive and rich in ludic, playful motives and aspects, where students are more free to use gestures and talk and laugh; in the classroom, discipline limits most of these features (e.g., laughing is often seen as an inconsiderate behavior). As the teacher/coach and I engaged with the students in the activities and I began to examine what was happening through the lens of assemblage theory, thinking about intensities, we began to stress this game space as opposed to the classroom learning norms in our pedagogy.

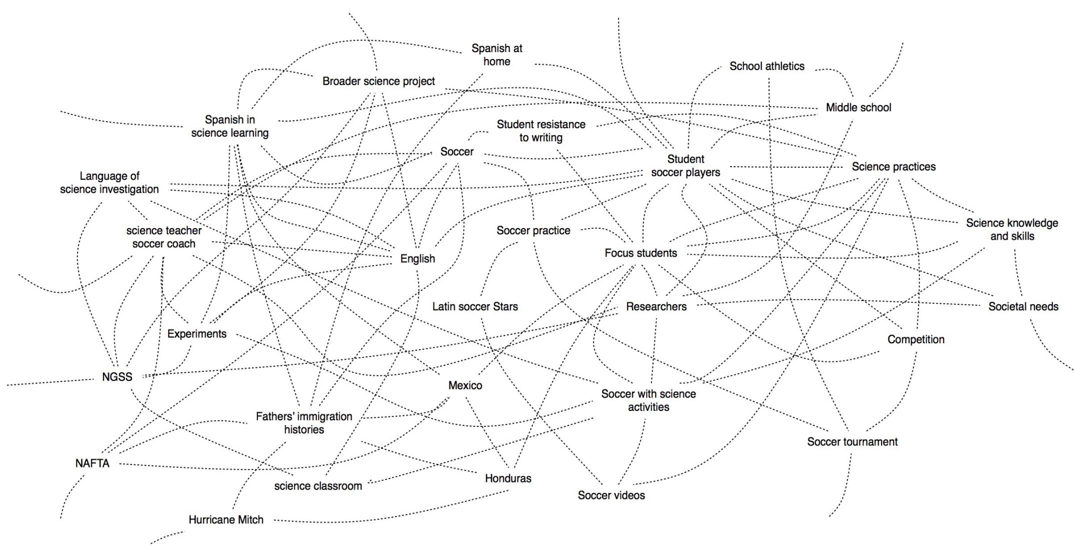

Figure 3.2 Soccer with science assemblage

On the other hand, we also worked to change extensities that emerged in this research: We altered the sequence and amount of questions, which had an impact on the intensities of some students, as earlier they were reluctant to participate, arguing that it was too much work. This change seemed to smooth the connections between soccer and science for the students and the transition between environments from the classroom to the soccer field. For instance, the way questions were posed helped in achieving the goal of smoothing connections for the students,

> Who kicks the ball harder, shorter or taller people? Who do you think kicks the ball harder in your team?

By posing these two questions, soccer participants were invited to coordinate a hypothesis while contextualizing students' knowledge of science and their physical skills within a spirit of competition. To which Esteban answered,

> My hypothesis is that it doesn´t matter. What matters is the physical state of the leg. My hypothesis is that Ricardo kicks harder because his leg is stronger.

In this case, the student stated, tested, and compared his hypothesis with the rest of the soccer team. Each participant had the chance to evaluate his hypothesis and then perform the soccer challenge. Although not every student identified hypotheses that were confirmed, the purpose of these science and soccer activities was not getting the correct answer or simply having a hypothesis confirmed, but rather thinking, acting, and communicating scientifically.

Figure 3.3 Enrique curling the ball to score an Olympic goal

With these goals in mind, in this previous example we can see that by elucidating the intensities and extensities in these activities we were able to localize elements and thresholds for building on our participants' learning processes, for instance, as Jose stated, "I learned some things helpful for me and you don't see many experiments with balls and soccer. I liked that, I want to see a ball and I want to play." He continued, saying that, with the Neymar video activity, "I made my hypothesis and [...] I was sure I was going to score and I scored when we curled the ball from the corner of the field." Here we can see that students used the soccer video as an anchor to recall what they did as they mixed their physical performance with what they learned about science practices as shown in figure 3.3.

We built on the combination of everyday language and the language of science that emerged, for instance, in the first activity, first question,

> You want to conduct an experiment in which you want to find out about different types of balls and if they curl like a soccer ball when kicked with the proper spin. Imagine that you ask Roberto Carlos (the one who scored a goal in the video) to repeat the same free kick with all the options you will try. What ball will curl the most and why?

Israel, who "hate[s] writing," answered,

> My hypothesis is that the plastic ball will curl the most because its lighter and easier to control or move by the wind. A soccer ball will curl to but not like a light plastic ball. A tennis ball is small and harder to kick how you want so it wont curl.

We argue that with six activities there was enough time to trigger the students' interest in participating in the soccer and science activities, using a structured writing process that is similar to laboratory reports used in science class. These type of reports, according to Buxton et al. (2013), "are an excellent context for meaningful writing practice, especially when students are encouraged to elaborate on their understandings, initially using everyday language and gradually building toward the academic vocabulary and discourse structures typical of scientific communication" (p. 349). Nevertheless, if we are to maintain using meaningful practices with emergent bilingual students, we must recognize that we as teachers of science have to create new approaches, new connections, and new collaborations for new situations that "shock thought and disrupt habits" (Marble, 2012, p. 29). In our case, and as argued by Lee and Buxton (2013b), it is necessary to continue incorporating home cultural practices, especially if those are a passion, as we suggest in the case of soccer; that is, we need to integrate the use of cultural practices in the teaching of science. These cultural and passionate activities, if assembled in meaningful and creative ways, can foster emergent bilingual students' engagement with and learning of science. As a consequence, assemblage theory has proved to be helpful in providing the analytic tools, such as the analysis of sociohistorical backgrounds and contexts of students and their families, to construct and reinforce the learning process of emergent bilinguals in science.

