A CRITICAL EXAMINATION OF DUAL-LANGUAGE SCIENCE EDUCATORS: IDEOLOGY, PEDAGOGY, ACCESS, AND EQUITY

by

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Abstract

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This study explores how K-8 critically conscious dual-language science teachers (CCDLSTs) working with bilingual learners (BLs) practice their critical consciousness via the four tenets of dual-language education: ideological clarity, pedagogical perspective and clarity, access for all, and equitable spaces (IPAE). This study is informed by the main research question: How are the IPAE tenets manifested in K-8 CCDLSTs' daily classroom practice? Previous research offers limited information on how dual-language science teachers practice their critical consciousness. Given the era of Common Core State Standards and the number of BLs left with underprepared teachers, this study advances understanding of what CCDLSTs are doing in classrooms to draw on the assets of BLs. A phenomenological design was used to gather interview and observational data of how six CCDLSTs employed a critically conscious pedagogy in a dual-language setting while creating access to science content, with equity at the core. Findings include research-based examples of the instructional processes CCDLSTs used in their classrooms and how they planned and implemented science lessons inclusive of the IPAE tenets.

Keywords: dual-language, science pedagogy, critical consciousness, equity, bilingual teachers

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"Washing one's hands of the conflict between the powerful and the powerless means to side with the powerful, not to be neutral." – Paulo Freire

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Definitions of Terms

Bilingual learners (BLs) – Refers to the student population identified as "English learner" in education policy. Also referred to as "emergent bilinguals," bilingual learners is a term inspired by Dr. Cristina Alfaro (personal communication, March 2, 2018) in an attempt to use an asset-based term for students learning two languages while learning academic content. "Students" will also be used interchangeably.

Critically conscious teacher – The next generation of teachers with a "voice that courageously and intelligently stands up against injustice and does so from a culturally and community-anchored standpoint" (Valenzuela, 2016, p. 5) that cultivates a sense of "fight back."

Critically conscious dual-language science teachers (CCDLSTs) – The participants in this study—teachers of bilingual learners—who teach science in various K-8 dual-language learning environments.

Dual-language program – A program in which the language goals are bilingualism, biliteracy, and biculturalism in English and a partner language. Students acquire content in both languages over the course of the program, the partner language is used for at least 50% of instruction at all grades, and the program lasts at least 6 to 7 years.

Latinx – While various scholars have recently written about the use of the term *Latinx*, I will be using Salinas and Lozano's (2017) approach to using the term as a way to "disrupt traditional notions of inclusivity and shape institutional understandings of intersectionality" (p. 1)

Chapter 1

In the United States, in 2010, only 14.7% of science, technology, engineering, and mathematics (STEM) bachelor's degrees were awarded to Black, Latinx, and American Indian students combined compared to over 70% of STEM bachelor's degrees awarded to White students (Estrada et al., 2016). Furthermore, in 2004, the percentage of White freshmen students who completed a STEM undergraduate degree within 4 years (43%) was nearly double the percentage of Latinx (29%), Black (21.8%), and American Indian (24.9%) freshmen students who did so (Herrera, Kovats Sánchez, Navarro Martell, & Zeldón, 2018). Underrepresentation of Latinx students may be attributed in part to the fact that a significant majority of students drop out of college or change to non-STEM majors during their freshman year (Tan, 2002; Taningco, Mathew, & Pachon, 2008).

During the 2017-2018 academic year, the majority of K-12 students in California (54.3%) were Latinx students (California Department of Education [CDE], 2018). Of all Latinx students, 91.6% were socioeconomically disadvantaged (CDE, 2018), which could explain the significant college dropout rate. With the growing population of Latinx students in K-12 classrooms who are bilingual learners (BLs), the STEM field is not representative of population and demographic trends (Estrada et al., 2016). This poses an issue of equity given the lack of perspectives in the field and how it results in a narrow pipeline for Latinx students with fewer choices for their future careers in general.

Unless this trend in Latinx participation in STEM dramatically changes, Latinx students will continue to be underrepresented in STEM fields. One reason for underrepresentation has been attributed to teachers who hold deficit perspectives and fail to recognize and value students'

funds of knowledge (Moll, Amanti, Neff, & González, 2005). As a result, students are tracked into classes and lack of access to rigorous curriculum. This is particularly the case for immigrants or children of immigrants who are forced to take courses that focus on language proficiency rather than college preparatory coursework (Bunch, 2013; Callahan, 2005; Olsen, 2010; Valdés, 2001). In other words, the focus becomes language development at the cost of cognitive development and concept acquisition. When Latinx students are unable to access college preparatory classes in high school, their pipeline further narrows, resulting in inequitable outcomes.

One approach, proposed by *Excelencia* in Education, to address this inequity is for academic institutions of higher education to partner with K-12 schools in Latinx communities to inspire STEM interest at an early age (Santiago, Taylor, & Calderón Galdeano, 2015). Despite this recommendation for partnerships, BLs are often placed in classrooms with underprepared teachers, especially in teaching and learning science (Aguilar-Valdez et al., 2013; Flores, Claeys, Gist, Clark, & Villarreal, 2015; Gándara, Rumberger, Maxwell-Jolly, & Callahan, 2003; Greenfield et al., 2009; Museus, Palmer, Davis, & Maramba, 2011; Olsen, 2010; Taningco et al., 2008; Wenner, 1993; Wilson, 2013). That is, underprepared teachers may obtain emergency credentials and have less teacher preparation in general, contributing to having low expectations of BLs (Callahan, 2005; Olsen, 2010). Additionally, teachers who have completed their credential programs may still be underprepared when it comes to teaching in culturally and linguistically diverse communities (Gándara, Maxwell-Jolly, & Driscoll, 2005; Olsen, 2010; Stoddart, Bravo, Solis, Mosqueda, & Rodriguez, 2011). Furthermore, in content areas such as science, BLs' negative experiences are exacerbated given the difficulty of schools filling STEM positions (Sutcher, Darling-Hammond, & Carver-Thomas, 2016). Thus, the likelihood of BLs

being placed with an underprepared teacher is even higher in STEM content areas. This inequity makes interrogation of this area of research important with a specific focus on how teachers' ideological, asset-based stance can increase the academic chances for BLs in STEM fields.

Furthermore, recent changes in K-12 science education offer a potential solution to the problem of Latinx underrepresentation in STEM. The California adoption of the NGSS in 2013 called for a transformation in the way instruction occurs in the science learning environment (NGSS Lead States, 2013a). One proposed change for science is to provide students with opportunities to conduct multiple hands-on investigations rather than teachers assigning textbook chapters for students to read about investigations (Bybee, 2013; Quinn, Lee, & Valdés, 2012; Spiegel, Quan, & Shimojyo, 2014). Also, the CA NGSS require rigorous work for all students, where teachers may set high expectations of all, resulting in science serving as a pathway to college preparatory content.

Given the growing number of BLs, their linguistic database, and their socioeconomic status (SES), investigating the STEM education of these underserved students can address the problems of underrepresentation, students being underserved, and lack of teacher preparation. This study investigated how critically conscious dual-language science teachers (CCDLSTs) in grades K-8 built on the assets of BLs when teaching science in Spanish dual-language classroom settings.

Purpose of the Study

The purpose of this study was to explore and document how K-8 CCDLSTs working with BLs examine and put into practice their critical consciousness as grounded in the following four tenets: (a) ideological clarity, (b) pedagogical perspective and clarity, (c) access for all, and (d) equitable spaces (Alfaro & Hernández, 2016) as they deliver Spanish language instruction based

on the CA NGSS. A phenomenological design was selected given that working in depth with a small number of K-8 CCDLSTs teaching science allowed me to capture the essence of the teachers' lived experiences in teaching science in Spanish in a dual-language context (Creswell, 2013).

One way to ensure science teachers are critically conscious is by examining their agency—how they perceive and enact their role as they advocate for their students' access to rigorous curriculum and create equitable environments for all. Due to its explicit purpose of fostering bilingual, biliterate, and bicultural students, a dual-language classroom provides the ideal context—one that allows space for CCDLSTs to incorporate BLs in a learning environment that is explicitly designed for their learning and with their needs prioritized (Darder, 2012; De Jong, 2016; Howard et al., 2018). Thus, one way teacher preparation programs can increase the number of critically conscious teachers (CCTs) for our nation's classrooms is by preparing more dual-language teachers. But, before informing teacher preparation programs, we must first uncover the practices of CCTs. Specifically, for science, CCDLSTs can help BLs be more fully integrated during science instruction. However, when examining the literature, additional research is needed to learn more about how CCDLSTs enact their ideologies through their pedagogy to create access and equity for all students as they create socially just science lessons.

Significance of the Study

This study has implications for practice, curriculum, and research. At the university level, addressing the development of CCDLSTs should be embedded in teacher education methods courses (Alfaro, 2017), particularly when preparing teachers who will be working in schools with high numbers of BLs of low SES. Additionally, school districts and classroom teachers would benefit from research and evidence-based examples of what CCDLSTs are currently

doing in their classrooms to develop equitable science curriculum inclusive of the ideology, pedagogy, access, and equity (IPAE) tenets and that include the three domains in CA NGSS: (a) disciplinary core ideas, (b) scientific and engineering practices, and (c) crosscutting concepts (NGSS Lead States, 2013a).

Little research on teacher education has focused on preparing bilingual or dual-language teachers (Alfaro, Durán, Hunt, & Aragón, 2014; Darder, 2012; Gándara & Hopkins, 2010; Guerrero, 1997), preparing teachers to deliver science instruction to BLs (Aguilar-Valdez et al., 2013; Avraamidou, 2014a, 2014b; Flores et al., 2015; Kier & Lee, 2017; Naidoo, 2016; Quinn et al., 2012; Rodriguez, 1998; Wilson, 2013), or preparing CCTs in general (Alfaro et al., 2014; Alfaro & Hernández, 2016; Darder, 2012; J. Freire, 2016; P. Freire, 2000; Jimenez-Castellanos, 2010; Valenzuela, 2016). This study contributes to existing research on preparing CCDLSTs, science pedagogy, and teaching in Spanish by providing specific examples of efficacious pedagogy by CCDLSTs. Given the nuance of the CA NGSS, the growth and rapid spread of dual-language programs, and the high number of BLs of low SES, this area of study is underresearched but has recently gained momentum in the education field.

Research Questions

The overarching research question for this study explored how the IPAE tenets manifest in CCDLSTs' pedagogy. Specifically, the questions asked:

- How are the IPAE tenets manifested in K-8 CCDLSTs' daily instructional practices?
    a. How do CCDLSTs practice developing **ideological clarity** in relation to science pedagogy?
    b. How do CCDLSTs practice **pedagogical perspective and clarity** in science learning environments?

c. How do CCDLSTs create **access for all** students of various cultural and linguistic repertoires in terms of curriculum, instruction, and materials in science learning environments?

d. How do CCDLSTs create **equitable,** safe, democratic spaces that examine group membership and balance language status in the science learning environment?

Chapter 2

As part of this research study, it was essential to review the existing literature for a comprehensive understanding of the experiences of BLs in K-8 dual-language learning environments. Also considered was an understanding of how the teachers of BLs impact BLs' academic opportunities. This literature review concentrates on empirical studies published within the last 15 years that focused on how teachers can draw on the assets of BLs. These studies originate from multiple research areas, including policy and the legal context for bilingual education in California, dual-language programs, preparation of CCTs, and science education.

The initial sections of this chapter discuss the general areas of research separately and as they relate to how teachers are prepared and continue to be professionally educated to serve BLs. The concluding section introduces the conceptual framework, based on Alfaro and Hernández's (2016) IPAE framework. The framework is paired with the literature review, which serves to advance the study by situating this work within the body of existing research and utilizing a social justice lens to explore the academic possibilities of BLs whose teachers strive to practice a critical consciousness.

Policy and Legal Context for Bilingual Education in California

Since the late 1960s, California has undergone education policy changes with differing impacts on students who are simultaneously learning content knowledge and English. Given the number of new standards in education since 2009, an overview of policies is needed as it relates to preparing teachers to serve BLs.

Implications of Language Labels Imposed on Bilingual Learners

By definition, U.S. policy identifies the student population whose first language is not English as English language learners (ELLs). Over 60% of Latinx ELLs in elementary schools across the United States become long-term English learners (LTELs; Umansky & Reardon, 2014). Although most LTELs are U.S.-born and make up almost one third of the middle school and high school BL population (Olsen, 2010), approximately one fifth of younger BLs are immigrants to the United States or children of immigrants (Medvedeva, 2010). And even when BLs might retain the asset of speaking two or more languages, they have historically tested academically lower than students whose first language is English and who are monolinguals, or speak English only (EO). Because BLs may not speak fluent English, there is an emphasis on language development over content knowledge (Gándara & Hopkins, 2010). However, certain bilingual programs show different academic results for BLs where during middle school, BLs in dual-language programs begin earning higher test scores in math and English language arts than BLs in English only settings (Steele et al., 2015; Umansky & Reardon, 2014; Valentino & Reardon, 2012).

Effects of Proposition 227

In 1998, California voters approved Proposition 227, nearly eliminating bilingual programs and enforcing extreme changes in instruction for BLs. The legislation sought to close the academic achievement gap by perpetuating language hegemony and emphasizing the teaching of English (Gándara & Hopkins, 2010; Mora, 2000). Research indicates, however, that there were not sufficient empirical findings to support the notion that the proposition indeed closed the achievement gap (Lindholm-Leary, 2017; Parrish et al., 2006). One repercussion of this proposition was an exclusive focus on developing English language skills by overteaching

grammar, spelling, reading, writing, etc. at the expense of the content areas, such as science (Gándara & Hopkins, 2010; López & Santibañez, 2018; Rossell & Baker, 1996). However, in the last decade, a new set of standards has been released and adopted by California that has the potential to support BLs in learning content and English simultaneously.

New Standards

It is important to reference the various standards that have come into play for CCDLSTs in California since 2009. Bunch (2013) referenced this "new standards era" and given the central role of language, starting with the Common Core State Standards of 2009, called for a specific type of preparation for mainstream teachers working with BLs. In 2013, the state adopted the CA NGSS (NGSS Lead States, 2013b), which are intended to serve as student performance expectations (NGSS Lead States, 2013c). In December 2015, the California Commission on Teacher Credentialing (CCTC) adopted the preliminary multiple and single subject credential program standards (CCTC, 2016), followed by adoption of the teacher performance expectations (TPEs) in June 2016. Most recently, the Center for Applied Linguistics (CAL) released the *Guiding Principles for Dual-language Education* (GPDLP) to assist institutions with dual-language programs in their program planning and implementation efforts (Howard et al., 2018). Each of the prior standards has its individual focus and purpose. And although some content-specific national organizations have incorporated and called for culturally responsive teaching (e.g., Gay, 2002) such as the National Association for Research in Science Teaching in 2014, the National Council of Teachers of Mathematics in 2000, and the National Science Teachers Association in 1996 (Flores et al., 2015), more is needed to guide CCTs to better instruct BLs. How can a teacher's critical consciousness and ideological clarity be measured? What are CCTs doing in the classroom? What are CCDLSTs doing in their dual-language classrooms?

Preparing Teachers of Bilingual Learners

Various researchers have argued that teacher preparation and professional development for teachers working with BLs must be explicit and have called for more research in this area (Bunch, 2013; Gándara et al, 2005; Gay, 2002; Lucas, 2011). Given the growing Latinx and BL population in the United States and in California, more needs to be done to ensure BLs' success.

Currently in California, teachers seeking specifically to work with BLs can obtain one of three special authorizations (CCTC, 2018a). The English learner authorization/CLAD certificate authorizes teachers to instruct BLs by either preparing to instruct English language development (ELD) or specially designed academic instruction in English (SDAIE; CCTC, 2018d). The Bilingual Authorization also allows for ELD and SDAIE instruction and has two additional options related to instruction in the learners' primary language (CCTC, 2018b). The third authorization is the Certificate of Completion of Staff Development, which allows for SDAIE instruction within subject matter content (CCTC, 2018c). Multiple subject credential candidates have some preparation that addresses teaching BLs in their teacher education programs (TEPs); however, research on teachers of ELLs or BLs has demonstrated that what is addressed in TEPs is not sufficient (Bunch, 2013; Gándara et al., 2005).

Given the underpreparedness of California teachers working with BLs, research on BLs' academic underperformance, as it relates to the effects of teacher underpreparedness, has also been considered. One area of research has analyzed educators' deficit thinking. Valencia (1997a) recounted the evolution of deficit thinking through a historical account of racist legislative measures beginning in the 1600s (Menchaca, 1997) and continued with descriptions of scientific reasoning in the form of genetic pathology "which contends that inferiority is transmitted by the genetic code" (p. 41) in the late 1800s and early 1900s (Valencia, 1997b), a concept that has

favored Whites over other groups, especially Blacks and Latinx. While Valencia's work on deficit thinking is two decades old, it remains critical in current times since this type of mindset persists overtly and covertly in many educational settings. Teachers and administrators with deficit views of BLs have perpetuated systematically oppressive practices that keep vulnerable groups oppressed and favor students of privileged backgrounds.

For example, tracking and ability grouping (Darder, 2012) is a systematic practice that has attached a level of inferiority to children of lower SES. Darder (2012) reminded us that "the notion that students' achievement levels at any given time will predict their achievement in the future becomes a self-fulfilling prophecy" (p. 16) that carries over to teacher expectations. And given the number of teachers in the United States (83%) and California (72%) that are White (Bunch, 2013) in comparison to growing Latinx K-12 student population (54%), there tends to be a disconnect between teachers and BLs. This situation often leads to "cultural dissonance" between White teachers and their BLs, especially in the teaching of science as it is a field long dominated by White males (Aronson & Laughter, 2016; Sammel, 2009).

However, even with the current legal context for bilingual education, the new standards, and the ways BLs' teachers are prepared, there exist certain educational contexts, such as dual-language programs, that naturally lend themselves to BLs' success. These include contexts where students have opportunities to retain their home language and cultures and learn culturally relevant content bilingually, in their home language and in English.

Dual-Language Programs

A dual-language program is one in which the native and partner language maintain equal status in the classroom, with the ultimate goal of developing bilingual, multicultural, and biliterate students (Baker, 2011). When implemented correctly, dual-language programs are an

ideal setting for equitable classrooms that provide access to powerful learning for all students (Alfaro & Hernández, 2016). While prior research on dual-language program effectiveness has been short-term and lacked causal designs, recent research supports the idea that these programs can be effective long-term and have the potential to support BLs in surpassing the academic performance of their counterparts not in dual-language programs (Steele et al., 2015; Umansky & Reardon, 2014; Valentino & Reardon, 2014).

Models and Purpose

Dual-language programs have existed in the United States since the 19th century (Baker, 2011; De Jong, 2016). Since then, various program models have developed with different purposes and with the intent to serve different student populations. Models types include two-way immersion, one-way immersion, the 50-50 model, the 90-10 model, and others (Baker, 2011; De Jong, 2016; Lara-Alecio, Galloway, Irby, Rodriguez, & Gómez, 2004; Lindholm-Leary, 2012; Thomas & Collier, 2002). Two-way immersion program models are specifically intended to serve both EOs and BLs (J. Freire, 2016; Valdez, Freire, & Delavan, 2016) with the goal of creating biliterate students, and in many cases, bicultural students who can function in two different sociocultural environments (Darder, 2012; Valenzuela, 2016).

While these programs have the potential to serve BLs and EO students, it is imperative that certain elements be in place to implement successful dual-language programs.

