



In the Trading Zone: Rethinking Science Education through Collaborative Curriculum Practices and Research *with* Bilingual Latino Students and Educators

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Abstract

In this article, we describe and discuss the negotiations and processes of carrying out a science curriculum-based research project with multiple stakeholders, including an 8th grade science teacher/soccer coach, and 24 student-participants from a middle school in the South-eastern United States. Drawing on the theoretical notion of trading zones, we focus on the negotiations, commitments, and collaborations that took place in order to: (a) teach science to Latino students in the context of an after-school soccer program, (b) develop curriculum and (c) carry out a research program in which both material things and physical spaces are recognized as central to this process. Our study presents these experiences and processes in relation to the characteristics of the human and non-human elements involved in this work. We conclude with a set of recommendations for pre-service and in-service science teachers developing science activities as part of a broader curriculum and teaching science to middle school students in multilingual, multi-ethnic, and multicultural settings.

Keywords: bilingual students, trading zones, Latinos, school-university partnerships, science education

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Introduction

The Latine¹ community plays an important and evolving role in United States society, contributing to cultural and linguistic diversity both in the workforce and in classrooms (Park, Zong & Batalova, 2018). Increased presence and visibility of Latine communities are occurring in regions like the ‘Deep South’ where the ethnic composition was relatively stable until the late twentieth century (Levine & LeBaron, 2011). This landscape coincides with societal demands for science knowledge and skills that are reflected in the current reform initiatives in science education (NGSS lead states, 2013; NRC, 2011), and are paralleled by calls for new science and engineering skills in the industrial sector (Gordon & DeBard, 2014). However, curricular changes in education have had only limited success in supporting Latine students in learning science, at least in part because their cultural practices are rarely addressed in frameworks that continue to view science “as culture-free” (Lee & Buxton, 2013). In the research described in this article, we² focused on cultural practices that have played an important role in the sociohistorical contexts of most Latin American countries; indeed, our understanding of these practices informed how we negotiated the implementation and adaptation of program activities. In this article we share parts of these activities to illustrate our approach, but we encourage readers interested in understanding the full structure of the science activities and other resources described here (e.g., use of bilingualism in science, translanguaging in science education) to refer to our work and materials in the following texts (e.g. Buxton et al., 2022; Cardozo-Gaibisso, et al., 2017 and Harman et al., 2022).

Our research focuses on how soccer and science can be used to engage Latine middle school students in thinking, learning, and communicating about their science ideas bilingually in an after-school program. We believe our approach provides examples of how science teachers can design activities based on their students’ interests and passions in the classroom. In a review of the literature related to culturally responsive science teaching, we have found no other studies using science and soccer for pedagogical purposes (Vazquez Dominguez et al., 2017). The soccer with science activities presented in this article follow a modified version of the Language-rich Inquiry Science with English Language Learners through Biotechnology (LISELL-B) pedagogical model (see Buxton, et al., 2016; Cardozo Gaibisso et al., 2022). Our earlier work on Latine emergent bilingual learners (EBLs) in soccer afterschool programs (Vazquez Dominguez et al., 2017) clarified how students engaged in planned curriculum activities, but it did not discuss key planning aspects that may help practitioners in developing collaborative science curriculum and resources with EBLs.

To address that gap, in this article, we explain: (a) How a teacher-research project changed over time through negotiations among the science teacher/soccer coach, researchers, and students; and (b) How the project continued to adapt according to shifting material conditions, such as the number of students, school facilities, weather conditions, and students’ feedback. As we discuss later, these modifications allowed us, in our multiple roles as science and language teachers/researchers/curriculum developers to consider and integrate institutional requirements, colleagues’ suggestions, and participants’ voices to make the curriculum-embedded activities more meaningful and engaging for the students, as well as relevant for the school context. With the aim of

¹ In this paper, we use the terms Latine and Latino. We use the term *Latine* throughout the paper to include all those who identify or are identified as coming from Latin American or Mexican cultural heritage and Spanish linguistic heritage. However, when discussing our specific study, we use the term *Latino* because this was how the participants playing in the soccer team identified themselves.