Discussion

As science teachers are facing increased cultural and linguistic diversity in their classrooms, new science reforms are simultaneously impacting the landscape along with high-stakes accountability. This scenario is causing more educators and researchers to consider how to utilize different elements involved in the societal and educational processes in school and the community. To achieve this, if we look at the unique features and trajectories of non-mainstream students and integrate these into the science classroom, we can create new ways of providing a more equitable learning context. In this light, cultural practices are a crucial part of an assemblage to consider in the classroom. This research provides new ways of connecting what other researchers have shown to work, such as the use of Spanish as a cultural resource, for teachers to include in the learning of science (Lee & Buxton, 2013a; Lee & Buxton, 2013b) with other cultural practices, in our case soccer, which is also a passionate activity for many Latino/a students, in order to help them as emergent bilinguals to speak, to listen, to read, and to write about their ideas about science investigation and the language of science. Not only did we connect a linguistic component to a kinesthetic activity to support emergent bilinguals as they built on their knowledge of science, but we also worked to connect two different environments for their learning: The science classroom and the soccer field. This maneuver of connecting science to soccer also complemented the purpose of science learning as emergent bilinguals took advantage of the agency available to them as they experimented outside the science classroom and learned that the soccer practices can be spaces for science learning. This connection between soccer and science did not come unchallenged as sometimes students showed some resistance to participate at the beginning of this process; however, by collaborating with the participants involved, we modified how we presented the activities to the soccer team. In this light, assemblage theory allowed us (a) to bridge a cultural practice and passion to science education, (b) to connect key science practices to soccer videos and scientific investigations of aspects of soccer skills, and (c) to make a ludic, playful space part of a science learning process. We encourage further research with emergent bilinguals (Latino/as and non-Latino/as) as well as with female students, and explorations of other cultural practices important to a diverse range of students, in order to make meaningful connections among these practices and students' science learning both in classroom contexts and out-of-school contexts.

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Appendix

Soccer with science
Activity #1
Kick-spin-air resistance-different balls activity

Watch this video about a free kick in soccer:
Ve el siguiente video acerca del tiro libre en el fútbol:

http://www.youtube.com/watch?v=3ECoR__tJNQ

Procedure:
You want to conduct an experiment in which you want to find out about different types of balls and if they curl like a soccer ball when kicked with the proper spin. Imagine that you ask Roberto Carlos (the one who scored a goal in the video) to repeat the same free kick with all the options you will try. What ball will curl the most and why?
Procedimiento:
Quieres hacer un experimento en el que deseas obtener información sobre los diferentes tipos de balones y el efecto que tienen cuando se patean con el giro adecuado. Imagínese que le pides Roberto Carlos (el que marcó un gol en el video) para repetir el mismo tiro libre con todas las opciones que tratará. ¿A qué balón se le puede dar más efecto y por qué?

Materials:
- 1 Soccer ball size 5
- 1 plastic ball
- 1 tennis ball

Materiales:
- *1 balón de fútbol del 5*
- *1 pelota de plastico*
- *1 pelota de tenis*

a) What is your hypothesis about your experiment? *¿Cuál es tu hipótesis acerca de tu experimento?*	b) What observations will you need to do in order to prove your hypothesis? *¿Qué observaciones necesitarías hacer para probar tu hipótesis?*

c) What is your evidence? *¿Cuál es tu evidencia?*

d) Now, it is your turn to try that kick with different balls and to write your results about which ball curls the most.
Ahora es tu turno de probar el tiro con diferentes pelotas y el escribir tus resultados de cual es la pelota que tiene más efecto:

e) What was varying in your experiment, that is, what were the variables?
¿Qué fue lo que varió en tu experimento, o en otras palabras, cuáles fueron las variables?

You read this activity in
Esta actividad la leíste en

☐ English ☐ *Español* ☐ *Ambos*/Both

CHAPTER 4

NEGOTIATIONS OF PRACTICE AND RESEARCH ADAPTATIONS IN INTENSIVE-SOCIAL-MATERIAL ASSEMBLAGES THAT HAPPENED AT BEAR HILL MIDDLE SCHOOL[10]

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Abstract

In this chapter, I talk about the negotiations and processes of carrying out a research project with the guidance of two university professors and in collaboration with an 8th grade science teacher/soccer coach and 24 students/participants in a middle school. Using a mixture of a design-based implementation research and a material perspective, I focus on the negotiations, commitments, and collaborations to: (a) teach science in the context of an after school soccer program, (b) develop a curriculum and (c) carry out a research program in which material things and physical spaces affected this process. In other words, I study these experiences and processes in relation to the characteristics of the human and non-human elements involved in this scenario. I conclude with a set of recommendations for pre-service and in-service science teachers developing science activities, doing research, and teaching science to middle school students in multilingual and multiethnic settings.

Introduction

Research on how soccer and science can be used to engage Latino middle school students in thinking, learning, and communicating about their science ideas bilingually in an after school program (Vazquez, Allexsaht-Snider, & Buxton, forthcoming) shows how science teachers could design different activities based on their students' interests and passions in the classrooms. In addition, Vazquez et al. (forthcoming) explained how a theoretical framework grounded in assemblage theory guided their work connecting the soccer practices to the science activities. The soccer with science activities followed a modified version of the Language-rich Inquiry Science with English Language Learners through Biotechnology (LISELL-B) pedagogical model (Buxton, C., Allexsaht-Snider, M., Kayumova, S., Aghasaleh, R., Choi, Y., & Cohen, A., 2015), and included the student-athletes' backgrounds and interests in soccer that were implemented in the soccer afterschool program. The research and work with the emergent bilingual students in the soccer afterschool program was helpful in understanding how these students engaged in these activities, but the article did not discuss key aspects that may help practitioners who are developing science activities with emergent bilingual students, to start a curriculum and teaching research project. In this paper, I explain: (a) How this teacher research project changed after meeting institutional requirements related to research and following negotiations between the science teacher/soccer coach, myself, and my two research advisors; and (b) How the project was adapted according to the number of students, school facilities, weather conditions, and students' feedback. These modifications allowed me as a science teacher/researcher/curriculum developer to consider and integrate the institutional requirements, my colleagues' suggestions, and participants' feedback to make these activities more meaningful and engaging for the students and me as a teacher-researcher.

I elucidate how the institutional requirements and negotiations among the science teacher/soccer coach, my two research advisors, and myself happened in this project. I conclude with a set of insights for science teachers developing science curriculum, doing research, and teaching science to middle school students. Science teachers who are not doing all three processes, teaching/researching/developing curriculum, but are focusing on a single aspect, whatever it may be, may also benefit from reading and considering the lessons learned from this project.

