An Exploration of Hybrid Spaces for Place-Based Geomorphology With Latino Bilingual Children

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ABSTRACT

Latino bilingual children hold rich understandings, which are underexplored and underutilized in the geoscience classroom. Oftentimes, young Latinos possess unique cultural land experiences shaping their place identities. We consider science as language and culture, and propose place-based geoscience hybrid space explorations that are culturally and linguistically relevant. We explore the different elements that help bilingual children learn geoscience using pre- and postsurvey of their understanding of the processes of erosion, transportation, and deposition; children's marks, drawing, and writing on a photograph; and graphic organizers with children's notes. Several different instructional elements for working with Latino bilinguals, organized around five tenets of culture, arise from our analysis: (1) Utilizing multiple linguistic resources, (2) making explicit connections to alternative interpretations of words, (3) using culturally relevant examples, (4) using alternative and creative ways of operationalizing hybrid spaces, and (5) learning in a community of practice. © *2014 National Association of Geoscience Teachers*. [DOI: 10.5408/12-407.1]

Key words: Latino education, English language learners, bilingual, geoscience, culture, place identity, place-based geoscience

INTRODUCTION

When working with culturally and linguistically Latino bilingual children in science, efforts must account for the language and cultural backgrounds of the learners (e.g., Lee, et al., 2008). This is particularly true in geoscience where meaning-making is influenced by cultural experiences and worldviews.

Different factors suggest that Latino children may hold understandings in relation to geomorphology that are underexplored and underutilized in the science classroom. For example, parents of Latino children in the U.S. tend to work in service and support occupations that may be connected to the outdoors. In fact, according to the National Council of La Raza, Latinos are disproportionately employed in these service and support occupations. This includes work in natural resources, construction, maintenance jobs, production, transportation, and material-moving occupations, representing 33% of Latino employment. These types of work often involve experiences with the natural environment, which may result in a range of expertise with geologically related processes. As parents talk to their children about their jobs, conversations around geomorphology-related aspects may arise, enriching children's intuitive understandings.

Another example suggests that Latino children may hold rich resources for learning geomorphology, as bilingual students often have experiences with international travel for different purposes, which may be influenced by their minority or majority status in the country where they live. One possible context for bilinguals traveling internationally is to visit their parents' home countries in order to connect with family, heritage languages, and lands. A second common travel context is Latino bilinguals' immigrant experiences that create situations in which they needed to engage with the landscape in various ways (i.e., traveling through deserts). Additionally, some students might be able to travel for enhanced educational opportunities such as to practice language skills or to study in more prestigious locations. Efforts to understand and interact with varying land experiences through visits to their homelands, immigrant experiences, or language study can help to shape bilingual children's place identities.

Lastly, an important factor that may impact bilingual children's geomorphological understandings is their indigenous roots. One of the most well-known indigenous peoples of Central and South America are the Maya and the Aztec (the first people of Mexico), and the Inca (the original people of Peru; Cyprus, 2003). While many bilingual children are born in the United States or immigrate here at a young age, their cultural heritages play an important role in who they are, and can influence their learning in the form of exposure to indigenous languages (such as Mixteco which is spoken by 7% of all Mexican indigenous speakers; Schmal, 2010) and on the impact of their understandings around geomorphology. The Inca indigenous people, for example, traditionally have organized celebrations to honor Mother Earth, or *Pachamama*, showing great gratitude, love, and respect for the spirits of the mountains, rivers, and other natural landforms through symbolism (Sanchez, 2009). These traditions, which are at times invisible in schools' curricula, are passed through generations by means of different conscious and unconscious processes, and can be used in instruction both as a source of pride in one's indigenous roots, as well as a source for rich environmental understandings impacting children's place identities.

To incorporate these cultural influences and build on Proshansky's (1978) work, we define place identity as "those

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dimensions of self that define the individual's personal identity in relation to the physical environment by means of a complex pattern of conscious and unconscious ideas, beliefs, preferences, feelings, values, goals, and behavioral tendencies and skills relevant to this environment'' (p. 155). Based on the understanding that place identity is not static but is impacted by the multiple spaces children navigate as they experience different landscapes (Korpela, 2002), we recognize the coexistence of multiple perspectives and beliefs for interpreting the landscape; thus, we refer to place identities in plural form, rather than singular. Even though these children may possess sophisticated place identities and a sense of these experienced physical land spaces, their early learning experiences in geoscience are often decontextualized or restricted to abstractions based on traditional curricular standards.

Science is defined as culture, and also language (Lemke, 2001). Thus, concomitantly to cultural resources based on Latino children's land experiences, bilingual students must actively be engaged as science-language learners ''who could benefit from instructional strategies, making the language and culture of science clear'' (Meyer et al., 2012, p. 218). Not only it is important to make connections with community and language experiences grounded in instructional strategies that clarify the language and culture in science, but it is also necessary to allow students' agentic behaviors to flourish in the science classroom. Agentic behaviors will be enacted if the science class includes diverse instructional strategies permitting kinesthetic, emotional, visual, and other forms of knowing. Agenticity is characterized in our work from a poststructural theoretical framework within Butler's (1998) notion of embodiment. For Butler, the agency of the subject emerges through a process of enactment and comes after the materiality of the body. In this way, Butler reveals the constructed nature of, not only sex and gender, but also of race, ethnicity, and class within which children perform according to historically accumulated scripts.

Thus, science instruction that is merely informed by a curriculum privileging bilinguals' afar ways of knowing, doesn't necessarily take into account their linguistic particularities, and can negatively impact students' views about science and their identity development as future scientists. As a result, culturally and linguistically diverse learners continue to underperform on measures of science and language, both in the U.S. and internationally (e.g., OEDC, 2011).

This is most prevalent in geoscience, a field in need of trained scientists. According to the American Geological Institute (2009), geoscientists are scarce and employment opportunities are expected to continue to grow about 23% between 2008 and 2018, much faster than the average growth of all U.S. occupations (10%). Culturally informed geoscience education, which takes into account bilinguals' place identities and linguistic characteristics, has the potential to better engage diverse students who are underrepresented in geoscience.

Specifically, place-based geoscience teaching may include elements such as greater emphasis on the study of local places, synthesis of local cultural knowledge, and community directed activities in science. In addition, we propose that when working with bilingual children, place-based geoscience teaching must also consider native language generation activities, and space for reflecting and using linguistic resources for learning. Operationalizing place-based geoscience in the elementary classroom with diverse learners may enhance science literacy among these underrepresented minority students, and bring more of these children into the geoscience profession (Semken, 2005).

