Mediation in a Science Classroom

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Mediation in a Science Classroom

David Ray Davis

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Arts

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ABSTRACT

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Master of Arts

Languaging and translanguaging are very important concepts in science classrooms when considering their role as mediational tools for supporting emergent bilingual students’ needs. Languaging, including translanguaging, has to do with how people perceive, connect, and understand the activities and utterances around them through verbal and non-verbal communication in any language. This study positions languaging and translanguaging as mediational tools that can be used for supporting the use of science terms and overcoming second language challenges with them. Emergent bilingual students can benefit from the implementation of languaging characteristics that promote classroom discourse spaces where all their repertoire for responding, and learning can occur. Using a sociocultural-ecological theoretical perspective and mediational analysis, this qualitative study provides descriptive evidence identifying important concepts and characteristics that emerged during languaging and translanguaging moments during naturally occurring classroom discourse among students and teacher. Findings demonstrated that when participants changed their participation and identity roles, extended their talk to negotiate meaning, used background knowledge, and applied language play with the scientific terms (i.e., biology vocabulary), it supported the participants in understanding and using those terms during biology lessons. This study discusses how the above language characteristics, as mediational means during languaging and translanguaging discourse, provided important paths for making meaning of scientific terms. Conclusions and implications include how lessons should provide spaces that welcome such characteristics for their meaningful roles in supporting emergent bilingual students.

Keywords: mediation, translanguaging, languaging, sociocultural theory
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CHAPTER 1

Introduction

Science classrooms require students to build an understanding of science content and scientific terms that for some students are completely new words and concepts. Most of the time, students have not previously heard or seen many of the words they encounter in a high school biology classroom. This is especially true for emergent bilingual students (EBs) who are presented with the challenge of learning to read, speak, and write English while simultaneously learning about words that they may not have yet heard in their native language. EBs refer to bilingual students as they develop and learn more than their home language (García, 2009a) and EBs will be the term used in this paper for students at all levels in their bilingual education to better describe the continuous nature of language learning, while still focusing attention on the advantages of knowing more than one named language. As bilingual learners, students incorporate the ways they construct meaning and resources in both languages to make sense of their classroom experience (García, 2009b).

This study focuses on how EBs use language in science, or in other words, how they use the concept of *languaging*, which for second language purposes is the “process of making meaning and shaping knowledge and experience through language” (Swain, 2006, p. 98). According to Vygotsky (1986), languaging plays a central role in mediating cognitive processes which includes that language be viewed as an activity while at the same time provides evidence of thought completion as well. Studying languaging and its subsidiary and complementary concept of translanguaging, when a speaker uses their full linguistic repertoire (García, 2009a), provides greater insight into how EBs make meaning of scientific terms in a high school biology classroom.
Understanding how EBs make sense of science academic language in biology is a mediational-filled endeavor (Lemke, 2001; Roth & Lee, 2007). Vygotsky (1978) provides this starting point with the theory that mediation, using physical, symbolic, or psychological means, is how all forms of mental activity or learning happens. Cultural artifacts like language, books, texts, and other objects can be used as tools to facilitate mediation. Mediation is defined as a process related to how humans form, develop or enhance mental functions (Lantolf et al., 2018; Wertsch, 2007). van Lier (1998, 2004) addresses mediation through the world-language and biology-based perspective of ecological linguistics, where the classroom is viewed as an ecology for learning and the semiotic signs are affordances that can be used for second language learning. Ecology from a biological perspective describes how organisms interact with each other and their surroundings. Ecology is the term used in this study to describe how students and teachers interact with each other and their surroundings in a biology classroom. Studying when teachers come together with students using language for mediation, it allows both parties to make sense of their learning process.

Language is the central mediational tool to learning and can be defined as any utterances that make up the action of sharing information (Kendon, 2004). Utterances are any action in language that provides information with an intent to inform oneself or others, which can include diverse forms of discourse, registers, gesture, and bilingualism. The communications of thoughts and words allows learning to happen as both the teacher and students work together as learners, and work together to make sense of the scientific terms in a biology classroom.

Classroom discourse has to do with how content specific language is communicated in a school setting. Discourse, or the ways of constituting a particular topic, subject, or form of knowledge for a particular purpose or setting, allows students and teachers to use utterances to
inform and create a space for meaning making to happen between people. How EBs make sense of science language can be understood through applying discourse analysis focusing on what mediation looks like between students and their use of tools and affordances, particularly translanguaging, as they learn science.

**Statement of the Problem**

This study is concerned with how languaging and mediation work to support EBs using scientific terms in my biology classroom. There is limited amount of knowledge concerning how EBs use language to learn and employ biology terminology at the high school level. Calls have been made for furthering the research concerning mediation and languaging (Rajendram, 2021; Smith & Robertson, 2020), and this study meets those demands by studying EB students and their conversations with the teacher-researcher in a high school biology classroom through a sociocultural theoretical (SCT) perspective.

Also appropriate in performing this study, as a teacher-researcher, I have struggled to teach EBs scientific terms, and this study was designed to descriptively address what language concepts and characteristics can help support instructional conversation supporting the teaching and learning of scientific terms in biology. By performing a qualitative study using discourse analysis, more information will be available to me concerning what conversational instruction in a biology class looks like for EBs. The study can illuminate and provide insights into how other biology teachers and educational researchers can meet EB students’ needs concerning the learning of biology scientific terms.

**Statement of the Purpose**

The purpose of this study is to examine the use of mediational tools, including the use of languaging and translanugaging by EB participants in a science classroom when learning
scientific terms in English. The study is concerned with classroom discourse having to do with how mediation, languaging, and translanguaging occur for EBs using scientific terminology required in the course standards.

**Research Questions**

This descriptive qualitative study will address the following research question: How is languaging, which includes the concept of translanguaging, by EBs and their teacher, used as a mediational tool to support the learning of scientific terms in a biology classroom?

**Research Question Rationale and Explanation**

This study and its research question were developed to find descriptive details of how turn-taking and communication occurs for EBs using science terms, what language characteristics and concepts this discourse carries, and what mediation through languaging looks like during authentic classroom conversations. The research question focuses on the overarching and holistic description of what languaging and its subordinate concept, translanguaging, may look like in biology classroom discourse. The inquiry from the research question, provides additional knowledge and insights towards offering answers in the research literature concerning how language is used to make meaning in a biology classroom by EBs. Languaging as a mediational tool is an important source of second language learning (Swain, 2006, 2010; Swain & Watanabe, 2012), and this study demonstrates language and classroom instructional turn-taking that created more quality extensions of meaning-making, not previously studied in the field of education. The research question also provides insights concerning types of conversations that might limit languaging or translanguaging from occurring.

I especially wanted to view the mediational process to understand the how languaging and translanguaging played a role in the meaning making of biology scientific terms for EBs in
the biology classroom, while still attending to gaps in this field. With some Spanish language knowledge, I positioned myself as a teacher-researcher participant along with student participants, creating an opportunity to translanguage with my students in spontaneous or natural occurring ways. As a teacher-researcher participant, I spent time providing instruction with the students and wanted to see how and if extended languaging with students might be used as a mediational tool for creating more opportunities and windows for learning.

This research provides implications for how to be a more effective teacher for EBs and contains some principles and concepts that are transferrable and helpful to other teachers. Teachers and researchers who want to foster translanguaging in schools will be able to better understand when and how students in science use languaging and translanguaging to make meaning of the scientific terms they are being taught.
CHAPTER 2

Review of Literature

The following sections contain information and background for using SCT as the framework for understanding how mediation occurs in a biology classroom. SCT provides a way to understand the concept of mediation during languaging in their biology classroom discourse. Other mediational tools such as translanguaging events and non-verbal communication are included as important guides in understanding the mediation that supports the learning of science terms. The rationale for the literature review is based on seminal and current literature demonstrating findings that address research concerned with languaging, translanguaging, negotiation of meaning or meaning-making, gesture, and language play. The review of these topics is limited to their relationship and intertwinment with SCT and second language learning, and according to their capacity to provide more information about learning as a mediational activity leading towards development (Duarte, 2019; Garza & Langman, 2014; Rajendram, 2021). The next sections address the literature review explaining and supporting the theory and framework applied, and then provides further literature review of the pertinent content topics found in the study.

Theory

SCT provides a theoretical framework to understand the mediational processes leading to meaning making through languaging and translanguaging. In SCT, language is viewed holistically, and social language and academic language are viewed together during the meaning making process for students and teachers as they make meaning of the scientific terms in a biology classroom. Additionally, in this theory, mediation is concerned with how people, in this case teachers and students, develop during the meaning making process to correctly define or use
a scientific term (e.g., biology vocabulary). Viewing language in action and the way it works to help participants develop, is central to Vygotsky’s (1978, 1986) general genetic law of development, which includes his most popular pedagogical concept exemplifying mediation known as the zone of proximal development (ZPD; Daniels et al., 2007).

**Mediation Leading to Development**

For Vygotsky (1986), learning and mediation is a cultural-historical process. Simply put, from birth, a baby encounters humans and is socialized into culture(s). In this study I use the concept of mediation from an ecological, also known as ecosocial learning perspective (van Lier, 2004). While there are a variety of related theories stemming from Vygotsky’s cultural-historical process, this study applies his principles through sociocultural theory (Wertsch, 1985) coupled with a second languaging learning lens (Lantolf, 2000; van Lier, 1998). A key concept Vygotsky (1978) used to explain the role of mediation is through the ZPD and the related concept of microgenesis and ontogenesis in second language learning (Lantolf & Thorne, 2006; Wells, 1999). A simple definition of ZPD is the learning process of how students gain understanding of a topic and use the learning in a way that supports them towards development which includes such ideas as incorporation, uptake, self-regulation, and transformation with the topic.

While this study does not focus on ZPD *per se*, the concept of ZPD and microgenesis as the beginning and initiating movements towards learning and development, is a foundational guide to understanding the genesis of the meaning-making processes or mediated processes between teachers and students (Lantolf et al., 2017). One clarification that is especially needed in the field of education, is that the ZPD is often simply viewed as the difference between what one can learn on their own and what one might learn or accomplish with assistance. However, a more comprehensive and appropriate understanding of the ZPD is the definition which demonstrates it
as a multidimensional learning process dealing with much more than just an expert teaching or the popularly quoted term: more knowledgeable other (Swain et al., 2015). Instead, ZPD is the revolutionary activity that allows for transformation of the learning process between everything, and everyone involved in the meaning making process (Chaiklin, 2003; McCafferty, 2002). This concept is at the core of a SCT ecological learning lens as described by van Lier (2004, 2008) which is applied in this study.

Mediation that helps a student to reach a new ZPD might come from the teacher or another tool that allows the student to make meaning of what is being learned (Daniels et al., 2007). Again, to be clear, this is fundamentally different than mediation as scaffolding (Wood et al., 1976), where the more knowledgeable other supports the students in obtaining the right answer. ZPD allows me as a teacher-researcher to position myself from the beginning of the school year as a Spanish-speaking teacher that is willing to learn together with students to build meaning of scientific terms through translanguaging. Mediation that demonstrates transformation and provides evidence towards development is key (e.g., microgenesis) and observing how EBs use mediational tools to make in-depth meaning in a science classroom will provide insight into how best to continue to teach science to EBs. In this study, SCT is the lens used to understand mediation, discourse analysis, interpretation, explanation, and conclusion. In addition, this study addresses second language mediation through a ZPD-like process diametrically different than mediation found through scaffolding processes (Dunn & Lantolf, 1998; Lantolf et al., 2017).

**Languaging**

Languaging has to do with how people perceive, connect, and understand the events and communication around them. Languaging connects cognition and lived experience with social activity (Cowley, 2014). Steffensen (2013) describes the entanglement of cognition and life
experiences, feelings, and actions as extended ecology, a similar concept to van Lier’s (2004, 2008) eco-social language learning. In this perspective, languaging goes beyond simple face-to-face exchanges but includes how people orient, act, and situate the events and messages between people. Languaging can also be viewed as a way to overcome new challenges, or basically how people can socially language through problems as they co-evolve during the activity. Concerning second languages, Swain (2006) uses languaging as a term used to describe the “process of making meaning and shaping knowledge and experience through language” (p. 98). Languaging forces attention to be placed on the action of classroom discourse and how second language learning happens through language use.