Negotiations When Planning and Carrying Out the Soccer with Science Project at Bear Hill Middle School

Because I was very interested in the LISELL-B project and especially in the process of engaging emergent bilingual students in learning science, I began my research proposal with the idea of linking a passion shared by several Latino/a students to science education. My experiences with the LISELL-B project doing ethnographic work for more than four years in science education, immigration, secondary and post-secondary education with parents and students from Bear Hill Middle School allowed me to gather enough evidence to support the claim that soccer is a passion shared by many Latino/a students and parents from México, Central America, and South America who are now living in the southeast region of the United States. Soccer as a driving force seemed to be a perfect locus for the science activities as this practice has been a very popular tradition for students and their parents since soccer has intertwined historically with most Latin countries (Vazquez, M., Allexsaht-Snider, M., & Buxton, C., forthcoming). Besides providing an important driving force, the popularity of the sport offers the advantage that most students know various things about it such as the rules, famous players, international tournaments, and iconic games. Additionally, the equipment needed for soccer is relatively inexpensive. These characteristics and conditions encouraged me to link soccer and science, thinking that the connection of these two elements could offer: (a) science teachers the possibility to teach science using a relatively easy and structured activity connected to soccer in the science classroom; and (b) emergent bilingual students the possibility to learn the language of science and the practices of doing science in English and Spanish while engaging in a familiar activity such as soccer in a familiar space.

Despite the popularity of the sport and the fact that many students play it in schools, the connection between soccer and science for educational purposes has not been researched. In this light, the activities we developed for this project were new in the sense of using soccer as a driving force to engage students in studying and communicating about science.

The structure of the soccer with science activities was very similar to that of the LISELL-B activities (see Vazquez et al., forthcoming) but this new iteration also included a short video that was followed by a brief introduction, questions about students' experiences mixed with science, the physical activity linked to soccer, students' data collection, and final science questions. This experimentation with a goal of science learning offered both exciting opportunities and pedagogical risks, because if not controlled properly, it could have easily and solely lead into play disconnected from science learning. Moreover, I expected middle school students to be very jealous of their soccer time and space, as I was the person taking away from their time to run, play, and enjoy a physical activity with their friends. In this light, a theoretical framework that discusses how negotiations and adaptations occurred would help me to explain this research/teaching/curriculum development process.

Trading Zones in Developing the Soccer with Science Project

The notions of research-practice partnerships as trading zones helped me to understand how participants in the soccer with science project negotiated their work, rules, and other exchanges between them (Galison, 1997; Penuel, Coburn, & Gallagher, 2013). A trading zone is an environment where people have many cultures, different practices and perspectives, and they converge in a place to collaborate, create, organize, and act as they look for a common ground. Of course, this common ground is not always achieved without frictions or problems, because participants have diverse status and interests in different hierarchical social structures. In these environments of collaboration where people's cultural tools intersect, there is the possibility for participants to create, through negotiation, new forms and ways of practice (Penuel et al., 2013). In the soccer with science research project there were negotiations from the moment the co-design process started among the university researchers, Mr. C, and myself, with the goal of developing a set of activities mixing soccer and science.

I was familiar with the middle school before I started this research project and knew many teachers from the school. Many science and ESOL teachers have participated in the LISELL-B project situated at a university in the southeastern U. S. since the early stage of the project in 2009 in which I was also involved before returning home to México for several years. I returned to the university in 2012, when the LISELL project was finishing the first stage and was about to continue as the next iteration, the LISELL-B project, in the Fall of 2013. I participated in the LISELL-B project with Mr. C, the science teacher/soccer coach, in different parts of the LISELL-B professional learning framework, i.e., summer institute, student summer academy, grand rounds classroom observations, bilingual family workshops, and the teacher exploration of students' writing workshops. During the LISELL-B activities, Mr. C and I talked about soccer many times and the challenges he had when participating in local soccer leagues as a goalie, and how he saw his responsibilities of teaching science and coaching the middle school soccer team as complementary. Mr. C shared with me his preference for the Premier and Spanish leagues and other international leagues through the year and how it was common for him to talk about those games with his students between periods or at the end of the day, just for the joy of sharing something different with his students. He always had something interesting to say in relation to science, soccer, and his class. I remember my first time in his classroom and all the different things displayed on the classroom walls: It was not a regular science classroom, for you were able to find Newton and Einstein bobblehead toys in the original packages, Matt Groening's framed artwork, vintage robot toys, and science cartoons around the room. However, Mr. C's enjoyment of and interest in soccer and other things out of the science field did not prevent him from establishing a rigorous discipline during the science class, soccer practices, and formal games with the students and student-athletes. In this light, the school policy about student-athletes, the students who are part of a sports club in school, was very clear in terms of expectations for their behavior and academic performance: if a student-athlete was not performing and behaving well, then his/her place in any of the sport teams would be jeopardized or lost until his/her performance in the classroom improved.

Communication between the coaches and teachers in the school was very effective, and if any student's infractions were detected in the school area or in the classroom, then, the rest of the teachers and coaches would know right away through email. I witnessed this when Israel was suspended one day because he misbehaved in the math class and on that day he did not go to soccer practice. Soon, I learned many of the rules and requirements for students in the school and his class that helped me in the research and teaching planning process.

Mr. C's familiarity with the LISELL-B project practices, our previous collaborations, and his interest in soccer and willingness to experiment with new things helped to facilitate the development of this soccer with science research project in his science classroom and soccer field spaces. Next, I will delve into the materials needed for this research and the negotiations that happened during this process.

Planning for Materials

The first step was planning for the material elements needed to carry out this research and teaching project. Space was not a problem; the school had two soccer fields and those were very accessible from the school building. The school also had an indoor basketball court that served the soccer team in case of bad weather. In regard to the equipment, for a maximum of 25 student-athletes in the soccer team to work in triads I would need 8 soccer balls; however, I had to contemplate the possibility of some students wanting to work in pairs and possible problems with the balls, so a total of 14 balls would be enough to cover those variations. If students were to complete the activity collecting their observations while performing the soccer activity in the field, I would also need enough clipboards, pencils, and hardcopies of each activity for every student. My two university advisors supported me with the clipboards and copies, and Mr. C let me borrow 6 soccer balls. I purchased 8 additional balls and a bag to carry them for the project. For the short video at the beginning of the activity, the science classroom had a projector and Internet access to show the short video to the class and Mr. C welcomed the idea to use the science classroom for this purpose.

From the conversations I had with Mr. C, we decided to use current soccer stars for the short videos included in every activity. He told me that most students were either Barcelona or Real Madrid fans and followed the Spanish tournament '*La Liga*' and the European tournament '*Champions League*'. Thus, I thought about using videos of Messi, Neymar, Zatlan, Cristiano and Ronaldinho.