Despite the recognition of the importance of place-based geoscience when working with diverse children, culturally and linguistically relevant research in geoscience is extremely limited. A review of the research in the field of geoscience education, more recently referred to as ''geocognition,'' shows that very little is known about how students progress toward expertise in geoscience and the role of education in geocognitive development (Petcovic et al., 2009). There is no question that more research is needed. Thus, this exploratory study is an attempt to expose some of the constructs unique to Latino bilingual children's understanding and learning of slow changes to the surface of the Earth.

THEORETICAL BACKGROUND

In this study, we integrate different theoretical constructs to (1) explore the gap in research on pedagogical approaches in geoscience that simultaneously value student understandings and experiences, (2) to allow student opportunities to learn the dominant codes by addressing children's alternative conceptions, and (3) to provide teacher and student opportunities to extend these dominant codes. The integration of theoretical constructs is based on the fact that there is a lack of research looking at bilingual learning in the geosciences. This lack of prior work requires bringing together a series of very important theories from both fields. This is an effort to provide a more robust connection between bilingual education and place-based education than most of the literature on place-based teaching has explored to this point.

With this intention, in our theoretical framework, summarized in Table I, we integrate the theories of funds of knowledge (Moll et al., 1992), hybrid spaces (Gutiérrez, 2008), and model-based co-construction (Rea-Ramirez et al., 2008) within geoscience learning. We next describe the theoretical constructs, while the more explicit connection of these theoretical constructs with geoscience learning is presented in the analysis section.

In our work, the appropriation of everyday concepts is operationalized via the construct of Third Space (Gutiérrez, 2008). Gutiérrez's Third Space is somewhat related to Soja's (1996) Thirdspace, which is used in cultural geography. However, these two constructs falling under the same words are distinct in that, while Gutiérrez's term refers to a metaphorical space that, via hybridity, has potential for learning and development, Soja's definition includes a unique notion of space as blending space, history, and society. Furthermore, Soja specifically highlights human experiences in spaces as a hybrid of empirical interaction and real phenomena, with the interpretation of those phenomena and utilized everyday microgeographies as macrogeographies of larger historical events. On the other hand, rather than focusing on human experiences in space and their interpretation of this actual experience, Gutiérrez, contextualizes the construct of Third Space within issues of education, while challenging traditional understandings in

TABLE I: Theoretical constructs for geoscience learning.

Theoretical Construct	Reference	Definition	Purpose for Integrating Construct
Third hybrid space	Gutiérrez, 2008	"[A] transformative space where the potential for an expanded form of learning and the development of new knowledge are heightened" (p. 152).	To expand what counts as knowledge.
Funds of knowledge	Moll et al., 1992	Historically developed and accumulated strategies and bodies of knowledge that are essential to a household's and an individual's functioning and well-being.	To expand what counts as knowledge by specifically recognizing students' linguistic and cultural resources.
Conceptual change pedagogy: Alternative conceptions	Resnick, 1983	Student-held theories about how the natural world works that they bring to their science classes.	To consider alternative conceptions as grounded in everyday experiences and as resistant to change so that they can be explored in the classroom.
Model-based Co-construction	Rea-Ramirez, Clement, and Núñez-Oviedo, 2008	A learning theory considering the role of cognitive changes and social interaction in the learning process.	To account for students' alternative conceptions as it helps to conceptualize the metaphorical bridge that blends two contrasting science and language learning theories.

relation to social justice. Gutiérrez speaks of the Third Space specifically as a space where the scripts of teacher and students, and the official and unofficial learning environments intersect and thus potentially shift what counts as knowledge (Gutiérrez et al., 1995). More specifically, Gutiérrez defines the Third Space in relation to education as "a transformative space where the potential for an expanded form of learning and the development of new knowledge are heightened" (Gutiérrez, 2008, p. 152).

This idea of Third Space is facilitated through the use of students' funds of knowledge, or those historically developed strategies and knowledge that are essential to a household's and an individual's functioning (Moll et al., 1992). In our work, students' funds of knowledge in the form of linguistic and cultural resources are invited into the academic space as fully developed sources of knowledge to challenge and expand what counts as knowledge.

Valuing and expanding upon bilingual students' funds of knowledge must be coupled with what is called from the field of conceptual change pedagogy, children's alternative conceptions, or student-held theories about how the world actually works (Resnick, 1983). It is important to realize that alternative conceptions are often grounded in everyday experiences and have been shown to be resistant to change (Osborne and Freyberg, 1985; Driver, 1989). Since it has been documented that children hold "extensive theories about how the natural world works" (Resnick, 1983, p. 477), exploring and inviting students' funds of knowledge into the classroom is necessary and will surely bring students' alternative ideas to the surface so that they can be explored within the generated hybrid space while in the classroom. Thus, to account for students' alternative conceptions, we utilize model-based co-construction, proposed by Rea-Ramirez and colleagues (2008), as it helps to conceptualize the metaphorical bridge that blends model-based reasoning based on theories of conceptual change (Clement, 2000), with sociocultural principles of learning (Vygotsky, 1978). Responding to critiques to sociocultural theories as "too broad and as lacking empirical support" (Anderson et al., 2001, p. 2), model-based co-construction is rooted in both Piaget's (1964) cognitive theories in which conceptual change is situated, and Vygotsky's (1978) social learning theories. With this reconciliatory approach, model-based co-construction is an attempt to consider the cognitive changes taking place within individual learners while considering previously ignored constructs such as motivational factors, the role of social learning, and the situational context of learning and thus, prioritizing the fact that knowledge is constructed through social interaction.

DESIGNS AND METHODS OF ANALYSIS

This exploratory study is an attempt to expose some of the constructs unique to bilingual children's place-based geoscience learning that is assisted by technology by investigating the following question: *What are the differential elements that help bilingual children learn geoscience?*

Participants

Twenty-three bilingual Peruvian children participated in the curricular assignments we proposed. Children had just completed fifth grade at the time of the investigation, which took place during their summer months. All children had been born in Peru and were learning in both English and Spanish in a bilingual private school located in Lima, the capital of Peru. All participating children's families were from medium to high socioeconomic and educational levels.