Classroom dialogue, whether science, math, art, or other content, provides EBs with opportunities to co-construct more complex and diverse language structures with the terminology they are learning. It provides them opportunities to revise and reapply their own language use, which has been found to be an important concept in second language learning in pioneering work such as Donato (1994) and Swain and Lapkin (1998). Languaging then can be used as an action for mediation to occur and is important to study when trying to understand second language learning (Swain & Watanabe, 2012).

Translanguaging

Languaging includes translanguaging as an important mediational tool of interest to consider when trying to understand the teaching and learning of science discourse for second language learners. Translanguaging is when a speaker uses their full linguistic repertoire, without the worry of the defined boundaries of named national languages (García, 2009a; Otheguy et al., 2015). When students translanguage, they use all the tools available to them to build the academic language and make meaning of what they are learning (García & Kleifgen, 2020). The
use of languaging, including translanguaging in a science classroom by students is one way they might build meaning of the scientific terms. These language modalities can be identified and studied to understand the learning process used by English learners, EBs, or other second language students as they navigate social and academic language in the biology classroom.

Translanguaging as part of languaging still has room for study using a SCT framework, especially in secondary education science courses. Duarte (2019) studied translanguaging in Hamburg, Germany using a SCT framework which focused on understanding peer interactions and multilingualism. Also, Smith and Robertson (2020) followed Roma-minority students in several countries and examined their use of inner and outer speech of language using SCT. Recently, Rajendram (2021) used SCT for understanding translanguaging pedagogy in multilingual settings in Malaysia. Additionally, Garza and Langman (2014) have argued that more research needs to be done using an SCT lens to better understand the role of translanguaging as a mediational tool in learning.

**Additional Mediational Tools**

**Language Play**

Language play is another important mediational tool to consider for understanding second language and science terminology learning. While there are a variety of different definitions that can be used to define language play, much of the research shares similar characteristics defining it as any time when language is used outside of norms for fun or in a unique, less-structured way (Broner & Tarone, 2001; Čekaitė & Aronsson, 2005). When students can move past structured use of language it can lead to more of a translanguaging stance of language use. Wei and Lee (2021) have gone as far as using the term of translanguaging language play to describe how people mix multiple named languages for fun. Language play has
been used by EBs to make meaning and use language in a different way to build context. Language play is beneficial to second language learning, providing better affect for learning and a way to expand knowledge and information in more contextualized ways (Broner & Tarone, 2001; Cook, 1997; Vygotsky, 1987). While the above studies may slightly vary their definitions of language play, this study uses Broner and Tarone’s (2001) definition of language play based on play that is ludic, fun, and jovial. This study does not address language play concerning private and inner speech (Vygotsky, 1986).

**Gesture, Non-Verbal Communication**

An additional mediational tool to study in the ecosocial setting of a biology classroom is nonverbal communication, or gesture as a full part of communication and learning in science discourse. From birth, humans begin to use gesture to communicate, and gesture is a full part of the learning process (Zlatev, 2006) as humans grow and build their language (McNeill, 1992, 2012) including school education (Lazaraton, 2004; Rosborough, 2012). In Spanish-English settings, gesture has been found to support students’ listening comprehension (Church et al., 2004). Similarly in a second language learning setting (English-Italian), Nardotto Peltier and McCafferty (2010) found gesture to be important in the students’ abilities to coordinate with their second language teacher’s stances and mannerisms. Concerning French-English study Stam and Tellier (2011) address how gesture supports comprehension between teachers and students learning the target language.

Gesture has been found to provide students and teachers common foundations for meaning making together in the study of science (Pozzer & Roth, 2020; Rosborough, 2014; Roth, 2012; Roth & Lawless, 2002; Roth & Welzel, 2001) and is important in understanding the eco-social learning goals of this study. Aimed at an eco-social stance and gesture, Chamberlain
(2008) found that gesture in the classroom serves, “as a cue for relational and interactional functions” (p. 31). Science and SCT have been researched to show how mediation helps students create meaning of science concepts (Lemke, 1990, 2001; Lin & Lo, 2017; Shepardson & Britsch, 2015). Gesture and SCT have been researched as well in the science classroom (Roth, 2001; Williams, 2020). This study seeks to further the research on how second language learners use languaging, translanguaging and other multimodalities for mediation in a high school biology classroom.

Overall, translanguaging, language play, gesture, and other multimodalities used for mediation have been found to support students and second language learning to create meaning and the above studies are used as guides to understand how discourse and mediation occur in an integrated Spanish-English biology classroom. Researching mediational processes through a qualitative study can provide insights into how teachers and students can build better discourse to support the learning of biology terms. This will help provide new understandings into the learning process for EBs in secondary science classrooms. The study of how languaging, translanguaging and other mediational tools are used in secondary science classrooms is an area that needs more investigation. The studies in this literature review provide many insights concerning many mediational tools but more studies are needed to address the intertwinement of SCT and ecosocial learning concerned with second language learning, with respect to how languaging, translanguaging, and other forms of communication occur in science classrooms, especially for EBs. The current study attempts to address this gap in the research.
CHAPTER 3

Methods

This general descriptive qualitative study analyzes the teacher and student participants interactions to gain an in-depth understanding of the mediation of meaning for second language learning (English) in a biology classroom. A basic interpretive and descriptive qualitative study seeks to understand how participants make meaning of a situation and how mediation occurs (Merriam, 1998). While the teacher-researcher did not apply a grounded theory approach, axial coding was used, where the collected data directly informed the discourse analysis. Mediated discourse analysis (MDA) explained below in the data analysis section, was used to understand the mediation that occurred in the biology classroom discourse. The purpose of the study was to learn how languaging and translanguaging and other accompanying mediational tools were used to learn science terms in a biology classroom, so that I could better understand how to provide appropriate instruction to EBs.

Setting

Research was conducted in a 9th grade biology classroom in a rural community in the western mountain region of the United States. The community is known for its ranching, farming, tourism, and as a commuting town supporting an adjacent Winter sports destination. The high school is fed by 5 elementary and 2 middle schools that run Spanish-English dual language immersion program strands. The high school population comes from families that are part of the service industry to these ski resorts and service industries that serve them. Students come from a variety of different socioeconomic backgrounds and race. According to the school district website, the student break down is 23% economically disadvantaged, 6% English learners, 78% White, 19% Hispanic, 2% multiple races, less than 1% Asian, African American,
Pacific Islander, American Indian. Spanish is likely to be the predominant majority-minority language in school district and community. The Hispanic population is mainly made up of first- and second-generation immigrants in this 9th grade biology classrooms.

**Participants**

The participants are the students and me as the teacher-researcher in my biology classroom. I am a Caucasian, English-dominant speaking teacher with Spanish bilingual experience who has taught science for eight years. Biology is a freshman course with mostly 9th grade students taking the class their first year of high school. Classes at this high school are on a block schedule that have students attend four class periods every other day for 80 minutes.

Two biology class periods of 69 total students with 14 Spanish-speaking EBs were purposefully selected by the teacher-researcher for this study and given pseudonyms. In these two classes, Spanish is the predominant minority language spoken with students with varying levels of English proficiency. I am aware that there are more Spanish-English bilingual students in other biology classes but purposefully selected the two classes with the most EBs. As a teacher, I work and support all students, but this study will focus on data concerning interactions with Spanish-speaking EBs and my interactions with them as they negotiate meaning of biology scientific terms in my biology classroom.

Participants come from a variety of language proficiency and world-class instructional design and assessment (WIDA) classification statuses to measure English proficiency. The transcripts include 4 Spanish speaking students of the 14 total students classified by the school district as second language learners. Diego and Ramon are classified as entering on the WIDA testing scale and have recently moved to the United States in the past year. Ana and Isabella are classified as bridging and fluent on the WIDA test at the end of the school year 2022. Sophia was
born in the United States with Spanish as her first language at home. She is the only student not officially recognized as an EBs by the district but is included in this study according to her science reading and writing needs being like her EBs peers, Ana and Isabella. She partnered well and conversed well with Ana and Isabella through many science activities in the course and because of her participation position with them, I deemed it appropriate to keep her a part of the study. Many more Spanish speaking students were participants during the data collection phase but were not selected as samples for their languaging for this study.

**Procedures**

District and administration approval was given for research in fall 2021. This study is embedded in a larger study occurring in the school district, and Institutional Review Board approval from BYU was granted on August 16, 2021 (see Appendix A). Participants were given consent and assent forms asking for participation in the language of the parents and checked by a native speaker for accuracy in translation. Time and contact information were provided for questions and responses between parents/guardians/participants and the researchers. Consent/assent forms were collected for all students who participated.

Video recordings of the classroom occurred on 10/1/22, 10/4/22, 10/6/22 and 10/8/22. Recordings of two different biology classes was done for the full 80-minute class periods to allow for data from different class activities and biology lessons. Two 80-minute classes recorded four times resulted in 640 minutes of video recording. The reason for multiple video recordings was to see different kinds of instruction and different subject matter over the four different class recordings. The classes recorded included lessons on ecology and macromolecules being repeated in two different groups of students in the two different classes.
Research Design Overview

MDA was performed, using Scollon et al.’s (2011) methodology, which will be discussed in a section below. Video was used to observe the mediation process between students and teacher. Video also captured the mediated actions as they occurred beyond student discourse. It is understood that capturing discourse by video cameras and having an observer (video recorder) in the classroom can create an observer’s paradox (i.e., Hawthorne effect) to an extent. The observer’s paradox refers to the effect that recording participants can cause them to change their discourse because they are being recorded, but that the only way to observe discourse is by recording it (Labov, 1972). The research assistants were as non-intrusive as possible, observing the teaching and learning as it occurred naturally in the classroom (keeping the observer’s paradox to a minimum). In being attentive to such a situation, both teacher and students understand that this is a holistic view of language in use and kept their usual and expected routines and conversations as one might expect since self-monitoring one’s language over multiple hours, days, and multiple activities is not a typical or easily accomplished venture. The recordings provided us with authentic language use and reduced the self-monitoring or increased attention to answers from participants. The cameras were positioned in parts of the classroom that were not being used.

The biology classroom typically had some multilingual practices as part of the common classroom procedure such as: PowerPoint subtitles in Spanish and supporting and encouraging the use of English and Spanish separately and together to foster translanguaging during instruction time and during small group time. A word wall with scientific terms in English and Spanish was posted in the classroom for each unit. My hope was that students would feel comfortable using any language that helped them learn the science terms and that this would
facilitate their full linguistic repertoire during class time. Advocating for EBs, I tried to create a community of practice that provided space and acceptance for all languages and allow students to participate and mediate in multiple ways according to their language needs. Given these parameters and practices, the study was then conducted to capture the actual language and descriptive manner of how students used languaging and translanguaged to make meaning of the scientific terms.

**Data Collection Measures**

Video recording of teaching was performed to collect data. Transcripts of interactions were transcribed by the research assistants and me, as the teacher researcher, to allow for more detailed understanding of the video. Video recordings provided a way for both teacher and students to be observed during the mediational processes involving languaging and translanguaging. Before class started, a research assistant placed cameras out of the way to allow participants to use the classroom in their usual and natural way. Two cameras were placed in the front and back corners of the room. One researcher held a third and mobile camera and moved it as appropriate to record student/teacher interactions. Microphones were placed at strategic places in the classroom to capture discourse. As the central participant, I was fitted with a microphone (i.e., lavalier) before the class began, which was synced with the mobile camera. The two other cameras had microphones as well to record audio. An extra microphone was also placed by the research assistant according to classroom situations.