Negotiations and Adaptations at Institutional and Individual Levels

Once the planning about material was considered, I then contemplated the social aspects, such as requirements and policies at the institutional and individual levels. It is here where most of the negotiations happened. At the institutional level, my research protocol had to follow the university Institutional Review Board (IRB), the county school district approval process, and middle school recommendations, which also affected the co-design process, for instance, the goals and activities had to be aligned to the school's mission and objectives. However, one additional step had to be met before writing the proposal; that was taking a mandated workshop in which a university liaison between the College of Education and the County School District explained the protocol for submitting a research proposal. The proposal package consisting of the research proposal, parent consent form, parent permission form for secondary and focal participants, and the minor assent for focal and secondary participants; consent forms had to be available in English and Spanish before the research project began. This mandatory step for all researchers added a level of formality to the conversations with parents, especially because I did not know about their status in the country, and I felt that asking them to sign permission and consent forms could jeopardize the initial rapport I wanted to build between us.

At the school level, the middle school principal was very careful in considering which investigations were to be permitted in the school since the teacher administrative load and the student responsibilities did not allow any other activity that would distract students and teachers from the main classroom objectives and school goals. However, the school participation in the LISELL-B project provided me with some legitimacy so the soccer with science project could be considered a branch of the LISELL-B project. As the project unfolded, the negotiation involved many participants: Mr. C, two university researchers, and towards the end of my project I also included the focal participants' suggestions in the last two activities. Mr. C and my university advisors reviewed every activity before I implemented it and made suggestions and comments.

Mr. C and I talked about two possibilities for the student-athletes to do the soccer with science activities each week during this research project: The first option consisted in having one soccer with science activity during one soccer practice a week for a total of six weeks. This option would have allowed students to immediately link the video and the first written activity to the physical performance related to a science investigation, collect their data, and write their results. However, this would not have allowed enough time on those days for students and Mr. C to train and practice for their upcoming games. From my perspective, this option would have posed a risk to the level of student-athlete attendance in the session where my research activities would have taken place. The second option was more viable as it required splitting each soccer with science activity into two parts, each one taking 30 minutes of two of the soccer sessions a week. This option would increase the continuity of the interactions between the student-athletes and myself and, thus, would facilitate the relationships between us. For my research purposes, in which interviews were scheduled at the middle and end of the research process, this second option seemed to work best for Mr. C, who responded “we can do the 1^{st} 20 min of each practice” (personal communication, November 26, 2014). The 20 minutes were later extended to 30 minutes as we discussed activities and transitions. As the time to submit the proposal to the county school district approached, Mr, C and I both agreed to plan according to the second option.

Both the university IRB and the county school district approved the protocol. I was ready to start with my first observation week in the science classroom but classes were canceled due to snow. The process started the following week. No negotiation there.

The soccer try-outs day arrived and Mr. C was in charge of the recruitment process. I helped him in distributing around 80 students around the soccer field and observing them. I have to say that the middle school soccer team has had an important reputation in the district soccer tournament and a history of having great players in the field. Mr. C’s commitment to maintain the best players in the field was only paralleled by his emphasis and recommendations to the soccer players to keep good grades and be good students in the classroom. Thus, it was not an easy task to choose 24 students, since a good player does not always mean a good student and vice versa. Only 21 student-athletes comprised the list of official players, along with three 6th grade students who were in charge of the equipment (balls, waters, cones, and nets) and also played in trainings. These three 6th grade students were securing their place on the soccer team for the following season. At this point I did not know who and how many students from Mr. C's 8th grade science class were considered to be part of the soccer team; fortunately, Mr. C emailed me the list of soccer players the following day and from these 24 participants there were four focal participants who were also in his science class.

My work with focal participants involved: (a) observing them in the science classroom and the soccer afterschool program; (b) conducting interviews and informal talks with them and their parents; (c) collecting and analyzing their written soccer with science activities; and (d) taking pictures of them while working on the soccer with science activities. My work with the other 20 secondary participants on the team included: (a) collecting and analyzing their written soccer with science activities; (b) taking pictures of them while working on the soccer with science activities.

Three focal participants took 8th grade science in 2nd period and the other focal participant was in 3rd period taught by the same teacher/soccer coach. Secondary participants were a mixture of 6th, 7th, and 8th graders from other science classrooms in the same middle school. In my proposal, I had planned for a total of five focal participants, but after discussions with my advisors, we agreed that four focal participants would most likely be sufficient. Focal and secondary participants joined together from 4 to 5:30 pm in the soccer afterschool program on Mondays, Tuesdays, and Wednesdays from early

February to mid-April. On Thursdays, official games were held at the school or at different settings around the county.

Student-athletes needed to take two additional steps to be on the team besides the try-outs, and that was to pass the physician's test that certified the student's good health, and to give that certificate to Mr. C. "I need [the form signed by the school physician], if you don't have it now, just go home" (personal notes, February 4, 2015). Three students missed the first three practices due to this requirement.

Negotiations with Focal Students and Curricular Adaptations

In the first week, I distributed the assent, and parent permission forms to my focal and secondary participants. I also collected these forms from the first through the fourth week. Since my secondary participants constantly forgot their signed forms at home, Mr. C warned them to "bring them back next week if you want to play ball," (personal notes, March 2, 2015) which helped me a lot having all forms on file on time. The first week, I was devoted to observing focal participants, and this was very useful in seeing how focal participants interacted in the classroom and in the soccer field. Israel (all pseudonyms), from 2nd period, was very extroverted: It was common to see him assessing if Mr. C's mood was adequate for him to talk and laugh with his friends. However, if Mr. C would ask a question to the group, it was usually Israel who first responded and his answers were most times correct. It was also very common for Israel to procrastinate with his science work and, as I found out later in the school year, with his homework and assignments for his other courses as well. Another common characteristic was that he usually sat in different places around the classroom.

Eduardo, from 3rd period, was also very extroverted and usually watched YouTube videos of soccer stars on his cell phone during the science class. Thus, it was very common that he did not turn in class assignments, which, as a consequence, jeopardized his position on the soccer team on several occasions during the season. He was the official goalkeeper and leader on the field. Another recurrent characteristic was the ease with which he got in trouble in and outside the school.

Esteban, from 2nd period, was very introverted in class but always had his assignments ready. He was one of the top students in the grade and was very close to Jose, another 2nd period student. Jose was very introverted as well and it was also common for him to turn in his class assignments on time. Esteban and Jose usually chatted and shared jokes, but these never disrupted the class nor disturbed Mr. C.

Throughout the first part of each soccer with science activity, which started in the classroom, it was common to see Jose with an apathetic face. But a different Jose appeared for the second part of each activity when he went to the soccer field for the physical activity and data collection. He enjoyed competing and testing his physical skills with the rest of the team, especially with those from his grade level.