² The word “we” is used in this article to refer to the two authors who collaborated in designing the study and analyzing and interpreting the data. The lead author collected the data. At points where the experiences in the field are being described, the term “I” is used to refer to the first author.

disrupting the artificial curricular divide between theory and practice our work is grounded in the notion that “one essential aspect of disciplining as well as of the concomitant homogenization and exclusion processes that are increasingly accepted as the norm since the rise of national schools is the artificial distinction between the practical and the theoretical. The critique here is that this distinction is perpetuated and entrenched in schools because theory is prioritized over practice” (Hestholm & Jobst, 2020, p. 271).

With the aim of elucidating the disruption caused by this theory-practice divide, we explore how the institutional requirements and negotiations among multiple actors derived insights for science teachers developing science curricula, conducting 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, may also benefit from reading and considering the lessons learned from this project, while thinking about the challenges and affordances of teaching and learning in the trading zone, a concept we develop later in the paper.

Context

As frequent visitors of the school in our role as researchers, we were familiar with the middle school before we started this project and knew many of the science teachers working at the institution. Many science and ESOL teachers have been participating in the LISELL-B project situated at a university in the Southeastern United States since the early stages of the project in 2009. From Fall of 2013, we participated in the LISELL-B project with Mr. C, the science teacher/soccer coach, with a special emphasis on the professional learning framework activities. During the project activities, Mr. C talked with us on multiple occasions about soccer and the challenges he faced as a goalie in local leagues. Furthermore, he also mentioned how he saw his responsibilities of teaching science and coaching the middle school soccer team as complementary ones, despite the artificial divide set by the school context. Mr. C also shared his preference for the Premier and Spanish leagues and other international leagues throughout the year and mentioned how it was common for him to talk about those games with his students between class periods or at the end of the day, just for the joy of sharing different topics with his students. Mr. C. always had something interesting to say about science, soccer, and his class, and the connections between these three components became clearer as his relationship with the research team deepened. It became clear that Mr. C., like many educators, was always carrying material and symbolic pieces of his personal trajectory to the classroom, and incorporating “institutional cultures, the academy, politics of inquiry, histories, languages, and ways we identify are a part of our teaching and learning” (Ulmer, Kuby & Christ, 2020, p. 5).

A vivid example of this can be linked to the first time we visited his classroom and were able to appreciate the myriad of resources displayed on the walls. This was not a regular science classroom, for you were able to find Newton and Einstein bubblehead 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 components outside 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, those students who are part of a sports club in school, was very clear in terms of expectations regarding their behaviour and academic performance. This meant that if a student-athlete was not performing and behaving as expected, then his/her/their place in any of the sport teams would be jeopardized or lost until their performance in the classroom met the required expectations. As shown by research there are positive effects associated with Latine student participation in sports and school performance (Bang et al., 2019).

Following this principle, 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 be informed through email. Indeed, we witnessed this when one of our student participants, Israel, was suspended because he misbehaved during math class which later prevented him from attending soccer practice. Soon, we learned the explicit rules and requirements for students both in the school and in Mr. C's class, which greatly aided us as we planned the research, curriculum development, and teaching process. Mr. C's familiarity with the LISELL-B project practices, our previous collaborations, and his interest in soccer, as well as his willingness to experiment with new things, contributed to facilitating the development of this soccer with science curriculum research project in his science classroom and soccer field spaces. Next, we will delve into the resources needed for this research, curriculum development, and teaching project, and the negotiations that happened during this process in the trading zone.

This study we present in this article is a sub-project which was part of a larger National Science Foundation-funded project, located and developed in the south-eastern United States. The project included a professional learning framework and pedagogical model for both teachers and EBL Latine students. The professional learning 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. This framework had the unique characteristic of disrupting the usual top-down professional development approaches and positioned teachers, students and other collaborators (Cardozo-Gaibisso & Harman, 2019) so that they could "co-construct knowledge and resources that can be used to address the needs of diverse student populations" (Buxton et al., 2015, p. 9). By collaborating with science teachers, the main objective of the project was to experiment with instructional strategies that promote students' engagement with and communication about science activities and ideas. To achieve this purpose, we worked closely over several years with the EBLs (n= 1,600), their families, and the science teachers (n= 25), in the different contexts of the professional learning framework.