The rationale behind working with this particular population of children is that our team was invited to Peru as part of the National Congress of Educators to conduct a series of workshops in STEM learning with Peruvian teachers. We were given the opportunity to work with this population of bilingual children in this particular bilingual school in Lima, Peru. While this population differs in socioeconomic levels to the majority of U.S. Latino bilingual population, our work benefited the actual learners, while at the same time shedding light on several aspects that apply to both groups of Latino bilingual children. Specifically, we find our work with the Latino bilingual Peruvian population

TABLE II: Questions and suggested responses for pre–postsurvey.

1. Piensa y con cuidado dibuja y escribe para explicar cómo se formó el Cañón del Colca en Arequipa o el Gran Cañón del Colorado. (Think and then carefully draw and write to explain how the Colca Canyon in Arequipa or the Grand Canyon formed).
Suggested Correct Responses for Question 1 The Colca Canyon was formed by the erosion of volcanic rock caused by the Colca River, at least 150 million years ago. It is one of the deepest canyons in the world and it is twice as deep as the Grand Canyon, although not as steep (more information can be found at http://www.colcaperu.gob.pe/). On the other hand, the Grand Canyon has been carved by the Colorado River over the past 6 million years. Water and wind have over the years eroded rock and swept it away. The Grand Canyon is considered one of the seven wonders of the world (more information can be found at http://grandcanyonhistory.clas.asu.edu/index.html)
2. Dibuja y escribe para explicar qué es erosión causada por el agua. (Draw and write to explain what is water erosion).
Suggested Correct Responses for Question 2 Water soil erosion is the result of water transporting vulnerable soil, either directly or indirectly, as runoff in small channels, or rills, or in larger channels, which are also called gullies. Indirect water erosion is caused by too much rain that is too intense for it to infiltrate the soil, or water that runs off because the soil is already fully saturated (more information can be found at http://www.soilerosion.net/doc/water_erosion.html).
3. Dibuja y escribe para explicar por qué los ríos no se mueven en líneas rectas, sino que se curvan. (Draw and write to show why rivers don't move in a straight line, but turn as they move).
Suggested Geoscience Responses for Question 3 Rivers always flow downhill. A stream, or a river, is formed whenever water moves downhill from one place to another attracted by gravity and from high to low. Hence, rivers usually begin very high in the mountains, and collect more water on their way down to the sea. Rivers wash plants and soil from the land in a process of renewal of nutrients for the plants in the rivers, as they meander to renew themselves (more information can be found at http://chamisa.freeshell.org/flow.htm).
4. Dibuja y escribe para explicar qué relación hay entre erosión, deposición, y transporte causados por el agua. (Draw and write to explain the relationship among erosion, deposition, and transportation caused by water).
Suggested Geoscience Responses for Question 4 As water moves through the surface of the earth, it transforms the landscape by *transporting* pieces of soil that is *eroded* from the landscape and eventually *deposited* in a lake or in the sea (more information can be found at http://www.aces.edu/waterquality/faq/faq_results.php3?rowid=1673).
EXTENSIÓN: Escribe al menos tres preguntas que tengas acerca del tema de erosión, deposición, y transporte. (Write at least three questions you have on the topic of erosion, deposition and transportation).
Students' responses for the extension question are shown in Table IV.

helped us better understand aspects of learning in relation to Latino bilingual U.S. population in the following ways:

- Since both groups included bilingual children, we were able to expose some of the constructs unique to bilingual children's place-based geoscience learning that is assisted by technology.
- While some cultural experiences and worldviews may be different in both populations, we believe that both groups hold common understandings in relation to geomorphology that are underexplored and underutilized in the science classroom. For example, both groups of learners share their indigenous roots, and have transnational experiences contributing to their place identity.
- Learning from the Latino Peruvian learners provides the necessary background (Latino cultural knowledge) for culturally informed geoscience education to better engage Latino children in the U.S.
- In relation to language use, both the Peruvian and U.S. groups share their bilingualism and therefore, the potential benefits of integrating spaces to reflect and use linguistic resources for learning is a common aspect of both populations.

This manuscript focuses on describing aspects from our work from the Latino Peruvian population that can help us better understand the needs of the U.S. Latino bilingual population for geoscience learning.

Data Collection

All participating children completed a pre–postsurvey of their understanding of processes of erosion, deposition, and transportation (open-ended questions with suggested geoscience responses are shown in Table II). Students were also asked to make marks, draw, and write to explain what they saw and/or noticed on a color photograph before and after participating in the proposed exploration activities. The researchers took the photograph, which showed the resulting effects of erosion processes on the school grounds. Finally, graphic organizers with students' notes during fieldwork experiences were collected. These graphic organizers included color photographs of the locations the class visited during the fieldwork with space for observation notes. Additionally, the researchers wrote daily field notes and tape-recorded all instructional sessions.

Data Analysis

This is a primarily qualitative (Erickson, 1986) and practitioner research (Cochran-Smith and Lytle, 2009) study documenting how students engage in geomorphological observation in their familiar environment.

We analyzed the qualitative data thematically in a recursive and iterative process (Strauss and Corbin, 1998), identifying patterns both in the content of children's notes and marks, drawings, and writing on the photographs, as well as in the process by which children engaged in making sense of the natural occurrences being observed. Part of our instruction aimed at exploring whether these bilingual children, who traditionally were encouraged to academically separate their two languages, would accept the assignment to integrate all their linguistic resources as they worked with our proposed activities. For this reason, we searched the data for instances of codeswitching.

As we worked with the data and realized the importance of culture in research such as ours, we noticed that many of the patterns arising could be understood around Sonia Nieto's (2009) sociocultural theoretical framework. Nieto (2009) proposes a definition of culture with five tenets. We employed Nieto's elements as a lens for examining and categorizing the data, which resulted in some rich insights toward addressing the research question.

Miles and Huberman (1994) speak to qualitative analysis as promoting open-minded, context-sensitive matching of observations to a theory or set of constructs. This is what we attempted to do in our analysis employing Nieto's elements, where we saw evidence and where we did not in this specialized context. We employed a two-level scheme to address the more general "etic" level of categorization of the data according to the elements, and then a more specific "emic" level analysis interpreting the contextualized nuances nested within the etic codes (Miles and Humberman, 1994). Thus, we organized the events we identified in students' pre–post answers to the questions within Nieto's five elements, eliciting their understandings on the content, pre–post drawing and writing on photographs, and notes taken during the fieldwork experiences, The elements she identifies as shaping culture are: *Agency/co-constructed learning, experience, identity/hybridity, context/situatedness/positionality, and community*. We now briefly provide Nieto's interpretation of each element.