With the exception of the last activity I taught, negotiations with students did not occur during the main part of this research project, but towards the end I had a group conversation with the three focal participants in the school. The purpose of this meeting was to gather information about the soccer with science activities and know the boys' thoughts about them and their participation in the project. However, this conversation also functioned as a negotiation process between them and the way I structured the activities. Jose was very direct in this matter: He suggested decreasing the length of each activity in order to have more time to perform the soccer moves in the field. He said that, “I liked the Olympic goal activity because I scored once and it was very challenging but there is a lot of writing.” Esteban and Israel agreed and Israel added, “I like the Ronaldinho and the Roberto Carlos activities.” Esteban added, “I liked the goalkeeper activity because it was fun to design it.” When I asked them about science concepts they learned in these activities, they mentioned that, “hypothesis, cause and effect.” In this light, and recognizing that they had been learning from and enjoying the soccer and science activities, I decided to modify the length of the last activity and the amount of writing so there would be more time for students to do the physical performance and data collection.

Language Adaptations with Focal Students

In regard to language adaptations, the written activities included the Spanish translation after every English paragraph, which followed the LISELL-B activity structure that has proven to work with the emergent bilingual student population, including that of Bear Hill Middle School (Buxton et al., 2015). In the last interview I had with my focal students they told me that they read, speak, and write in Spanish, but they decided not to answer the soccer and science questions in Spanish. However, the extent to which focal participants used Spanish, varied in the interactions we had during this project. I paid special attention to their use of Spanish in the interviews and whether or not they read the Spanish parts of the activities, a question I addressed in our conversations. For instance, the activity where I encouraged the focal students to speak Spanish was in the individual interviews, at the beginning of the project, and the group interview we had at the end of the project.

Enrique spoke Spanish many times to describe his experiences with soccer and science and we switched back and forth between the two languages during the 15-minute conversation. Enrique shared that, “I read the Spanish parts to see if I could,” when I asked him about the soccer with science activities. Jose, a close friend of Enrique, spoke very little Spanish during the one-on-one conversations and described his soccer preferences and interests in English. When we spoke about his ability to read, write, and speak Spanish, I asked Jose if he read the Spanish parts of the soccer with science activities and he responded, “I didn’t have to.” Israel, who was very extroverted in class with his peers and the teacher, was also open to share many school and family anecdotes during our conversations in Spanish. Israel, as opposed to Enrique and Jose, elaborated more on his answers and touched on more topics such as his relationship with his father and whole family, his weekend activities, jobs, and goals in life. I asked him about the Spanish parts in the soccer with science activities and he said he read the Ronaldinho activity and the Messi one in Spanish. Esteban, who was very extroverted as well, initially spoke to me in English during the first informal conversations that took place in the dinning room during the periods I was not observing the science classroom. Many times he was by himself in the dining room because he arrived late to school and was not allowed to go to his classroom, thus, we started talking while he waited for the next period. After the first conversation Esteban seemed to trust me and shared many personal issues and experiences in and outside school about his teachers, family, and friends, using a mixture of English and Spanish. These informal conversations were common even when he was suspended from the soccer team because of his behavior in science class and he worried that his chances to return to play as a goalkeeper were slim. He said he did not read all the Spanish parts of the written activities.

In this light, none of the four focal participants chose to use Spanish to write their answers in the soccer with science activities. Only two focal participants reported using Spanish when they read the activities. These two students who used the Spanish text to complement their understanding of the English text, “just to see if I could,” each student answered.

It may be the case that Jose did not read the Spanish parts because of his urgency to play soccer, a situation that he later expressed during the last interview. Thus, language adaptations in the soccer with science activities with emergent bilingual students who are beginning to work with bilingual materials seemed to be helpful for some emergent bilingual students, like Enrique, who is interested in testing his language skills in deciphering the text, or like Israel who enjoyed the soccer activities and was very communicative with his experiences. On the other hand, for Esteban and Jose, who did not engage in the same way than Enrique and Israel with the Spanish opportunities, but are also fluent in Spanish, it may be necessary to develop and establish a different relationship between their Spanish skills and science activities for them to use their language knowledge as a support in the science class.

Conclusions and Implications

The process of developing curriculum/researching/ teaching science is very complex and requires the collaboration of many people and institutions in co-designing each step along the way. The complexity of collaborating in this project, where many goals and processes existed, was very challenging for it included institutional and individuals' requirements just for the approval stage of the project, as more complexities were added as the project unfolded. I must say that developing curriculum/researching/ teaching science was, for me a single and dynamically interactive process, for many times I was not able to distinguish between my three roles as they constantly intertwined in this project.

Collaborating Partnership with the Science Teacher/Soccer Coach

I had the advantage of working in the first iteration of the LISELL-B project for a semester and then in the LISELL-B project for three years where I met and worked with Mr. C, the science teacher/soccer coach, in several parts of the LISELL-B professional learning framework. It was during these activities that Mr. C and I talked about general things about soccer like international games, famous players, and coming tournaments, which facilitated our professional relationship as members of the same project. Developing my relationship with Mr. C during the LISELL-B project helped me as a science teacher/researcher/curriculum developer as Mr. C welcomed my project in his classroom and soccer afterschool program. He also saw how relevant soccer was for his Latino students in the science classroom and how they could benefit from connecting their motivation for soccer to the science learning. When asked about the ethnic composition of his soccer team he answered, "almost 99% of the team is from Mexican descent" (personal communication, November 5, 2014). Put simply, to start a collaborative research process in a middle school it is important to find a teacher or group of teachers whose vision, responsibilities, and activities in the school match your goals and proposed activities as a researcher/science teacher/curriculum developer. In addition, developing a relationship before beginning the research process helps participants to facilitate communication and to adapt to the rules of the context (classroom and soccer field). For instance, when Mr. C shared the discipline in his classroom and afterschool program, he shared that, "If they failed 2 or more for the period, they lost eligibility to play. If they got in trouble twice, they missed a half. Three times, they missed a game" (personal communication, November 11, 2014).

Once the researcher/science teacher/curriculum developer is familiar with the contexts, then, it is easier to imagine and plan what the research process may look like in the setting with the students and teacher.

Designing and Adapting the Soccer with Science Activities

One of the parts where collaboration was crucial was designing the science activities used in this project. For this, I decided to use a modified version of the LISELL-B written assessments that included a short video at the beginning of the activity showing a soccer star doing a soccer move to engage students in the activity before going to the soccer field, perform move, and gather data. My advisors and Mr. C agreed with this and the classroom resources made this a feasible modification. Thus, the only part I discussed with Mr. C was the implementation, as there existed two possibilities, to do each soccer with science activity in one afterschool session a week, or to divide each soccer with science activity in two parts to implement in two consecutive afterschool sessions a week. Mr. C decided to do the second option as the first one would have required his students to miss one entire session without soccer practice and the school's reputation in the soccer tournament was something he cared about a lot.