Framing the Study: Trading Zones in Developing the Soccer with Science Curriculum and Student Passions

The notions of research-practice partnerships as *trading zones* guided our understanding of how participants in the soccer with science project negotiated their schoolwork, rules, and additional interpersonal and academic exchanges (Galison, 1997; Penuel, Coburn, & Gallagher, 2013). A trading zone can be defined as an environment where people have many cultures, different practices, and perspectives, in spite of which they converge in a place to collaborate, create, organize, and act as they look for a common ground and to fulfil a specific objective. Nevertheless, this common ground does not emerge without conflicts or tensions, as participants have diverse statuses and interests, and they are positioned differently within hierarchical social structures. In these collaborative environments where people's cultural tools intersect, there is the possibility for participants to create new forms and ways of practice through negotiation (Penuel et al., 2007).

In the soccer-with-science research project presented in this article, negotiations began from the moment the co-design process started among participants. This involved interactions and adaptations between university researchers and Mr. C, the science teacher and soccer coach, all with the goal of developing a set of activities that incorporated both soccer and science. Choosing soccer was a decision inspired by the idea that learning can be enhanced when classroom content is connected to student passions, and when teachers are able to create a motivating and exciting learning climate (Serin, 2017). Indeed, a review of the existing literature (Newell, 2003; Manuel, 2017; Ball, 2016)

confirms the notion that engaging and connecting students with motivating and culturally relevant content is not only advantageous but also necessary. Therefore, teachers and educators should attempt to design activities that fulfill this objective.

Materials and Methods: Negotiations When Planning and Carrying Out the Soccer with Science Curriculum Practices at Bear Hill Middle School

Since the beginning of our involvement with the LISELL-B research project, and especially in the process of engaging EBLs in learning science, we started our research planning with the premise of linking a passion shared by several Latine students to science education. Our previous experiences with the 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 us to gather enough evidence to support the claim that soccer is a passion shared by many Latine students and parents from México, Central America, and South America who are now living in the southeast region of the United States for multiple reasons and under diverse circumstances (see Cardozo-Gaibisso et al., 2018). As Latine scholars and immigrants ourselves, it was clear that this passion for soccer was not just a superficial trait of our culture, but one that carries deep meaning and connections to our cultural roots that go far beyond the sport, connecting to the indigenous roots shared by members of the research team and the students who were part of the project (Blümchen, 2009). Indeed, soccer, as a driving force, seemed to be a perfect locus for the science activities we were developing as this sport practice has been a very popular tradition for students and their parents since soccer has intertwined historically with most Latin American countries (Vazquez Dominguez et al., 2017). Besides providing an important driving force, the popularity of the sport offers the advantage that most students possess vast previous knowledge and understanding of it, such as its rules, famous players, international tournaments, and iconic games. Additionally, the equipment needed to practice soccer is relatively inexpensive. These characteristics combined, as well as the conditions available to develop a curriculum project involving soccer and science encouraged us to link these two realms with the motivating idea that the connection of these two elements could offer: (a) science teachers the possibility to explore how to teach science by developing curriculum in a relatively straightforward and meaningful manner; and (b) EBLs the possibility to learn and expand on the language of science and the practices of doing science bilingually, in English and Spanish, while engaging in a well-known activity such as soccer in a familiar space such as the school (Vazquez Dominguez et al., 2017).

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 thoroughly or in a culturally sustaining way that builds meaningfully on students' passion for soccer. What is more, while many teachers working with linguistically and culturally minoritized students recognize the need to bring their experiential knowledge to the science classroom they are often not successful in doing so (Vazquez Dominguez et al., 2017). A predominant approach to this is to include a set of tools and practices in their classroom activities, usually known as the tourist approach. This approach often fails to acknowledge the potential of using students' backgrounds to create whole learning units and curriculum throughout the academic year instead of just adding isolated information about soccer sporadically or as a starting point of a lesson or learning unit.

To address this issue, our intervention explores the problems, including negotiations and adaptations of students' cultural tools and practices, while implementing them with the middle school science teacher and students as part of an afterschool program. The emphasis of our work with the focal teacher (Mr. C.) was soccer as the Latino students in the class were very explicit about their

interest in the game. Moreover, the science teacher/soccer coach recognized the importance of this activity for these students.