Nieto (2009) defines *agency/co-construction* as a "mutual discovery by students and teachers" to emphasize that the production of knowledge is social and requires action on behalf of both parties. *Experience* is the second concept in Nieto's construct of culture: the prism through which we see the world is framed by our lived experience and the knowledge we construct of the world in relation to others. The third tenet is that of *identity/hybridity*, which builds on culture as complex, dynamic, and unbounded. Specifically, Nieto speaks to the transcultural and transnational experiences of many students that call for consideration of hybridity and fluidity in the process of identity building, and that complicate the process with issues of power/privilege/unprivileged that minoritized youngsters face in educational institutions. *Context/situatedness/positionality* is the fourth tenet of Nieto's framework through which she reminds us that the focus on formal rituals, foods, and holidays of specific groups of people are social markers differentiating one group from another (or one individual from the next). These events and rituals are most likely products of power relationships in society that, when left unexamined, will reproduce what exists. Finally, *community* is the last tenet emphasized in Nieto's framework, which calls for an understanding of the depth of connection of what students know, the practices at home, and the communities to which they belong. These five components are thus integrated in this manuscript in our findings to assist with reporting the patterns and consequent ideas we found to be significant.

Exploration Activities Facilitating Third Spaces

Researchers engaged with children in exploration activities lasting for a total of about 12 hours distributed over six consecutive sessions to learn about slow changes to the surface of the Earth caused by the constant movement of water. Activities were conducted primarily in the native language of the participating students, which was Spanish. However, due to the tradition of strictly separating the languages of instruction in a bilingual curriculum so that neither teachers nor students are allowed to use the other language (Brisk, 2006), we wanted to purposefully explore whether these bilingual children would integrate more codeswitching as they worked in the activities if they were explicitly given permission to use both languages. Thus, children were given explicit permission to use all of their linguistic resources.

In our work with the children, we included assignments within the four proposed dimensions in relation to place-based geoscience activities for the creation of Third Spaces: Emphasis on the study of local place, synthesis of local cultural knowledge, community directed activities, and native language generation and reflection activities. A summary of the assignments is presented in Table III.

RESULTS AND DISCUSSION

The proposed activities yielded interesting observations in relation to the research question. As explained, the identified data was organized and situated in our search within Nieto's five tenets. We first discuss the five tenets in the context of participating children's responses.

Agency/Co-construction

Our field notes document the students' engagement with the proposed activities. As students took the digital cameras in their hands and moved around the field to document instances of erosion, they demonstrated not only motivation, but also ownership of where they wanted to go and how to spend their time outside. This ownership documents shifts in agency not commonly experienced in the traditional classroom. Contrary to what may seem precarious for teachers who encourage highly structured situations, children were on task at all times during their individual and small group explorations. Another space that facilitated participating students' enactment of agentic behaviors was the online discussion and analysis of photographs via an online Geological Observational Inquiry system called *GoInquire* (Martínez-Álvarez and Bannan, 2013). Children were observed moving at their individual paces through the photographs. While working in the *GoInquire* system, children excitedly read and responded to other group's online comments. These examples illustrate how a highly structured teaching and learning environment, in which students are not encouraged to make decisions, might encourage Butler's (1998) notion of embodiment, and thus result in missed opportunities for students enacting agentic behaviors that could potentially be generalized to other contexts.

In addition, the analysis of students' notes on the individual graphic organizers for note-taking demonstrates

TABLE III: Place-based geoscience activities facilitating Third Spaces.

Emphasis on the Study of Local Place	Synthesis of Local Cultural Knowledge	Community Directed Activities	Native Language Generation and Reflection Activities
–Group discussions around photographs showing processes of erosion from the school's grounds. –Online work in pairs using a web-based system called *GoInquire*, which allowed digital manipulation of community photographs and online synchronous discussion. –Children also were encouraged to identify sites showing the processes or resulting signs of erosion around them and photograph these signs for class analysis. –Drawing and writing on community photographs to select areas showing erosion.	–Use of questions to connect to larger culturally relevant context (such as the *Colca Canyon,* situated in Peru, or the *Grand Canyon*, as a few children had visited the United States and had personally seen the Grand Canyon, or heard about it). –Use of questions in relation to potential children's understandings linked to their indigenous roots (*Why is the land important? How do you and your family interact with the natural environment? How do you feel about extreme erosion? What has been the role of indigenous people of Peru in relation to the natural environment?)*	–Field visits to observe the three-dimensional and more current view of the sites presented on the analyzed photographs (historical view). –Visit to a landmark park near the children's school to study instances of erosion.	–Online production of a synthesis while working in pairs after reading and selecting information from the group's photograph-based digital discussion. –Online generation of collaborative definitions of unknown terms based on prior understandings. –Students were encouraged to generate questions during the learning experiences. –Student-generated questions were entered in the *GoInquire* system in which children contributed their ideas to answer the questions. –Drawing and writing to explain their emergent understandings of the processes of slow changes on the surface of the Earth.

careful observation with geomorphological lenses. In addition to the close analysis of the familiar photographs, children made inferences based on their observations. The amount of text in their notes also provides some evidence of children's engagement. Figure 1 presents an example of high-level thinking (inferences based on geomorphological observation) from Carlos's graphic organizer.

Translation of text from Figure 1:

"In the area of the soil the water has eroded it (in some areas).

There are loose solids around in the land. Then, there it is going to erode but where there is grass there will be no erosion because the grass absorbs the water. This photograph is almost the same as the second photograph because in the side of the land there are loose solids that can be eroded with the water."

In this example, Carlos mentions important features of the photograph, which most often go unnoticed by young children (i.e., areas with more or less vegetation, loose solids). He also takes it a step further by explaining the relationship between the observed features and processes of erosion (i.e., the terrain will erode less if there is more vegetation). Carlos's work, which is representative of most of the other children, shows both children's ability to retrodict (the act of making a prediction about the past), and to predict to better understand processes of erosion.

While in the class, children were excitedly engaged as they worked with the photographs they brought from outside. On the contrary, we documented that agenticity was less evident during our initial work where children were analyzing photographs that had been taken by the researcher and/or teacher.

FIGURE 1: Carlos's completed graphic organizer for note-taking.