In regard to the adaptation process, there were two situations that changed my research project: inclement weather and students' feedback. Inclement weather not only forced me to start one week later than planned but also made Mr. C begin the try-outs later too. I also adapted the length of the activities due to my students' feedback. I was interviewing my focal participants almost at the end of my research project when one of the students told me he liked the activities but did not like to write. This was a decisive adaptation process since Jose was being very open with me about the activities and his interests in soccer. I decided to reduce the amount of writing for the last two activities so that student in particular and others in general would feel considered and more engaged in their participation.

A third feature that was also crucial in designing this research project and developing curriculum activities is the material things in the project. Acquiring equipment like soccer balls, cones, clipboards, and being familiar with physical spaces makes planning each activity key to implementation, especially if implementation time is limited. Along with the equipment and familiarity to the space, something to consider as part of an indoor/outdoor research project is how weather conditions may affect the development of the activities, which connects to the knowledge of the school facilities so that the teacher may use an alternate space.

Two important aspects should be noted as a result of designing and adapting these activities: The research project has to be flexible enough to get feedback from the different people involved (i.e., science teacher, participants, advisors, researcher) in each process (e.g., written activities, conversations) as the project begins and develops to match the host institution's goals and the people's vision, responsibilities, and interests (e.g., science teacher/soccer coach and the students) as well as other conditions (e.g., field, weather, internet access). The flexibility in including participants' feedback as part of the research project not only informs the researcher in his/her actions for the current project adaptations and future endeavors but also nurtures the roles of science teacher and curriculum developer working with other colleagues and students in the school context.

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CHAPTER 5

CONCLUSION

In this dissertation, I examined contexts for science teaching and learning in which Latino/a students, their families, and science teachers participated with university researchers from three perspectives: science teachers as architects in designing science learning environments; soccer as a passionate activity for many Latino students with potential for integration with science teaching and learning environments; and a study of my teaching-researching experience in science teaching with a group of emergent bilingual students in the southeastern United States. Using assemblage theory as my main theoretical approach, I demonstrated in chapters two and chapter three ways to bring new perspectives and practices for beginning and experienced science teachers who are looking to enhance their work with emergent bilingual students in the science classroom. Chapter four functioned as my reflection as a science teacher/researcher and my processes of negotiations and navigations through environments that included material and expressive elements, with a goal of providing insights for other science teacher/researchers who might pursue investigations of teaching and learning with emergent bilingual students.

Lessons Learned from an Architectural Perspective on Science Teaching and Learning

My driving questions in chapter two were: (a) What are the lessons learned from utilizing an architectural perspective to make sense of science and ESOL teachers' work in an outside-of-school learning environment for emergent bilingual students? And (b) How can those lessons be adapted by science and ESOL teacher educators designing dynamic learning opportunities for current and future teachers committed to language-rich science learning for all of their students, including their emergent bilingual students?

By using an architectural perspective, the science educators participating in the LISELL-B teacher institute and the student summer academy used and established a different relationship between the physical space and the social and academic interactions of students, teachers, and the academic materials in order to foster science learning and communication. By establishing a more direct learning relation between the physical space and the students, teachers showed ways of supporting students, especially their emergent bilingual students, in communicating their scientific ideas using cultural resources. As a result, students integrated those primary interactions with the space in their academic science learning experiences. Students often have a direct relationship with the equipment in the science class because when they manipulate these objects to understand scientific concepts they establish a primary interaction with them. On the other hand, the physical space in which students learn science is not always conceptualized as something to experiment with to enhance students' learning but, in the LISELL-B project, science and ESOL teachers pushed learning environments to become learning territories using three processes: (a) The integration of the students' home language as a resource for learning; (b) the incorporation of science inquiry along with the structure of the LISELL-B pedagogical model to design science investigations; and (c) imagining a learning space as a key element in the learning process with the purpose of supporting students in domesticating the space they inhabit as shown in chapter 3, Figure 3.6 and Figure 3.7.

Adapting these processes to science classrooms in schools with high numbers of emergent bilinguals is not an easy task or educators, nor will it happen instantly. For science teachers to build a learning territory, they will need to work with ESOL and bilingual colleagues and students to develop ways to integrate students' home language with the science content and the physical space and materials in the classroom so students can have another route for establishing a direct relation to the classroom as they interact with it. This will take time for teachers to collaborate with others to use their ethnographic, inquiry practices to gather information from parents, students, and the community, since the students' language and its use may change from house to house in their particular school-community contexts. Also, with the wide range of immigrant students in U.S. classrooms today, we know that teachers encounter students from many different language backgrounds ranging from Korean to Vietnamese to Arabic to Spanish, most of which will be unfamiliar to the teacher. Once teachers collect information about their students' home language experiences, they can begin integrating that understanding with implementation of the LISELL-B pedagogical model based on science inquiry into their own science teaching practices in the classroom. These two parts, the exploration of students' home language experiences and the LISELL-B implementation, are crucial to fully develop this architectural model in the classroom. It is also important to collaborate with ESOL teachers and to look for support of local universities or other resource centers for supporting teacher professional learning so that teachers have ongoing opportunities to collaborate with other professionals engaging in thinking, in particular, about helping emergent bilingual students see their home language resources as a means of supporting robust science learning.

Finally, teachers need support to be consistent with integrating these two processes of incorporating home language resources and developing the language of science through participating in science investigations, as they encourage their students, especially the emergent bilingual students, to establish a direct relation with the classroom space (e.g., displaying their work on the walls and constantly connecting it to their previous and future work in the classroom and outside the classroom, such as through visits to local industries and postsecondary institutions where science can be investigated). Therefore, consistency, as the last step, makes the process of enhancing interactions between students and the space around them the domestication needed to create a learning territory. For instance, in the soccer with science project in which four focal participants engaged in English and Spanish activities, there were two students who used Spanish as a resource and there were two students who did not use their home language to engage in the activity. For these students and others who do not regularly use their home language as support for learning of science practices, it may be possible to start creating learning environments that use Spanish or other home language support in the form of bilingual language cards on the classroom walls, access to bilingual text and media to support science learning, and use of the classroom space to display students' bilingual work. As this process becomes a regular activity in the classroom, these students can build learning territories.