**Data Analysis**

MDA of how language as a “tool” is used has been applied in formalized methodological procedures (Jones & Norris, 2005; Scollon & de Saint-Georges, 2012; Scollon et al., 2011). Such an analysis of language is appropriate when trying to capture holistic discourse which includes
the use of artifacts, objects, gestures, facial expressions, bodily positionings, verbal-aural sounds, and so forth when communicating. MDA was used as the primary methodology for analyzing data. This allowed for the mediated actions to be analyzed and allows for additional bounding of the data for the case study.

MDA was used to focus and identify central concepts created by the mediated actions of the participants. As previously mentioned, mediation is defined as a process related to how humans form, develop or enhance mental functions. In this study, mediation towards development is viewed and will be identified as the process students use to appropriate and develop scientific terms.

MDA was used as a method to specifically observe and identify the utterances and actions of students that leads towards languaging within the science discourse. Focusing on and describing what the characteristics of languaging and translanguaging look like creates a parameter for the analysis. MDA provides a framework for how to begin coding to describe and understand students’ science discourse when they try and incorporate scientific terms in biology.

**Coding**

To begin the analysis, video was viewed by myself as the teacher-researcher and an additional researcher for confirmation and validation issues. Transcripts were made of the exchanges and non-verbal features such as eye-gaze, gestures, embodied positionings, high or low pitches, laughter were added as guides for turn-taking and lead-taking in the conversations. The non-verbal descriptions were placed in italics below the verbal transcript and were not formally coded but left as general descriptors to guide the analysis. The excerpts selected for this thesis were chosen based on moments where scientific terms were used and exchanges among students and teacher were prevalent.
Once the transcripts were made, general open and then axial coding were the next starting steps for investigating the recorded classroom discourse. These two codings were the primary types used to identify discourse language characteristics. Included in the process were similar tenets often found in thematic coding, such as segregating the data, categorizing, searching for patterns, interpretation steps, and explanation of the data. Open coding is the procedure to turn data into small sets and discrete components, analyzable at a micro-level. Similar sets or characteristics are labeled with the same code. Axial coding is used to find connections and relationship among the selected sets and labeled characteristics. In this phase, both beginning and aggregate connections are determined. Continuing after open and axial coding is general purposeful coding, where overarching relationships within characteristics were identified and analyzed.

In this study, open coding was applied by identifying and selecting the moments where scientific terms (ST) were used and relevant to the study (Creswell & Guetterman, 2019). The open coding can be found in Appendix B. In the axial phase, the terms were then evaluated in context for types and characteristics which were Spanish-English code-switching (CS), change in terminology (CT), terminology with personal background (PB), and any unique utterances (UU) that did not simply mimic the teacher. Both open coding and axial were analyzed together in chart form found in Appendix C. In the purposeful selection phase, the axial coding characteristics were noted for their groupings and use in the discourse (Appendix D). Analysis through viewing the video, writing, and reading the transcripts and coding was repeated numerous times.

During the combination of both open, axial, and purposeful coding, I as the teacher-researcher noted that students took differing turns talking, responding, and positioning
themselves with differing participation roles and/or identities during the discourse. The turn-taking and embodied positionings were particularly identified through the non-verbal channel, as eye-gaze demonstrated joint-attention, movement of heads by students in the group established shared-intentionality, and facial expressions, voice tones, and laughter provided context for the discourse. Non-verbal communication was added as a column to better support the analysis. As a result of identifying non-verbal features in understanding new or changing participation roles and identities, an entirely new coding chart (Appendix C) was created to search for any additional traits, characteristics, or patterns that might emerge. How students changed identity and participation roles during the discourse was then specifically coded to further enhance how to understand the mediated actions in a clearer way.

Participation roles or the changing of identity roles during the conversational exchange was deemed as playing an important role in how the students mediated with the science terminology. One repeated characteristic was that when students changed their positions or roles in the discourse, they tended to have more extended negotiating moments, where more diverse ways to language and translanguage using scientific terms occurred. As mentioned, differing student participation roles were coded, which provided supporting evidence for how the roles were contributing characteristics for mediated languaging and translanguaging moments. Mediational moments were labeled MDA once characteristics were established and participation roles were noted for change (i.e., whether they changed roles and what type the role played). After analyzing the participation roles separately, a new column was added to the previous open and axial codings chart to be able to see and review the all the findings together in one format (see both Appendix C & D).
In reviewing the codings chart, central concepts emerged from the classroom discourse data, with some patterns of “data-clumps” (Glesne, 2006, p. 147) demonstrating possible relationships among mediational tools, and these were used to continue and review the steps of categorizing and interpreting the analysis. While this qualitative descriptive study did not use any a priori coding for analysis, it did apply general coding patterns as mentioned above, and as a guide, included general characteristics and concepts related to languaging and translanguaging from previous literature (Duarte, 2019; Rajendram, 2021) such as supporting one another’s language learning and identity roles, drawing on knowledge and making connections across languages and background, identifying and describing available knowledge to solve the task, negotiate meaning and the process of making meaning.

While the codings and literature guidelines selected were found in “data clumps” (Glesne, 2006), one concept, language play, occurred somewhat separately than the others. Although separate, this concept was deemed noteworthy and insightful to include in this study because of the unique use and reactions of the scientific terminology by the participants, and this too was given the labeled moment of MDA.

In summary, the methodology used for this study applied guidelines and descriptors from previous research with general qualitative inquiries that included open, axial, and purposeful selection of data. Such a qualitative study design provides abductive access to understanding how languaging and mediation occurs when studying scientific terms in my biology classroom. The findings in the next section reveal the central concepts and characteristics used mediationally in this science classroom by EBs based on the coding steps as described above.
CHAPTER 4

Findings

The following transcripts show the emergence of how students used languaging and translinguaging during negotiating moments of meaning in learning and using scientific terms. Recognizing and understanding classroom discourse as a negotiating meaning-making process in using biology scientific terms, provides insights as to how languaging and translinguaging emerges. How students negotiate meaning, use available knowledge to solve a task, use language play and change participation roles, was aggregated in a table to synthesize the data (Table 1). Table 1 was created to help explain how the central concepts were found emerging in the excerpts in Appendix C and D, and to show the relationships that occurred in the coding. Column one in this table displays where mediation was labeled based on the relationship to columns two, three, and four. How the participation roles and the characteristics came together helped to explain the mediation processes that students used to make meaning in the biology classroom. The main participation roles that informed learning were questioner, listener, instructor, and advocate for language (column four). The central concepts and characteristics of language type was found to always be in association with changes in the students’ participation role. The change in roles between student and teacher helped inform the way that mediation of science terms occurred.
Table 1

Mediated Discourse Analysis Evidence of Intersecting Characteristics of Languaging & Translanguaging

<table>
<thead>
<tr>
<th>MDA Example</th>
<th>Central Concepts</th>
<th>Characteristics</th>
<th>Participation Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Excerpt 1 Lines 3-9, 20-28</td>
<td>Negotiation</td>
<td>Scientific Terms</td>
<td>Unique Utterances</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Personal Background</td>
</tr>
<tr>
<td></td>
<td>Negotiation</td>
<td>Scientific Terms</td>
<td>Change of Terminology</td>
</tr>
<tr>
<td>2. Excerpt 2 Lines 31-50</td>
<td>Negotiation &amp; Background Knowledge</td>
<td>Code-Switching</td>
<td>Personal Background</td>
</tr>
<tr>
<td></td>
<td>Language Play</td>
<td>Code-Switching</td>
<td>Scientific Terms</td>
</tr>
<tr>
<td>3. Excerpt 3 Lines 14-22</td>
<td>Language Play</td>
<td>Code-Switching</td>
<td>Personal Background</td>
</tr>
<tr>
<td></td>
<td>Participation Role</td>
<td>Scientific Terms</td>
<td>Unique Utterances</td>
</tr>
<tr>
<td>4. Excerpt 4 Lines 33-38</td>
<td>Participation Role</td>
<td>Scientific Terms</td>
<td>Code-Switching</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Personal Background</td>
</tr>
</tbody>
</table>

Note. The coming together of characteristics, as data clumps, provided evidence for when and how rich moments and spaces for translanguaging and languaging emerged.

The four central concepts that emerged from the data are described below using transcript samples from the classroom discourse. The transcript clips selected provide evidence for how languaging and translanguaging moments occurred. Selection of the following excerpts was done by me, as the teacher researcher, to provide insight into where multiple characteristics occurred together. The full transcript of each excerpt can be found in Appendix B.

The four sections below provide transcripts samples demonstrating concepts and characteristics coding for this study. These sections are (a) negotiation of meaning, (b) using available knowledge to solve tasks (i.e., background knowledge), (c) language play, and (d) changing of participation roles. Findings are explicated to provide context for why the excerpts were selected and what evidence they offer in supporting what mediation looks like during...
science classroom instructional conversations and dialogue. Larger pieces of the selected
samples are provided in each section to provide appropriate context, and the smaller and specific
areas of focus for this study are labeled between slashed lines when appropriate. After the
findings section, the discussions chapter will provide further explanation and understanding of
the data through a SCT view of the mind framework.

Negotiation of Meaning

The following excerpt was chosen to show an example out of several places where
students negotiate the meaning of scientific terms. Negotiation of meaning occurred when
students and participants had discourse around the meaning of the scientific terms: habitat and
niche. The students were working in small groups during an ecology unit in my classroom.
Excerpt 1 below happened at a time when students were filling out a test review assignment to
prepare for the final exam on ecology. I moved around the room helping students answer the
questions on the assignment. A group of students raised their hands and asked for help. Sofia,
Isabella, and Ana wondered how to answer the questions. The scientific terms in the lesson
review were abiotic, biotic, habitat and niche. The group of students worked together with the
teacher to answer questions. I will be described as Mr. Davis in the transcript to refer to myself
as the teacher.

Excerpt 1 (Day 2 5:12-7:33)

1. Mr. Davis: So which ones don't you know?
2. Students: All of them.
------------------------
3. Mr. Davis: Abiotic and biotic?
5. Isabella: Abiotic is a non-living thing biotic is a living thing.
6. Mr. Davis: Yeah, so you got those two.
[Sofia and Ana laugh and put their heads down]
    So, what’s the habitat?
7. Isabella: Outside
8. Mr. Davis: Yeah, it’s its house, it’s where it lives.
9. Isabella: 
[Isabella makes eye contact with Mr. Davis for confirmation]

------------------------
10. Mr. Davis: I would put like a home.
    So, like a habitat is where somebody lives.
11. Ana: Wait, where are we talking about?
12. Mr. Davis: We’re underneath biotic.
    Are you on the first one still?
    Where are you at?
14. Isabella: A habitat goes with an ecosystem and uh, and it…
15. Mr. Davis: Okay you’ve lost me.
    Where are you guys?
[Ana laughs and Isabella points with finger to the question on her computer]
17. Mr. Davis: So, interactions. A habitat is an organism’s like, um, let’s see here.
    Like how I describe this. So, a habitat is going to be like where something lives.
    So, like your habitat would be your house and the high school and wherever else you
guys go. And if you lived in a cave that’s your habitat.
    So, like deer live on the mountain. The mountain is the deer’s habitat.
18. Sofia: So, then what do we put?
19. Mr. Davis: So, the habitat is an organism’s, I would put home but that’s just me.

------------------------
20. Isabella: An organism’s home.
21. Mr. Davis: Yeah. Does that make sense?
22. Ana: Wait what does that word mean?
23. Mr. Davis: So, habitats are where something lives. Where do you live?
24. Isabella: A niche is like where they
25. Mr. Davis: So, the niche is like what the animals do in the habitat, so like its job. I put job.
    That’s easy, you know what a job is. So, like its role in the habitat, like what does that
mouse do in that area. Or the fish. What does the fish do? Your fish is still swimming
over there.
[Mr. Davis points to the fish in the ecosystem model in the back of the classroom]
26. Sofia: Really?
27. Mr. Davis: I checked it this morning and was like is it dead is it dead? Nope, still going
    strong.
28. Isabella: So, it’s just its job.
[Isabella looks from Mr. Davis to Sophia for verification]

------------------------
29. Ana: So, for the biotic versus abiotic and then a.k.a., can we put living?
30. Mr. Davis: So, a.k.a. yes, you should put living.
The scientific terms of abiotic, biotic, habitat and niche were used by students and teacher. Lines 7, 9, and 24 showed unique utterances that do not just repeat the teacher. Lines 20 and 24 allowed for students to use personal background knowledge. MDA of the lines provides insight into the actions of the participant’s discourse in this excerpt, which was mainly negotiation. Specifically, the concept of negotiating meaning of habitat and niche was identified in Excerpt 1. Appendix B contains the full transcript for a deeper understanding of the negotiation of meaning that occurred in this example.