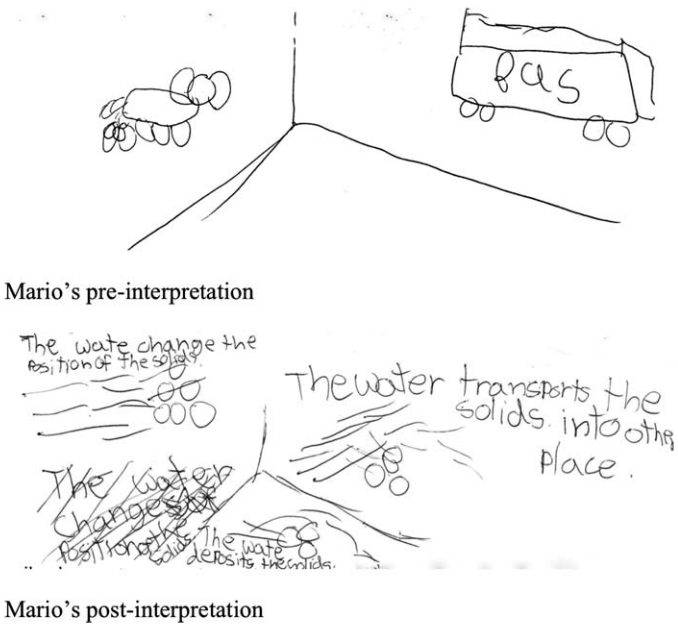

FIGURE 2: Mario's pre–post interpretation of terminology.

Experience

There is much evidence emulating Nieto's explanation of experience, described as a prism through which we see the world as framed by our lived experience and the knowledge we construct of the world in relation to others. One strand in relation to experience is students' interpretation of the terminology. Students consistently interpreted the already familiar words according to their prior experiences. However, even though most children's interpretations of the relevant terminology were not directly related to the context of geomorphology, they appropriated geomorphological epistemologies when the words they already possessed, were situated in this new context. Figure 2 is an illustrative example showing Mario's response before and after participating in the activities when asked the following assignment: "Draw and write to explain the relationship among erosion, deposition, and transportation caused by water." It is interesting to note that Mario decided to write his answers in English, which was not his native language.

Mario demonstrated understanding of the terms transportation and deposition in a nongeomorphological way in the preparticipation survey, shown in the upper part of Figure 2. Although the response might not be the scientific interpretation teachers are seeking, it demonstrates the child owns the particular word, and it is just a matter of attaching a new meaning to the existing vocabulary. Mario's work after participating in the activities, which shown in the lower part of Figure 2, is much more aligned with the geomorphological interpretation of the terms we were exploring.

Furthermore, we found that, after participation in the collaborative explorations, children's questions took on a different tone. Table IV presents translated preparticipation questions versus postparticipation questions from three children. We have also added sample geomorphological responses for these children's questions.

As can be seen in the examples in Table IV, there is a tendency in most of the work by the participating children to formulate longer and more complex questions after participating in the activities. The preparticipation questions mostly circled around asking for meanings of the terminology, while the postparticipation questions attempted to extend the topics we had been discussing in class.

Identity/Hybridity

Culture and hybridity were present during our work in many implicit and explicit ways. One aspect in which issues in relation to identity arose was the choice of language. While two of the researchers were bilingual and native speakers of Spanish, and the other two were monolingual English speakers, most students used Spanish when orally communicating for learning. We see this as an expression of identity as Spanish speakers, as well as a habit of separating their two languages when in school.

Also, when given the choice to either write about the Grand Canyon, which is in the United States and therefore farther away from these Peruvian young children, and the Colca Canyon, which is located in their own country, over 90% of the participants embodied hybrid stances by contextualizing their answers in the Colca Canyon. Students' responses also illustrate interesting issues in relation to epistemological appropriations. Figure 3, for example, presents the work of a girl, Nina, who chose to use the phrase "Great Colca Canyon" to refer to the Colca Canyon. Nina's response presents an alternative conception in relation to slow geomorphological changes explained as accumulation (implying deposition) rather than erosion, that has been previously documented in the literature with bilingual learners as a "child's conception." While frequent among upper elementary learners, this conception can improve through high quality instruction (Martínez et al., 2012). Nina's case is nonetheless included as an illustrative example of epistemological appropriations. Nina's preference for using the local Colca Canyon could have been purposefully made, and could be interpreted as a demonstration of national pride, which is not often observed in regular classrooms where bilingual children might be minoritized.

Translation of text from Figure 3:

"I think that since there is a river near the Colorado canyon, the river transported all the solids that it found in its path. These solids ended up forming the Great Colca Canyon."

Text on drawing:

"River, solids."

The second example of a hybrid stance in relation to choosing the Colca Canyon is presented in Figure 4. In this case, Sara chose to call the Colca Canyon, the Colca Valley, which is also an appropriate term of a landform. Peruvians, refer to the extended area around the canyon as the Colca Valley, which contains the Colca Canyon.

Translation of text from Figure 4:

"First, it was a plane surface. The rains eroded the rocks making it a profound depth. Second, the rain kept falling until it formed a long and narrow river at the deep bottom of the mountain (River). Third, the Colca Valley was formed (River)."

TABLE IV: Pre–post questions from three children.