Making Sense of Students' Experiences with Soccer and Science Using the Lens of Assemblage Theory

I asked the following questions in chapter three: (a) How did Latino students make sense of their experiences with a project that integrated their cultural practices and passions for soccer with science learning in an afterschool program? And (b) In what ways might assemblage theory help educators and researchers explore the potential for deepening understanding of material and expressive elements interacting in disruptive and homogenizing processes in the context of science learning situated in soccer practice?

In regard to question one, each emergent bilingual student had a different experience interacting with key components of this project: the written science investigation activities, the science teacher/soccer coach, the soccer field, and with me. Moreover, their relationships and communication with their parents as well as their backgrounds and status in the country were diverse; however, one crucial common aspect was present in all of the students at the time of this research: their passion for soccer. This passion was reflected in their reported interests and participation in soccer in and out of school and in related activities like video games, soccer polls, and watching professional soccer games, among other things. Soccer, as I found out in my research, was more than an accessory in their lives as it has infused and continues to permeate their social, political, family, and community contexts with their peers, parents, and other relatives. The ubiquity of soccer in the students' and my own life provided the driving force for me to experiment with and design soccer with science activities that fostered science inquiry and communication. However, I needed a structure for the science investigation activities; in other words, I came to see the challenges in designing the activity to provide the necessary balance between the students' interest in soccer and their engagement in the reading and written activities using the language of science. This balance was key since the context in which this project took place was the afterschool soccer program and not the science class. Why is this important? The students' perspectives and motivations may vary from one scenario, the science class, to the other one, the soccer practice. Put differently, it was important for me to know that, from the students' perspectives, the science content could be seen as an element invading their soccer practice and not the other way around, where some soccer activities could be taking place in their science class. I did not want students to see learning science as a threat to their engagement in their after school soccer context, but to use soccer as a driving force to engage students in studying their favorite activity from a scientific perspective.

Most students accepted the soccer with science activities as challenges to be overcome after watching a video of a soccer player and reading the questions designed to prompt their thinking about science investigation practices and aspects of force and motion, but there were some students who did not receive them in the same. They showed some discontent especially with the writing part of the activity. Regardless of the modifications included in the activities, such as the inclusion of the small video showing a soccer star at the beginning of each activity, some students' body gestures facial expressions indicated discontent when they arrived to the soccer with science afterschool activities. Most times students' discontent faded away after starting the activity and engaging in the physical and academic explorations with their peers. However, Jose, a focal research student, was consistent for most part of the research with this resistant behavior at the beginning of each soccer with science activity. Although he participated in and finished every activity, the division between learning science and soccer practice was very sharp for him, as his motivation to write was less evident than his motivation to play soccer. For the most part, all students who participated in these activities enjoyed the challenges and competitions included in the activities, but I was that I was not reaching and linking Jose's interest in science and his passion for soccer. The connections between science and soccer I was trying to help him make were tedious for Jose, and if I was to do something to change this I had to know what was bothering him. From the interviews I had with focal students, Jose shared that the amount of writing and length of the activities were causing his discontent and, as a result, I decided to modify the length of the activities for the last part of the project. This process is how assemblages work, you plug in some elements and see how the assemblage works and then unplug something else that was causing a problem and evaluate again. Since assemblages are open, that is, other aspects could have been affecting the behavior of the students in this project, the as the teacher/researcher I had to monitor and be aware of any change or movement in the connections and interactions between material, expressive, and human elements in the project to assess and rectify the course of the assemblage. I hoped for Jose to interact in a different way now once his recommendations were taken into account. It may have been that the last two activities were shortened as he requested, or the perception that I heard his recommendations, that influenced Joes to change his behavior and participate more in working with Enrique on the last two written activities.

My second question, which addressed the importance of assemblage theory for science educators, is essential for teachers and educational researchers to understand and act in a context where material and expressive elements dynamically intersect in teaching and learning processes. An immense variety of human and non-human elements attract and connect, reject and repulse, and fluctuate, intertwining in the school classroom every day as teachers aim to meet the science teaching and learning standards and administrative requirements. In this light, assemblage theory provides a framework to experiment with these elements by elucidating them, connecting new parts or changing the current dispositions and responding as they evolve in the new part of what Deleuze and Guattari called *the map*. In other words, assemblage theory can be seen as a practice to be used in search of thresholds for productive interaction in which human and non-human bodies, such as the interaction between Enrique and the soccer ball in my study, are at the same level of importance. This perspective is also woven throughout my dissertation where I studied the teaching experience of other science teachers and my own in front of the class or as a supporting staff in science learning activities. I continuously worked to keep in mind both the human and non-human bodies, and the expressive and material elements, of the assemblages I was interacting in during my research and teaching during this dissertation study.

Negotiations of Practice in Intensive-Social-Material Research

The dynamic aspect of designing, implementing, and adapting a curriculum while doing research and teaching science becomes evident as the initial ideas and the available materials intertwine in the social process. The social process exemplified in chapter 4 by the collaboration of many people and institutions in co-designing each step along the way reflected the complexity of collaborating in this project, where many goals and processes existed. The challenges posed at the first stage of this project included institutional and individuals' requirements just for the approval, as more complexities were added as the project unfolded. I must say that developing curriculum/researching/ teaching science was, for me a single and dynamically interactive process, and the success of implementing it depended, to some extent, on the ability to elucidate issues, gather information, and adapt each element and reevaluate the process. Thus, many times negotiations with participants and research members became collaborative processes that promoted lines of feedback that affected the formation and information of this project and my different roles and interactions.

Implications

These topics I investigated in the dissertation included explorations of aspects and ramifications of the Language-rich Inquiry Science with English Language Learners through Biotechnology LISELL-B project that could enrich the teaching-learning science process in formal and informal school settings. My research demonstrates the importance of using and stressing what could be referred to as secondary activities and elements in education[11], like the afterschool programs and the creative and dynamic use of physical spaces as part of learning process. Moreover, this dissertation functions as a gateway for using new theoretical approaches and practices for in-service teachers, teachers in training, and researchers in science education who are facing new challenges and opportunities posed by curricular reforms in science education and student demographic

[11] These could be secondary activities if one thinks of the science learning as the primary activity. Of course, these positions are relative to where we as science teachers stand: the science classroom. For instance, the soccer training may be the primary activity for the soccer coach and science learning the secondary one.

changes in their current schools. Furthermore, as in the case of many universities in the U.S., this theoretical framework encourages researchers to challenge current structures in post-secondary academic institutions to establish lines of research, to begin collaborative programs with schools and communities, and to start other type of connections and work with minorities in their path to higher education using all the resources available.