Program Implementation Requirements

Since 1997, researchers have been working to identify the essential factors needed for implementation of successful dual-language programs (De Jong, 2016; Lara-Alecio et al., 2004; Lindholm-Leary, 2016; Thomas & Collier, 1997), which include:

- Participation in 6 years (minimum) of biliterate instruction

- A proportional number of speakers of each language (ideally)
- Separation of languages during instruction; lessons are not repeated and material is not translated
- Allotment of as much as 90% of instructional time on the non-English language in the early grades and up to 50% in the later grades
- Emphasis on core academics and instructional excellence, not watered down curriculum
- Positive parental relationships with the program and active parent-school partnerships
- Effective leadership and support by administrators and instructors who are proficient in the languages of instruction
- Positive school environment composed of an additive bilingual environment, including full support of administrators, teachers, and parents
- High-quality instructional personnel and staff training; instruction in both languages in the form of thematic units

De Jong (2016) highlighted the principles that cannot and should not be negotiated: "long-term commitment, separation of languages, and a minimum of 50% of instruction in the non-English language" (p. 8).

Given that teachers and administrators have the responsibility of implementing and overseeing dual-language programs, preparing educators to be critically conscious leaders in dual-language programs is another key prerequisite to ensuring the success of the program. In these asset-focused environments, teachers may better see the assets BLs bring into the classroom. When accessible, research-based dual-language programs have the potential to be the

most beneficial pathway to addressing the needs of BLs because they extend benefits to all students in the program (Hernandez, 2017).

Preparing Dual-Language Teachers

People working in bilingual teacher credentialing programs have a very challenging job. When preparing preservice teachers to work with BLs, there are different knowledge, disposition, and skill sets teachers need to develop *prior to* having their own classroom and students. For example, the Dual Language and English Learner Education Department at San Diego State University prepares dual-language teachers and states five elements its program graduates should be able to demonstrate (Alfaro et al., 2014). These include: (a) ideological and pedagogical clarity; (b) biliteracy development and success across the content areas; (c) collaboration with peers, students, parents, administrators, and community; (d) creation of inclusive learning environments; and (c) global (linguistic and cultural) competence.

Another aspect of teacher preparation involves preparing teachers to be accountable to teaching *all* students in their classroom. Regardless of the student and teacher's cultural background and teacher's skin color, bicultural BLs are better served by teachers who understand and value their diversity as an asset (Alfaro & Bartolomé, 2017; Bartolomé, 2008; Darder, Torres, & Baltodano, 2017; Gándara & Hopkins, 2010; Jimenez-Castellanos, 2010; Moll et al., 2005; Valenzuela, 2016; Yosso, 2005). Scholar Donaldo Macedo would argue that it is not about the color of the teacher's skin but the color of the teacher's ideology (C. Alfaro, personal communication, May, 1, 2015). However, before teachers can connect with students, they need to understand their own identities by analyzing and reflecting on what informs their ideologies, a topic discussed in a later section of this review (Alfaro & Bartolomé, 2017; Bartolomé, 2008; Salinas & Blevins, 2013).

Dual-language teachers must also be prepared to draw on the assets of BLs and their communities. These assets, or funds of knowledge (Moll et al., 2005), are valued and sought out in the dual-language classroom. Dual-language teachers know their BLs and their communities and see them as a collective of community cultural wealth (Yosso, 2005), which is welcomed and acknowledged in the classroom. One way to draw on the assets of BLs is by co-constructing knowledge with students where teachers and learners engage in discovery together (Darder, 2015). Furthermore, dual-language teacher candidates, as student teachers, should be placed in schools with cooperating teachers who model successful implementation of dual-language programs and who allow for BLs' home language and culture to be acknowledged, honored, and validated (Alfaro, 2017).

Language Demands of the Spanish Dual-Language Teacher

Returning to the effects of Proposition 227, many post-baccalaureate students entering bilingual teacher credential programs in California now, 20 years later, lack language fluency and literacy in Spanish, which is both directly and indirectly attributed to that law (Alfaro, 2017; Guerrero & Guerrero, 2017). Alfaro (2017) quoted a student who discussed the detrimental effects Proposition 227 had on her directly and on her students indirectly:

> I am a product of CA Prop 227, *deslenguada* (de-tongued) due to restrictive language policies. I lost my language, *pero no perdí el orgullo de mi cultura y raí*ces (but I did not lose my roots and cultural pride). As a result, I have worked hard to regain and reclaim my language (español) in an effort to develop a high level of language and cultural efficacy to better serve my bilingual students. (p. 36, italics in original)

Teachers, like the one quoted above, have goals of serving their students but must cope with how restrictive policies have become obstacles. However, since California's Proposition 58

overturned Proposition 227 in November of 2016, the new legislation has opened more opportunities for growth of dual-language programs (Hernandez, 2017) and there is a rising need for fluent bilingual and biliterate teachers in California (Santibañez & Luschei, 2018). It is essential, for the success of any school that decides to implement a dual-language program, to have prepared and confident biliterate teachers with the self-efficacy to teach bilingually. At a more critical level, teachers must learn to recognize their BLs as linguistic geniuses (Alfaro & Bartolomé, 2019). One study compared teacher preparation requirements in California, Arizona, and Texas and determined that in the case of novice teachers, "the more rigorous training potentially attenuates obstacles in meeting the needs of EBs" (López & Santibañez, 2018, p. 30) suggesting that more rigorous training created obstacles to preparing enough teachers. Another study from Texas addressed the growing demands of bilingual teachers by examining the effects of requiring passage of a test to ensure bilingual teachers were linguistically prepared (Guerrero, 1997); however, the test presented more obstacles than it provided solutions. In the United States, California is among multiple states facing a bilingual teacher shortage and a lack of teachers who are prepared to teach bilingually.

Ideally, for a successful implementation, teachers in dual-language programs must be biliterate in the two languages of instruction in addition to being able to deliver academic content in both languages. For example, when teaching science in a Spanish/English dual-language program, the teacher should be able to deliver science content in English and in Spanish. When teachers are unable to deliver content because of language limitations or lack of confidence, it affects program quality and implementation and this becomes an issue of access and equity (Alfaro, 2017; Alfaro & Hernández, 2016; Hernandez, 2017). Therefore, TEPs must prepare

dual-language teachers with the self-efficacy to deliver instruction in all content areas in two or more languages.

Preparing Critically Conscious Teachers

Drawing from critical race theory (CRT; Solórzano, 1997; Yosso, 2005), critical pedagogy (Apple, 2017; Darder, 2015, 2017; P. Freire; 2000; Giroux, 2017; McLaren, 2017) and praxis (Darder, 2015; P. Freire, 2000; Solórzano, 1997), Valenzuela (2016) approaches her work of examining and defining CCTs by defining those in the new generation of teachers with the courage and intelligence to stand up against injustices from a cultural and community oriented standpoint.

As previously mentioned, dual-language programs have the potential to improve the experiences of BLs. None of the components of teacher preparation would be as impactful to BLs if teachers do not see themselves as critical educators ready to challenge and transform traditional American pedagogy and educational practices into equitable and just learning environments (Alfaro & Hernández, 2016; Cadiero-Kaplan, 2008; Darder, 2012, 2015; Ochoa, 1979; Valenzuela, 2016). Because CCTs know their students and the local communities, they are aware of the needs of BLs and are able to address them in their learning environments.

Critical Race Theory and Critical Pedagogy: Praxis

Adapted from critical theory, CRT is a framework used to challenge and transform oppressive systems in education that perpetuate inequities (Solórzano, 1997). However defining the theoretical lens of CRT and critical pedagogy is almost impossible because constraining them to one definition would work against their purpose (Darder, 2012; Kincheloe & McLaren, 2002). Although often misunderstood, critical theories are used to challenge and disrupt the status quo

(Kincheloe & McLaren, 2002). Darder (2012) would argue that there is no "recipe" for implementing and applying critical theory and would add to critical pedagogy that

> the theoretical foundation of any educational practice must be understood by educators in order to develop fully the ability to evaluate their practice, confront the contradictions, and transform their classrooms into democratic environments where they can genuinely address the actual needs of the students, anchored in the conditions of their everyday life. (p. 81)

Teachers need to be able to examine their practices and be aware of the power they hold in classrooms (Palmer, 2009) to use this power in a transformative manner.

Critically Conscious Teachers

As practitioners and implementers of CRT and critical pedagogy, CCTs have a difficult task because self-examination requires multiple steps toward achieving the goal of standing up against injustice and creating equity in schools and classrooms (Alfaro & Hernández, 2016; Darder, 2012; Salinas & Blevins, 2013; Valenzuela, 2016). Critically conscious teachers must recognize the difference in power relations in the classroom between the students and the teacher. Along the same lines, teachers need to interrogate their beliefs about education and what informs these beliefs and ideologies to determine if it will be necessary to "announce or denounce" (Alfaro & Hernández, 2016) them to create an environment that allows for co-construction of knowledge alongside students (Darder, 2012, 2018; P. Freire, 2000). As such, teachers and students interact and engage in dialogue as a process to empower BLs as CCTs create equitable spaces for their learners (Darder, 2012, 2018; P. Freire, 2000) spaces where "dialogical praxis is collective human action grounded in reflection and the naming of the world" (Darder, 2018, p. 125).

Not only is the CCT an agent of social change (Biesta, Priestley, & Robinson, 2015), but the CCT also prepares students to be agents of social change and engage in the transformation of education (Pantić, 2015). Critically conscious teachers serve as advocates for BLs, their families, and communities, especially when their students and families are members of vulnerable populations (Alfaro & Bartolomé, 2017; Arellano, Cintrón, Flores, & Berta-Ávila, 2016; De Lissovoy, Means, & Saltman, 2017; Gonsalves, 2008) related to their language, sexual orientation, SES, immigration status, and other social justice considerations that are present and in effect in schools (Page, 2017; Pérez, 2011). The CCTs must be strategic in addressing inequities to be able to transform the school setting to serve diverse learners, families, and their communities (Douglas & Nganga, 2017).

Arellano et al. (2016) discuss critical areas TEPs lack in preparing teachers to teach for social justice. The scholars identified various themes that apply to preparing teachers to teach for social justice, which includes preparing credential candidates to:

- Advocate for social justice perspective across school, community, and political contexts.
- Use and further develop students' cultural funds of knowledge, bilingualism, and biliteracy.
- Lead students to achieve at academically high standards across the core curriculum.
- Guide students to explore issues of prejudice, discrimination, and multiple forms of oppression involving people of different races, socioeconomic classes, language varieties, abilities and disabilities, and sexual orientation.
- Engage students in naming, interrogating, and transforming deficit ideology related to culture, language, class, gender, race, and sexual orientation.

- Promote school transformation toward equity and social justice on multiple levels (Arellano et al., 2016, p. 41).

Preparing Ideologically Clear Teachers

Bartolomé (2008) defined ideological clarity as "the framework of thought constructed and held by members of a society to justify or rationalize an existing social order" where "dominant ideologies are typically reflected in both the symbols and cultural practices of the dominant culture that shape people's thinking such that they unconsciously accept the current way of doing things as 'natural' and 'normal'" (p. xiii).

The challenge and richness teachers face in developing their ideological clarity is that of identifying, naming, and giving voice to knowledge that is not yet codified and legitimated by the dominant society (C. Alfaro, personal communication, April 5, 2018). Critically conscious teachers must engage in the practice of reflection and ideological clarity to be able to confront institutional practices and to best serve culturally, economically, and linguistically diverse learners (Jimenez-Castellanos, 2010; Salinas & Blevins, 2013).

Alfaro and Bartolomé (2017) discussed the importance of dual-language teachers honoring the various types of languages that may be spoken in the dual-language classroom. Specifically, BLs from working-class families enter the classroom with a linguistic database that, for the most part, is not valued by the educational system. In their study, the example of Mrs. Franco addressing a BL demonstrates how the teacher clearly values standard Spanish in her classroom to the point that she ridicules and insults a BL in her class by calling out his "wrong" word usage in front of his peers (Alfaro & Barolomé, 2017). This ideology is deficit-based and can interfere with BLs understanding concepts. While dual-language teachers teach in a context with the potential to better serve BLs, if a teacher is not striving for ideological clarity, BLs will

be oppressed. In sum, ideologically clear dual-language teachers honor working-class nonstandard language use because this takes the student into account in a holistic way.

Teachers need opportunities to examine their critical consciousness while in their teacher preparation programs and soon after in their in-service professional development. Because standards change over time and what we know about learning and teaching changes, it is important for teachers to stay current in their practice. One content area that has undergone a paradigm shift, given the expectations of the new standards, is science. Introduction of the NGSS, along with the other previously mentioned new standards, makes this a crucial time to start implementing and introducing new ways of teaching in the sciences with a critical consciousness.

Science Education

Scholars have geared their efforts toward analyzing and improving the educational experiences of students of low SES in the STEM fields in higher education (Carlone & Johnson, 2007; Crisp, Nora, & Taggart, 2009; Herrera et al., 2018; Richardson Bruna & Vann, 2007). However, while this focus addresses a major challenge for students of low SES who have navigated into college, the urgency of improving STEM representation needs to be considered with students in earlier grades as a preventative measure (Akerson, Buck, Donnelly, Nargund-Joshi, & Weiland, 2011; Archer et al., 2013; Basu, 2008; Brickhouse, Lowery, & Schultz, 2000; Brotman & Moore, 2008; DeWitt et al., 2013; Greenfield et al., 2009; Hughes, Nzekwe, & Molyneaux, 2013; Museus et al., 2011; Saçkes, Trundle, Bell, & O'Connell, 2011; Varelas, Martin, & Kane, 2012; Wade-Lyles, 2016).

For students to be prepared to pursue majors in science in college, teachers need to relinquish the former science standards and be prepared to deliver CA NGSS-aligned content to

all students using effective pedagogical approaches such as the biological sciences curriculum study's (BSCS) 5E instructional model (Bybee, 2013). Because high school teachers with single subject credentials hold subject area-specific degrees, this section of the literature review, as well as this study, will focus on science education as it relates teaching and learning in grades K-8.

Former Science Standards

In the same year Proposition 227 passed, California adopted the "Science Content Standards for California Public Schools" with the goal of providing "world-class science education for all California students" (CDE, 2003, p. vii), making the claim that the content was "attainable by all students, given sufficient time, except for those few who have severe disabilities" (pp. vi). Considering California's science test scores over the last two decades, the 1998 science standards failed at accomplishing this goal while neglecting the needs of a diverse student population, and not just "those few who have severe disabilities." Overall, scholars have criticized the failure of various political administrations' attempts to improve public education through mandated curriculum (Bartolomé, 2008; Elliott, 2008; Kincheloe, 2008). Moreover, since the late 1990s, new discoveries about how people learn science have resulted in a movement toward creation of the NGSS (NGSS Lead States, 2013c). Thus, inservice and preservice teachers need to be prepared to teach to the new standards.

Demands of the NGSS

With the release of the NGSS in 2013, this new research about how people learn science has been addressed and incorporated into state standards (NGSS Lead States, 2013b). According to the NGSS, elementary school teachers must teach science with an inquiry approach that allows students to conduct purposeful investigations (Aguilar-Valdez et al., 2013; Bybee, 2013; Quinn et al., 2012; Spiegel et al., 2014). This means all K-8 teachers must have the ability to

read, understand, and implement the standards; however, they also need the support of district personnel and administrators in obtaining resources and materials to provide access to science content, especially if this content is to be delivered in a language other than English. With regard to BLs, the NGSS have specific features that allow for rigor in the classroom, but the level of rigor is contingent upon teachers' comfort with teaching science. Yet another level added to teaching to the NGSS entails teaching science for social justice.

Elementary Science Teacher Identity

In addition to understanding how to read and implement the NGSS, elementary school teachers must also be confident in teaching science content, especially if the content is taught in a language other than English. Given this need, it is important to discuss and discover teachers' science identity as soon as possible, such as in teacher preparation programs (Avraamidou, 2014a, 2014b; Kier & Lee, 2017; Naidoo, 2016).

Various scholars agree about the relevance of teachers exploring their prior relationships with science (Avraamidou, 2014a, 2014b; Kier & Lee, 2017; Naidoo, 2016); in other words, prior to teaching science, how do teachers feel about science? Avraamidou (2014b) reviewed 29 empirical studies on science teacher identity. The majority of her work addressed the framing of science teaching identity and supported the need for teacher identity development in science. Furthermore, Kier and Lee (2017) emphasized the importance of teachers reflecting on their prior experiences with science. Altogether, these studies have implications for TEPs incorporating science teacher identity development along with candidates learning how to plan for and teach science lessons aligned to the NGSS (Avraamidou, 2014a, 2014b; Kier & Lee, 2017; Naidoo, 2016).

Linguistic Databases During Science

Some scholars have addressed the intersection of science instruction and language usage in the form of translanguaging in the bilingual science classroom (Mazak & Herbas-Donoso, 2014; Poza, 2018; Stevenson, 2013). If the goal of a science lesson is to comprehend and apply science content, language can be used as a vehicle to accomplish this goal. Poza (2018) claimed that providing BLs with spaces to use their full bilingualism assists in the meaning-making process. Stevenson (2013), however, warned that teachers must be purposeful in creating the spaces, scaffolds, and opportunities for BLs to develop and advance a rich vocabulary in creative ways. Moreover, others have invited us to question what is considered "science" and the role that language, English specifically, plays in defining science as a content area for the privileged (Mazak & Herbas-Donoso, 2014; Sammel, 2009).

Conceptual Framework

I use Alfaro and Hernández's (2016) IPAE framework to ground this study conceptually. Alfaro and Hernandez proposed four tenets through which dual-language teachers can engage in the process of examining their critical consciousness through the act of problem-posing (Darder, 2012, 2018; P. Freire, 2000), with the ultimate goal of analyzing their pedagogy in the dual-language classroom (Alfaro & Hernández, 2016). For each tenet, the researchers problem posed as teachers, schools, and districts engaged in the process of questioning and reflecting on their pedagogy. Given the student populations with which teachers often work in dual-language programs—high numbers of BLs of low SES—the researchers emphasized, "it is imperative that the initial preparation and continued professional development of DLE [dual-language education] teachers include an understanding of the IPAE dimensions, particularly for 'vulnerable student populations'" (Alfaro & Hernández, 2016, p. 8) where the first step in

analyzing critical consciousness lies educators in identifying the four tenets and asking themselves the "tough questions" (see Appendix A).

Ideological Clarity

First, critical dual-language teachers must be able to identify the dominant ideology. Then, teachers must be able to compare and contrast the dominant ideology to their own. At this point, they have a choice to "announce or denounce" the dominant ideology and determine how they are going to move forward in preventing and/or interrupting the perpetuation of hegemonic practices.

Hegemonic practices are covert practices that institutions naturally and unquestionably favor. One example mentioned by Darder (2012) was identifying, or announcing the presence of the "hidden curriculum," which is how curriculum used by schools and districts favors a cultural group as dominant and imposes subordinate roles on another. A common example of the hidden curriculum in U.S. history is the "discovery" of the American continent, which presents the appearance, intelligence, and culture of the indigenous people as worthless through the eyes of the European colonizers. Announcing this ideology would involve identifying the existence of the oppressive system and point of view and calling it out either to oneself or with others. Denouncing it would involve providing the opposing point of view and engaging in dialogue about the problem within how this "history" is presented, taking this issue one step forward from teachers who acknowledge oppression but do not act on it (Darder, 2012).

To prevent the perpetuation of hegemonic practices, teachers can assess where they are in their development toward ideological clarity. For example, they need to determine if changes they make to their teaching will enhance their BLs' bicultural identity and biliteracy development (Alfaro & Hernández, 2016). Another example would be how teachers who are

ideologically clear constantly self-reflect. In going through this process, six critical questions are offered for dual-language teachers to ask themselves while engaging in the process of developing ideological clarity (see Appendix A).