Preparticipation Questions	Postparticipation Questions
–What is erosion? –What is transportation? –What is deposition?	–Is it only water that can transport? –In what ways does erosion impact the environment?
Suggested Geoscience Responses *Erosion* can be defined as the removal of surface material from the Earth's crust and *transportation* of the eroded materials by natural agencies (water, ice, or wind) from the point of removal. *Transportation* is when the moving water carries the loose material away. *Deposition* is the process that takes place when the water slows down and the load it carries sinks, collecting on the riverbed. Adapted from: http://www.watersafetykids.co.uk/pdfs/Ripples-1.pdf	**Suggested Geoscience Responses** It is not only water (river and stream processes, marine processes such as sea waves) that transports materials on the surface of the earth. Wind action and glacial processes are other natural agents that can also cause erosion. In relation to how erosion impacts the environment: Erosion, transportation, and deposition are three processes that help shape our countryside and make special features. More specifically, soil erosion from water comes in the form of rain and runoff. When the rain falls, it can break up the particles of the soil (especially fine sand and silt) and disperse them. This destruction of soil increases with thunderstorms, or heavy rain. Runoff can carry these particles to rivers, oceans, streams or lakes. Adapted from: http://www.watersafetykids.co.uk/pdfs/Ripples-1.pdf http://www.odec.ca/projects/2004/derk4d0/public_html/Erosionaffectstheenvironment.htm
–What is erosion? –What is deposition? –What is transportation by water?	–What are other existing types of erosion? –Where are the sediments deposited? –Is transportation caused by water the only type of transportation?
Suggested Geoscience Responses See answers above.	**Suggested Geoscience Responses** Wind action and glacial processes are other natural agents that can also cause erosion. Some different types of water erosion include splash erosion (raindrop impact), sheet erosion (the particles moving downslope in flowing water), rill erosion and gully erosion (flowing water can also detach soil particles if the velocity is high enough, usually where water starts to concentrate), or stream bank erosion (streams meander causing erosion). As flowing water enters a lake or other body of water, its velocity decreases and its ability to carry sediments also decreases. Sediments carried by the stream are deposited where the slowing water can no longer move them (largest ones near the shore and smaller ones farther from the shore). Adapted from: http://extension.missouri.edu/explorepdf/agguides/agengin/g01509.pdf A simulation is available from: http://www.classzone.com/books/earth_science/terc/content/visualizations/es0604/es0604page01.cfm
–What is erosion? –What do erosion, deposition, and transportation have in common?	–What other things cause erosion? –Are there other things that are related to this topic?
Suggested Geoscience Responses	**Suggested Geoscience Responses**
See responses for these questions in Table II, question 4	Landforms, man-made features, and stages of a river are sample topics that relate to water erosion. See additional responses above.

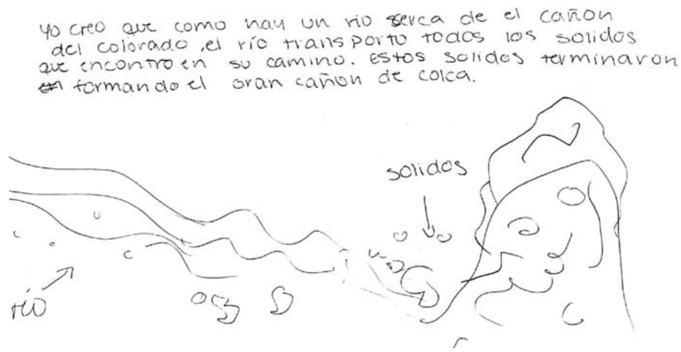

FIGURE 3: Nina's example illustrating hybrid stances.

Sara's answer demonstrates a hybrid stance between the expected academic answer (expressed in terms of canyon), and the child's prior knowledge of this landform.

Despite the fact that most children chose the local landform to speak about complex content, there were two children who decided to write about the Grand Canyon. When asked about their choices these children explained that they had visited the United States and had heard of the Grand Canyon (one of the students had seen it). This data speaks to the hybridity of the transnational experiences of many bilingual children, who surely find a sense of accomplishment when allowed to share their expertise in a context that sometimes places them at a disadvantage.

We felt it was important to extract these notable stances of our Latino bilingual participants' identities because the literature often presents Latino bilingual populations from a deficit perspective in the U.S., from which follows an unnecessary emphasis in remediation efforts over more enriching instructional approaches (Rodriguez, 1997; Lee and Fradd, 1998; Seiler, 2001; Roth and Calabrese Barton, 2004).

Context/Situatedness/Positionality

As documented, we found bilingual children might make choices that openly challenge common beliefs. So, while most children would prefer to communicate in their native language when making meaning, a few might choose not to do so for different reasons, such as for identity purposes. Also, while the majority of Peruvian children would show preference for a context close to their own experience, such as electing to use the Colca Canyon rather than the Grand Canyon to explain their understanding of erosion, we found exceptions where children decided to use the alternative sample. We are reminded by Nieto that focusing on social markers differentiating one group from another is never going to work for all individuals. Thus, offering and accepting alternative ways of operationalizing hybrid spaces is called for in any teaching and learning context, but particularly when working with bilingual children.

Community

The last tenet highlighted by Nieto calls for understanding the connection of children's practices and those of their communities. If we interpret the class as a community of practice (Lave and Wenger, 1991), then we can better understand children's observations after participating in activities facilitating Third Spaces. Figure 5 presents a sample observation form completed by Andrés, one of the participating children.

Translation of text from Figure 5:

> *"There is more grass than soil. The soil will erode more than the grass because the grass absorbs the water. The step has weathered out because of the water becoming little pieces of parts. In this area erosion has not impacted that much because there is much grass."*

His notes are a complex recollection of the group's discussion integrating different agents related to geomorphological change, such as the different solids available (plants, cement, soil, insects), the role of the existing vegetation (the grass absorbs the water and that diminishes the erosion), and the high and low parts of the terrain, which are documented via the careful observation of where the solids are located in the photograph.

Finally, Figure 6 is a second example illustrating how children integrate complex ideas after participating in a

FIGURE 4. Sara's example illustrating hybrid stances.

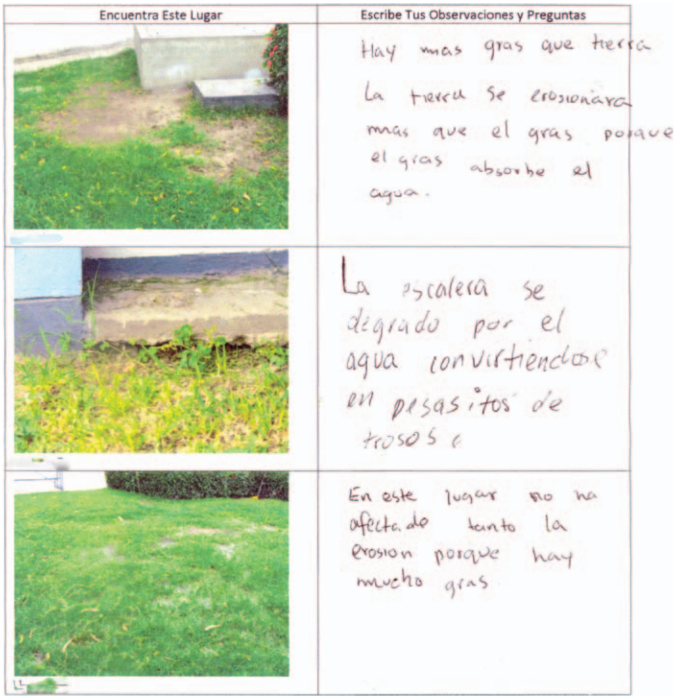

FIGURE 5: Andrés's completed sample observation form.