Using Available Knowledge to Solve Tasks

Excerpt 2 was selected to demonstrate how the participants included some personal language and a level of comfort in trying scientific terms in their discourse. The discourse shows students using their previous knowledge to solve the task. I continued to help Ana, Sofia, and Isabella with more questions on their test review. Students continued to use negotiation strategies in the discourse to create meaning of scientific terms. Students and teacher each used their available linguistic repertoire and background knowledge to answer the questions on the test review assignment.

Excerpt 2 (Day 2 7:33-10:00)

31. Ana: Okay I was just making sure. Okay the next, and anything moving … such as, water.
32. Mr. Davis: Yeah, water is a good one.
33. Ana: Oh, I am smart.
34. Mr. Davis: What else would be something an animal would need?
35. Sofia: Food
36. Mr. Davis: Yes food, space, and shelter.
37. Ana: Shelter.
38. Mr. Davis: Shelter is the best one. Because that’s, what are the three things you need for life? Food, water, space. Yep. Like you need shelter to stay alive because without like shelter you wouldn’t live for very long. You need your cave.
39. Isabella: Need food… wait what? Water?
[Isabella yawns then leans in to see Sophia’s computer]
40. Mr. Davis: Animals must compete or fight for their stuff.
41. Ana: Compete? How do you spell that?
42. Sofia: It’s like pete.
43. Isabella: And what?
44. Ana: Is where one species, oh it’s like, I forgot what it is called.
45. Mr. Davis: But it is, what is it when an organism kills and eats another one?
46. Ana: Consumer? Oh no. No se.
47. Mr. Davis: There’s better words.
48. Sofia: I don’t know. … something. I don’t remember. It started with like an h.
   [Students look at word wall and help each other find scientific terms.]
49. Ana: Herbivore. Oh no.
50. Mr. Davis: I put predator or prey, that seemed to fit better.

The scientific terms of compete, consumer, herbivore and predator/prey were used by the students. Evidence of students using their previous background knowledge of the content is found in Excerpt 2 lines 31, 35, 42, and 46. In addition, students used their background knowledge to figure out how to work on the problems in accordance with the community of practice found in the classroom. Concerning turn-taking and the building of discourse, all three girls seemed to understand how to interject terms that they remembered to try and answer my probing questions. In a collective cognitive way, they are able to submit differing words providing evidence of terms they were acquainted with from their background knowledge. Lines 46 and 49 also demonstrate students changing their terminology as they work together to negotiate meaning of the scientific terms. It should be noted that the change in terminology characteristic that was coded had some evidence of students simply guessing what the teacher wanted and was not used to inform the analysis. There is evidence that some of the background knowledge applied was not used in a languaging way that mediated learning but instead shows a lack of mediation, bringing the caveat that not all talking, or use of science terms leads to the emergence of learning.

Also, there is emerging evidence of code-switching, a characteristic of translanguaging, demonstrating that students were comfortable in trying and applying multiple scientific terms.
Basic code-switching in line 46 shows one possible characteristic of translanguaging occurring. For more examples of background knowledge see Appendix C.

**Language Play**

I moved to help Diego and Ramon with the test review. Ramon and Diego chose to use Spanish to negotiate the meaning of science words and begin to include personal language in their discourse. Ramon and Diego worked together with Mr. Davis to build an emerging ZPD for the learning of scientific terms. Excerpt 3 was selected to show how languaging occurs in my biology classroom.

**Excerpt 3 (Day 2 11:00 to 12:50)**

13. Mr. Davis: Ok. Hay algunas partes que son quizás más importante. (There are some parts maybe more important).
   Deben saber que son biotic y abiotic. (You should know what biotic and abiotic are).
   Yeah? ¿Qué es biotic? (What is biotic)
   [Ramon leans in to see Diego’s computer and then shakes his head.]

------------------------

14. Mr. Davis: Ya no? Nada? (Still noting?)
   Biotic dice que esta vivo. (Biotic says it is alive).
   Yeah? So esta vivo. Si es bioitic. (It’s alive yes it would be biotic).
   Como nosotros, los plantas, los animales, esas todos son los partes que son biotic. (Like us, the plants, animals, those are the parts that are biotic.)
   ¿Los abiotic, que son? (The abiotic, what are those?)

15. Diego: Muerto (Dead)

16. Ramon: No estan vivo.

17. Mr. Davis: Yeah, Que son, no estan vivo. (Those are the ones that are not alive.)
   Yeah. Como los rocas, la agua, esas partes son abiotic. (Like the rocks, the water these parts are abiotic.)

18. Ramon: No tiene vida el. (He doesn’t have life.)
[Ramon nods his head towards Diego as he mentions that his friend doesn’t have a life and laughs. Mr. Davis leans his head back and laughs with Ramon]

   (Good. Biotic is alive.)
   Porque lo quito? Déjalo.
   (Why did you get rid of it. Leave it.)
   Y ese es, muerto, o no están vivo. Algo así.
   (And that is dead or not alive. Something like that.)

20. Diego: Muerto, no Tambien o?
   (Dead, too or)

21. Mr. Davis: Yeah, abiotic quiere decir que no
   (Abiotic means to say that no)

22. Ramon: no tiene vida.
   (Doesn’t have life)

[makes joint-attention eye-contact with Diego]

The scientific terms of biotic and abiotic are being used in this excerpt. Ramon uses unique utterances in Excerpt 3 lines 16 and 18 that don’t just simply mimic the teacher. In line 18 Ramon demonstrates the SCT concept of amplification, emotion, and identity when making the joke that Diego “No tiene vida el” (He doesn’t have a life). The transfer of the term by Ramon from the worksheet to his friend is a form of language play, where scientific terms are used in extended ways that make sense between participants. Laughter and coordinated smiles between the participants provide context that this is a ludic form of language play (Broner & Tarone, 2001) and provides evidence of Ramon’s understanding and use of the term as he is able to transform and apply the science term in a new way. Additionally, Ramon takes on the participation role of teacher in line 22 to help make sure Diego understands what abiotic means. He faces Diego, making eye-contact with him, and rephrases the teacher’s comment so that Diego better understands the answer (see also Appendix C). In this act and utterance (line 22), Ramon provides evidence of the student-advocator and student-as-teacher roles, which is further discussed in the next section.
Changing of Participation Roles

I moved to help Diego and Ramon negotiate the meaning of macromolecules. Ramon and Diego chose to use Spanish to negotiate the meaning of science words. On this day students were making macromolecules by cutting out the individual monomers and gluing them together. While changing of participation roles happened in all the excerpts and in a variety of forms during the analysis of all the videos, Excerpt 4 was selected to demonstrate how participation roles can be changed even during procedural and task related languaging.

Excerpt 4 (Day 4 15:10 to 16:24)

   (Those are going to be the fats. And they will be red)
23. Diego: Ok.
24. Mr. Davis: Para los azúcares?
   (For the sugars?)
25. Diego: cuáles son?
   (Which one are they?)
26. Mr. Davis: Los hexagons, estos.
   (The hexagons, these.)
27. Diego: Estos?
   (These?)
28. Mr. Davis: Yeah. (mumble) hay 5 para ser pelo. 5, ok?
   (Five to be red)
29. Isabella: What does the last page, like the…
30. Mr. Davis flips page
31. Isabella: Ok.
------------------------
32. Mr. Davis: Ummm, los amino acids seran
   (The amino acids will be…)
33. Diego: estos?
   (These?)
34. Mr. Davis: azules, yeah.
   (Blue, yeah).
35. Diego: Son 5?
   (There are 5)
36. Mr. Davis: Ahi. Ok, Y por fin, los nucleic acids, su DNA, ADN, yo creo que se dice,
   (There, ok and the last nucleic acids, your DNA, ADN I believe you say.)
37. Ramon: ADN (DNA)
38. Mr. Davis: Yeah. Exacto
   (Yeah Exactly)

The scientific terms of sugar, fats, amino acids, nucleic acids and DNA are being used in this excerpt. Translanguaging is used to communicate how the different macromolecules are put together. As previously mentioned in Excerpt 3 (ln. 22), Ramon takes the time to advocate and support Diego in his learning. Ramon understood the turn-taking pattern between Mr. Davis and Diego as he watched and listened to their conversation. Using good timing, Ramon demonstrates the participation role change of student listener to student instructor as he interjects and helps pronounce and instruct Diego on what DNA is and how the acronyms are ADN in Spanish. The use of Spanish and the ability to interject and assert one’s opinion and answer is evidence of how students can use their full linguistic repertoire (e.g., translanguaging) through languaging and making meaning of the science terms. In this case, Ramon uses his full linguistic repertoire by changing his participation role and becoming a student advocate to help instruct the scientific term to Diego.
CHAPTER 5

Discussion

This section discusses the development and integration of how languaging and translanguaging mediotionally supported EBs in their use, understanding, and learning of scientific terms in a high school biology class. Studying natural classroom discourse provided insights into how languaging and translanguaging occurred for the students. By recording and analyzing the discourse surrounding the scientific terms, this study provided evidence of how mediation occurred, and what role it played in supporting the students’ learning.

As a review, Vygotsky’s (1987) version of SCT was applied to make meaning of the teacher and students’ process and negotiation for meaning while working with scientific terms. This theoretical perspective is important to use as it can account for unique and idiosyncratic learning paths of the individual EB, while also accounting for how learning and development occurs mediotionally through social endeavors and interactions. In this case, the classroom, curriculum, vocabulary, instructional conversations, questions and answers, and teacher-student relations were all part of the classroom ecology as affordances for learning about scientific terms in biology. In this ecology, all aspects of the discourse are social, and so negotiation, mediation, and attunement between all participants were important concepts that needed to be considered for second language learning. Using an eco-social sociocultural interpretation of the data shows how the students were able to utilize their personal background and build alignment with the science terms embedded with their current knowledge. This helped the students bridge the science content and connect to all their available knowledge – a central principle when attempting to apply translanguaging in the science classroom. For example, through languaging,
multiple and diverse characteristics were identified when the participants negotiated the meaning of scientific terms in all the excerpts.

The discourse analysis also revealed opportune moments (i.e., germinating moments) where the second language learners were using more of their repertoire for understanding and using scientific terms, especially when they moved beyond the role of student-as-learner and took upon themselves the role of student-as-instructor or student-advocate during the conversational learning process. Such moments were identified as nascent spaces that meet the definitions for how languaging and translanguaging can emerge in a classroom to support learning. Languaging characteristics and translanguaging, as a subset of languaging, were coded and identified as emergent when students advocated in support of other students and/or took the initiative in asking questions and checking for the correct answer. These emergent spaces were broken down into four categories which are discussed below. These subset categories as found in the findings are negotiation of meaning, using available knowledge or background knowledge, language play, and participation role change.

**Negotiation of Meaning**

MDA provided insight into how negotiation of meaning played out and helped students build meaning with the scientific terms. Language was used by students to negotiate the meaning of scientific terms. In the transcripts students negotiated the meaning with the teacher of several scientific terms to build meaning. The transcripts show that when languaging occurs it provides a space for the negotiation of meaning. For example, the scientific terms of abiotic and biotic show up in the conversation in Excerpt 1 and Excerpt 2. When the participants use languaging to negotiate the meaning of the scientific terms it provided a space where the teacher could understand how the students were using the scientific term. Also, it demonstrated a space where
more than just memorization and regurgitation of the terms happened. The languaging moments of the students showed evidence of how students created meaning with the scientific terms, which provided an important germination space where translanguaging or the principles of translanguaging could emerge. This coincides with Swain’s (2006, 2010) work describing that languaging can be a form of learning. This also provided evidence of the Vygotsky’s (1986) work and van Lier’s (2004) eco-social SCT framework, concerning the importance of mediation, where multiple people and their dialogue, as afforded in their ecology, were used as psychological tools for using and applying the science terms.