Pedagogical Perspective and Clarity

In terms of how ideological clarity informs classroom practice, critical dual-language teachers create democratic learning environments where teachers and students co-construct knowledge. For instance, in a democratic learning environment, students have a say in curriculum and may contribute topics of interest to be addressed in class. Rather than the teacher "banking," what Paulo Freire (2000) referred to as depositing knowledge into the student brain by simply lecturing, the teacher and students interchange roles in the learning environment where the teacher is a learner and the learner is a teacher; in other words, they learn together. Students and teachers co-construct and approach learning and discovery together.

However, for CCTs to create this democratic learning environment, they need to view students holistically. Teachers should recognize the assets, or funds of knowledge students bring into the classroom (Moll et al., 2005). Whereas most teachers will express their belief in appreciating their students' funds of knowledge, CCTs will take additional steps to get to know the students, their families, and their communities. In practice, these teachers conduct home visits and community scans. As Ochoa (1979) described, these activities maximize the learning of culturally and linguistically diverse student because they enable teachers to integrate students' home and community into the curriculum. Critically conscious teachers are also aware of, and demonstrate respect for, students' cultural and linguistic wealth and honor their nonstandard language use while also teaching standard language. Seven critical questions are offered for CCTs to examine their pedagogical and perspective clarity (see Appendix A).

Access for All

Another essential action for critically conscious dual-language teachers is providing "access for all" by supplementing curriculum and materials to improve instruction (e.g., culturally relevant examples). In other words, CCTs are purposeful in how they create access for BLs through bilingual and critical curriculum and through bilingual, bicognitive, and biliterate instruction and materials. After teachers identify and announce what is missing in the existing curriculum, they reflect on ways to supplement it. For example, cultural representation in science is an area that must be supplemented. Sammel (2009) discussed how science has been socially constructed, is far from being neutral, and has been colonialized to serve particular groups of people and exclude others. Specifically, Sammel (2009) mentioned the power and normalization of Whiteness in science where "science and Whiteness [have been] historically friends" (p. 651), affirming the existence of inequities in science since the arrival of European colonizers. Teachers must be aware of the biases in science, mindful of diverse learners and how these diverse learners are incorporated in the science learning environments. Whereas good teachers, in general, might be aware of who needs additional support in the classroom and who they call on to answer questions, CCTs explicitly consider the needs of all students, plan for each student's access, and apply rigor and high expectations for all learners. Seven questions are offered for critically conscious dual-language teachers to ask themselves as they examine whether they are providing access for all students by enhancing curriculum, creating materials, and changing their approach to instruction (see Appendix A).

Equitable Spaces

At the core of the IPAE tenets is the notion of equitable, safe, and democratic spaces. This tenet challenges critically conscious dual-language teachers to maintain a balance of

language and cultural power in dual-language classrooms, especially given the power and status of English in the United States. And in the case of trilingual learners who speak an indigenous language and use Spanish to communicate, critically conscious dual-language teachers must balance the power and status of all languages.

Alfaro and Hernández (2016) provided two examples that describe how the following dynamic takes place. First, they noted that "dominant speakers disrespect the academic spaces of heritage language speakers by cutting off classmates and taking over oral contributions" (p. 10). In this situation, the critically conscious teacher needs to be aware that this dynamic is occurring, and then must address it to maintain a balance in class discussions. Whereas good teachers might be aware of the presence of various forms of inequities, CCTs are purposeful in how they navigate the status of languages and cultures in the classroom and act when students conform to subordinate roles. Second, critically conscious dual-language teachers act when they notice school and classroom activities contributing to inequitable spaces as they influence the power of the dominant language or group. Eight critical questions are offered for teachers to ask themselves as they create equitable spaces (see Appendix A).

Figure 1 depicts the four IPAE tenets in diagram form. At the center is the CCDLST surrounded by the tenets. The IPAE tenets link to each other in a circular motion because they are fluid and interconnected. In summary, the goal is for CCDLSTs to engage in the process of examining their critical consciousness via the IPAE framework while teaching science in a dual-language setting.

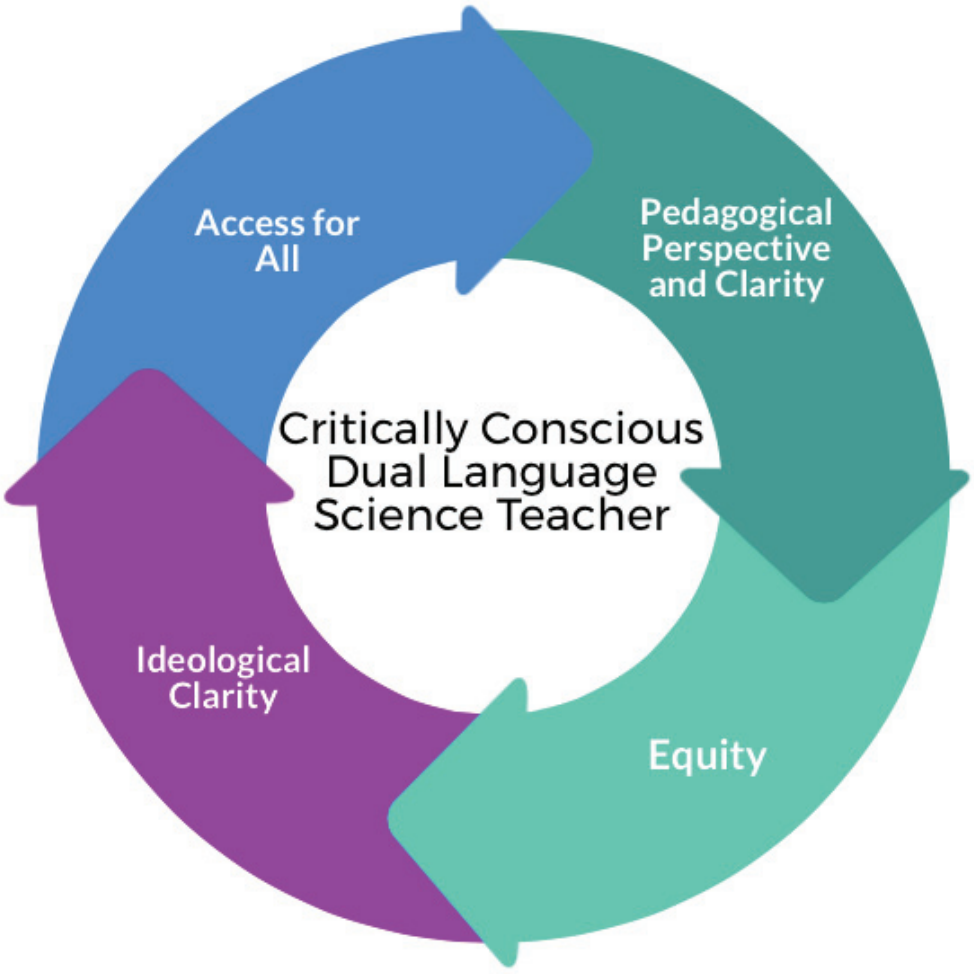

Figure 1. Four tenets of a dual-language science teacher's examination of critical consciousness.

Summary

The most notable gap in dual-language literature is the dearth of studies examining the intersection of how critically conscious dual-language teachers teach science for social justice and equity, which provokes key questions. How are these teachers prepared in TEPs? How do they continue to develop once in the classroom? Are they truly critically conscious educators? Are they able to implement their critical pedagogy in the classroom? How so? More specifically, research is needed that applies the critical model of examining how ideology informs a teacher's pedagogy to create access and equity in the dual-language science classroom as has been

proposed by Alfaro and Hernández (2016). Given that this study will focus on the experiences of CCDLSTs, this framework is especially fitting. Chapter 3 will provide a description of this study's methodology in responding to these questions.

Chapter 3

This chapter describes the phenomenological qualitative approach used to explore the experiences of K-8 CCDLSTs in science learning environments. The purpose of the study was to gain an in-depth understanding of how K-8 dual-language teachers teaching science put into practice their critical consciousness via Alfaro and Hernández's (2016) four tenets of dual-language education (IPAE). This chapter highlights the research design of the phenomenological study, describes its participants, and details the methods employed to examine the overarching question and sub questions which explore how the IPAE tenets manifest in critically conscious K-8 dual-language science teachers' pedagogy:

- How are the IPAE tenets manifested in K-8 CCDLSTs' daily classroom practices?
    a. How do CCDLSTs practice developing **ideological clarity** in relation to science pedagogy?
    b. How do CCDLSTs practice **pedagogical perspective and clarity** in the science learning environment?
    c. How do CCDLSTs create **access for all** students of various cultural and linguistic repertoires in terms of curriculum, instruction, and materials in a science learning environment?
    d. How do CCDLSTs create **equitable,** safe, democratic spaces that examine group membership and balance language status in the science learning environment?

This chapter provides a detailed overview of the research design and methodology for understanding the pedagogical and reflective practice of critically conscious K-8 dual-language science teachers in dual-language classroom settings. First, the chapter examines the research

design that framed the study and provides information related to the phenomenological approach and research questions. Second, the chapter examines data collection and analysis methods. Third, the chapter presents information related to researcher positionality and researcher bias.

Research Design

Creswell (2013) identified a phenomenological study as one that "describes the common meaning of several individuals of their lived experiences of a concept or a phenomenon" (p. 76). Whereas other qualitative approaches focus on the lives of the individual participants (Creswell, 2013), the focus of this phenomenological study was on understanding the phenomenon of teaching kindergarten through eighth-grade science, through a critical lens, in a Spanish/English dual-language learning setting. As such, this research study examined and documented how CCDLSTs manifest the IPAE tenets in their classrooms as they improve the experiences and future opportunities of BLs. Due to the fact that research highlighting the voices of this particular participant population and phenomenon is nonexistent, a qualitative research study with semi-structured interviews, classroom observations, field notes, and analytical memos was conducted with CCDLSTs. Other qualitative approaches were not considered given their distinct purpose and foci outside the scope of this study.

Participant Selection

Institutional Review Board approval was obtained prior to commencing the study and establishing contact with potential participants (see Appendices B and C for approved consent form and recruitment letter). This study focused on describing and documenting the essence of the experience of six K-8 CCDLSTs teaching science in a dual-language context. Sampling was done from information-rich cases. Patton (2002) described information-rich cases as those in which participants who have experienced a phenomenon can speak to it. In this study,

participants who have experienced the phenomenon of teaching science in a K-8 dual-language learning environment were considered. Two purposeful sampling techniques were employed to identify participants. A combination of criterion and snowball sampling procedures were employed. Criterion sampling involves "selecting cases that meet some predetermined criterion of importance" (Patton, 2002, p. 238), and snowball sampling consists of asking people in the field of study to recommend participants who are then selected based on established criteria (Patton, 2002). As seen in Table 1, participants for this study met the following criteria: (a) teaching in grade level K-8, (b) holding a bilingual multiple subject or single subject credential, (c) teaching CA NGSS aligned science in the 2017-2018 academic year, (d) teaching in a Spanish/English dual-language program, and (e) currently teaching science in Spanish. These selection criteria helped ensure identification of information-rich cases of teachers who have experienced the phenomenon of teaching science in a Spanish/English dual-language learning environment and who could provide insights to better understand this phenomenon.

Table 1

Criteria for Selection

Participant Characteristics
• Dual-language teaching experience in Spanish • Multiple or single subject credential • Bilingual authorization • Has taught science in Spanish • Currently teaching in a K-8 grade level • Teaching science in the 2017-2018 academic year

An expert in the field of dual-language education and critical pedagogy in the southern California border region initially recognized teachers and identified other experts who then recognized more teachers. Identified teachers and experts also had an opportunity to recommend

additional potential participants who met the selection criteria. Both experts and CCTs recommended teachers based on their understanding of a teacher encompassing the elements in the tool "Critical Transitive Consciousness in Science Pedagogy" (see Appendix D). All identified teachers were given researcher contact information and a participation flyer to initiate interest in participating in the study. Single subject high school science teachers, teachers teaching outside the region in which the study was conducted, and teachers in monolingual or transitional bilingual settings did not meet the criteria for this study.

An overview of Table 2 demonstrates that the majority of the teacher participants were in the age range of 30-39, identified as female, had earned a master's degree, held a multiple subject credential to teach K-6 grade levels, and had been teaching between 3 and 10 years. All participants had learned Spanish as their first language and English as their second. Also, all CCDLSTs taught in the southern California border region in a school with a Spanish/English dual-language program. Four participants taught at the elementary school level and two at the middle school level. When asked to self-report their proficiency in Spanish literacy modalities, for the most part, teacher responses were very high. As seen in Table 3, the area with the lowest scores out of a possible 100 points, was writing. A score of 90-100 indicated native-like ability, a score of 80-90 indicated advanced, 70-80 indicated intermediate, and any score below 50 indicated novice stages.

Data Collection

Per Creswell's (2013) suggestion for phenomenological data collection methods, data collection in this study included classroom observation field notes, analytical memos, and multiple semi-structured interviews with the CCDLSTs. Data collection began with the initial interview tool (see Appendix E), which was based on the work of Darder (2015), Spiegel (2013),

Table 2

Participant Demographics

Participant	Grade level taught	Age	Gender	Education Level	Credential Type	Years of Teaching Experience
Antonia	8	30-39	F	MA	SS	6 to 10
Carmen	1	30-39	F	MA	MS	6 to 10
Itzpapalotl	7	25-29	F	MA	MS	3 to 5
Ana	2	25-29	F	MA	MS	3 to 5
María	4	30-39	F	MA	MS	6 to 10
Juan	5	30-39	M	BA	MS	3 to 5

Note. Credential type MS indicates multiple subject and SS single subject.

Table 3

Participants' Self-Reported Spanish Proficiency

Participant	Listening	Reading	Speaking	Writing
Antonia	95	95	85	85
Carmen	92	92	80	78
Itzpapalotl	100	99	90	91
Ana	100	100	100	90
María	100	100	100	100
Juan	99	100	100	100

and the National Research Council (2015). This interview tool had been shared with previously identified experts and teachers to assist in recommendation of CCTs. After the nomination process, the teachers who reached out to the researcher were contacted via phone or email with general information about the study. Once the CCDLST agreed to participate in the study, a second email or phone call was followed by the consent information and details about setting up the initial interview. The process is illustrated in Figure 2.

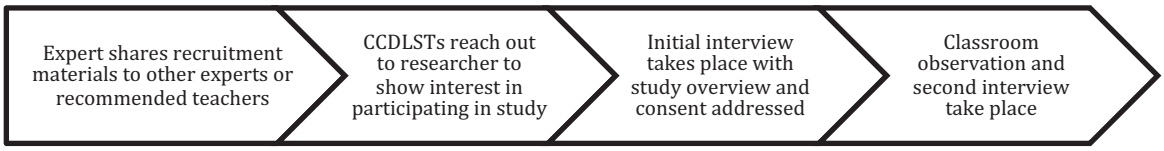

Figure 2. Recruitment process.

Again, purposeful sampling was applied (Mertens, 2015) given the difficulty in accessing the desired population. Patton (2002) wrote about there being no rule for sample size in qualitative research since it depends on the methodology and purpose of the study. Polkinghorne (1989) suggested five to 25 individuals as an ideal sample size while Creswell (2013) suggested up to 10. The aim for this study was to retain five to 10 of the CCTs who met the qualifying criteria for further interviews and observations of a science lesson. Teachers were selected to represent various schools and districts in the southern California border region to provide diversity of school programs. Once teachers provided initial verbal consent to participate, a date was selected for the first interview. At this first interview, questions were asked related to teacher and teaching background (see Appendix E). Then, the CCDLST selected the date for the science lesson observation and second interview, both of which took place on the same day. The CCDLSTs selected their classrooms as the location for the interviews and observations.

Data Sources

Table 4 presents how evidence was gathered in response to each research question.

Interview. The interview was an important tool for this phenomenological research study because it provided teachers a voice in the data. In her interview section on transformative perspectives, Mertens (2015) highlighted the work of feminists who express the desirability of conducting more than one interview with the same participant with multiple interviews serving the goal of increasing accuracy. Given the importance of providing participants with multiple

opportunities for reflection, the main instruments in this study were the researcher's use of two semi-structured interviews and field notes.

Table 4

Research Questions and Data Sources

Research Question	Data Source
a. How do CCDLSTs practice reaching **ideological clarity** in relation to science pedagogy?	• Interview
b. How do CCDLSTs practice **pedagogical perspective and clarity** in science learning environments?	• Interview • Observation
c. How do CCDLSTs create **access for all** students of various cultural and linguistic repertoires in terms of curriculum, instruction and materials in science class?	• Interview • Observation
d. How do CCDLSTs create **equitable,** safe, democratic spaces that examine group membership and balance language status in the science learning environments?	• Interview • Observation

There were two semi-structured interviews per participant. Interview questions were piloted with a teacher who met the research criteria but was not a study participant to reword questions as needed. The interviews were conducted in the location and language the participants preferred. There was a one to two week gap between the first and second interviews to ensure the science lesson observation occurred the same day as the second interview. The first interview (see Appendix E for protocol) took up to an hour and consisted mainly of obtaining background information and establishing rapport with the participant prior to the classroom observation. Questions related to motives behind becoming a teacher and specializing in bilingual education, as well as questions about materials needed to teach science in a Spanish dual-language setting were employed. The second interview (see Appendix F for protocol) lasted up to two hours and took place on the same day as the science lesson observation, after the lesson. The main purpose

of the second interview was for the teacher to reflect on the lesson through the modified "tough questions" in Alfaro and Hernández's (2016) dual-language teacher's examination of critical consciousness as they apply to the teaching of science in a dual-language setting. Additionally, the second interview served as a reflection piece to the CCDLST after the observation.

Observation. For the science lesson observation, field notes were recorded in a notebook and typed into a Word document afterward. From the moment students walked into the learning environment to the moment they left, minute-by-minute accounts were annotated, including the dialogue and actions of BLs and the CCDLST. In the case of the two middle school CCDLSTs, observations were recorded for two class periods where the same lesson was taught to a different student group. Additionally, pictures were taken of materials present in the learning environment, which were helpful with data collection and analysis. According to Mack and Woodsong (2005), field notes should include researchers' experiences and interactions during the observation; notes may be soon after expanded to add detail. Analytic memos followed the observations where details and researcher reflections were added.

Phenomenological Data Analysis

The interviews were recorded with a digital audio recorder. In addition to the audio recording, notes were taken throughout the interviews and analytic memos followed. Interview audio was submitted to a second party, Rev.com, an online transcription service, the same day the interviews were conducted. Transcriptions were received within 24 hours of submission and were reviewed by the researcher for accuracy. Although a transcription service was used, only English recordings qualified for transcription. The researcher transcribed interviews that were in Spanish. Given the nature of bilingual teachers' speech, all transcripts had to be revised for language switching.

Data analysis consisted of the researcher identifying consistent themes using initial coding, focus coding, and the constant comparative method to categorize codes into themes. Charmaz's (2014) "initial coding" method was employed on printed transcripts for both the first and second interview to begin engaging with and defining data. Subsequent, "focused coding" deductively grouped codes into four themes after the structure of the IPAE framework (Charmaz, 2014). Transcriptions of the second interviews were also entered into Dedoose, a computer software program for qualitative data analysis, to assist in analysis of interview data.

As there were codes that did not fit into the four themes as defined by the framework and research questions, separate codes were categorized into different themes that were not reported because they did not respond to the research question(s). Next, Dedoose software was used to facilitate identification of subthemes and assist with data analysis and reporting via classification, sorting, and information management. The constant comparative method was used throughout the entire analysis to compare each incident to other incidents and to find similarities and group together codes, which were then reported into themes.