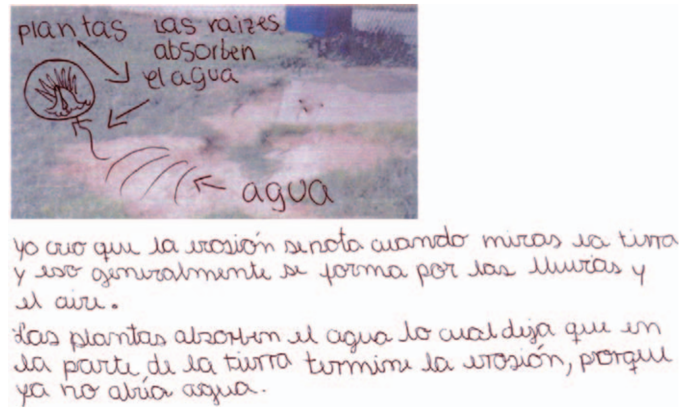

FIGURE 6: Verónica's postparticipation response.

community of practice. In this case, the postparticipation response of Verónica, one of the children, is shown.

Translation of text from Figure 6:

"I think that the erosion can be observed when you look at the ground and that generally is formed by the rain and the wind. The plants absorb the water, which results in that the part of the soil ends the erosion because there was not so much water."

Text on photograph:

"Plants, the roots absorb the water, water."

Verónica draws and writes to demonstrate her knowledge and fully communicate her understanding of erosion and related factors.

In reference to the community, we noticed high interest in reading each other's comments while working online in pairs using the web-based system of the *GoInquire*. The synchronous discussion tool did not always result in insightful comments, however. For example, some students posted ideas that provided a mere description of the action rather than an explanation, or asked irrelevant questions for explaining their choices on where to place the stamps to identify important areas. Despite these observations, the potential of using communal discussions in which children can respond to each others' comments in a safe space is noticeable.

Five Stances to Address the Research Question

Our proposed research question was: *What are the differential elements that help bilingual children learn geoscience?* We addressed the question by means of Nieto's stances of the construct of culture within a learning context. Through our analyses, each one of the five stances led to one differential element we found that helps bilingual children learn in geoscience.

Agency/Co-constructed Learning: Bilingual children benefit from being allowed and encouraged to utilize their multiple linguistic resources when making meaning of complex content

One differential strategy we classified as agentic was the use of both English and Spanish within the same piece of written work. Bilingual education has traditionally encouraged language separation. Rationales for strict language separation include the recognition that mixing languages are taxing on the teacher (Legarreta, 1977), or the fact that when teachers mix languages, students may wait for the statement in their strongest language (Baker, 2006). However, Wei (2006) and García (2009), among others, recommend flexible bilingual arrangements that consider a holistic approach to educating bilingual children. We certainly saw evidence of this strategy as a tool for meaning making.

Thirty-five percent of the participating children used both English and Spanish within the same product. The sample from Figure 1 shows how Carlos used Spanish, his mother tongue, to explain his thinking, but also used one word in English "grass" in an integrated manner. This strategy, which was encouraged by the researchers, appears to help Carlos write a complex idea fluently. Other examples of the use of both languages show children using their multiple linguistic resources for meaning making with the proposed complex content. One child, for example, used English to write the questions we ask them to generate (i.e., *are they important for the environment?*) or both English and Spanish (i.e., *¿Qué es erosión? What is erosion?*), while the rest of the information is in Spanish, which suggests the recognition of a different discourse. Another example is a student who wrote the full explanation in Spanish, but used English to label the parts of the image. We also observed students using English for different purposes, such as to point out things he didn't know (i.e., *I don't know what they mean*), or for not having questions (i.e., *any questions*), while Spanish was used for statements on what she knew.

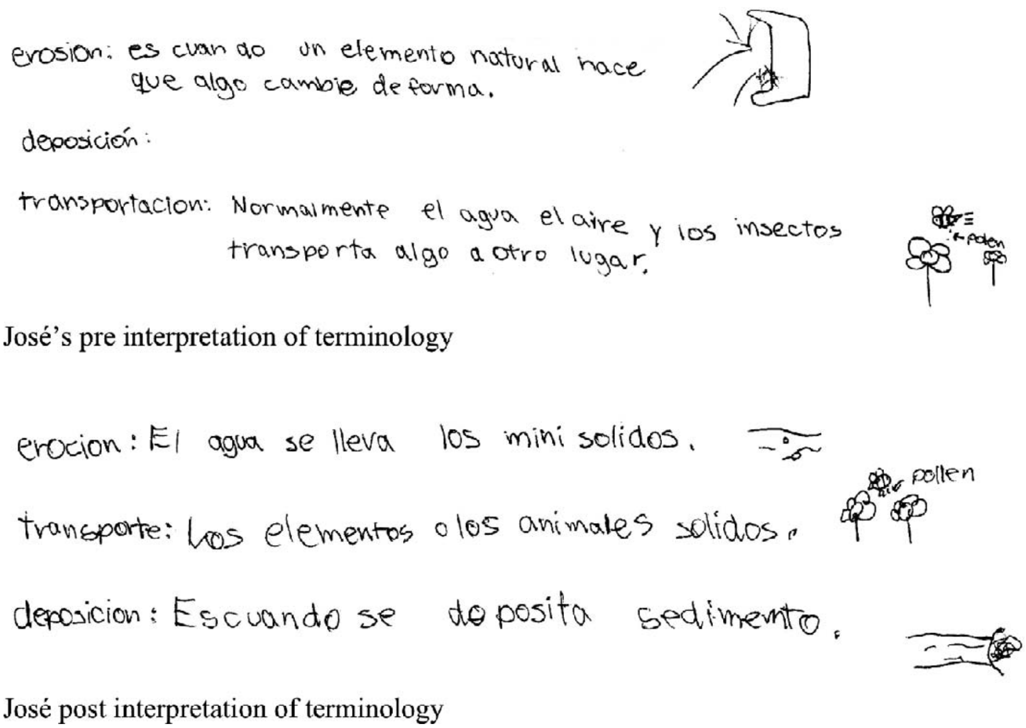

FIGURE 7. José's pre–postinterpretation of the terminology.