Using Available Knowledge to Solve a Task

The languaging of the students provided a place where they could use their own background knowledge to build meaning of scientific terms. Participants used personal language and a level of comfort in trying scientific terms in their discourse. There was evidence that shows students bringing their background knowledge and previous life experience to help students answer the teacher’s questions. Students using their full linguistic repertoire and personal background knowledge created the beginning of a space where students are comfortable using scientific terms in biology. This foundation provided for a place where students could use scientific terms in their discourse. Such spaces add specificity to Garcia’s (2009a) definition that translanguaging is concerned with students being able to use their full repertoire in learning. Background knowledge included the science terms the students knew or thought they knew, and spaces to apply them into, including the turn-taking spaces between the three young ladies provided additional instances of how use of a full language repertoire looks like in a science classroom.
**Language Play**

Somewhat in relationship to background knowledge, there is evidence of how language play (Broner & Tarone, 2001; Cook, 2000) provides additional opportunities as a part of the students’ entire repertoire was being utilized for understanding of scientific terms can be expanded to possibly create more space for learning. As evidenced in the conversation shared when Ramon moved past simply saying what the teacher wanted to hear, or what was simply the correct test answer, by using the language in a personal way. By including the playing off the abiotic/biotic definition, Ramon was able to transfer the somewhat abstract concept of the task on paper to jokingly apply the definition to Diego and his life. Ramon’s language play action also pairs well with Vygotsky’s (1987) findings that such transformative ways of using language helps students overcome learning challenges and can accelerate learning – two important needs for English learners. While there was only one example of language play from the selected scenes, it is possible that this concept should also be considered as a full part of translanguaging’s definition for allowing all participants to use their full linguistic repertoires to express themselves. Also, Ramon’s example provides evidence of using multiple semiotic resources to make meaning, which meets van Lier’s (2004) perspective of language through an ecological perspective. In his eco-social language system, all symbolic or representational signs can be used mediationally to negotiate meaning and in this case, to support the use and application of scientific terms. Such an example also supports the more holistic definition of translanguaging, where use of all a student’s repertoire is given space and respected in the second language learning process.
Change of Participation Roles

The language and multiple participation roles of students also provide insight into the mediational process for how languaging and translanguaging helped support and mediate the students’ understanding of scientific terms. Of note were the moments where participants not only worked together but changed their roles from learner to advocate or teacher/instructor for each other. When a student took the lead in inquiring about the scientific term, they took on a more active role and were in a moderating role for those sitting around them. They changed their role from passive listener to the teacher’s answer to a role where they were responsible for themselves and others to initiate and engage in more languaging about the science term. Sometimes the role changed from lead inquirer to actual teacher as they turned and shared their findings with their partners. The multiple changing participation roles finding is significant because it shows that regardless of the language being used, whether in Spanish or English, the new role created new opportunities and ways to use the scientific term. Such open opportunities with differing students taking differing roles and different times provides additional evidence that more repertoire for languaging and translanguaging was available when students did not remain in the same participation role. This evidence supports findings from Swain and Lapkin (1998) and Swain and Watanabe (2012) concerning the importance of collaborative dialogue in learning content as a second language learner.

Research Question Discussion

The research question guiding this inquiry was how languaging and translanguaging are used by the participants to negotiate meaning for second language learning in a biology classroom. As mentioned in the literature review, languaging focuses on the process of how language and meaning making come together (Swain, 2006). An important part of the way
participants built meaning around scientific terms was when language was happening. Students' use of languaging and the negotiation of meaning around the scientific terms provides a space where translanguaging principles could occur in the science classroom. Languaging by participants provided a space for mediation of scientific terms. In this classroom data, negotiation of meaning was found to be possibly more effective when the students' discourse contained more space for languaging that contained evidence of negotiation, personal background, role changes, and language play with concepts. These characteristics may have been brief but can be signals for teachers to explore and expand to provide more space for translanguaging.

Languaging allowed for the students to negotiate meaning of the scientific terms and the combination of how they negotiated meaning of the terms, brought in personal background, and played with the terms, which were all part of how translanguaging occurred in the classroom. While this study did not address the amount of translanguaging that occurred, it does address the part of the definition of translanguaging for allowing an EB's full repertoire to be practiced in the classroom, including the characteristics of languaging and negotiation of meaning, personal background manifestations, language play, and space for the students to change their identities and participation roles during the learning experience. Language used mediational to negotiate and make meaning was found across all the excerpts but was particularly established and interesting when students altered their participation roles, as it demonstrated their attentiveness to the task and situation. At times, students changed multiple participation roles from being listeners and questioners, to more active roles as advocates and instructors. Changing roles was an important finding as a mediational process, and with the participation role changes there were extended uses and connection with the science term. The participation role finding included
demonstrations of extending their languaging beyond the basic labeling or memorization of the term by showing how differing ways to use the science terms, especially salient when the term is used well in differing contexts, such as found in the language play example by Ramon. When students played the role of student-as-teacher, student-as-peer-supporter, or other advocate-leading ways, it demonstrates a form of uptake and comprehension with the scientific terms. Language play itself was a form of uptake and comprehension of the scientific terms, which included positive affect such as smiling and laughter coinciding with Broner and Tarone’s (2001) call for second language learning and laughter (i.e., ludic/fun). In addition, such examples of uptake and diverse roles supports the SCT focus on learning leading to transformation rather than a focus on simple transmission in learning content. This also provides additional evidence for how translanguageing concepts were used in the classroom to support mediation of the science terms.

In summary, languaging and translanguageing, as mediational tools for supporting science terms and/or overcoming challenges concerning scientific terms, helped both the teacher and students to build a classroom ecological style of learning. This ecological perspective included evidence that the emergence and beginnings of translanguageing occurred and was identifiable in these data, when the following characteristics in the discourse occurred:

- allowing participation roles to change
- negotiation of meaning
- background knowledge
- language play

When one or a combination of the above four characteristics occurred, the EBs demonstrated more diverse ways to use the scientific terms, which, although beyond the scope of
this study, has been shown to improve second language comprehension (Rajendram, 2021). In all four excerpts, the samples demonstrated how translanguaging emerged when the intersection of multiple characteristics created new spaces and ways for students to negotiate meaning. The intersection of multiple characteristics facilitated and invited students to engage in making meaning more fully and should be considered an important process when engaging translanguaging concepts in science classrooms.

While we have literature and research concerning translanguaging (García, 2009a) and biology discourse analysis (Lemke, 2001) this study adds important insights into how EBs made meaning of scientific terms in a biology classroom. Using a SCT perspective to better understand languaging and translanguaging in a science classroom provided an extended lens for how differing semiotic resources came together to support the teacher-researcher and students. The identified four characteristics provides further information concerning how languaging and translanguaging can support communication and mediation of scientific terms in a high school biology classroom for EBs, and such findings may be transferrable to support secondary education science teachers to understand how to more effectively support EBs (Garza & Langman, 2014).

Limitations

The data for this master’s thesis is limited to four days of data collection. This provided only a short sample of the biology classroom over a few weeks. While the research provides some preliminary evidence of how languaging and translanguaging occurred in the science classroom, more time and follow up studies are needed to understand how the emergence of these concepts might come to fruition and continue to support EBs in learning scientific terms. As a qualitative study, it should be understandable that results are not replicable, but that
findings and suggestions may be transferrable and insightful for assisting other content settings and teachers who are interested in applying languaging and translanguaging concepts in the classroom.

The data collected and analyzed demonstrated patterns of rich discourse and more meaning filled extensions with the scientific terms when the intersection of multiple language characteristics came together; however, such a pattern was limited given the data sample and it is not necessarily known whether this coming together (i.e., data clumps) are themes that will always be found in science vocabulary discourse with EBs. I as the teacher researcher recommend that characteristics in any languaging situation can be evaluated and then analyzed for possible themes as found in this study, but it is not conclusive that resulting characteristics will be the same as the ones found in these data.

A teacher reflection journal was started but not formally used to inform the analysis. It is possible that the use of a journal would have benefitted the interpretation and understanding of the research and provided new insights into the languaging and translanguaging processes in the classroom. More time documenting the emergence of languaging and translanguaging should support the current findings, while also provided other characteristics not identified in this qualitative study.

**Conclusion**

This study demonstrates some potential ways that languaging and translanguaging can be used mediationallly to support EBs to apply and practice using scientific terms. Specifically, scientific term use was identified during moments of languaging and translanguaging, and the use of science terms were identified as particularly rich experiences or emerging learning moments when the participants engaged in the practices of negotiation of meaning, using
background knowledge, changing their roles of participation and identity, and when implementing language play. Such occurrences, both individually and together, provided moments where students could show their abilities to use and apply the scientific terms in multiple ways.

By using SCT and MDA, teachers should be better able to identify the characteristics of languaging and translanguaging that their EBs are using, which should provide a way to better understand the characteristics of how languaging and translanguaging supports the learning of scientific terms or other content-specific vocabulary. An important factor in how languaging and translanguaging spaces are created and helpful in understanding science terms may be related to when EBs moved beyond the role of student-as-learner and take upon themselves the role of student-as-instructor or student-advocate. Rather than simplify the vocabulary or simply scaffold the students to the correct answer, languaging and translanguaging may be better applied when the classroom practices allow the EBs to take more leadership as advocates for other students’ learning and/or as teacher-instructor to them. There is evidence for multiple positive characteristics of languaging and translanguaging when EBs were given more space to apply all their repertoire to negotiate for answers, share background knowledge, language play, and change their participation roles. This is important evidence that languaging supports learning and provides EBs multiple ways to think about the content (Swain, 2010).

By identifying the roles of the students, the ways they negotiate their language around the scientific terms, apply their background knowledge, change their positions from listeners to teachers, and/or add language play during classroom conversation, teachers can improve their discourse around the scientific terms, including ways to support making meaning of the scientific terms using the language repertoire of the students. In this way, EBs could be more empowered
to engage with challenging scientific terms rather than just looking for the right answer. Findings from the discourse showed that when multiple discourse characteristics lined up in the transcripts, a high potential for the emergence of translanguaging as mediation occurred.

Languaging and translanguage, to solve or resolve learning challenges, needs to happen in a biology classroom for the negotiation of meaning of scientific terms to take place. Science teachers will have to navigate the constraints of what specific scientific language needs to be taught and accept more diverse characteristics in discourse to be used to allow more mediation with the vocabulary of science. Open discourse with characteristics that provide mediation towards scientific terms should be found when languaging and translanguage occurs and support the needs of all EBs. How biology teachers assist students in using more authentic languaging and translanguage within the constraints of the curriculum is by moving past what Vygotsky (1986) termed, “empty verbalism” (pp. 110-113). Vygotsky warns against simply stating or restating the term to provide the right answer by recommending a more ZPD-like learning experience, where the discourse allows students to create and demonstrate meaning around the scientific terms. The results show that the discourse of languaging around the scientific terms is important for students to negotiate meaning and allows for students to use the scientific terms in ways more than just fill-in-the-blank for the test.

In summary, emergence of languaging and translanguage occurred when teachers and students used mediated discourse during their instructional conversations in the classroom. Spaces and moments where language characteristics such as negotiation, background, multiple participation roles, and language play created conditions that foster the principles of languaging and translanguage. When the participants worked together and extended the discourse, more mediation was available, and this extended the ways the scientific terms were used. This type of
languaging and extension has been shown to support second language and content learning and showed up in contingent moments not necessarily expected by the teacher-researcher. As a result, I as the teacher researcher recommend that lessons and science outcomes do not need to be prescribed in a linear way as to how to get second language learners to the correct answer, but instead, through indirect and application of mediational tools, plan and allow the instructional conversations to be built together in ways that make sense and meaning to the learners.
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APPENDIX A

Institutional Review Board Approval Letter

Memorandum

To: Alessandro Rosborough
Department: BYU - EDUC - Teacher Education
From: Sandee Aina, MPA, HRPP Associate Director
Wayne Larsen, MAcc, IRB Administrator
Bob Ridge, Ph.D., IRB Chair
Date: August 16, 2021
IRB#: IRB2021-100
Title: Teachers and students' language use in dual language immersion/multilingual settings: Understanding communication patterns and social action growth

Brigham Young University’s IRB has approved the research study referenced in the subject heading as expedited level, categories 6 and 7. This study does not require an annual continuing review. Each year near the anniversary of the approval date, you will receive an email reminding you of your obligations as a researcher. The email will also request the status of the study. You will receive this email each year until you close the study.