In terms of the demographics of the school, 84% of the student population was eligible for free/reduced lunch, and the ethnic composition of the 640 students in the school at the time of this research (2014) was: 52% African American, 2% Asian, 33% Hispanic, 3% Multi-racial, and 10% White. For this culturally and linguistically diverse group, we believe that creating meaningful opportunities for science content and the language of science learning was, and still is, crucial both in terms of equity and social justice (Harman et al., 2021). In this light, the curriculum activities we developed for this project were innovative in the sense that they used soccer as a driving force to engage students in studying and communicating about science throughout the year.

The structure of the soccer with science curriculum activities was very similar to those developed in the LISELL-B Project. They started with a Language Booster, which consisted of a one-page introduction to the science topic using what is usually known as academic vocabulary, in context. This was followed by a hands-on activity aimed at exploring the focal science concept while gathering scientific evidence and concluded with a summary template to guide students to connect the concepts they were learning with the investigation practices they were using. For this soccer and science project, we used an adapted version of the lesson framework from the LISELL-B project (see figure 1). Additionally, we included short videos of soccer stars making amazing plays that were followed by an introduction and questions about students' experiences as related to science. To support the inquiry approach to science meaning making, we linked the physical activity to soccer, students' data collection, and final science questions, which all resulted from the ongoing trading or negotiations with participants. This experimentation of including a video excerpt from a soccer match as an initial part of the activity offered both pedagogical opportunities and risks because if not planned and executed properly, it could easily lead to a focus on soccer play disconnected from science learning and the school curriculum. In the end, we settled on a structure where the students read about a soccer scenario first, then watched a short video and discussed a picture and a challenge for the students. Students were asked to predict who on the team would be able to best perform that soccer trick, then work together to gather data and finally to summarize their results using the science concepts. It took several sessions in what we consider the main trading zone for the collective group to settle on and apply this structure.

Figure 1. 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 plástico
- 1 pelota de tenis



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

Addressing this issue openly, and due to these potential frictions, a theoretical framework that discusses how negotiations and adaptations are developed to address this possible conflict was selected to explain this research/teaching/curriculum development process. We introduce and describe this approach in the following sections.

Positionality

We would like to expand on our researcher positionalities by briefly stating our background. The first author is a Mexican science educator who has worked for the last eleven years in the United States with K-12 multilingual children, their parents/guardians, and teachers co-constructing science learning environments. The second author is a Uruguayan Latina language educator who has worked with Latine children and youth, their teachers, and their families on developing the language of science for the past nine years in the Southeastern United States.

Planning and Developing Curriculum Resources

The first step to carry out this project, was planning for the material elements and resources needed to perform this research and teaching plan. A clear advantage in the research context was material

space, as the school had two soccer fields and those were close and 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 we would need soccer balls, clipboards, pencils, and hardcopies of each activity for every student. Senior University professors helped with the clipboards and copies, and Mr. C let us borrow six additional soccer balls for a total of twenty. For the short videos, included for the activities for the second half, presented at the beginning of each soccer and science activity, we used the projector and internet available in Mr. C.'s classroom.

Mr. C. informed us that most students were either Barcelona or Real Madrid fans and followed the Spanish tournament '*La Liga*' and the European tournament '*Champions League*'. Barcelona and Real Madrid are two of the most famous soccer clubs in the world and they play in the Spanish tournament and often in the Champions league. Thus, we thought using videos of Messi, Neymar, Zlatan, Cristiano and Ronaldinho would be timely and effective in terms of catching students' attention.

Processes of Data Collection and Analysis: Negotiations and Adaptations at Institutional and Individual Levels

Once the planning about materials and resources was considered, we then contemplated the social aspects, such as requirements and policies at the institutional and individual levels. It was at this level where most of the negotiations happened. At the institutional level, the 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 with the school's mission and objectives. However, one additional step had to be met before writing the proposal: 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. This mandatory step for all researchers added a level of formality to the conversations with parents, especially because we did not know about their legal status in the country, and we felt that asking them to sign permission and consent forms could jeopardize the initial rapport we aimed at building trust between us.