Experience: Bilingual children benefit from explicit connections to alternative interpretations of words, which already exist in their repertoires of practice

The dominant pedagogical model still considers the experiences of many emergent bilinguals as deficient in comparison to what is considered an average level of achievement. Unfortunately, this results in curricular remediation and tracking (Spencer, 2011). Our work was filled with examples of children's knowledge about the terminology we were using in geomorphology. Even when the knowledge presents alternative interpretations, these are children's interpretations and we must consider them as we build new meanings. Other stances documenting the need of considering students' alternative interpretations of terms include Carla's answer when asked to explain what water erosion is. She wrote, *"No sé qué es la erosión causada por el agua pero creo que es cuando el agua forma remolinos."* (I don't know what water erosion is but I think it is when the water forms swirls.)

There is certainly a connection that could be made between the water swirling and erosion, and it must be made as this is what Carla is imagining when she hears the term *erosion*.

Another example we would like to present to illustrate the need to consider bilingual students' alternative interpretations of the terminology comes from José's work. Figure 7 shows his answer to explaining the relationship between erosion, deposition, and transportation caused by water, before and after participating in the curricular assignments.

Translation of text from Figure 7, preinterpretation:

"Erosion: is when a natural element makes something change its shape. Deposition. Transportation: Normally the water the air and the insects transport something to another place."

Translation of text from Figure 7, postinterpretation:

"Erosion: The water takes the mini solids. Transportation: The elements or the animals solids. Deposition: It is when the sediment is deposited."

During the presurvey, José had a definition for erosion that includes the fact that it is a natural phenomenon, and he refers to *something changing its shape,* which can be directly connected to the scientific interpretation of erosion. His presurvey definition of transportation explains how *water, air and insects all transport things to a new place*, and includes a tiny illustration of an insect carrying pollen from flower to flower. During the postsurvey, José includes the same exact drawing to illustrate his definition of transportation, but this time his words include both *elements* and *solids*, which are more specific to geomorphology. He also adds a geomorphological definition for erosion and deposition, and includes another scientific term, *sediment*.

The final example we present is from Esteban's work. His notes while observing in the field are shown in Figure 8.

Translation of text from Figure 8:

"A broom swept all the solids transporting them to another place."

In these notes, Esteban demonstrates he is keenly observing the clues in the field for information and then he is providing an explanation based on his prior experience on how the solids in the natural environment moved. This is certainly an alternative interpretation, which must once again be considered and discussed as learning occurs.

FIGURE 8. Esteban's notes.

Identity/Hybridity: Bilingual children benefit from culturally relevant examples when observing the familiar to understand the unfamiliar

In relation to Nieto's third stance, *identity/hybridity,* we observed evidence of students' preference for a familiar landform when asked to apply the skills they had been learning in a familiar environment (observing photographs from school's grounds with a geomorphological perspective) to a less familiar and more abstract example of erosion.

Context/Situatedness/Positionality: Bilingual children benefit from alternative and creative ways of operationalizing hybrid spaces

As other scholars have pointed out, there are certain traits that might group children from a particular cultural and linguistic background, but there are also many individual differences. Bilingual children stand out for having multiple transnational experiences, and this results in greater diversity in prior understandings and resources. We learned in our work that teaching and learning with bilingual children involves an individualized process, and that there are no set recipes for teaching science to bilingual children. Every year, teachers will need to explore the experiences their new students bring and the wealth of resources they possess to help create new understandings.

Community: Bilingual children benefit from learning in a community of practice

We found ample evidence of students' engagement and learning as they participated in our hybrid space in a community of practice. This evidence comes mostly from two sources, the online discussion and the observation notes from the field visits. First, children were very excited to be able to read each other comments via the online discussion forum in *GoInquire*. As students participated in the proposed activities, they were exposed to a variety of different interpretations of the terminology. This, we observed, resulted in children using these words with different meanings in their own work and conversations.

The same can be said of students' understanding of the underlying processes of erosion. Second, the field experiences were face-to-face opportunities for deep observation experiences in groups. Evidence of keen observations and processes of retrodiction and prediction is present in students' notes as they worked in the graphic organizers in the field.

IMPLICATIONS AND CONCLUSION

The hybrid spaces (Gutiérrez, 2008) facilitated by the four levels of place-based geoscience activities (study of local place, local cultural knowledge, community directed activities, and native language generation and reflection), resulted in rich explorations that were informative in identifying elements that make a difference when teaching geosciences to emergent bilingual children. We would like to reiterate that there are no recipes for teaching all emergent bilinguals. Through this exploratory study, we were able to identify a number of ideas, which seemed to spark a hybrid space for learning to occur in a most effective way.

Considering, recognizing, and building from students' own resources was present from beginning to end in our work in geoscience education. Language, understandings, and worldviews intertwined to permit improved observation and expansion of children's repertoires of practice (Gutiérrez and Rogoff, 2003). Children clearly built connections from the familiar to the unfamiliar when their funds of knowledge were respectfully valued as powerful for the learning environment (Moll et al., 2001). So, in order to spark a productive hybrid space, we hypothesize that alternative ways of considering what learning means and what is worth learning, given sensitivity to culture, space, and community, appear to be influential for these students. This involves some creativity and much flexibility on the parts of all those involved in the teaching and learning process.

Productive hybrid spaces for bilingual children are situated in communities of practice (Lave and Wenger, 1991). We identified some evidence that these communities of practice were successful at facilitating the expansion of children's models within a constructive setting (Rea-Ramirez et al., 2008). In these communities, the teacher positions himself or herself as one more participant and allows for others to be experts and take the initiative in finding answers to their queries.

We found Nieto's definition of culture to be useful in encapsulating the hybrid spaces created, and the tenets she presents guide essential parts to come together for bilingual children's holistic geoscience learning. In our work, considering the five tenets created spaces and meaning for realizing that Latino children do hold rich understandings and have experiences that can be directly connected with geoscience concepts.

Therefore, we propose the five tenets *agency, experience, identity/hybridity, context/situatedness/positionality,* and *community* are conceptual tools that allow those involved in the process of educating bilinguals to consider multiple important aspects of the Third Space learning process.

Overall, the results from this exploratory study provide information on how to guide geoscience experiences with emergent bilinguals that diverge from deficit perspectives where existing gaps comprise the way to measure this. Our work integrates alternative theoretical frameworks, that when combined, value student understandings and experiences, potentially providing students with opportunities to learn the dominant codes, and also open up spaces for expanding these dominant codes. We hope this direction may contribute to the accumulating work situating Latino children as expert learners, who can enact agentic behaviors and become a valuable source for expansive curriculum development.

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