The IRB may re-evaluate its continuing review decision for this decision depending on the type of change(s) proposed in an amendment (e.g., protocol change the increases subject risk), or as an outcome of the IRB’s review of adverse events or problems.

The study is approved as of 08/16/2021. Please reference your assigned IRB identification number in any correspondence with the IRB.

Continued approval is conditional upon your compliance with the following requirements:

A copy of the approved informed consent statement and associated recruiting documents (if applicable) can be accessed in iRIS. No other consent statement should be used. Each research subject must be provided with a copy or a way to access the consent statement.

Any modifications to the approved protocol must be submitted, reviewed, and approved by the IRB before modifications are incorporated in the study.

All recruiting tools must be submitted and approved by the IRB prior to use.

In addition, serious adverse events must be reported to the IRB immediately, with a written report by the PI within 24 hours of the PI's becoming aware of the event. Serious adverse events are (1) death of a research participant; or (2) serious injury to a research participant.

All other non-serious unanticipated problems should be reported to the IRB within 2 weeks of the first awareness of the problem by the PI. Prompt reporting is important, as unanticipated problems often require some modification of study procedures, protocols, and/or informed consent processes. Such modifications require the review and approval of the IRB.
APPENDIX B

Open Coding

1. Translanguaging Moment TM
2. Scientific Terms ST
3. Change of Terminology CT
4. Terminology with Personal Background PB
5. Unique Utterances that do not mimic the teacher UU
6. Mediated Discourse Analysis MDA

Excerpt 1 - B1 10-4 Mobile (2)
5:12-10:00

1. Mr. Davis: So which ones don't you know?
2. Students: All of them.
3. Mr. Davis: Abiotic and biotic?
5. Isabella: Abiotic is a non-living thing biotic is a living thing.
6. Mr. Davis: Yeah, so you got those two.
   So, what’s the habitat?
7. Isabella: Outside
8. Mr. Davis: Yeah, it’s its house, it’s where it lives.
9. Isabella: Can we put outside?
10. Mr. Davis: I would put like a home.
    So, like a habitat is where somebody lives.
11. Ana: Wait, where are we talking about?
12. Mr. Davis: We’re underneath biotic.
    Are you on the first one still?
    Where are you at?
14. Isabella: A habitat goes with an ecosystem and uh, and it…
15. Mr. Davis: Okay you’ve lost me.
    Where are you guys?
17. Mr. Davis: So, interactions. A habitat is an organism’s like, um, let’s see here.
    Like how I describe this. So, a habitat is going to be like where something lives.

[Mr. Davis brings left and right hands together on the desk palm down on the table and then moves right hand up and then back towards the left hand on table to show organisms moving towards their home.]
So, like your habitat would be your house and Wasatch High School and wherever else you guys go. And if you lived in a cave that’s your habitat.
So, like deer live on the mountain. The mountain is the deer’s habitat.
18. Sofia: So, then what do we put?
19. Mr. Davis: So, the **habitat** is an organism’s, I would put home but that’s just me.

20. Isabella: An organism’s home.

21. Mr. Davis: Yeah. Does that make sense?

22. Ana: Wait what does that word mean?

23. Mr. Davis: So, **habitats** are where something lives. Where do you live?

24. Isabella: A niche is like where they hide? Hibernate?

25. Mr. Davis: So, the **niche** is like what the animals do in the **habitat**, so like its job. I put job. That’s easy, you know what a job is. So, like its role in the **habitat**, like what does that mouse do in that area. Or the fish. What does the fish do? Your fish is still swimming over there.

26. Sofia: Really?

27. Mr. Davis: I checked it this morning and was like is it dead is it dead? Nope, still going strong.

28. Isabella: So, it’s just its job.

29. Ana: So, for the **biotic versus abiotic** and then a.k.a., can we put living?

30. Mr. Davis: So, a.k.a. yes, you should put living.

**Excerpt 2 Time 7:33**

31. Ana: Okay I was just making sure. Okay the next, and anything moving … such as, water.

32. Mr. Davis: Yeah, water is a good one.

33. Ana: Oh, I am smart.

34. Mr. Davis: What else would be something an animal would need?

35. Sofia: Food.

36. Mr. Davis: Yes food, space, and shelter.

37. Ana: Shelter.

38. Mr. Davis: Shelter is the best one.

Because that’s, what are the three things you need for life? Food, water, space. Yep. Like you need shelter to stay alive because without like shelter you wouldn’t live for very long. You need your cave.

39. Isabella: Need food… wait what? Water?

40. Mr. Davis: Animals must **compete**, or fight for their stuff.

41. Ana: Compete? How do you spell that?

42. Sofia: It’s like pete.

43. Isabella: And what?

44. Ana: Is where one species, oh it’s like, I forgot what it is called.

45. Mr. Davis: But it is, what is it when an organism kills and eats another one?

46. Ana: Consumer? Oh no. No se.

47. Mr. Davis: There’s better words.

48. Sofia: I don’t know. … something. I don’t remember. It started with like an h.

49. Ana: Herbivore. Oh no.

50. Mr. Davis: I put predator or prey, that seemed to fit better.

51. Sofia: Oh my gosh. I am going to fail this test.

52. Mr. Davis: So, what’s the question?

53. Ana: Can I go to the bathroom?
54. Mr. Davis: So, a **predator, a predator** is the one organism that kills the other.
55. Sofia: Is a cow a predator?
56. Mr. Davis: Does it kill the grass?
57. Sofia: No
58. Mr. Davis: Sometimes. You could argue either way. It’s your preference.

**Excerpt 3 - B1 10-4 Mobile (2)**

11:00-17:55
1. Mr. Davis: What are the relationships called?
2. Sofia: I feel like it is up there.
3. Mr. Davis: It is up there.
   Where is it?
   ![Looking at word wall.]
4. Sofia: Symbiosis?
5. Mr. Davis: There you go.
6. Sofia: Oh, I am right?
7. Mr. Davis: You got it. I forgot about all the words up there.
8. Sofia: I should not have told you about them.
9. Mr. Davis: Oh, I’ll leave them up for you, I won’t take them down till after the quiz.
   It’s been there all semester and you should be able to still use it. Keep going.
   You guys got this. You got a good start.
10. Mr. Davis: [moving to another student]
   ¿Cómo les va?
   (How is it going?)
   ¿Bien Bien?
   (Good, Good)
   ¡yeah, No?
11. Diego: Muy poco, no
   (Very little, no)
12. Mr. Davis: Muy poco
   (Very little)….  
   Ok. Hay algunas partes que son quizás más importante.
   (There are some parts maybe more important).
   Deben saber que son biotic y abiotic.
   (You should know what biotic and abiotic are).
   Yeah? ¿Qué es biotic?
   (What is biotic)
13. [Diego shakes head.]
14. Mr. Davis: Ya no? Nada?
   (Still noting?)
   Biotic dice que esta vivo.
   (Biotic says it is alive).
   Yeah? So esta vivo. Si es biotic.
   (It’s alive yes it would be biotic).
   Como nosotros, los plantas, los animales, esas todos son los partes que son biotic.
   (Like us, the plants, animals, those are the parts that are biotic.)
¿Los **abiotic**, que son?
(The abiotic, what are those?)

15. Diego: **Muerto**
(Dead)

16. Ramon: **No estan vivo.**
17. Mr. Davis: **Yeah, Que son, no estan vivo.**
(Those are the ones that are not alive.)
Yeah. Como los rocias, la agua, esas **partes son abiotic.**
(Like the rocks, the water these parts are abiotic.)

18. Ramon: **No tiene vida el.**
[Points to Diego.]
Laughs, Ray laughs

19. Mr. Davis: Bien. **Biotic es, biotic es vivo, yeah.**
(Good. Biotic is alive.)
Porque lo quito? Déjalo.
(Why did you get rid of it. Leave it.)
Y ese es, muerto, o no están vivo. Algo así.
(And that is dead or not alive. Something like that.)

20. Diego: **Muerto, no Tambien o?**
(Dead, too or)

21. Mr. Davis: **Yeah, abiotic quiere decir que no**
(Abiotic means to say that no)

22. Ramon: **no tiene vida**
(Doesn’t have life)

23. Mr. Davis: **Yeah. No tiene vida.**
(Yeah. It doesn’t have life.)

24. Diego: **Muerto, no tiene vida.**
(Dead, doesn’t have life)

25. Mr. Davis: Como la agua y las rocias y la tierra. Eso es los parte que son **abiotic.**
(Like the water, rock, dirt. Those are the parts that are abiotic.)

26. Mr. Davis: Okay?

27. Sofia: Wait, where do we put this here?
[**Pushes her computer across table to teacher.**]

28. Mr. Davis: So that’s **symbiosis, parasitism, mutualism, commensalism.**

29. Ana: What was the other one?

30. Mr. Davis: Okay, y, let’s see…. A ver(Let’s see)...**organism. Habitat.**
Es la casa de las, es donde lo, a ver.
(The house or the, its where it, let’s see)
Es el lugar de que los animales viven, yeah?
(It’s the place where the animals live)
So cuando digo **habitat**, or yeah,
(Ray looks at word wall to see a translation for habitat)
habitat es el lugar, su casa es como dónde van a encontrar animales or nosotros también.
(So when I say habitat, habitat is the place, your house where you are going to find animals or us as well).
31. Mr. Davis: Aquí
   (Here)
32. Diego: Allí?
   (There)
33. Mr. Davis: Yeah. So para mí un recuerdo que el **habitat** es como la casa de los animales,
   es el lugar donde van a encontrar animales y el **nicho o niche** es donde,
   es que hacen en la…
   (So for me, I remember that the habitat is like the house of the animals,
   it is the place where you will find animals and the niche is where, its what the…)
34. Diego: No puedo recordar
   (I can’t remember)
35. Mr. Davis: La casa de los animales, yeah perfecto.
   (The house of the animals, yeah perfect.)
   Okay. Y el **nicho**? El segunda parte.
   (And the niche? The second part.)
   Niche dice que es como es el trabajo lo que hacen en su **hábitat**. So este dos partes (Niche
   says that is like the work or what it does in it’s habitat. So those two parts.)
36. Diego: Y esto que es?
   (And what is this)
37. Mr. Davis: El nicho es como el trabajo.
   (The niche is like it’s work)
38. Isabella: **Isn’t** that commensalism? The last one?
39. Mr. Davis: Commensalism? Yeah. So you have mutualism, commensalism, parasitism.
40. Mr. Davis: **Pero,** es del animal
41. Diego: Animal?
42. Sofia: **Where?**
43. Isabella: By mutualism. But it’s the blue one.
44. Sofia: Yeah, where does it say that? Where does it say commensalism?
45. Ana: Over at the top, with water cycle.
46. Mr. Davis: The blue shark, or whale. It’s hard to see.
47. Ana: The water cycle and right.
48. Sofia: Oh, I see.
49. Mr. Davis: So it’s the blue shark one.
50. Isabella: Go three and to the right and it’s the blue image.
51. Ana: You can barely see the letters.
52. Mr. Davis: I’m sorry, it had a cool picture. You could also look in your notebook,
   it’s on the pink papers. Alright. Umm….
53. Ana: **Cows?** I don’t know.
54. Mr. Davis: Mutualism?
55. Ana: Yeah.
56. Mr. Davis: The example we used on the last quiz, and it will probably show up again,
   is like the sea anemone and the clown fish. They both have kind of a
   (gestures back and nods head).
Ana: A what? Sea anem and that’s like all I heard.
Mr. Davis: Finding Nemo? If you’ve watched Finding Nemo? No?
Ana: Yeah.
Mr. Davis: They’re clownfish. The little orange fish lives in what’s called a sea anemone. Or
Ana: So sea aneme?
Mr. Davis: Anemone. It’s in the notebook, it should be the last one that you wrote down.
Ana: Oh, sea anemone.
Mr. Davis: Yeah, there you go.
Ana: And clownfish?
Mr. Davis: Yeah
Ana: Ahhhh

Ramon: Aqui pone, en la casa de los animalitas. [points to other student’s screen]
(Here put, in the house of the animals.)
Diego: Allí?
(There)
Ramon: Sí
(Yes)
Ramon: No, pero borra esto.
(No, but erase that)
Diego: Oh
Mr. Davis: Alright, um, estes son los tres partes que de que hablamos son
parasitism, mutualism, commensalism, y esa parte es de esta
[points to pink paper in another student’s notebook]
si recuerdas.
(These are the three parts that we talked about are parasitism, mutualism, commensalism,
and that part is part of this if you remember.)
Ramon: Sí, sí, sí, lo tengo.
(Yes I have it.)
Mr. Davis: Yeah, y este es este parte abajo.
(That is the part here below)
Ramon: Oh, okay.
Ana: I’m pretty sure it’s an A, right? Or is it an O? Sea Anem
Mr. Davis: Sea Anem A-N
Sofia: Uh huh, E-M-O-N-E
Mr. Davis: Yeah
Ana: Uh-huh.