Finally, findings were interpreted with the support of existing literature on critically conscious K-8 dual-language science teachers to describe the phenomenon and highlight new contributions to the field.

Trustworthiness

Three primary methods were employed to establish credibility and trustworthiness: triangulation, peer debriefing, and member checking.

Triangulation consists of researchers using "multiple and different sources, methods, investigators, and theories to provide corroborating evidence" (Creswell, 2013, p. 251). In this study, data were triangulated with interviews, field notes, and analytic memos. Furthermore, peer

debriefing was used to "provide an external check of the research process" (p. 251). A doctoral candidate who is a former classroom teacher and current critically conscious dual-language educator served as the peer reviewer. Lastly, member checking entails the researcher approaching the participants with data analysis, interpretations, and conclusions to solicit "participants' views of the credibility of the findings and interpretations" (Creswell, 2013, p. 252). The CCDLSTs had multiple opportunities to clarify findings and how they were reported. Since data were collected from two different points in time and from different school sites in the same county, this process allowed the researcher to provide conclusions and interpretations that are trustworthy.

Positionality

In their longitudinal study of adolescent immigrants to the United States, Suárez-Orozco, Suárez-Orozco, and Todorova (2008) quoted a teacher's view on immigrant students: "You know, the immigrants, even though they don't have much education, they have such a willingness to learn—such a strong desire to learn" (p. 135). As an immigrant to the United States at the age of 11 from Tijuana, México, being a bilingual learner in the state of California was a very challenging experience. I could not use my Spanish language to show my teachers how much content I knew; however, the limited number of hands-on activities for math and science that I participated in allowed me to communicate that I had knowledge. My experiences growing up in a country that favors monolinguism have impacted my career choices and heavily influenced my commitment to equity and social justice.

This research area is of particular interest to me as a BL and as a former dual-language teacher who taught all subjects, including science, in Spanish. The lack of materials in Spanish language doubles the work of dual-language teachers. Aside from lesson planning, dual-language

teachers have to translate and recreate materials for their students and their families.

Although my experiences at one particular institution can speak for *my experiences only*, I am interested in knowing what TEPs can provide for their bilingual preservice teachers and what professional development opportunities districts and administrators can provide inservice teachers once hired. I address this by presenting current voices in the field. Many teacher credentialing programs are approximately one academic year in length; one year is not enough for novice teachers to learn and apply theory and best teaching practices. School districts need to continue to prepare and develop CCTs, especially those teaching in dual-language learning environments while practicing social justice.

Lastly, it is important to note that my research and methods are informed by my positionality as a critically conscious researcher with a commitment to social justice and to preparing critically conscious dual-language educators to work with all students, but specifically, to serve linguistically diverse student populations who are BLs, as I was.

Chapter 4

Chapter 4 presents data so as to construct an understanding that responds to the research questions, which are guided by the study's 4-tenet framework: (a) ideological clarity; (b) pedagogical perspective and clarity; (c) access for all; and (d) equitable, safe, and democratic spaces (IPAE). The data respond to the overarching question: How are the IPAE tenets manifested in K-8 CCDLSTs' daily instructional practices?

Restatement of the Research Questions

The specific research questions that guided this study are:

- How are the IPAE tenets manifested in K-8 CCDLSTs' daily classroom practices?
    a. How do CCDLSTs practice developing **ideological clarity** in relation to science pedagogy?
    b. How do CCDLSTs practice **pedagogical perspective and clarity** in the science learning environment?
    c. How do CCDLSTs create **access for all** students of various cultural and linguistic repertoires in terms of curriculum, instruction, and materials in a science learning environment?
    d. How do CCDLSTs create **equitable,** safe, democratic spaces that examine group membership and balance language status in the science learning environment?

Based on careful bilingual transcription, extensive coding, and thorough analysis as described in Chapter 3, each section in this chapter is organized by themes as presented by each of the four tenets in the framework. Within each theme, subthemes that directly respond to the research questions are included in table format. Subthemes that were common across all

CCDLSTs are presented. Most data derived from the second interview were supported by the observations documented in the field notes and the first interview of the six CCDLSTs: Antonia, Carmen, Itzpapalotl, Ana, María, and Juan.

Summary of Results

Given that data were arranged according to the four tenets that guide the research questions, themes and subthemes were organized according to each of the four tenets: ideological clarity, pedagogy perspective and clarity, access for all, and equitable spaces. Table 5 presents a summary of the themes and subthemes that emerged from the data.

Table 5

Themes and Subthemes

Theme	Subthemes
Ideological Clarity	• Valuing BLs' backgrounds • Teaching science for transformation and liberation • Reading the scientific world before reading the word • CCDLST practice and praxis
Pedagogical Perspective and Clarity	• Teaching and learning with BLs • Planning for teaching and learning with BLs • Learning as BLs—the biliteracy process
Access for all	• Curriculum: supplementing and creating critical curriculum • Instruction: instructing BLs with rigorous curriculum • Materials: reclaiming and recreating bilingual materials
Equitable Spaces	• Equitable space • Safe space • Democratic space

The following subthemes emerged from each of the four themes. For the theme of ideological clarity, four subthemes arose, including valuing BLs' backgrounds, teaching science for transformation and liberation, reading the scientific world before reading the word, and CCDLST practice and praxis. For the theme of pedagogy, the three subthemes that emerged

included teaching BLs, planning for teaching BLs, and learning as BLs. Access, the third tenet, also consisted of three subthemes which included supplementing and creating critical curriculum, instructing BLs, and reclaiming and recreating bilingual materials. Lastly, the equity tenet had three subthemes consisting of equitable spaces, safe spaces, and democratic spaces.

Theme 1: Developing Ideological Clarity Through Science Pedagogy in Dual-Language Learning Environments

> I think also it's about stepping away from these hegemonic ideologies that are so easy to buy into when you start in education and really understanding who you're teaching and understanding how and what you choose to teach impacts who you're teaching and why. (Itzpapalotl)

In this opening quote, Itzpapalotl affirmed that when one first becomes a teacher, it is easy to subscribe to what is "easy to buy into" (the dominant ideology) as she explained the connection between how and what a teacher thinks and acts on leads to what is put into practice in the classroom. Classroom practice is impacted by a teacher's ideological clarity and serves to contrast with the dominant ideologies perpetuated in the current educational system and how she is able to contest them in her practice.

As illustrated in Figure 3, four subthemes emerged from the data that address how CCDLSTs developed their ideological clarity in relation to dual-language science pedagogy (see also Appendix G). In this section, subthemes and data are presented with illustrative quotes and images and linked to the IPAE framework.

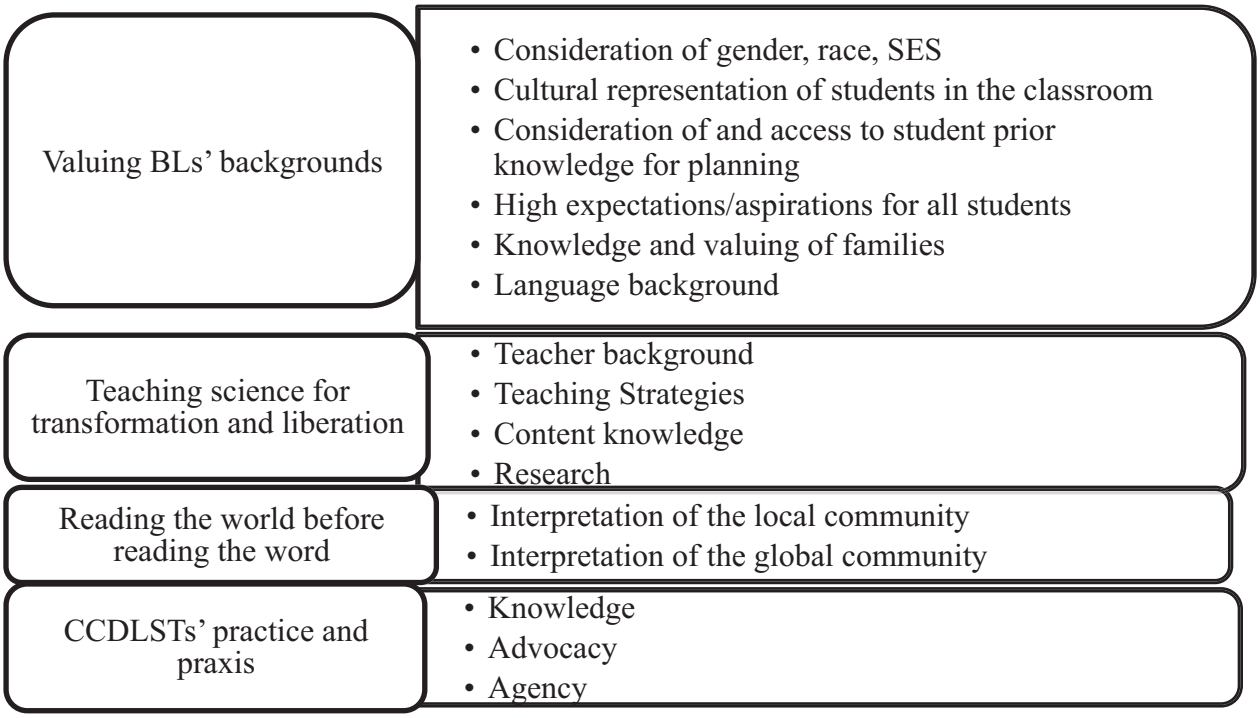

Figure 3. Subthemes for ideological clarity.

Valuing bilingual learners' backgrounds. The CCDLSTs are keenly conscious of, and have identified, different ways the education system perpetuates inequities, especially for BLs in general, and in the science classroom in particular. One way they have denounced this deficit ideology is by valuing their BLs' funds of knowledge. This subtheme consists of fully knowing and understanding BLs with regard to the children's demographics, family and cultural background, linguistic database, and the CCDLSTs' aspirations for BLs. Six subthemes emerged from the data across all CCDLSTs.

Having high expectations and aspirations for BLs was present across all CCDLSTs, even though they had unique manifestations. Carmen reflected on her planning practices, "You have to have a high standard of learning for them. So, whatever it is that I want to teach them I want to make sure that I'm taking all of those things into consideration when planning or when doing my lessons so that I can meet all of their needs." When Carmen refers to "those things" she is talking about her students' backgrounds and specific needs. This quote reflects how Carmen has high

aspirations for her students and uses her BLs' background and life trajectories as she plans and implements her lessons. In similar comments, Juan had the most to say about what high expectations look like in the science classroom.

> I think one of the ways is being able to realize that every student has potential. And then with that in mind, then you also begin to create lesson plans, where you are working the potential of our students. And then also believing in them and then working a lot on their mindset when it comes to obstacles and perseverance, especially when it comes to science.

Juan's statement incorporated conversation around the BLs' mindsets, impacted by their backgrounds, which was also supported by the observations conducted in his class and evident in the way student learning occurred outside of instructional time. He was committed to maximizing all students' potential and worked from an asset-based perspective. The following conversation with his students as they were lining up for lunch further elaborated what this looks like in the classroom. Even after they had packed up their belongings and were ready to leave the classroom to go to lunch, a group of students continued to engage in dialogue and debate about which one of the Earth's spheres was the most important and they were supporting their arguments with evidence they had gathered in prior lessons. Juan recalled that during the "side conversation [they] were having when they were lining up, they were still fighting for the best sphere. It's like bringing them back and then challenging their own thinking." It was evident by the students' continued engagement in the lesson that Juan was able to engage his students given the BLs' commitment to the lesson.

Other subthemes related to valuing BLs' background included the CCDLSTs being ideologically clear in that prioritizing all students being culturally represented in the classroom

was important in creating access to learning. After identifying the lack of cultural representation in curriculum, CCDLSTs got to know students' families and linguistic database. For example, CCDLSTs were aware of the importance and value in knowing and addressing BLs' language abilities in both English and Spanish and beyond, since some students are trilingual learners. María identified that in her school there is a large population of Filipino students who are trilingual in Tagalog, Spanish, and English. María used this knowledge of the community's cultural and linguistic wealth to build community in her classroom as she compared and contrasted the various ways holidays and language varieties are celebrated during a teachable moment that came up while teaching a science lesson. During the second interview, as debriefing of the classroom observation was taking place, María shared:

> We connected it to how they celebrate the holidays but also how it's, similar to how we celebrate here or in México. We don't just say, "Oh, this is how it is," but we compare it and see the similarities in languages.

María was flexible during the science learning time and made time to address an opportunity for her students to make a cultural connection. María's clear understanding of students' multiculturalism consists of her incorporating her students in both the general and the science learning environment. The CCDLSTs focused on getting to know their students, families, and communities to incorporate their realities into their science teaching and learning environments as one way to practice ideological clarity in an educational system where these realities typically go unrecognized and undervalued.

Teaching science for transformation and liberation. To Freirean scholars and those who have laid out the foundation of critical pedagogy (Apple, 2017; Darder, 2015, 2017; P. Freire, 2000; Giroux, 2017; McLaren, 2017), the quest towards liberation signifies having the

power to engage in reflection on one's identified oppressive realities. Likewise, liberating the self consists of freeing the mind and rejecting being a prisoner of identified oppressed realities for the purpose of transforming the world we live in (Darder, 2015; P. Freire 2000). This subtheme consisted of CCDLSTs planning well thought-out lessons that allowed for BLs to critically engage and reflect, thus being able to transform their world into a better place for them and future generations. The BLs and their CCDLSTs had opportunities in their learning environments to become agents of social justice where they took charge and advocated to improve the current world. The four subthemes that comprise this subtheme included the CCDLST's background, their knowledge of science content, repertoire of teaching strategies, and initiative and ability to conduct research. These are all connected to how they learn, plan, and teach science for transformation and liberation.

The CCDLSTs reflected on their experiences as children carrying the label of "English learners," or ELs During the first interview, Antonia, Carmen, Itzpapalotl, and Ana discussed their experiences with the EL label as a series of disappointments in K-12 education in the United States that served as strong motivators in their decision to become bilingual and dual-language teachers. Antonia shared:

> I'm bilingual, and since I'm the oldest in my family, when I went to school, I didn't know any English, so I was considered an EL I grew up in east LA, so the dominant language was Spanish. I do remember in fifth grade actually transitioning to all English classes, and that was a little bit shocking, so I remember feeling scared, and I think as the years went by, that feeling never went away, and so when I went to college and I decided, "Okay, I want to be a teacher." I thought, "Okay, I want to make sure if that happens to a student that was like me, I don't want them to feel scared. I don't want them to feel

nervous," so I wanted to be able to create an environment that's safe for everyone, and so that inspired me to go into getting my bilingual credential.

It is evident that Antonia was profoundly aware of what the EL label implied to students like her attending school in the United States while learning English. Because she did not wish to perpetuate her experiences as a K-12 EL student, as she was bureaucratically labeled, she decided to become a bilingual science teacher. Juan and María, on the other hand, were motivated to become bilingual teachers because they were aware of the shortage of bilingual teachers in California and they decided to make that commitment to the profession and their future BLs. Their early experiences and understanding for the need for ideologically clear bilingual educators contributed to their commitment to teaching science for transformation and liberation and their continued development as ideologically clear teachers in the science learning environment.

In terms of the CCDLSTs' background with science as it impacts instruction, the experiences varied. Antonia (eighth-grade teacher) was the only CCDLST that holds a single-subject credential in science teaching at the middle school level. She reported enjoying her credential program. María (fourth-grade teacher), Juan (fifth-grade teacher), and Itzpapalotl (seventh-grade teacher) hold multiple-subject credentials and shared positive experiences in the science methods courses offered in their credential programs. Itzpapalotl remembered her Spanish science methods course, saying "It's sad, but it's probably one of the only positive science experience in my own education that I've ever had." She shared that before she took her science methods course with me as her instructor, her experiences with science in K-20 were not positive and that is why she decided to teach science in a way that was authentic and meaningful for her students. Ana and Carmen, who obtained their teacher credentials from the same program

and currently teach at the same school, shared very similar experiences in their credential program. Ana expressed the following during the first interview about how prepared she felt to teach science:

> You know what, I don't think I was prepared. And part of it is because I always had this negative feeling towards science because I never understood it because growing up I never was taught it, because in school I remember just doing reading and math, and then I was an EL. So, I was in ELD. So I was never taught science [it] was always hard for me. And I feel like I never had enough science. So I remember it was just like one class I dreaded and it was so boring, and I just didn't like it. So, I don't know, maybe that was the reason why I felt that way in the credential program. I felt it was boring. I just didn't like it because I didn't like science overall.

In addition to science content not being present in her elementary level education as an EL child placed in ELD classes, Ana's experience in her science methods course offered in her teacher credential program was not one that prepared her to teach science content in general, much less in a transformative way. Through reflection, she realized she needed to further develop her knowledge of science as a content area because reading about content a few weeks before teaching was a temporary solution. Because Ana is a reflective, ideologically clear teacher, she used these experiences to reflect on what she needed to work on to teach science in general and in a transformative way because she wanted her science lessons to make an impact on the local and global communities. The most common area Ana said she needs to develop, consistent with all CCDLSTs, is requesting professional development in implementing the NGSS in a critical and impactful way, which would contribute to the subtheme of teaching science for liberation and transformation and therefore developing ideological clarity. For instance, when asked to

describe her ideal CCDLST and what steps she needed to become that teacher, Itzpapalotl stated, "In order for me to get better, I've asked to be able to go to professional development." There, she could learn to develop CA NGSS-aligned units with social justice in mind so she can provide more opportunities for her seventh-grade BLs to transform the world they live in.

In addition to their experiences as students in K-12 education in California and in their science methods courses, the CCDLSTs reported a variety of teaching strategies that have contributed to the way they teach science for transformation and liberation. The strongest evidence common across all CCDLSTs was their purposeful and flexible student grouping strategy. Bilingual learners had different partners and working-groups depending on the objective of the lesson. Ana stated:

> It depends on the lesson. In the rug, they have rug partners. So, partner A goes first, then partner B. And then I change it up, first B and then A so that way they have the same opportunity [to talk]. And then I also have "tea parties" where they have two lines. And then A and B talk to each other, and then they rotate and they switch partners. So I'll be like, "Okay, row A, you're going to move one to the right", and then they rotate and they switch partners.

Ana employed a variety of grouping strategies that allow students to discuss what they are learning with different partners for every lesson. Other CCDLSTs arranged their groups by language levels, both English and Spanish—some differentiated based on content level—and all CCDLSTs provided students with opportunities to choose with whom they wanted to work at different times.

In teaching science for transformation and liberation, all CCDLSTs mentioned how they were informed by and cited empirical research (addressed in more detail in the Chapter 5

discussion). The empirical research areas mentioned consisted of two specific frameworks on working with diverse student populations, Yosso's (2005) community cultural wealth and Moll's funds of knowledge (Moll et al., 2005). Additional research discussed was being aware of educational gaps such as the lack of people of color and women in branches of science, social language inequities, health issues encountered by communities of color, problematic and hegemonic ideologies, implications of language policies, and the effects of having a growth mindset. As a result of the CCDLSTs being informed and inspired by research, they were interested in learning more about recent critical pedagogy research and how to interrupt harmful dominant ideologies practiced in both science and bilingual learning environments as they relate to changing the world. Itzpapalotl recalled finishing her master's thesis two years ago and how the entire basis of her research was in "bringing in my students, bringing in the families, and the things that they know because this is their world" and added, "that's the research that I think I'd really like to continue learning about to further inform my practice." This was evident through all six CCDLSTs discussing interest in attending, and requesting, professional development opportunities. This includes Itzpapalotl's mentioned interest in returning to school to obtain a science single subject credential because she recognized a lack of content knowledge. Also, all CCDLSTs reported learning from others as they attended conferences, observed colleagues, and had colleagues and administrators observe and provide them with feedback.