At the school level, the middle school principal was very cautious and strict in considering which research projects would be authorized in the school since the teacher administrative load, as well as the student responsibilities did not allow any other activity that would distract students and teachers from the main curriculum objectives and the overarching school goals. However, the school's active participation in the LISELL-B project provided us with enough legitimacy and previous relationship-building 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, university researchers, and, towards the end of the project we also added the focal participants' suggestions in the last two curriculum activities. Both Mr. C and the full research team reviewed every activity before they were implemented, making suggestions and comments.

Mr. C. discussed two possibilities for the student-athletes to do the soccer with science activities each week during this research project. The first option consisted of 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 our perspective, this option would have posed a risk to the level of student-

athlete attendance in the session where the 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 the researchers, thus, facilitating the relationships between us. For our 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 1st 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. By the time the proposal was submitted to the county school district, Mr. C agreed to plan according to the second option.

The soccer try-outs day arrived, and Mr. C was in charge of the recruitment process. We helped him in distributing around 80 students around the soccer field and observing them. It must be noted that the middle school soccer team has had an important reputation in the district soccer tournament and a history of having great players on 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 twenty-four students, since a good player does not always mean a good student, or at least what schools label as good students, and vice versa. Only twenty-one 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 training. At this point we 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 us the list of soccer players the following day and from these twenty-four participants there were four focal participants who were also in his science class: Israel, Esteban, Jose, and Enrique. All four focal participants were categorized as EBLs by their school.

Following the participant selection, our 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. Additional work with the other twenty 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 the original proposal, we had planned for a total of five focal participants, but after discussions and negotiations with all of those involved, 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.

Findings: Negotiations with Focal Students and Curriculum Adaptations Portrayal of Focal Participants

The first week was devoted to observing focal participants, which proved very useful in seeing how focal participants interacted both in the classroom and on the soccer field. Israel, a student from 2nd period, was very extroverted. In fact, it was typical to see him assessing if Mr. C’s mood would favour his talking and laughing with his friends. However, if Mr. C asked a question to the group, Israel was usually the first student to respond, and his answers were most times correct. From our observations,

it was also very common to see Israel procrastinate with his science work in the classroom and, as we found out later in the school year, with his homework and assignments for other courses as well. Another characteristic he would display was that his usual sitting assignment around the classroom. He had some formal education in Spanish and, when he arrived in the US, in English.

Eduardo, another student participant 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 for him to 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. His formal education was in English only.

Esteban, from 2nd period, was very introverted in class but always had his assignments ready. He was one of the top students in his grade and was very close to Jose, another 2nd period student. Jose was very introverted as well, and it was also usual 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.'s instruction. His formal education was in English only.

Throughout the first part of each soccer with science activity, which started in the classroom, it was usual to see Jose with an apathetic face. However, a different version of Jose appeared for the second part of each activity when he went to the soccer field for the physical activity and data collection portion of the lesson. It could be observed that he enjoyed competing and testing his physical skills with the rest of the team, especially with those from his same grade level.

Trading Zones: First Negotiations with Students

Except for the second half of the activities we taught, negotiations with students did not occur during the first part of this research project, but towards the second half we 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 to learn the boys' thoughts and their participation in the project. The conversation also functioned as a major trading zone where we discussed and adapted activities based on their insights about what they enjoyed and what they disliked. This feedback led us to include short YouTube videos about soccer stars and to decrease the length of the activities though still using science content, making them more effective. Jose, for example, 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, "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 students were asked about the science concepts they had learned in these activities, they mentioned "hypothesis, cause and effect." In this light and recognizing that they had been learning from and enjoying the soccer and science activities, we decided to adapt the length of the last activities and the amount of writing so there would be more time for students to do the physical performance and data collection portion of the activity. This was a crucial part of the implementation of soccer with science activities as the initial structure of the activities was not working as expected as students wanted to rush their answers to go to the field to play without making sense of the science-soccer connection. It was clear students were not engaged in the activities. However, it was after having the space where I met with the students and received their feedback that we could adapt the activities and experiment by including a short video of a soccer star and decreasing the length the activity. This trading zone was only possible by having this space where participants felt comfortable sharing their ideas about the activities.