Excerpt 4 - 10-8 B1 Mobile (2)
14:14-17:15
1. Mr. Davis: Should I come stand over here? You guys can all see my beautiful artwork.
2. Sofia: I have a question. But not about that. (laughs)
3. Mr. Davis: Can I explain this
4. Sofia: Yeah
5. Mr. Davis: first and then I can help you?
6. Ana: Oh, so we need to cut one of these out?
7. Mr. Davis: Yeah, so there’s this part, that is yellow. And it’s for those other two… that should be yellow.
8. Ana: Oh
9. Mr. Davis: Ok? So those are the way they are going to be connected together. Then for the blue ones, you have your amino acids connected together to make a protein.
10. Ana: Ah-huh
11. Mr. Davis: And then these nucleic acids, those are going to connect together to make your DNA or your nucleic acids. So these connect in a chain. These ones are set up so that the glycerol and the phosphate group, have fatty acids attached to ‘em.
12. Ana: Ah-huh
13. Mr. Davis: And then these ones are set up.

Time 15:10

Turns to other side of table, with Diego and Ramon.

Diego raises hand, makes gesture of confusion??

Mr. Davis laughs and heads over to the two students.

14. Mr. Davis: Alright. Quizás quieres ponerlo (Maybe you want to put it)
15. Diego: Ah-huh
16. Mr. Davis: todo eso serán amarillo. (All of these will be yellow)
17. Diego: Amarillo (Yellow)
18. Mr. Davis: Ah-huh
19. Diego: Esto? (This)
20. Mr. Davis: Y uno, dos, tres (Counting one, two, three)
21. Diego: Esto amarillo tambien? (This yellow also?)
22. Mr. Davis: Yep. Y estos van a ser los grasas? Fats? Ok. Y estos, van a ser rojo. (Those are going to be the fats. And they will be red)
23. Diego: Ok.
24. Mr. Davis: Para los azúcares? (For the sugars?)
25. Diego: cuáles son? (Which one are they?)
26. Mr. Davis: Los hexagons, estos. (The hexagons, those.)
27. Diego: Estos? (These?)
28. Mr. Davis: Yeah. (mumble) hay 5 para ser rojo. 5, ok? (Five to be red)
29. Isabella: What does the last page, like the…
30. Mr. Davis flips page
31. Isabella: Ok.

32. Mr. Davis: Ummm, los **amino acids** seran
(The amino acids will be…)
33. Diego: estos?
(These?)
34. Mr. Davis: azules, yeah.
(Blue, yeah).
35. Diego: Son 5?
(There are 5)
36. Mr. Davis: Ahi. Ok, Y por fin, los nucleic acids, su DNA, ADN, yo creo que se dice,
(There, ok and the last nucleic acids, your DNA, ADN I believe you say.)
37. Ramon: **ADN** (DNA)
38. Mr. Davis: Yeah. Exacto
(Yeah Exactly)
39. Diego: Cuales son?
(Which ones?)
40. Mr. Davis: Son estos cinc- estos 3.
(They are these three)
41. Diego: Este, este,
(This, This)
42. Mr. Davis: Y este, perfecto.
(And this, perfect)
43. Diego: Esto tambien verdad?
(And this one as well, yes?)
44. Mr. Davis: Si, Tambien
(Yes, that one also)
45. Diego: Este, y este
(This and This)
46. Mr. Davis: Ah-huh
47. Diego: este, y este, y este, y este!
(This and this and this and this!)
48. Mr. Davis: Perfecto!
(Perfect)
49. Ramon: Hablas bien el español teacher.
(You speak good Spanish teacher.)
50. Mr. Davis: Laughs. Pense que quiere decir que no es perfecto, pero esta bien.
(I think what you are trying to say is that it isn’t perfect, but its good.)
51. Ramon: Noooooo, laugh, que lo hablabas bien.
(No, that you speak it good.)
52. Mr. Davis: Hago la lucha aqui no mas,
(I am fighting here no more)
53. Diego: Cómo, asi esta bien?
(Like is this good?)
54. Mr. Davis: Si
   (Yes)
55. Diego: Escribido?
   (Written)
56. Mr. Davis: Yeah, vas a clarar
   (Yeah, you going to clarify?)
57. Diego: ....
58. Mr. Davis: Ummm, yeah. So, **nucleotides**. Puedes ponerlo de esto, quizas
   (It says nucleotides. You can put it like this, maybe)
59. Diego: Completo?
   (Complete)
APPENDIX C

Axial Coding

Key code of the transcripts
1. Translanguaging Moment TM
2. Scientific Terms ST
3. Change of Terminology CT
4. Terminology with Personal Background PB
5. Unique Utterances that do not mimic the teacher UU
6. Mediated Discourse Analysis MDA

Types of Participation Roles
A. Teacher-Researcher (Mr. Davis)
   a. Teacher Instructor (TI): When a teacher actively explains content to students and instructs.
   b. Teacher Listener (TL): When the teacher steps back and listens to students and their needs.
   c. Teacher Advocate for Language (TAL): When a teacher actively campaigns and promotes students to use all their language.
   d. Teacher Questioner (TQ): When questions are asked to students or answered from students.

B. Students (69 total students, 14 EBs total, and 5 EBs used in study)
   a. Student Questioner (SQ): Student asking a question or answering a question.
      i. Primary (PSQ): Primary student asking question
      ii. Following (FSQ): Following up questions that answer or coincide with previous questions
   b. Student Listener (SL): When student listens actively to who is talking.
   c. Student Advocate for Language (SAL): When a student helps another student and encourages all language.
   d. Student Instructor (SI): When student takes on traditional teacher role and helps instruct others.

<table>
<thead>
<tr>
<th>Time</th>
<th>Participants</th>
<th>Gestures</th>
<th>Codes</th>
<th>Central Concepts</th>
<th>Participation Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excerpt 1</strong>&lt;br&gt;-5:12-7:33</td>
<td>1. Mr. Davis: So which ones don't you know?  2. Students: All of them.  3. Mr. Davis: Abiotic and biotic?  4. Sofia: Oh yeah. It’s a nonliving thing.  5. Isabella: Abiotic is a nonliving thing biotic is a living thing.</td>
<td>Mr. Davis puts left hand on forehead.  Sofia and Ana laugh and put their heads down on</td>
<td>ST</td>
<td></td>
<td>Mr. Davis – TQ  Sofia – PSQ  Isabella – Moves from SL to PSQ</td>
</tr>
<tr>
<td>6. Mr. Davis: Yeah, so you got those two. So, what’s the habitat?</td>
<td>7. Isabella: Outside</td>
<td>8. Mr. Davis: Yeah, it’s its house, it’s where it lives.</td>
<td>9. Isabella: Can we put outside?</td>
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<tr>
<td>10. Mr. Davis: I would put like a home. So, like a habitat is where somebody lives.</td>
<td>11. Ana: Wait, where are we talking about?</td>
<td>12. Mr. Davis: We’re underneath biotic. Are you on the first one still? Where are you at?</td>
<td>13. Sofia: Where it says interactions.</td>
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<tr>
<td>14. Isabella: A habitat goes with an ecosystem and uh, and it…</td>
<td>15. Mr. Davis: Okay you’ve lost me. Where are you guys?</td>
<td>16. Sofia: On the first sentence under interactions. Where it says habitat.</td>
<td>17. Mr. Davis: So, interactions. A habitat is an organism’s like, um, let’s see here. Like how I describe this. So, a habitat is going to be like where something lives. So, like your habitat would be your house and Wasatch High School and wherever else you guys go. And if you lived in a cave that’s your habitat. So, like deer live on the mountain. The mountain is the deer’s habitat.</td>
<td>18. Sofia: So, then what do we put?</td>
<td>19. Mr. Davis: So, the habitat is an organism’s, I would put home but that’s just me.</td>
</tr>
<tr>
<td>21. Mr. Davis: Yeah. Does that make sense?</td>
<td>Negotiating the meaning of niche.</td>
<td>Mr. Davis – TI</td>
<td>Sofia and Isabella – SL</td>
<td>Ana and Isabella – SL</td>
<td>Mr. Davis – TI</td>
</tr>
</tbody>
</table>
22. Ana: Wait what does that word mean?
23. Mr. Davis: So, habitats are where something lives. Where do you live?
24. Isabella: A niche is like where they hide? Hibernate?
25. Mr. Davis: So, the niche is like what the animals do in the habitat, so like its job. I put job. That’s easy, you know what a job is. So, like its role in the habitat, like what does that mouse do in that area. Or the fish. What does the fish do? Your fish is still swimming over there.

26. Sofia: Really?
27. Mr. Davis: I checked it this morning and was like is it dead? Nope, still going strong.
28. Isabella: So, it’s just its job.
29. Ana: So, for the biotic versus abiotic and then a.k.a., can we put living?
30. Mr. Davis: So, a.k.a. yes, you should put living.

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<td><strong>Excerpt 2</strong></td>
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<td>7:33-10:00</td>
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<tr>
<td>31. Ana: Okay I was just making sure. Okay the next, and anything moving … such as water.</td>
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<tr>
<td>32. Mr. Davis: Yeah, water is a good one.</td>
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<td>33. Ana: Oh, I am smart.</td>
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<tr>
<td>34. Mr. Davis: What else would be something an animal would need?</td>
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<tr>
<td>35. Sofia: Food</td>
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<td>36. Mr. Davis: Yes food, space, and shelter.</td>
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<td>37. Ana: Shelter.</td>
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<tr>
<td>38. Mr. Davis: Shelter is the best one. Because that’s, what are the three things you need for life? Food, water, space. Yep. Like you need shelter to stay alive because without like shelter you wouldn’t live for very long. You need your cave.</td>
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</table>

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Mr. Davis points to back of class where their ecosystem in a jar is located.

Mr. Davis holds up three fingers as he lists the 3 needs of living things.
39. Isabella: Need food… wait what? Water?
40. Mr. Davis: Animals must **compete**, or fight for their stuff.
41. Ana: **Compete**? How do you spell that?
42. Sofia: It’s like **pete**.
43. Isabella: And what?
44. Ana: Is where one species, oh it’s like, I forgot what it is called.
45. Mr. Davis: But it is, what is it when an organism kills and eats another one?
46. Ana: **Consumer**? Oh no, No se.
47. Mr. Davis: There’s better words.
48. Sofia: I don’t know. … something. I don’t remember. **It started with like an h**.
49. Ana: **Herbivore**. Oh no.
50. Mr. Davis: I put **predator or prey**, that seemed to fit better.
51. Sofia: Oh my gosh. I am going to fail this test.
52. Mr. Davis: So, what’s the question?
53. Ana: Can I go to the bathroom?
54. Mr. Davis: So, a **predator, a predator** is the one organism that kills the other.
55. Sofia: Is a cow a predator?
56. Mr. Davis: Does it kill the grass?
57. Sofia: No
58. Mr. Davis: Sometimes. You could argue either way. It’s your preference.