Reading the world before reading the word. Before learning science content from a textbook, BLs must learn about the world they live in by reading into their communities. The CCDLSTs recognized the pressing issues in the world and the local communities and used this information to plan meaningful lessons to which their BLs could connect. In other words, BLs learned science content through the experiences in their local and global communities. The two

subthemes that emerged from this section included how CCDLSTs privileged teaching science to have an impact on the local and global communities.

All teachers prioritized how BLs can impact their local communities in their interview transcriptions and ample evidence was collected through field notes during observations. For BLs in María, Ana, Itzpapalotl, and Antonia's classes, students engaged in drafting petitions and making signs and posters to share with, and educate, the community to make a change.

CCDLSTs regarded their BLs as current and future problem solvers. Figure 4 is an example of a fourth-grade BL's poster from María's class that was shared with the local community and was posted on school grounds to encourage families to use bicycles to go to school to help the environment. The first box with blue text on the top left is a call for people to stop burning fossil fuels; the box below on the left side makes a statement about how it is best to ride a bike to school because it is better for the environment. The third box, in orange, explains how using renewable energy is an optimal choice because that way we do not run out of energy. The box in green at the lower right side explains how burning fossil fuels affects climate change, and the box on the top right encourages people to bike to school because it helps with health and exercise. This is just one example from María's fourth-grade class on how CCDLSTs can create opportunities for BLs to understand, or read, their world and impact their local communities.

Another example of how CCDLSTs created spaces for BLs to address and impact their global and local community was by the seventh-grade students in Itzpapalotl's class studying the effects of burning fossil fuels. Itzpapalotl mentioned:

> By just providing them examples of the way that we are impacting the world, or fossil fuel usage is impacting the world, I think that's another way for them to start thinking

about it. Not just in the sense of the chemical composition and the way that it's formed, but in understanding what are the impacts.

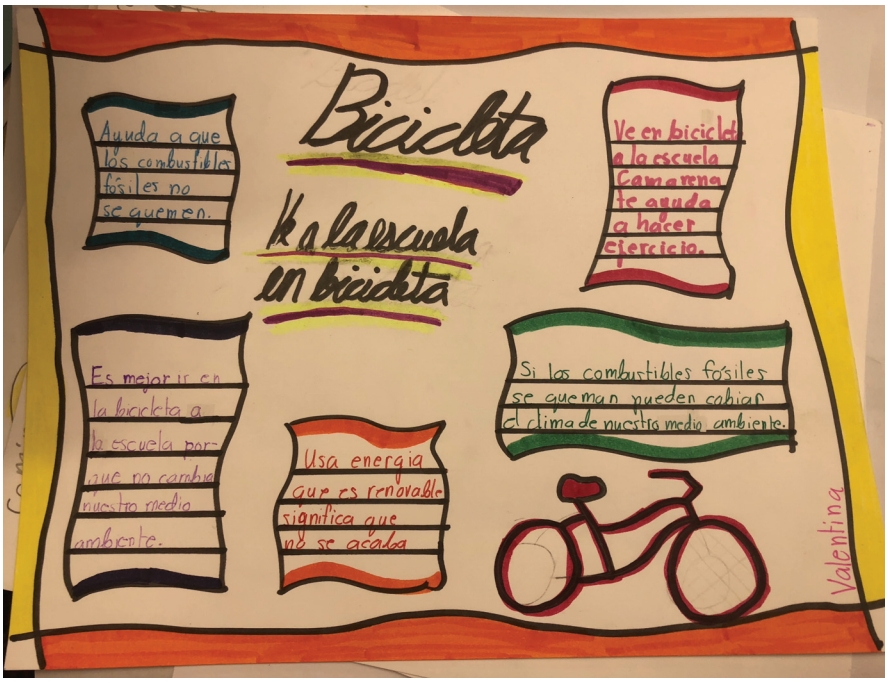

Figure 4. Fourth-grade poster on helping the environment by biking.

After first exposing students to images of different parts of the world dealing with the effects of burning fossil fuel, Itzpapalotl encouraged her seventh-graders to read more about their world by doing research. Then, Itzpapalotl taught a chemistry lesson about chemical structures and bonds in a way that was meaningful as it connected to those images BLs. Figure 5 illustrates the four charts used throughout the unit: covalent bonding, ionic bonding, synthetic materials' impact on society, and the structure of an atom. The bottom left chart has the written objective "Gather and make sense of information to describe that synthetic materials come from natural resources and impact society." Itzpapalotl described how the chart was presented and processed (co-constructed) with her seventh-grade BLs, which is visible on the chart in how the words "gather and make sense" are circled and have the word "research" written above them. Then, the

words “synthetic materials” are also circled and have the added words “gasoline, energy, oil,” which are examples of synthetic materials. The word “fossil fuels” is also added and “impact society” is circled with an arrow pointing to a list of seven ways the world is impacted: oil spills, water and air pollution, illnesses, rise in sea levels, acid rain, greenhouse effect, and solid waste. These were the seven areas students researched in their groups. Furthermore, the seventh-grade BLs were encouraged to construct solutions that addressed the seven identified environmental problems they brainstormed. As Itzpapalotl demonstrated, CCDLSTs provided BLs with opportunities to embody agency and an identity as problem solvers to address global issues.

For CCDLSTs to plan lessons where BLs get to scientifically read the world, teachers need to be informed of current events and political movements that affect students directly and indirectly. For example, Ana was aware of the fires occurring to both the north and south of the school where she teaches. As she was planning her lessons on natural disasters, she opened up her unit by sharing news clips and other information with her second-grade BLs since this was something that was affecting them. By being aware of current and political events, CCDLSTs were able to instill a sense of urgency and encourage students to make changes, especially by making connections to the past and what has occurred in history to “avoid repeating it” as two CCDLSTs specifically highlighted.

Other current events that came up during interviews and observations included the situation with the Dakota Access Pipeline and recent natural disasters in Puerto Rico, México, and the United States. Itzpapalotl recalled a time a student made a connection from a current event to his local community:

> We talked about the Dakota Access Pipeline…a student was able to make a connection that somewhere around here they were doing something with the water pipeline…just

becoming aware of the things that we're doing in our communities and how the little things can make a big impact.

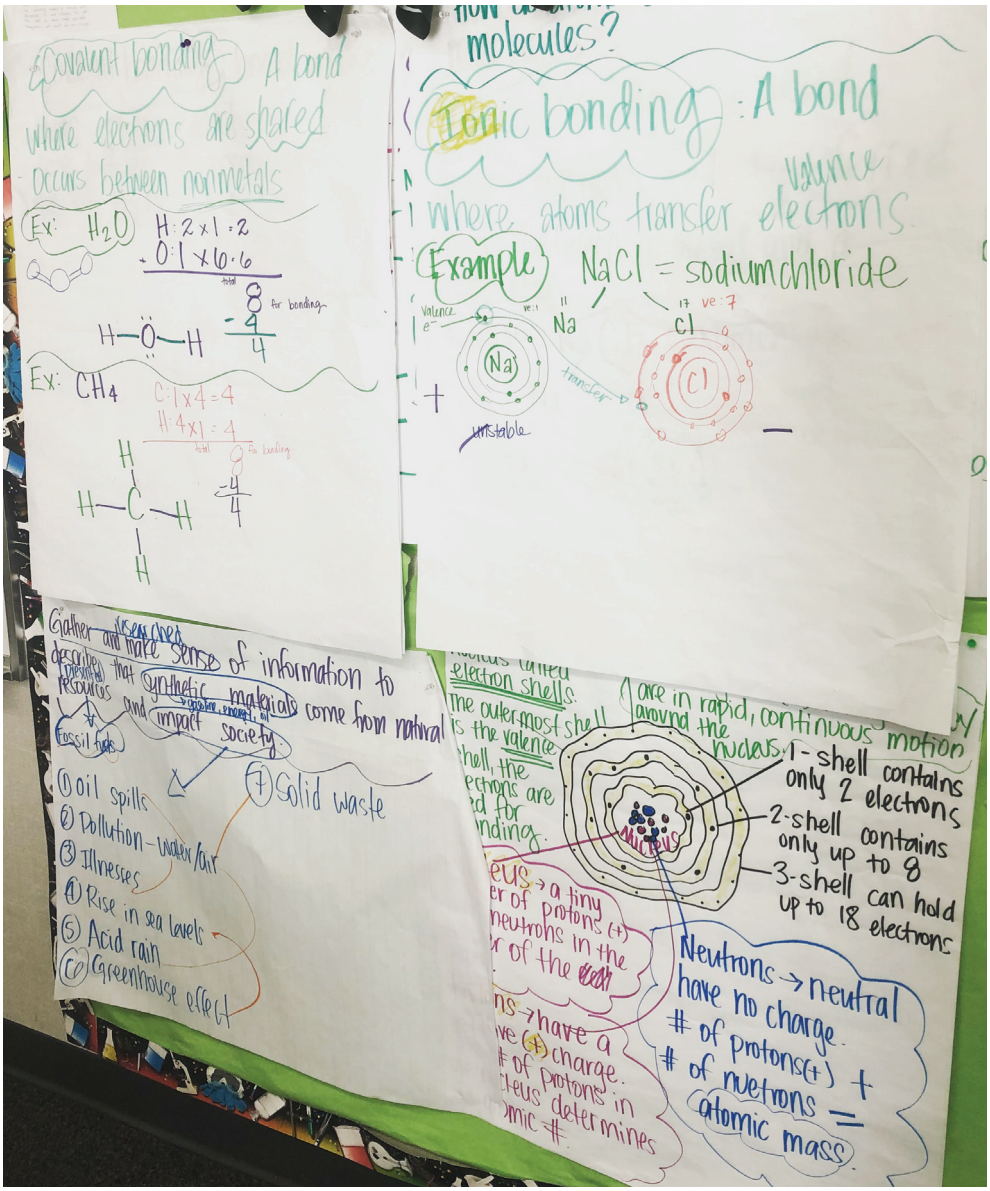

Figure 5. Itzpapalotl's chemistry unit charts.

Furthermore, Itzpapalotl elaborated on the importance of creating spaces for BLs to engage in dialogue about the impact a national event may have on those immediate communities, and also

the repercussions and effects on their own marginalized communities. The CCDLSTs made sure to engage in dialogue with their BLs about making connections to their lives by raising questions such as Ana did during her lesson on natural disasters: What does it mean for the people of Puerto Rico to not have electricity for months? What should the government do? What can the people of Puerto Rico do? And most importantly, what can I do to help the people of Puerto Rico? The CCDLSTs were purposeful in the questions they asked students about reading their world, which provided students with opportunities to identify how events in their world affect them directly and indirectly.

Critically conscious practice and praxis. The CCDLSTs' qualities and characteristics supported the process of becoming ideologically clear and fit into the areas of knowledge, agency, and advocacy. The teachers know and believe in the importance of biliteracy and as such, are prime examples of biliteracy in that they continue to invest time in improving their language practices and the biliteracy of their BLs. As middle school teachers, both Antonia and Itzpapalotl chose to collaborate with the Spanish language teacher to ensure correct use of grammar and *acentos* in their posters and other materials for BLs. Antonia only teaches science and has one class she teaches in Spanish; she shared the following on building biliteracy:

> Finally last year, we all got together and the content teachers all agreed that we should be supporting their Spanish development, so the posters we all got from our Spanish teacher, and every DLI teacher has them in their room, so whenever possible I remind them, "Okay, donde va el acento?" you know, and we try to do it together.

As Antonia taught science, she addressed Spanish grammar. The CCDLSTs have knowledge on biliteracy and accept what they do not know and seek collaboration to improve on those areas. The elementary level CCDLSTs, Ana, Juan, María and Carmen, collaborated with

their grade level partner teachers to revise each other's work and attend professional development opportunities in Spanish because they, too, were clear about the importance of continuing to develop their biliteracy as it leads to issues of equity for both teachers and students.

Another aspect of teacher knowledge is that CCDLSTs understood the struggles that accompany being CCTs who implement a social justice lens. The CCDLSTs exemplified agency as a way to direct their knowledge and professional growth with a social justice lens in various ways. During the second interview, all CCDLSTs were asked to describe their ideal dual-language science teacher. The most common answers included description of teachers who aspire to be better science content and dual-language teachers, have a sense of responsibility to improve the world, are critical and reflective practitioners, are hardworking, and are committed to loving their students. As an ideologically clear reflective practitioner, Carmen shared the importance of requesting to be observed by colleagues and her principal to be provided with feedback to enhance her teaching:

> Any time I get observed, I try to really internalize what people tell me and I try to do it. So, if they tell me, "Oh, you need to do this different," or, "You need to change this about your teaching," I do it. So, just taking any feedback into consideration and really working on it because at the end of the day it is what makes me get stronger as a teacher.

Carmen elaborated on her approach of attending workshops during conferences:

> I am very observative [sic], so when I go to workshops or conferences or anything, I really look, okay, what is that teacher doing? What do I like about that teacher? And really see, okay, oh, they're doing this. I really like what they're doing. They're doing this with their hands. They're really engaging their students by doing call and response or doing something. And I'll go ahead and apply it into the classroom as well.

Carmen's statement clearly depicts that she is purposeful and invested in improving her practices to have a greater impact for her students. Similar to Carmen, after describing their ideal dual-language science teacher, all CCDLSTs shared that they aspired to be that efficacious teacher who goes above and beyond the traditional curriculum and practices to authentically and critically engage their BLs, their families, and communities.

And although they all seemed to believe they were far from it, there was ample evidence demonstrating that the CCDLSTs were already becoming and embodying that ideal dual-language science teacher they were describing, the teacher who connected situations in the students' local communities to the classroom to find solutions. For example, Carmen shared the relevance of teaching concepts and also teaching BLs to understand how their actions affect the world:

> I want them to get the concepts; I want them to understand what we're teaching them. But I think also applying it to real world issues. What are we doing? What are they doing that affects the Earth? What are they doing that is going to have an impact too? So, what are things that they can do that can have an impact?

Out of the six CCDLSTs, María was the only one that followed a prescribed curriculum. Mystery Science is a science curriculum that incorporates NGSS and Common Core aligned hands-on activities with short videos and discussion questions. It is designed in English even though instruction is in Spanish, so she negotiated the language difference by constantly pausing and engaging in dialogue in Spanish with her students during the video. Itzpapalotl had the option to purchase seventh-grade science curriculum when she began teaching middle school; however, she opted for creating her own curriculum mainly because of her experiences with textbooks that tend to provide a single-sided point of view favoring hegemonic practices; for example, only

picturing male scientists and mainly White folks. All CCDLSTs followed the CA NGSS to the best of their abilities and found online materials and resources to create and supplement their lessons to be more critical and meaningful. In other words, the CCDLSTs planned lessons that included culturally inclusive materials and represented issues relevant to BLs in the communities they serve.

According to the study data, critically conscious science teachers who are ideologically clear tended to be well-prepared, self-driven, genuine, hard working, and flexible. With regard to the subtheme of hard working, CCDLSTs worked many unpaid hours beyond their regular workday and week. On the weekends, Itzpapalotl visited community organizations to learn more about how she could bring the community into the classroom and science lessons. Antonia arranged weekend meetings with teachers outside her school but within her district who were engaged and committed to similar work. In developing their ideological clarity, CCDLSTs did what was necessary to get the job done.

By being hopeful and thankful for their BLs, valuing all students' families, and fostering what they believe to be core values and virtues in the BLs, CCDLSTs practiced advocacy and agency in their sense of pride for all of their students. Itzpapalotl recalled the day prior to her science observation, when one of her three BL groups of seventh-graders were engaged in conversations of their own, describing it as something beautiful:

> I had that moment yesterday with one of the classes. It was like, "Well, like, Fulanito said da da da. I agree with da da da." And it was a natural conversation. It was like, probably, I don't know, 7 minutes of just them talking. And I just listened to them. And I didn't even have to do [anything]. It was just kind of like, and then, someone else. And then,

> everybody shared and it—it was just—it was such a beautiful feeling, you know? I'm not there with all my three classes yet.

Itzpapalotl, wide-watery-eyed and with a huge smile, explained how her BLs engaged in respectful and meaningful dialogue for 7 minutes and mentioned being so proud of them. This was an authentic moment of realizing the impact a teacher has on her students; as she was witnessing the BLs' virtues, she had strived to develop her students as critical thinkers, and as respectful, honest, and good listeners. Although this account happened with one of her three groups, there was still work to do with her other groups and she mentioned working with them to make sure they reach this level of dialogue. Itzpapalotl's quote exemplified her praxis; the way her ideology manifested in her pedagogy, which will be further discussed in Chapter 5 as an approach that provides authentic, positive results.

The CCDLSTs employed a variety of strategies and practices to engage in the process of developing ideological clarity. There were many instances where CCDLSTs had to identify and juxtapose the dominant ideologies in relation to their science and dual-language pedagogy that resulted in them: (a) valuing their BLs and their entire families and communities, (b) teaching meaningful lessons that allowed for transformation and liberation, (c) providing BLs with opportunities to read the world before reading the word, and (d) practicing agency and advocacy with a social justice lens.

Theme 2: Practicing Pedagogical Perspective and Clarity in Dual-Language Science Classrooms

> Okay, so they're challenging me. Okay, so we're going to change that information. I always tell them, "I make mistakes so make sure that you have open eyes and open ears and you can [provide] input too." So they challenge me it's like, "Oh, okay I don't have

the answer right now but remember that you can go back and research and you can bring that information to us. Because I'm here to support you and I'm a guide but *you* can also provide information for us." (María)

In this statement, María recalled a time of reflection when her BLs recognized her making a mistake. María listened to her students, corrected her mistake, and reminded her students of her pedagogical role as a guide in the classroom and how students could also contribute to the learning environment as co-constructors of knowledge. Based on Paulo Freire's teachings, María practiced the role of the teacher being the learner and reflective practitioner.

The CCDLSTs who practiced pedagogical perspective and clarity viewed their students through the assets they bring to the classroom and were strategic and intentional in their instructional delivery. Given the teachers' clarity in their role as a critical dual-language science teacher and the role the BLs play, students and teachers co-constructed knowledge and collaborated. The CCDLSTs and BLs learned in democratic and safe environments where students felt comfortable enough to contribute to the lessons, teach, and respectfully challenge the CCDLST based on established student-teacher relationships, which contributed to how the CCDLSTs practiced pedagogical perspective and clarity in the science learning environment.

As illustrated in Figure 6, the three subthemes that emerged related to pedagogical perspective and clarity in the Spanish/English science learning environment included: (a) teaching BLs, (b) planning for teaching BLs, and (c) learning as BLs (see also Appendix H).