Language Adaptations with Focal Students

Regarding 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 EBLs, including those of Bear Hill Middle School (Buxton et al., 2015). As both researchers shared ethnicity (Latinos), and languages (Spanish and English) with students, this mostly influenced the conversations and exchanges between us. In the last interview conducted with the focal students, they shared with us 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. We 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 we addressed in our conversations. For instance, the activity where we 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: “I read the Spanish parts to see if I could,” when we 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, we 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. We 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 with us in English during the first informal conversations that took place in the dining room during the class periods in which we were not observing the science classroom. Often, he was sitting by himself in the dining room as he arrived late to school and was not allowed to go to his classroom. Consequently, we started talking while he waited for the next class period to start. After the first conversation, Esteban seemed to trust us and shared many personal issues and experiences in and outside school about his teachers, family, and friends, translanguaging in English and Spanish. These informal conversations were common even when he was suspended from the soccer team because of his behaviour 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.

All things considered, 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 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 EBLs who are beginning to work with bilingual materials seemed to be helpful for some students, like Enrique, who was interested in testing his language skills to build disciplinary knowledge, or like Israel, who enjoyed the soccer activities and was very communicative and open of his experiences. On the other hand, for Esteban and Jose, who did not engage in the same manner than Enrique and Israel did with the Spanish opportunities provided but are also fluent

in Spanish, it may have been necessary to develop and establish a different relationship between their Spanish skills and science activities for them to use their language skills as a support to build knowledge in the science class.

Conclusions and Implications

In this article, we reflected on trading zones as an approach that can expand our understanding of how to enact our multiple roles as science teachers, researchers, and curriculum developers. We also reflected on how to navigate processes of negotiations through environments that included material and expressive elements, with a goal of providing insights for other science teachers and researchers who might pursue investigations of teaching and learning with emergent bilingual students.

The process of developing a triad of 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 projects such as the one presented in this article, 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 intricacies were added as the project unfolded. It must be noted that developing curriculum/researching/ teaching science was a single and dynamically interactive process, for many times we were not able to distinguish between the three roles as they constantly intertwined and overlapped in this project. Next, we explore the main findings and reflections emerging from the project.

Collaborating Partnership with the Science Teacher/Soccer Coach

Having worked in the first iteration of the LISELL-B project for a semester and for three additional years, we had already established a professional relationship with Mr. C. It was during the LISELL-B project multiple teacher professional development activities that Mr. C had the opportunity to share his interest about soccer, such as international games, famous players, and upcoming tournaments, which facilitated our professional relationship as members of the same project. Developing this relationship with Mr. C during the LISELL-B project helped us in our roles as science teachers/researchers/curriculum developers and consequently made Mr. C welcoming of the soccer and science project in his classroom and in the afterschool program. Mr. C. also saw how relevant soccer was for his Latine students in the science classroom and how they could benefit from connecting their motivation for soccer to enhance 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, we decided to use a modified version of the LISELL-B written activities 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. Mr. C agreed with this, and the classroom resources made this a feasible modification. Thus, the only part we discussed with Mr. C was the implementation, as there were two possibilities available: 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.

About the adaptation process, there were two situations that changed the research project: inclement weather and students' feedback. Inclement weather not only forced us to start one week later than planned but also made Mr. C begin the try-outs later. The length of the activities was also changed due to students' feedback. We were interviewing focal participants almost at the end of the research project when one of the students said that he liked the activities, but he did not like to write about them. This was a decisive adaptation process since Jose was being very open regarding the activities and his interests in soccer. As a result, we 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 elements 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. On the one hand one, the researchers need to be flexible enough to get feedback from the different people involved (i.e., science teacher, participants, senior university professors, researchers) 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 researchers and their actions for the current project adaptations and future endeavours but also nurtures the roles of science teachers and curriculum developers working with other colleagues and students in the school context.

Future Directions and Limitations

Overall, this research demonstrates the importance of using and emphasizing what could be referred to as secondary activities and elements in education, like the afterschool programs and the creative and dynamic use of physical spaces as part of the learning process. 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.

Moreover, this study could serve 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 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 curriculum development programs with schools and communities, and to start other type of connections and work with minoritized populations in their path to higher education, using all the resources available.

Finally, a limitation we have identified in this study is the role of teachers in designing learning environments that lead to combined learning spaces within their school's academic and administrative constraints. Additionally, although soccer is an important aspect in the lives of the participants of this study, this may not be the case for many other students, for which another activity or topic would be of more relevance to their learning.

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