---

**Isabella looks up from her phone.**

**Negotiating the meaning of what a predator is using the previous knowledge of students.**

**Identifying and describing available knowledge to solve the task.**

**Ana leaves to bathroom**

---

**Expert 3 – 11:00 to 12:50**

10. Mr. Davis: ¿Cómo les va? (How is it going?)
   ¿Bien Bien? (Good, Good)
   ¿yeah, No?
11. Diego: **Muy poco, no** (Very little, no)
12. Mr. Davis: **Muy poco** (Very little) …. 

---

**Mr. Davis moves closer to Diego to help Ramon and him more.**

---

**Mr. Davis – TAL**

---

**Diego – SL to PSQ**
Ok. Hay algunas partes que son quizás más importante. (There are some parts maybe more important).
Deben saber qué es biotic y abiotic. (You should know what biotic and abiotic are).
Yeah? ¿Qué es biotic? (What is biotic)
13. [Ramon shakes head.]
14. Mr. Davis: Ya no? Nada? (Still noting?)
Biotic dice que esta vivo. (Biotic says it is alive).
Yeah? So esta vivo. Si es biotic. (It’s alive yes it would be biotic).
Como nosotros, los plantas, los animales, esas todas son los partes que son biotic. (Like us, the plants, animals, those are the parts that are biotic.)
¿Los abiotic, qué son? (The abiotic, what are those?)
15. Diego: Muerto (Dead)
16. Ramon: No están vivo. (Those are the ones that are not alive.)
17. Mr. Davis: Yeah, Que son, no están vivo. (Like the rocks, the water these parts are abiotic.)
Mediation between teacher and students to find the words to describe what abiotic is.
Ramon noda head and is looking at Mr. Davis
18. Ramon: No tiene vida. (Dead, too or)
19. Mr. Davis: Bien. Biotic es, biotic es vivo, yeah. (Good. Biotic is alive.)
Porque lo quito? Déjalo. (Why did you get rid of it. Leave it.)
Y ese es, muerto, o no están vivo. Algo así. (And that is dead or not alive. Something like that.)
20. Diego: Muerto, no También o? (Dead, too or)
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<tr>
<td><strong>Excerpt 4</strong></td>
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<tr>
<td>14. Mr. Davis: Alright. Quizás quieres ponerlo (Maybe you want to put it)</td>
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<td>Mr. Davis – TI</td>
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<td>15. Diego: Ah-huh</td>
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<td>Diego – SL</td>
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<td>16. Mr. Davis: todo eso serán amarillo. (All of these will be yellow)</td>
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<tr>
<td>17. Diego: Amarillo (Yellow)</td>
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<tr>
<td>18. Mr. Davis: Ah-huh</td>
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<tr>
<td>19. Diego Esto? (This)</td>
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<tr>
<td>20. Mr. Davis: Y uno, dos, tres (Counting one, two, three)</td>
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<tr>
<td>21. Diego: Esto amarillo también? (This yellow also?)</td>
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<tr>
<td>22. Mr. Davis: Yep, Y estos van a ser los gruesas? Fats? Ok. Y estos, van a ser rojo. (Those are going to be the fats. And they will be red)</td>
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<tr>
<td>23. Diego: Ok.</td>
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<tr>
<td>24. Mr. Davis: Para los azúcares? (For the sugars?)</td>
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<tr>
<td>25. Diego: cuáles son? (Which one are they?)</td>
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<tr>
<td>26. Mr. Davis: Los hexágonos, estos. (The hexagons, those.)</td>
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<tr>
<td>27. Diego: Estos? (These?)</td>
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***Diego raises hand, makes gesture of confusion??***

*Mr. Davis laughs and heads over to the two students.*

*Diego colors the different shapes on his paper.*

---

21. Mr. Davis: **Yeah, abiotic quiere decir que no** (Abiotic means to say that no)
22. Ramon: **no tiene vida** (Doesn’t have life)
23. Mr. Davis: **Yeah. No tiene vida** (Yeah. It doesn’t have life.)
24. Diego: **Muerto, no tiene vida** (Dead, doesn’t have life)
25. Mr. Davis: Como la agua y las rocas y la tierra. Eso es las partes que son abioticas. (Like the water, rock, dirt. Those are the parts that are abiotic.)
26. Mr. Davis: Okay?

---

21. Mr. Davis: **Yeah, abiotic quiere decir que no** (Abiotic means to say that no)
22. Ramon: **no tiene vida** (Doesn’t have life)
23. Mr. Davis: **Yeah. No tiene vida** (Yeah. It doesn’t have life.)
24. Diego: **Muerto, no tiene vida** (Dead, doesn’t have life)
25. Mr. Davis: Como la agua y las rocas y la tierra. Eso es las partes que son abioticas. (Like the water, rock, dirt. Those are the parts that are abiotic.)
26. Mr. Davis: Okay?
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<tbody>
<tr>
<td>28. Mr. Davis: Yeah. (mumble) hay 5 para ser rojo. 5, ok? (Five to be red)</td>
<td>29. Isabella: What does the last page, like the…</td>
<td>30. Mr. Davis flips page</td>
<td>31. Isabella: Ok.</td>
</tr>
<tr>
<td>32. Mr. Davis: Ummm, los amino acids seran (The amino acids will be…)</td>
<td>33. Diego: estos? (These?)</td>
<td>34. Mr. Davis: azules, yeah. (Blue, yeah).</td>
<td>35. Diego: Son 5? (There are 5)</td>
</tr>
<tr>
<td>36. Mr. Davis: Ahi. Ok, Y por fin, los nucleic acids, su DNA, ADN, yo creo que se dice. (There, ok and the last nucleic acids, your DNA, ADN I believe you say.)</td>
<td>37. Ramon: ADN (DNA)</td>
<td>38. Mr. Davis: Yeah. Exacto (Yeah Exactly)</td>
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</tbody>
</table>

*Mr. Davis shows what the second page looks like.*

Ramon helps translanguag the scientific term DNA into Spanish ADN for Diego.

Isabella – SL to PSQ

Mr. Davis – TI

Diego – FSQ

Mr. Davis – TAL

Diego – FSQ

Mr. Davis – TI to TAL

Ramon – SAL to SI
## APPENDIX D

### Purposeful Coding

<table>
<thead>
<tr>
<th>Unique utterances negotiating meaning of science terms</th>
<th>Participation Roles</th>
<th>Central Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excerpt 1</strong></td>
<td>Mr. Davis – TQ</td>
<td>1. When students use their own language it provides a space for languaging.</td>
</tr>
<tr>
<td>3. Mr. Davis: Abiotic and biotic?</td>
<td>Sofia – PSQ</td>
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<tr>
<td>4. Sofia: Oh yeah. It’s a nonliving thing.</td>
<td>Isabella – Moves from SL to PSQ</td>
<td></td>
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<tr>
<td>5. Isabella: Abiotic is a non-living thing biotic is a living thing.</td>
<td>Mr. Davis – TL to TQ</td>
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<tr>
<td>6. Mr. Davis: Yeah, so you got those two.</td>
<td>Isabella: PSQ to SAL</td>
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<tr>
<td>So, what’s the <strong>habitat</strong>?</td>
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<td>7. Isabella: <strong>Outside</strong></td>
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<td>24. Isabella: A niche is like where they hide? Hibernate?</td>
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<tr>
<td>25. Mr. Davis: So, the niche is like what the animals do in the <strong>habitat</strong>, so like its job. I put job.</td>
<td>Isabella – SI to PSQ</td>
<td></td>
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<tr>
<td>That’s easy, you know what a job is. So, like its role in the <strong>habitat</strong>, like what does that mouse do in that area. Or the fish. What does the fish do? Your fish is still swimming over there.</td>
<td>Mr. Davis – TL to TI</td>
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<tr>
<td>27. Mr. Davis: I checked it this morning and was like is it dead? Nope, still going strong.</td>
<td>Sofia – FSQ</td>
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<tr>
<td>28. Isabella: So, it’s just its job.</td>
<td>Isabella – FSQ</td>
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<tr>
<td><strong>Excerpt 2</strong></td>
<td>Mr. Davis – TI</td>
<td>Time spent using known language can help students find scientific terms.</td>
</tr>
<tr>
<td>45. Mr. Davis: But it is, what is it when an organism kills and eats another one?</td>
<td>Ana – FSQ to SAL</td>
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<tr>
<td>46. Ana: Consumer? Oh no. No se.</td>
<td>Mr. Davis – TQ</td>
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<tr>
<td>47. Mr. Davis: There’s better words.</td>
<td>Sofia – FSQ to SAL</td>
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<td>48. Sofia: I don’t know. … something. I don’t remember. <strong>It started with like an H</strong>.</td>
<td>Ana – FSQ to SI</td>
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<td>49. Ana: Herbivore? Oh no.</td>
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<td>50. Mr. Davis: I put predator or prey that seemed to fit better.</td>
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<td><strong>Excerpt 3</strong></td>
<td>Mr. Davis – TAL to TI</td>
<td>Student takes up the scientific term definition and uses it.</td>
</tr>
<tr>
<td>14. Mr. Davis: Ya no? Nada?</td>
<td>Diego – PSQ</td>
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<tr>
<td>(Still noting?)</td>
<td>Diego – SI</td>
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<tr>
<td><strong>Biotic dice que esta vivo.</strong></td>
<td>Ramon – SI</td>
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<tr>
<td>(Biotic says it is alive).</td>
<td>Mr. Davis – TL to TI</td>
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<tr>
<td>Yeah? So esta vivo. <strong>Sí es biótico.</strong></td>
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<tr>
<td>(It’s alive yes it would be biotic).</td>
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<tr>
<td>Como nosotros, los plantas, los animales, esas <strong>todos son los partes que son biótico.</strong> (Like us, the plants, animals, those are the parts that are biotic.)</td>
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<tr>
<td>¿Los <strong>abótico</strong>, que son?</td>
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<tr>
<td>(The abiotic, what are those?)</td>
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<tr>
<td>15. Diego: <strong>Muerto</strong></td>
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<tr>
<td>(Dead)</td>
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<tr>
<td>16. Ramon: <strong>No estan vivo.</strong></td>
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<td>17. Mr. Davis: Yeah, Que son, no estan vivo.</td>
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<td>(Those are the ones that are not alive.)</td>
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<td>Yeah. Como los rocas, la agua, esas <strong>partes son abiótico.</strong></td>
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<td>(Like the rocks, the water these parts are</td>
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</table>
Excerpt 1
20. Isabella: An organism’s home.
21. Mr. Davis: Yeah. Does that make sense?
22. Ana: Wait what does that word mean?
23. Mr. Davis: So, habitats are where something lives. Where do you live?
24. Isabella: A niche is like where they hide? Hibernate?

Excerpt 2
31. Ana: Okay I was just making sure. Okay the next, and anything moving … such as, water.
32. Mr. Davis: Yeah, water is a good one.
33. Ana: Oh, I am smart.
34. Mr. Davis: What else would be something an animal would need?
35. Sofia: Food.

Excerpt 3
15. Diego: Muerto (Dead)
16. Ramon: No estan vivo. (Those are the ones that are not alive.)
17. Mr. Davis: Yeah. Como los rocas, la agua, esas partes son abiótic. (Like the rocks, the water these parts are abiotic.)
18. Ramon: No tiene vida el. (Doesn’t have life)
21. Mr. Davis: No tiene vida. (Yeah. It doesn’t have life.)

Excerpt 4
37. Ramon: ADN (DNA)