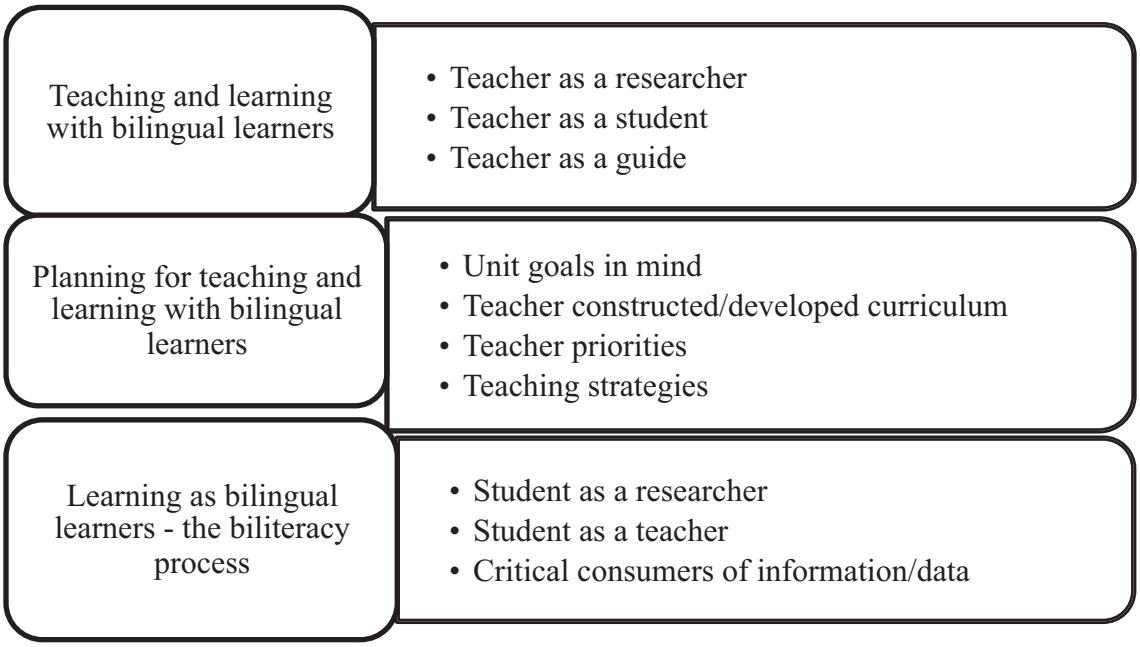

Figure 6. Subthemes for pedagogical perspective and clarity.

Teaching and learning with bilingual learners. The CCDLSTs partook in particular roles to be efficacious teachers for BLs. The three subthemes included in this section comprise the role of the CCDLST as a researcher, a learner, and a student guide. Ample evidence was gathered on all CCDLSTs' familiarity with the research on bilingual education; however, Itzpapalotl, Juan, and Ana were explicit in their interviews about the researchers that inform their pedagogical perspective and clarity as described further in Chapter 5.

One area researched by CCDLSTs that extends beyond science content had to do with cultivating and instilling core values. Juan's school site prioritizes students learning lessons on virtues. One of the lessons he enjoys teaching is on critical thinking and growth mindsets. Because he teaches about these two topics, he had to conduct research to learn more about them before presenting to his fifth-graders. In his classroom, visitors see charts on his classroom wall that were used in his lesson dedicated to the topic of "being a critical thinker." Juan posted a definition derived by the students with examples on what reflection "looks like" with fifth-grade

students. Juan mentioned how his students use the wall as a resource whenever situations come up to remind themselves on what they learned in relation to reflection.

Moreover, Ana's familiarity with bilingual research was visible in the way she provided students with the space to use their linguistic databases to cognitively engage in academic tasks. In her interview, Ana communicated how she explicitly works towards avoiding hegemonic practices that police the separation of languages, relevant to the social and emotional wellbeing of students in bilingual settings. Ana not only understands this dynamic firsthand from being biliterate, but she mentioned being familiar with the research on how the bilingual brain works. Additionally, Itzpapalotl was the only CCDLST to discuss her favorite critical thinkers and researchers in the field by name, demonstrating her commitment to staying current and informed by research. She commented on

> thinking critically like critical thinkers in the field…Freire, bell hooks, and Darder's research that I'm lucky enough to have come across these things and to read these things. I mean, there's countless others, right? But just the research that shows what is being done in the classroom. And then, a shout out to people like you and other people who show me, the importance of bringing it back into the classroom. I think that's just one of my critiques of certain researchers. If you're not in the field, how come you've never been in the field? I don't know.

Itzpapalotl's researcher and framework list included Tara Yosso's community cultural wealth, Luis Moll's funds of knowledge, and Maslow's hierarchy of needs as they all connect to learning about her BLs. Furthermore, she posed a critique of research that comes from scholars who have never been in the field and expressed her appreciation for scholars and faculty who are able to make the connection between theory and practice (praxis). Itzpapalotl specifically mentioned two

faculty she has had, one from her master's program and one from her dual-language credential program, who were impactful in her development of ideological and pedagogical clarity. She felt strongly about valuing researchers, such as her two faculty members, who are former K-8 practitioners who can connect educational practices to theory. She labeled this connection as "praxis," which will be addressed in more depth in Chapter 5.

In teaching BLs, another subtheme that impacted pedagogical clarity was the role of the teacher as a learner where CCDLSTs learn about more than just research. For instance, all CCDLSTs mentioned being lifelong learners as they learn new science concepts, co-construct knowledge with BLs, seek professional development opportunities in their districts and through community organizations, and pursue further formal education by obtaining additional credentials and authorizations to expand on what they learned during their teacher credentialing programs. The most common professional development area mentioned was in teaching science content using the CA NGSS with a social justice lens. During the second interview, María recalled a school-wide professional development opportunity where administrators and teachers engaged in dialogue about including lesbian, gay, bisexual, and transgendered (LGBT) families in their classroom practices. However, the conversation occurred only once and for a short period of time and María felt like it was not enough; "like I said previously, we don't have professional development really on social justice, and now with families [I] was wondering how I could integrate" them. María would like to learn more about how she and her school can celebrate diversity authentically, reinforcing the role of the CCDLST as a lifelong student in preparing to teach linguistically diverse learners of all backgrounds.

The CCDLSTs seeking professional development conveyed great interest in the area of preparing to read and implement the CA NGSS. Antonia, who has a single subject credential in science, mentioned how she feels about the CA NGSS:

> They're crazy! I think they're still a little ambiguous, and personally I'm going to be honest, I don't know if I'm teaching it correctly. I'm trying the best that I can, and I know that our district has provided us with trainings, and I have gone to trainings outside of our district to try and understand it better, but overall I feel like nobody understands it 100% yet, so it's been tough; I'm not going to lie. It's been tough and I feel like working collaboratively with other schools, I've learned that we all have our own interpretation of even one performance expectation, so we're all teaching it slightly different, so yeah, I would say I don't feel as prepared. I'm just trying to do the best that I could.

Even for someone with a single subject credential in science, the CA NGSS prove to be challenging. Antonia expressed that professional development in using the CA NGSS needs to be ongoing because even when collaborating with others, and even when she is very comfortable with science content, reading and implementing the CA NGSS is very difficult. If the task of reading and implementing the standards alone has proven a challenging task, how are teachers expected to go beyond implementation? All of the CCDLSTs mentioned their strong interest in learning more about how to read, interpret, and implement the CA NGSS to create democratic learning environments and co-construct knowledge with their BLs.

A third common role in preparing to teach BLs across all CCDLSTs was the role of the teacher as a guide, or facilitator in the learning process and in the development of critical BLs. All of the CCDLSTs introduced their science units in the form of problem-posing that provided students with problem-solving processes. The CCDLSTs asked questions that sparked BLs'

interest around a phenomenon and they provided students with opportunities to explore and conduct meaningful research that lead to the students asking even more critical questions. The ultimate goal of the CCDLST was to provide students with opportunities to identify issues and seek solutions that would consequently benefit their local and global community. The CCDLSTs guided BLs through investigations to obtain answers to an overarching question while developing biliteracy and bilingualism. In sum, CCDLSTs addressed being pedagogically clear in how they create democratic spaces where they guide their students to discover, to research, to address or solve issues, to explore, to summarize, and to ask difficult questions by establishing explicit expectations and maintaining an active role in the teaching and learning process.

The prior teacher roles contributed to how the CCDLSTs practiced pedagogical perspective and clarity in the science learning environment as they teach, learn, and co-construct knowledge with BLs.

Planning for teaching and learning with bilingual learners. The data on the CCDLSTs indicated that they are purposeful and deliberate in how they create a democratic learning environment through well-defined unit goals, clear priorities, teacher-developed curriculum, and an extensive repertoire of teaching strategies. This was common across all CCDLSTs when they discussed their process of planning for teaching BLs. These four subthemes are expounded on in this section.

The CCDLSTs planned science units based on an overarching phenomenon related to a global issue to be addressed through a critical lens with equity and social justice at the core. Itzpapalotl stated:

> If I'm going to learn about all these concepts, why wouldn't I look at it with this one overarching phenomenon and why wouldn't I look at it through this critical lens? Because overall, I want to apply it to my world.

She explained her current focus on the effects of humans burning fossil fuels and how bad it is for the environment. As mentioned in an earlier theme, rather than lecturing her students about fossil fuels, Itzpapalotl provided students with opportunities to contribute to what they wanted to learn therefore becoming co-creators of their curriculum.

The CCDLSTs prioritized BLs' learning by being critically conscious and aware of how time is used in the learning environment. Carmen addressed the concept of time when she said she was "making sure that every minute is accounted for" for her to "get the most out of the learning for [her] students in an appropriate, timely manner." Because she had defined purposeful student working groups based on English and Spanish language fluency since the beginning of the academic year, Carmen spent class time circulating and working with the students who needed additional scaffolding. While teachers in general are required to post weekly or daily objectives, CCDLSTs post weekly objectives and go over them with the whole class and then in smaller groups to make sure all BLs have understood the purpose of the lesson in both English and Spanish. In Figure 7, the photograph illustrates how Antonia wrote the objective of the week for her eighth-graders. It was evident from classroom observations that she reviewed the objective with every class period at the beginning of class and with her dual immersion class, she went over it verbally in Spanish (even though it was not translated in writing).

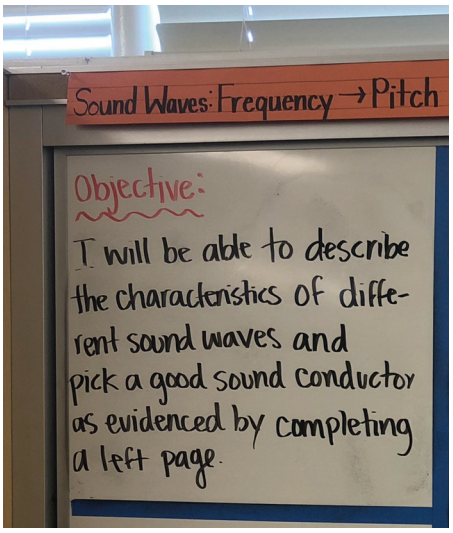

Figure 7. Antonia's eighth-grade weekly objective.

Additionally, Itzpapalotl posted an overarching question (see Figure 8) that guided her seventh-grade unit rather than an objective statement. Since this was a unit objective, Itzpapalotl continued to revisit it every time new information was covered or brought up in class.

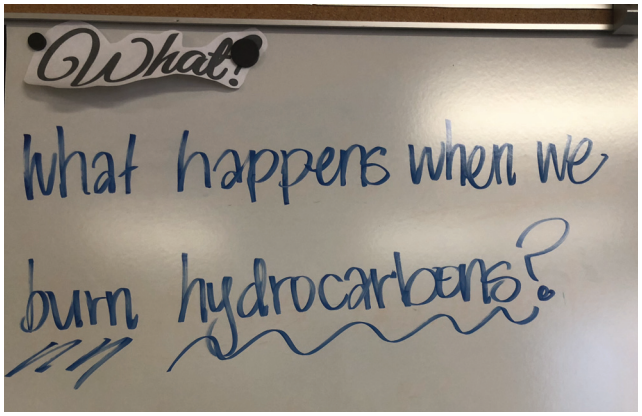

Figure 8. Itzpapalotl's seventh-grade unit objective.

In addition to an objective for the week and one for each unit, María had one objective for every activity with her fourth-grade BLs. This objective was discussed in detail with the BLs until all students could say in their own words what the objective meant. The CCDLSTs engaged their

students in discussions where they got to ask questions and add information. The objective was always visible and available for the students. María's students could distinguish it with the marking of a red target next to the objective sentence (see Figure 9). As a CCDLST, María was clear about the importance of engaging in dialogue with her students before beginning instruction. Figure 9 is one example from María's class and how she used charts during a science experiment to engage her students in building a car and using energy to move it. María's chart illustrates another goal for all CCDLSTs, which is to have high and rigorous, but accessible objectives.

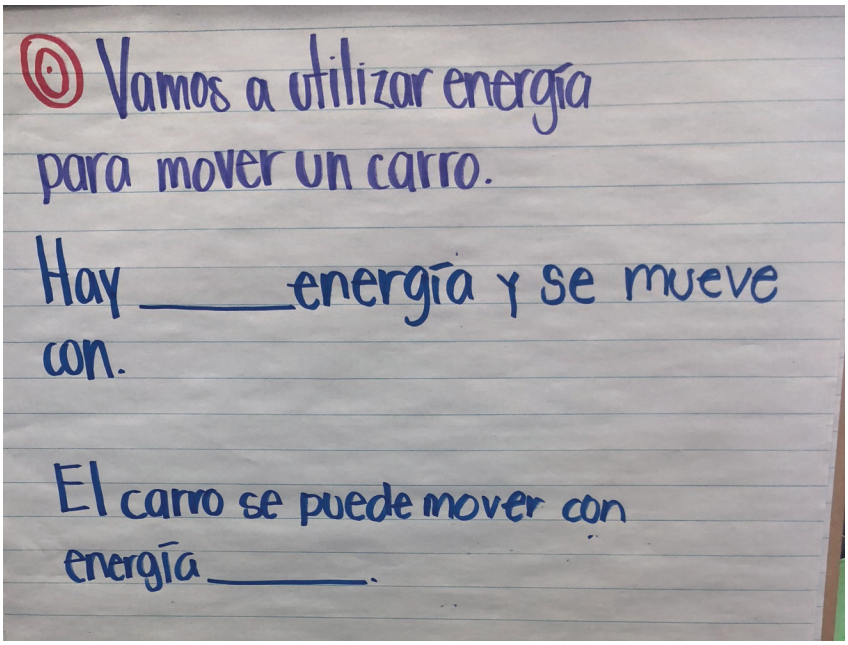

Figure 9. María's fourth-grade objective.

To promote higher-level learning by challenging BLs to think beyond what is in front of them in simple texts, CCDLSTs must set time aside to develop, supplement, or construct their own critical and Spanish dual-language curriculum. The CCDLSTs first recognized that most

textbooks available to them and their students are in English and are missing information, like cultural and gender diversity, to make learning relevant to the student populations they teach. As previously mentioned, only one CCDLST had a set curriculum to support her science planning, Mystery Science. And even though she teaches in Spanish, Mystery Science is in English. Therefore, as CCDLSTs plan for teaching BLs, they must search for Spanish materials that are aligned with the CA NGSS and relevant to the student population they are teaching. All CCDLSTs also discussed having to create materials in Spanish since the options are limited, costly, and not available at their schools. Ana described the process of planning a CA NGSS aligned Spanish science lesson:

> So first, it's the standards, right? So, that's the first thing we research. What are we supposed to teach them? What are the students supposed to be able to do? And then, from there, like I mentioned there are no resources. We do our own research on the topics that they need to learn about, like *desastres naturales*, right? We research, we create those, and it's basically Google, Teachers Pay Teachers, you know? Whatever we can get. We create that and a lot of that is copy and pasting, but I also make sure that it makes sense to them. So, I read it and then I sometimes modify the words or the vocabulary words for them depending on their reading ability. I work with my partner, so we do half and half. We could do it in a couple hours depending on the topic and how much information we can find.

Planning lessons in Spanish and English is a very labor intensive and time consuming process and sometimes costly. Ana described the typical planning scenario for dual-language teachers, which includes translating all materials and differentiating to the BLs' appropriate levels. The CCDLSTs create worksheets and materials that are differentiated by the various Spanish

language abilities found in the classroom. On the rare occasion that teachers find translated materials in their online searches, they must pay for the materials and most of the time are not reimbursed. Also illustrated by the previous quote, most CCDLSTs collaborated with colleagues across grade levels and content areas where the explicit objective was content-related to science, but where there was also an implicit, language-related objective.

For their lessons to be delivered effectively, teachers prioritized various aspects in their planning that benefited both the CCDLSTs and BLs. For Carmen, María, and Ana, preparedness included attending conferences on dual-language and bilingual education and finding and sharing resources with colleagues. For Antonia, being prepared included collaborating with colleagues in her entire district and with her local county office of education. For Itzpapalotl, being prepared meant reaching out to community organizations to seek collaboration and guest speakers for her BLs. Itzpapalotl and Antonia mentioned exposing BLs to different fields and branches of science such as marine biology, which is a very popular major in universities in California. All CCDLSTs agreed to one top priority: to make science fun and memorable for their BLs.

Other areas CCDLSTs prioritized included making time to check for understanding and having set and clear classroom routines to foster safe environments and build community. These included providing students with democratic spaces to create their own knowledge and to engage in conversations about their feelings and emotions. Altogether, these teacher priorities resulted in the CCDLSTs fostering dialogue for the purpose of seeking BLs' perspectives, voice, and opinion. The CCDLSTs also emphasized the need to create a safe space for all students by establishing norms for dialogue, using sentence frames, practicing purposeful student grouping, and having meaningful physical organization of the classroom.

The CCDLSTs had an array of instructional strategies they used in the learning environment to build on the assets of BLs. Because they know students learn in different ways, they employ multi-modal ways of teaching BLs and they move beyond traditional settings where learning can happen. Juan stated, "I just don't want them to be inside but also outside and see the world and question the world," elaborating on the work of one of his favorite critical scholars, Paulo Freire. Using the outdoors was one way CCDLSTs planned lessons that used more than just the classroom as a learning environment. Furthermore, the learning modes that appeared in the data across all CCDLSTs included hands-on approaches to learning science. Most teachers used materials found in their local home and school communities, such as cups and straws. The CCDLSTs and their BLs also used home-made manipulatives; note-taking according to students' needs (drawings, typing, handwritten); technology in the form of videos and PowerPoints; and graphic organizers, charts, and chants in both English and Spanish to engage with science concepts.

In their interviews, CCDLSTs mentioned how their science teaching strategies overlap with other content areas, especially with teaching history. All teachers planned to differentiate and scaffold during instruction based on language levels. They had small groups purposely arranged by Spanish and English language abilities including reading levels, they had group projects with heterogeneous groups, and they used centers as a way to differentiate and meet with smaller groups during center rotations. The CCDLSTs also followed gradual release of responsibility as a teaching strategy that allows for students to gradually own their learning; a strategy where the CCDLST models, then has BLs attempt examples collaboratively in whole group, then with partners, and finally independently. The CCDLSTs were constantly assessing if

the strategies they used were working with their BLs to intervene, shift, and modify lesson delivery as needed.

All the CCDLSTs hold a multiple subject credential certified by the Guided Language Acquisition Design (GLAD) project and used it as a resource to enhance science lessons. During Carmen's science lesson observation, her first-grade BLs conducted an investigation to determine which of three containers filled with water, dyed water, or different legumes were *translucido* (translucid)*, transparente* (transparent), or *opaco* (opaque) by using a flashlight to shine light through the containers and onto a sheet of paper behind the container. To enhance the hands-on activity with home materials, Carmen used GLAD strategies: "I also do a lot of GLAD strategies. Anything that I do I try to incorporate GLAD strategies." Carmen, along with other CCDLSTs, used pictorial input charts, expert groups, chants to Spanish tunes familiar to BLs, and other GLAD strategies in Spanish to assist in teaching science and making content accessible to BLs. Carmen mentioned the use of GLAD strategies along with "call and response to keep them engaged" and used

> little sticks so that I'm not being biased and calling on all students. When we're reading, they're reading and then they're pair-sharing all that information. A lot of visuals too, so that they can understand it. Hands-on learning too, so that they're actually doing it. But we read about it and we write about it, so we're kind of, uh, reading, writing and talking about it orally. So, honestly we're integrating all of the Common Core into the NGSS when planning. Like, classroom management. So I try to have a good routine, that way they're able to follow along.