Continuing Data Analysis

I collected a large amount of data for chapter two, examining science teachers building learning territories with emergent bilingual students, and was only able to consider the aspects of the LISEL-B students' problem posing projects and how they used the university's physical space to present their work. I did not include the process of negotiation between science teachers and the collaborations between them and ESOL teachers when studying how they constructed these learning territories. Another important aspect that may help in elucidating the students' role in domesticating these spaces is an examination of students' work to investigate the students' production of scientific ideas and how they communicated these to their teachers and peers, and how they used the different resources available to construct their projects and activities.

The data I collected at the Bear Hill Middle School with the soccer with science project was robust as participants were from 6th through 8th grades. As I analyzed the large body of data I collected for my research and key themes emerged, I made decisions to focus on particular sets of data and to defer more in depth analysis with some of the data to subsequent studies. I based chapter 3 on the data I collected with focal students, and at the time of this research, they were in 8th grade, which left out all the information from their peers from the other grades. Although I collected data about the focal students' fathers' experiences in science and their roles in their children's education, I decided to defer in depth analysis for this set of data also. Questions I am pursuing with these two sets of data for future studies are: Did younger middle school emergent bilingual students interact differently with the soccer with science activities than their older peers who were about to attend high school? Did their fathers' experiences in science and roles in their children's education affect how the students related to the soccer with science activities? What other soccer with science activities could be developed based on the students' interests and performances in the team?

I am planning to revisit the data collected from the conversations with the science teacher/soccer coach I collaborated with in the after school soccer practice to more fully explore his role and influence on my and the students' interactions in the classroom and the soccer field. I am particularly interested to see how Mr. C's role as a science teacher and soccer coach affected focal participants' engagement in the soccer with science project.

Future research

The work with teachers engaging students, especially emergent bilingual students, with their science classroom as a learning resource using the LISELL-B pedagogical model based on inquiry leads me to consider the academic goal to have not only activities that incorporate the pedagogical processes but also science classrooms where the space is dynamically adapted to reflect the LISELL-B pedagogical practices. The LISELL-B project is currently working with several science teachers in middle and high schools who are using many LISELL-B activities that integrate science topics, standards, and activities and one of my goals is to have a pilot science classroom in which the collaboration between university researchers and school science teachers and staff with a goal of supporting emergent bilingual students permeates every activity and practice, and every report and material in the science class with the students. Another aspect that would be very interesting to study is the teachers' use of technology in the upcoming LISELL-B summer institute and the teachers' and students' use of technology in the LISELL-B student summer academy for constructing their science projects and explaining their findings.

In regard to the soccer with science activities, chapter 3, a goal I have would be to implement them as part of the regular science classroom activities in addition to the work we did with the afterschool program. What might be the role of those students who like soccer and belong to the soccer school team with their peers participating in these classroom activities? What is students' process of interacting with the written activity and reporting their results, and what evidence do we find of development of the ownership of the language of science? Another part to help in strengthening the understanding of the importance of soccer as a passionate activity for Latino/a students is to implement it with middle school girls and study the possibilities of this project along with the activity structure offered in the afterschool program. It would also add to this research to see how parents engage in the soccer activities with the female team. In addition, I designed another two soccer with science activities that were not implemented in my dissertation study. Both activities were group activities, that is, activities in which students would collaborate in pairs or triads to develop their answers, e.g., write a hypothesis, based on their experiences playing together on the team. I would argue that by including these group activities, we would be inviting those students who like cooperation to participate with those who enjoy competition, thus, enriching these practices that could also fit with classroom activities outside the soccer afterschool program.

Overall, I would like to continue researching the emergent bilingual students' interests and passions that could lead to implementing new ways of engaging them in science. This goal should also involve parents, teachers, and the community so students connect what they learn with everyday life, making learning meaningful and with possibilities of expanding to other learning situations.

For chapter four, I would also like to continue researching how the processes of negotiations among teacher educators, researchers, teachers, and students happen with science teachers who do not have the soccer coach position at their schools but would like to participate and engage their students in soccer and science activities.

Limitations

An important limitation in my study of the role of teachers designing learning environments that lead to learning territories is the short duration of the student summer academy. Put simply, teachers and students glimpsed the possibility of dwelling in the university settings where the academy took place. This brief time that students used to inhabit the university spaces was meant to function as a threshold for the students to trigger their motivation and interest in careers and jobs related to science and not for them to dwell in them; however, I expect this motivation and interest could fade away if not reinforced by their teachers in the school classroom through the regular year with the classroom science teaching practices. This is another reason why students' learning environments and territories need to be promoted and supported by science teachers in collaboration with university researchers, the industrial sector and the community.

Although soccer was an important aspect in the lives of the focal and secondary participants in my study, the focal students were in 8th grade and reflected their contextual interests appropriate to their age and place on their way to graduate from middle school and start high school -and be part of the high school soccer team. Thus, their answers, involvement, and actions in the science classroom and soccer field responded to this situation, which was different than the rest of their peers in 7th and 6th grades. I did not interview secondary participants, nor did I meet with their parents and teachers. I cannot, therefore, talk about their opinions about these activities and their recommendations to modify the activity structure to make them more attractive and meaningful. Also, I do not know if secondary participants talked about their participation with their parents and relatives.

Another important limitation was my somewhat limited involvement in the soccer team: I observed focal students for two hours a week and worked with them for one hour a week. Of course, this was a result from the negotiations with the soccer coach, but I could have volunteered and helped Mr. C with the athletes as an assistant coach or as a referee for training matches –which I did twice after the 30 minutes devoted to my research in the afterschool program. I would argue that my involvement with the students in more soccer activities would have enhanced their perspective of me as a soccer assistant rather than as a graduate student. Would their view of me as a soccer assistant contribute to their participation in the project? Would my involvement as an assistant coach have affected the acceptance of those students who were at the beginning of this research reluctant to participate? In addition to my limited participation, the short amount of time the soccer league lasted also impacted the interactions and familiarity of the students with the soccer with science activities.

I realized almost at the end of my research that I needed to modify the written activities after I interviewed my focal students. The goal of this interview was not to make changes to the structure of the activities but to gather data about the focal students and their experiences in this project. Jose helped me realize that the dynamic nature of the activity and its structure has to respond to the students' feedback, which I did not account for at earlier stages in this project. In other words, the limitation here was that I only contemplated students' interest in a limited way at the beginning of the research to design the activities but did not continue to include their feedback once the research started.