Carmen's quote on her usage of popsicle sticks with student names for randomly calling on students was an example of practicing pedagogical perspective and clarity. This supports the

subtheme of CCDLSTs' careful planning for teaching BLs in the way she considered the many aspects of planning and teaching a dual-language science lesson. Also, Carmen's consistent routine to guide her students was a common theme among the CCDLSTs. Furthermore, CCDLSTs were flexible, used repetition, frontloaded terms as needed, and were aware of speaking time, such as how much time they spoke versus how much time BLs were given the space to discuss, question, and collaborate. Continuing with Carmen's interview, she was very specific about how she used her time, "I'll do the 10-1 where I'm talking no more than 10 minutes and then they're doing [the talking]." Carmen kept track of how long she had been talking and when she reached 10 minutes, she provided students with an opportunity to discuss for at least one minute. Critically conscious teachers are aware of the concept of time and plan for every minute accordingly to make sure they are not the ones doing all the talking.

Furthermore, to practice pedagogical perspective and clarity, the CCDLSTs employed a repertoire of instructional strategies that were common across all teachers; however, there were instructional strategies unique to each teacher. Itzpapalotl began almost every seventh-grade science lesson with a "first five":

> I always start off with something called the first five. Essentially it's a warm-up. I pose a question to them and I give them 5 minutes to write about it, a warm-up into what we're going to do that day where they have to think back to what we did in the previous science class but gives them a preview of what we're going to do that day and then we share as a class, and then together we come up with maybe like in the lesson, maybe I give them a quick just background into that segment or next segment or whatever but we, together, come up with how we want to solve that problem or how we want to construct meaning around that science topic in class. And, ideally, I'm gonna guide them to whatever I have,

> right? But it's where respectful academic dialogue is happening where students are building upon each other's ideas, um, and we all get excited about doing a project together.

Itzpapalotl shared a typical start of her science lesson where students had an opportunity to make connections to their prior and future learning while also having an opportunity to contribute to their learning through dialogue as they planned how to approach solving their issue for their science unit. Itzpapalotl created a particular mood with her selection of music while students worked independently. Also, Itzpapalotl played music for her seventh-graders when she provided them with opportunities to stand up and walk around to share what they wrote in their first five activity with classmates.

Similarly, Antonia's unique instructional strategy was the opening routine for her eighth-grade students. From field note observations, her routine consisted of students walking in and picking up handouts from a table near the rear entrance. These handouts were all the materials students would need for the duration of the class period and included teacher-created bilingual worksheets and rubrics to revise and evaluate work from the previous day. Once all students sat down, BLs knew to begin the warm-up projected on the white board. On this particular day, the warm-up included three items based on the lesson objective of the week (reviewed in an earlier subtheme). The three warm-up items were:

1. Dibuja una onda que representa un sonido fuerte con tono alto.
2. Dibuja una onda que representa un sonido bajito con tono alto.
3. Describe como un murciélago ciego en una cueva oscura seria capaz de: moverse, encontrar su comida, y comer.

Which translates to:

1. Draw a wave that represents a loud high-pitched sound.
2. Draw a wave that represents a soft high-pitched sound.
3. Describe how a blind bat in a super dark cave would be able to: move around, find its food, and eat.

Without Antonia providing directions, BLs walked in, collected their daily materials, and began writing while the teacher set a timer. As they were writing in their science notebooks, the assignment from the previous day was left next to their warm-up notebook for Antonia to stamp, acknowledging her quick review of the assignment. When the timer went off, Antonia greeted the students and the students greeted her with a *buenos días* from the teacher and a *buenos días maestra* from the students. By the time the timer had gone off, Antonia had already walked around to check and stamp all homework, answered clarifying questions about the warm-up, and also checked online to make sure their assignments had been submitted.

The CCDLSTs employed a variety of teaching strategies with their BLs. Carmen's unique teaching strategy with her first graders included using the terms "*luces, cámara, acción*," which translates to "lights, camera, action," which appeared effective with her first-grade BLs during carpet dialogue time. This was one way for them to: (a) sit (*luces*), (b) face each other (*cámera*), and (c) begin talking (*acción*). Ana mentioned how, from day one, her students practiced what body language may look like when one is engaged in dialogue and careful listening by following that particular example during rug time. Through set routines from the beginning of the school year, Ana created an environment that allowed the students to listen and learn from one another.

Juan's unique instructional strategy consisted of him using the Socratic method with his fifth-graders. Juan mentioned practicing for a Socratic seminar classroom style since the beginning of the academic year:

> And another thing that I do a lot at the beginning also is the Socratic seminars where the first time I let them do it. And then as they're doing it, I'm on the board. I do a circle and I draw dots. The dots represent which students spoke the most. And so after that, we go and reflect but at the same times it's like, in the Socratic seminar there's a kid behind another kid taking notes as they're speaking. And they're saying whether they're using the language frame that we gave them. And at the end they reflect upon their own way, how they are doing. And then through the Socratic seminars, they reflect on themselves but also reflect as a group and how we do.

Juan used the Socratic method as a way to engage students in dialogue but also as a way for students to reflect on their participation individually and as a whole class. Through the Socratic seminar, Juan provided his students with the democratic learning environment where they had a say in what was discussed and their CCDLST was a collaborator in the discussion.

María's unique strength lay in the way she incorporated all students during a lesson by using the idea of a talk show:

> And now we're empower[ed] with the dialogue, doing like a little talk show where they present their information and they feel important standing up, or when they want to add information to another student, they call out the other students like, "I agree with Melissa or I disagree but I want to add this."

Evident in field notes, María walked around with a prop that was symbolic of a microphone where all students who participated in any way had an opportunity to hold the microphone while

everyone else listened. María provided a space where all students could contribute to the class conversation. As she stated in her quote, students listened to one another and built on each other's responses as they answered their CCDLST's guiding questions.

The CCDLSTs had an extensive repertoire of teaching strategies. While some may be attributed to their individuality, the CCDLSTs ultimately accomplished the same goal of planning and developing meaningful bilingual science lessons for teaching their diverse BLs.

Learning as bilingual learners—The biliteracy process. Emerging from the data, another way CCDLSTs practiced pedagogical perspective and clarity was by providing BLs with opportunities to practice two roles in their process of learning, with the goal that students become critical consumers of information. One role taken on by the BLs was the role of the student as a researcher.

The CCDLSTs planned lessons where students have opportunities to ask questions and find answers from varying perspectives. Visible during the science lesson observations, Carmen, María, and Ana's students asked questions related to the current lessons that were not the focus of the learning objective. The CCDLSTs took these opportunities as teachable moments and, as a whole-class, took time to address the questions at hand. On the other hand, Antonia's seventh-graders all had school-provided iPads that were used for many purposes, including searching for answers as questions arose. For example, while Antonia was going over the warm-up with the class, students looked up information online and volunteered to answer follow-up questions that were asked by their peers or their teacher. Antonia recalled a moment from her science lesson: "You got to see today, Luz was adding to the lesson the research that she had found about, you know, with the clicking. And that was something new that I didn't even know." As students were reviewing how bats travel through echolocation, which was one of the three warm-up questions,

Antonia shared a current example she heard on the radio of a woman who lost her sight and made clicking noises to determine the proximity of objects as she rode a bike. A BL, Luz, had researched and shared additional information she had found on her iPad that Antonia was not aware of. Luz took on the role of the researcher and also a teacher. The CCDLSTs had democratic learning environments that provided students with spaces that contributed to their learning while embracing various roles.

The second role BLs assumed was the role of teachers. One way this role was enacted was by BLs contributing information to their CCDLSTs that may be used in an assessment. Itzpapalotl recalled a moment in her science class where students embodied the role of both teachers and researchers:

> Part of the unit . . . they had to do their own research about the [global] impacts. So I just chose basically a few different effects or impacts, right? It was seven different ones. *Acides* - ocean acidification, acid rain, ground water pollution, oil spills. Like, there was a whole list of them. But they came up with them and they chose them. And then, you know, it was the expert group. I was like, "You're going to teach us and you're going to teach me about what these things are." And they did an amazing job because they were so into it, you know? So, that was [how] we created that knowledge together. At the end of it, they had the opportunity to teach each other. And it was so cute, seeing them asking questions. Like, "Wait, go back to that slide." So, they were even fact-checking each other, you know, (laughing) on certain things. And then, I was like, "I'm going to take your presentations and I'm going to create an assessment based on what you guys presented." And that's what I did.

The BLs in Itzpapalotl's class had opportunities to be researchers by coming up not only with the topics and questions they wanted to answer and address during instruction time, but also by using different tools to research their topics and co-construct knowledge with their teacher. Afterward, they organized their data and taught the rest of their peers, including their CCDLST, through carefully thought-out presentations. This process was so carefully executed that their teacher used the presentations to create a class assessment for that science unit.

Evident from the field notes, all BLs had various opportunities to be critical consumers of information. Students practiced asking critical questions such as questioning where information came from and identifying the dominant point of view and considering varying points of view. The BLs were also able to present and argue in favor of differing points of view, even if they did not agree with them. Students felt empowered and were able to challenge each other, challenge their CCDLST, and even challenge other adults throughout their learning process.

These are but a few examples of how teachers practiced pedagogical perspective and clarity in the dual-language science classroom as it related to the success of their BLs.

Theme 3: Creating Access for All in Dual-language Science Classrooms

In the following quote, Itzpapalotl, who was currently teaching a science lesson in English, shared her experience in creating access for three students who were new to the United States from México and were learning science content while learning to speak English:

> I have three newcomers and they're difficult [science] concepts, right? So, I had to look up *como se dicen fósiles combustibles*. I had to look up these things and sometimes I do a better job than other days, and sometimes it's during their first five. [They] come with me and [I] just prep them. *Fósiles combustibles* is fossil fuel. But they're hard workers, so at the end of the day, you know what? They know how to use research tools. And it goes in

> both English and Spanish, whatever I teach. They use computers at their disposal. They type in their question into Google translate. I think I'm at the point where I'm telling them, "You have to advocate for yourself. And so, if there's something that you don't understand, please let me know." But I always make sure to check in with them, "Okay. Are you understanding this? Okay. *Ahora dime en español que entendiste*." Or I will talk to them in English and they will speak to me in Spanish. But I want to make sure that they're hearing the English vocabulary and the Spanish vocabulary. So, it is a lot of work and there are days that I feel like I'm more conscious about it than others. But that's always a goal of mine because I have language learners in both of my classes.

Itzpapalotl described the process of engaging with her BLs who had recently immigrated from México. She was aware of their needs and continued to check in with them during her lessons. She also provided them with research tools so they could use them as a guide, but was careful not to let technology replace her as teacher. During another part of her interview, Itzpapalotl also highlighted the importance of creating access for students who are native English speakers learning Spanish and provided BLs with various forms of technology to encourage them to be resourceful.

To create access for BLs in dual-language science classrooms, CCDLSTs had intentional ways of supplementing and creating their own curriculum. The CCDLSTs also had specific ways of approaching instruction for all students, as they constantly reclaimed, created, and recreated bilingual materials. The subthemes are presented in Figure 10 (see also Appendix I).

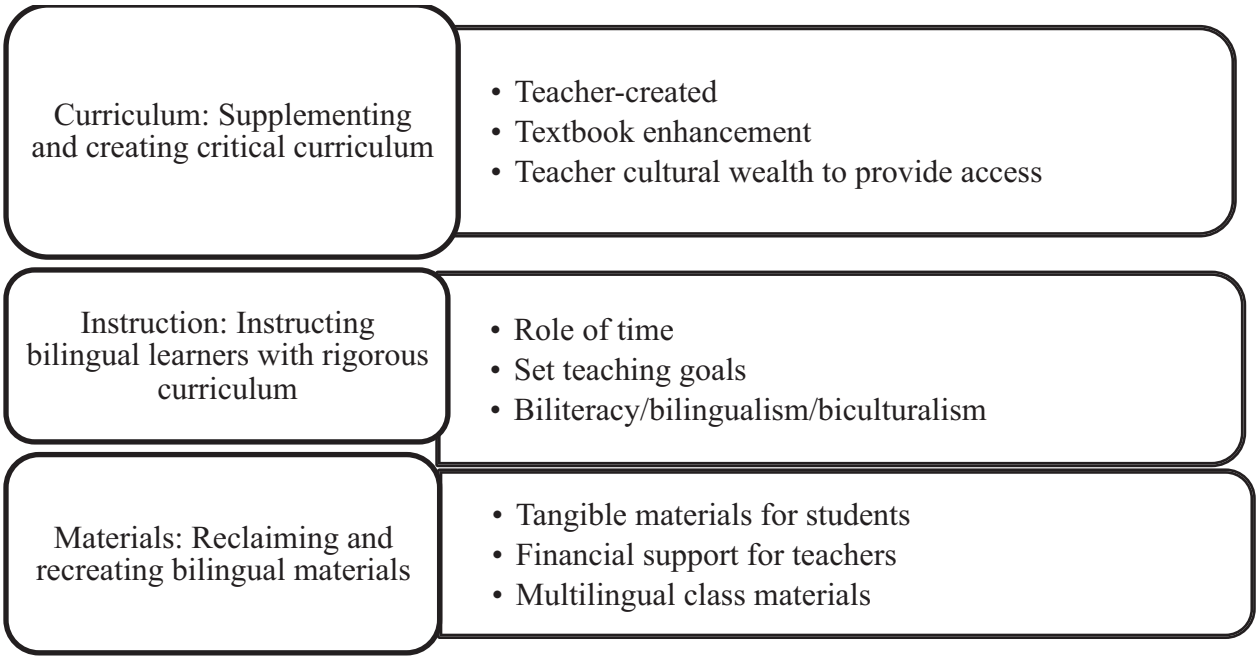

Figure 10. Subthemes for access for all.

Supplementing and creating critical curriculum. When examining how CCDLSTs create access to curriculum for culturally and linguistically diverse student populations, three subthemes emerged: (a) teachers creating materials, (b) teachers supplementing textbooks, and (c) teachers using their background to provide access. As previously mentioned, only one of the CCDLSTs had school-purchased curriculum; the remaining five had to create their own curriculum by conducting careful research since their schools provided them with very limited resources to teach CA NGSS-aligned science. In their creation of curriculum, the CCDLSTs took into consideration geographic location to make content accessible. The BLs were exposed to issues and situations found in the world as they connected to the country, the state, and their local communities. The teachers were also considerate of students' culture as they presented new information. For example, Ana had a large population of students who were immigrants from México (or had immigrant parents from México) and when she taught her lesson on natural disasters, she made the connection to her students about a recent earthquake in México. In that

same lesson, she also made a connection to fires that were taking place near their local community.

María, who was the only CCDLST with a school-bought curriculum, also found herself having to supplement curriculum to create access and inclusivity and then to translate it to Spanish. She incorporated differences amongst students and families to teach about respect as it came up, even if it meant stopping science instruction to address a teachable moment. The example from her class addressed the existence of curriculum perpetuating heteronormative family practices that considered a male and female parent as the only parental role types. María recalled how her school staff and administration came together to initiate conversation with students and families about incorporating families who identify as LGBT:

> We are going to focus on how to speak to students about differences in families now that we're including, LGBT families. And how to encounter those questions from them and be critical about how to answer and respecting both sides. Even if the parents decide, if they don't agree, but also respecting. So it's evolving each year with professional development, student experiences, your own research and reading.

As María continued to learn about the students and families represented in her classroom and school, she discussed how she planned ways to inform herself to create access for all students from various cultural backgrounds. The same was evident in how María addressed linguistically diverse students since she was the only CCDLST who reported having a third language and culture heavily present in her classroom and school that academic year; Tagalog-speaking students and families who identify as Filipino. Creating access, addressing, and learning about culturally and linguistically students were evident with all other CCDLSTs as they reflected on prior teaching years and class groups and created critical curriculum for BLs.

The CCDLSTs' personal experiences and background also emerged as a way teachers supplemented critical curriculum. Storytelling and religion were two common ways culture emerged in the data. The CCDLSTs had personal and individualized connections with students; something textbooks and curriculum cannot provide. All CCDLSTs began their science lessons with stories that connected to the objective of the day. As previously mentioned in the theme of pedagogy, Antonia began a lesson with a story about her drive to school and listening the radio podcast about a human being who had lost her sight but used her hearing to ride her bike across her community. She then connected this to echolocation, which was part of her warm-up. Juan shared his experience of learning about the different geospheres and his struggle with determining which one of the four (*hidrósfera, biósfera, atmósfera, cromósfera*) was the most important one to the planet. Because he introduced the lesson as a personal struggle, BLs were invested in learning about the geospheres. After researching all four, they engaged in a debate about which one of the four was the most important one by having students defend their positions with claims from their research findings. To reach their science objectives, CCDLSTs began with stories or personal connections that allowed BLs to invest in the topics and engage in dialogue.

In terms of religion creating access, María brought it up in conversation as a way to connect with her students who were sharing their vacation activities in December. María recalled sharing with her BLs what she did over winter break, which resulted in students' ability to make language connections with Tagalog. She shared what she did for the holidays "and then we encountered it like *misa* it was the same, *gallo*, *misa de gallo*, *queso*. There were a lot of common words in Spanish and they were surprised to see the commonalities." Students who identified as Filipino were able to connect to their CCDLST in a new way. In sum, for BLs to

feel personally invested in what they are learning, they need to be able to connect to content and this is why critical curriculum is a necessary aspect in creating access and equity in the science learning environment.

Instructing bilingual learners with rigorous curriculum. The CCDLSTs have clear goals when creating access through instruction to culturally and linguistically diverse students that leads to the biliteracy, bilingualism, and biculturalism/multiculturalism of BLs. The concept of time in various forms was a recurring subtheme across all CCDLSTs in this subtheme as well. First, time presented itself in the data in terms of CCDSTs bringing up the past, present, and future as a way to create access for all BLs. For example, five of the six CCDLSTs used the fact that they also taught history as a way to look at the past to inform the present for students to make connections during science. Another way time presented itself was that every instructional and noninstructional minute was accounted for and included opportunities for students to access critical curriculum. In the previous example of Juan's BLs lining up for lunch, students continued conversations about their day's objective that carried on to their lunchtime. Every minute BLs are in the presence of their CCDLST is a minute accounted for and an opportunity to continue dialogue about the rigorous science content.

There were six overlapping CCDLST goals across all teachers that were used to provide access for BLs. First, students were provided with various opportunities to make choices, depending on the lesson. For instance, Antonia shared how she always planned for one part of her instructional day that allowed students to make decisions about something related to the lesson, whether it was selecting their group or partner they wanted to work with, where they wanted to sit during independent time, or what resources they wanted to use to do their work. Evident from the field notes, she allowed her seventh-graders to select their working partners.

The BLs had choices about what they wanted to learn and how they wanted to approach their learning. Second, to make content accessible, CCDLSTs had to differentiate materials, which required them to be aware of their students' reading levels in English and Spanish through assessments at the beginning of the school year and ongoing, formative assessments, and also their comfort levels with the scientific concept that was the focus of the objective. In an earlier quote, Ana discussed how devoted she was to creating instructional materials from conducting her own research and sometimes paying for materials, and ensuring they were at the students' reading levels, or what Vygotsky refers to as the child's zone of proximal development. Third, CCDLSTs had goals that consisted of providing BLs with access to various future paths in science by exposing them to different science fields and careers such as being a chemist, biologist, doctor, teacher, and researcher. Itzpapalotl made connections to prestigious local college programs with emphasis in areas such as marine biology.

Another goal CCDLSTs emphasized in creating access for BLs was prioritizing spaces for students to help each other and co-construct knowledge with their teachers. Together, CCDLSTs and BLs translated materials as needed and reflected on how lessons went. One example was Juan's use of the Socratic method with fifth-graders. Juan provided the time and space; the students engaged in and lead the dialogue. Then their CCDLST joined them as they reflected on the effectiveness of the process and what they learned. And lastly, CCDLSTs shared the goal of providing students with access to spaces where they could own their learning with the ultimate goal of BLs developing multiculturalism and biliteracy, as was evident in the field notes from María's classroom with her Filipino students and the rest of her class. Altogether, CCDLSTs shared the goal of finding ways to provide BLs with access to a rigorous curriculum as they selected the best strategies for instruction based on the content objective.

Reclaiming and recreating bilingual materials. For CCDLSTs to instruct BLs with a critical lens, they needed to have access to materials that were tangible for students and they needed access to funding so they could obtain materials in languages other than English that were aligned with the CA NGSS. From the field notes of classroom observations, it was evident that Carmen had a space in her classroom where she stored items used during science instruction. The CCDLSTs in the middle grades, Antonia and Itzpapalotl, had access to lab equipment and classroom spaces to conduct different types of investigations that required specific safety equipment. For example, Figure 11 shows a goggle ultraviolet sanitizer used to disinfect goggles, which allows multiple class periods to use the safety equipment on the same day, from one period to the next.

Figure 11. Goggle ultraviolet sanitizer.

Figure 12 shows the image of three straw rocket launchers used during physics labs to conduct investigations using pneumatic forces; as weights are dropped into the cylinder they allow a rocket to be launched. However, besides having these materials accessible, it was also important for the CCDLSTs to be able to practice and use them before planning a lesson.

Figure 12. Straw rocket launcher.

In addition to BLs having access to tangible materials, CCDLSTs were able to create access through financial support and resources as needed. Figure 13 is a photograph of Ana's second grade classroom, focused on the area with five desktop computers. Her students also had access to iPad carts that were shared with other teachers in her grade level. Carmen's students, who were also at the same school as Ana's but one grade lower, only had eight iPads to a class for all students to share. Antonia's seventh-grade students had their own laptops that were provided by the school, and Itzpapalotl had a full set of Chromebooks, enough for each student to freely use. María's students had one-to-one computers and shared four iPads for the entire class. Juan also shared a Chromebook cart with his fifth-grade level team. While there were limited materials and resources in Spanish, CCDLSTs found ways to use technology to expand on their bilingual resources and make content accessible.

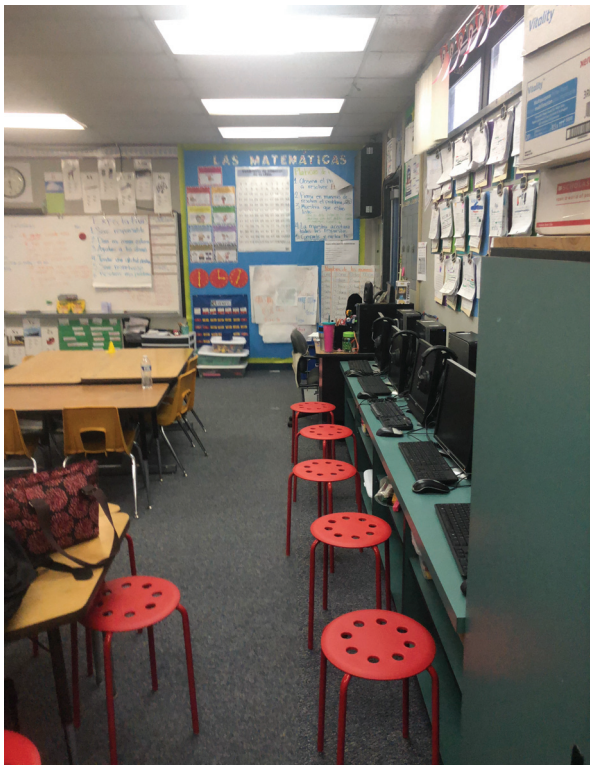

Figure 13. Ana's desktop computers.

Another way CCDLSTs used resources was by taking advantage of and seeking professional development opportunities. These included curriculum trainings; CA NGSS training; local, state, and national conferences; and opportunities to apply for grants and materials. The main reason for the emphasis on obtaining materials was due to the time needed to recreate and translate materials to Spanish. The CCDLSTs needed a variety of resources in English and Spanish, to address not just teaching science content, but also to address different processes like reflection and community building time.

The CCDLSTs had to be purposeful in how they created access through their use and creation of curriculum, through the strategies they used during instruction, and through their selection of bilingual materials.

Theme 4: Creating Equitable, Safe, and Democratic Spaces in Dual-Language Science Classrooms

All CCDLSTs had a desk or workspace in their classrooms that was personalized. Besides family pictures and office materials that were used daily, all the CCDLSTs had images symbolic of resistance that they connected to student empowerment. Itzpapalotl had a poster with a definition of social justice, shown in Figure 14, that read, "SOCIAL JUSTICE means recognizing our responsibility to become aware of inequalities in society in order to educate and empower ourselves and others through education and resist oppression." The sign was near her desk and next to where her students sat. Two feet away were two more posters (center and right images of Figure 14) that Itzpapalotl shared and discussed with her students at the beginning of the school year as they connected to how the images related to her students. The CCDLSTs were intentional in how they used learning environments for the purpose of creating equitable, safe, and democratic spaces in their dual-language science classrooms for their BLs. Figure 15 provides an overview of the subthemes (see also Appendix J).

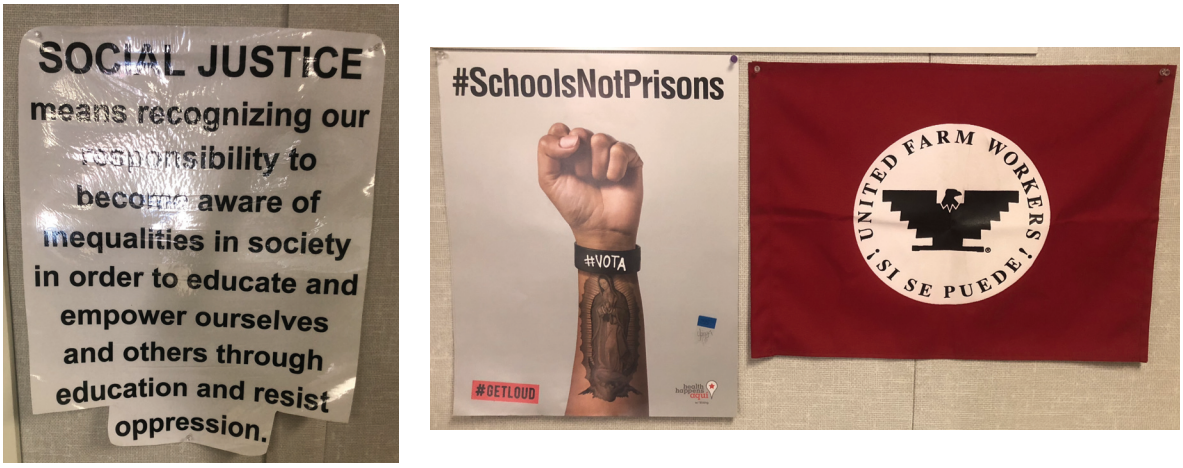

Figure 14. Posters displayed in Itzpapalotl's classroom.

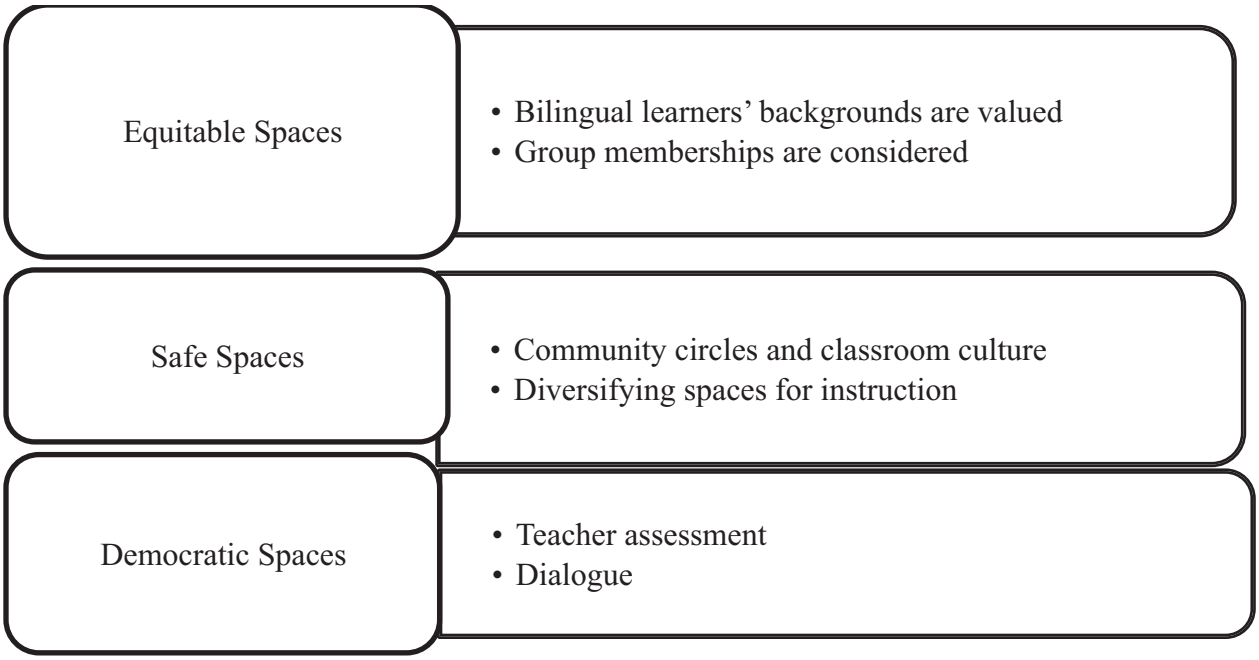

Figure 15. Subthemes for creating equitable, safe, and democratic spaces.

Equitable space. In equitable learning spaces, all BLs are valued and have an opportunity to learn and to persevere. The CCDLSTs created spaces where all students were valued for what they brought to the classroom. These include the assets students bring in terms of their language and religious backgrounds, as well as CCDLSTs being mindful of gender inequities and students' socioeconomic background. In one of her interviews, Antonia mentioned:

> I would hope that my students understand that they can do whatever they want to do whenever they want to do it. Sometimes your route will be different, but if it's something that you really want, you can still get there. I also value the fact that you don't have to be a certain gender to do science or not. So I hope that that, that comes through.

In the prior quote by the seventh-grade teacher, Antonia highlighted how she purposefully acknowledged, presented, and addressed gender roles with her class. Being the only CCDLST

with a single subject credential in science, Antonia also mentioned that she was very proud to be a Latina with a science degree, especially given her background as first-generation college student who held the EL label, thus making a connection to importance of group membership and representation.

Group membership was the second subtheme for equitable spaces and was reflected in four areas. First, as many science fields were introduced in class, they were treated equitably and not one was prioritized over another. For instance, Itzpapalotl made sure her seventh-graders had ample examples of the career possibilities in studying science, which went beyond becoming a medical doctor or physician:

> Well, I want them to know that there are so many branches of science. There's just so much to explore in science because, I think [e]specially for being a student of color in communities where you don't see, or even in fields where you don't see too many students of color, I want them to know that there's lots of opportunities for them in their future to create and to explore within the field of science. Whether it is being a teacher or a researcher or a chemist, a geologist, whatever it is. I want them to know that. Because as a kid, and I think I shared this before, as a kid, it's like, I knew *doctora y maestro* and, whatever, right? But it's like there's so much! So, I want them to know.

Itzpapalotl was very passionate about sharing her thoughts and experiences going through the educational system and the lack of representation of students of color in higher education. Growing up, she had very little information about the different branches and areas that fall under science. The second subtheme discussed in this section is that all BLs can do science and be someone who engages in science because all students have the potential to pursue a career in a STEM field. In a previous example, María recalled her experience being one of the only Latinas

majoring in science in college. Given her experience as a woman of color, she ensures that in her class she doesn't perpetuate hegemonic ideologies with her students and purposely addresses these conversations around gender. Third, in an equitable dual-language science classroom, all students' needs are met as mentioned in a subtheme of the first theme, and fourth, all students have ample opportunities to engage in critical dialogue. For example, Carmen mentioned her use of popsicle sticks to randomize who she called on during class. María had an application on her phone that also randomized student numbers when she called on someone to answer a question or participate in class. For the most part, the CCDLSTs kept track of which students had and had not contributed to classroom dialogue and also kept track of what kind of contributions were made. Those BLs who had not yet shared were approached and prepared to be able to participate.

Safe space. All six CCDLSTs mentioned two ways they created safe spaces for BLs. The CCDLSTs created safe spaces by practicing building community the first few days of the academic year. Community building activities were those in which CCDLSTs and BLs got to know each other's similarities and differences that allowed them to learn with and from each other as they learned content. The CCDLSTs were also intentional about diversifying spaces for instruction. Juan shared in an interview:

> The beginning three days it's all about creating community. So everything's based on community and how each student contributes to our community in a positive or a negative way. And also they have lesson plans in the other homerooms about mindset. About growth mindset and fixed mindset. So we all do a certain lesson that at the end is going to contribute to our own community for the wellbeing of our community. I did "what is thinking and what is critical thinking." So that's the wall over there. How we went through about, being a critical thinker.

Juan shared an example of how his entire school practiced building community. Each homeroom, which consisted of his fifth-grade level teacher colleagues, had a focus related to growth mindset. As previously mentioned, Juan was in charge of teaching about critical thinking and had a space reserved on his classroom wall for what critical thinking means and looks like as interpreted with his students. Other CCDLSTs shared the various ways they spent the first three to 10 days at their school sites building community; however, these were not school-wide expectations but rather practices CCDLSTs felt were necessary to engage in.

The CCDLSTs diversified spaces to teach respect and empathy because they understand the need for them. They were intentional about the location and appearance of the learning environment for particular lessons and challenged traditional learning environments. They also considered language objectives and used this information to pair or group their students. The most common strategy across all the teachers was intentional grouping, a subtheme that also arose in a prior section. The CCDLSTs had students collaborate in pairs based on language or reading level. They also had students move around the classroom to engage in dialogue with different peers. For example, Itzpapalotl would play music during a lesson while her students walked around; when the music stopped, students would engage in conversation with the closest person to them as they revised their first five, the warm-up. In the elementary classrooms, teachers created small groups of three or four students and students would transfer between sitting on the rug in pairs or triads to going back to their table groups of four to five students to provide them with mobility. María commented:

> They have to have a range of, students to dialogue with. It's not only with the same partner all the time, so we did a little chart where I decided based on their language skills

and their academics, who their partner would be. So we have pairs, triads, and we have a group of four.

Based on María's objective and purpose, BLs would be grouped with specific peers who would challenge each other to think and speak critically. This example illustrated one way a CCDLST created safe spaces where students could be their true selves in front of others who may be different from them and their families.

Democratic space. Democratic spaces are those where CCDLSTs and BLs can be themselves and be evaluated according to their contributions to the learning environment, as reflected in the learning objective. One way the CCDLSTs practiced equity was in the way they assessed BLs and fostered dialogue. As reflected in the field notes, Antonia and Itzpapalotl provided rubrics as they and their students gathered evidence for grading assignments. Antonia's eighth-graders had opportunities to grade each other's work using the same rubrics (see Figure 16) the she provided them with when the task was first assigned the day before. In this CCDLST's classroom, the students used the rubrics as they engaged in the task and they used the rubric to peer evaluate: The teacher used the same rubric to calibrate all grades.

In a democratic space, CCDLSTs had various ways to ensure all students' voices and opinions were at the center and were equally valued. Dialogue varied according to the purpose of the lesson. If the objective was related to the content area, the dialogue centered on that content area. For instance, Juan's students engaged in various types of dialogue through the entire observed class period. From the beginning of class, as they engaged in conversation about the best geosphere, through the moment when they were lining up to go to lunch, BLs continued to discuss which geosphere was the best. And even during lunch, Juan met with five of his students to engage in dialogue about emotions when among a group of fifth-graders issues of

The Best Cup Telephone Rubric TRANSLATED

Dueño: CP:

	3	2	1	0
Conclusión **Afirmación**	Identifico una afirmación correcta que contesta la pregunta.		La afirmación es incorrecta.	No hay una afirmación.
Conclusión **Evidencia**		Usa 2 piezas de evidencia del texto/datos que apoyan la afirmación.	Usa 1 pieza de evidencia del texto/datos que apoyan la afirmación.	No hay evidencia.
Conclusión **Razonamiento (Justificación)**		Explica como las 2 piezas de evidencia apoyan la afirmación.	Explica como 1 pieza de evidencia apoya la afirmación.	No explica como la evidencia apoya a la afirmación.

Gran Total: _____/ 7 Puntos

Figure 16. Antonia's rubric.

friendships, related to who got invited to a birthday party and who was excluded, emerged. Juan used dialogue with his students to address not only science concepts, but also any social-emotional situation that came up during, and outside, instructional time.

Overall, the CCDLSTs in this study used dialogue to promote equity in their instructional settings whether it was related to science content or students' reality beyond the classroom.

Summary of Themes

This chapter documented how six CCDLSTs (Antonia, Carmen, María, Ana, Itzpapalotl, and Juan) enacted the four tenets of dual-language education, the IPAE, as they applied to the science learning environment. Each tenet represented a theme with its own subthemes and codes around how CCDLSTs put into practice their critical consciousness.

The participants in this study engaged in a variety of pedagogical practices that created access to rigorous science curriculum for BLs both inside and outside the dual-language science classroom. Overall, the K-12 experiences of the CCDLSTs as BLs themselves influenced and

informed their approaches, their pedagogical practices, and their ideologies about the BLs they serve and for whom they advocate. In the end, because the four tenets are interconnected, the subthemes may have overlapped as they connect CCDLST practices to create equitable, safe, and democratic spaces for all BLs.

Chapter 5

Discussion, Recommendations, and Reflections

Initially, this study set out to articulate how teachers' ideological clarity impacted their pedagogy in creating access and equity in the dual-language science learning environment for BLs, as framed and organized according to Alfaro and Hernández's (2016) four tenets of dual-language education. To understand the experiences of CCDLSTs, a phenomenological design was employed. Research in the fields of science education and bilingual education has overlapped (Quinn et al., 2012; Stoddart et al., 2011). Similarly, the areas of dual-language education and CCTs have overlapped (Alfaro & Bartolomé, 2017; Alfaro et al., 2014). However, studies that examine all areas together continue to be limited, and for BLs there are unfortunate consequences to researchers not considering their combined impact. With the growth in the number of BLs in California, specifically in dual-language classrooms, a lens that unites these areas is critical. What follows are discussion, reflections organized by theme, and recommendations based on the findings from this study.

Developing Ideological Clarity

Critically conscious dual-language science teachers read the world before reading the word while teaching science for transformation and liberation to BLs in dual-language learning environments. The CCDLSTs in this study practiced ideological clarity by rejecting dominant ideologies that contribute to BL inequity in educational settings in general and as they relate to science specifically. As such, they explored, valued, and incorporated BLs' community cultural wealth (Yosso, 2005) and funds of knowledge (Moll et al., 2005) in their learning environments. Whereas previous scholarly work has focused on dual-language education with BLs (Gándara &

Hopkins, 2010; Guerrero & Guerrero, 2017), this study adds the intersection with science pedagogy from an equity stance.

The CCDLSTs were also clear on their purpose and articulated clarity in their ideological stance overall. Recalling Itzpapalotl's quote in the opening theme of Chapter 4, one of the three BL groups she taught in middle school had engaged in respectful dialogue about an environmental problem. While she recognized what the "amazing" moment meant to her, she knew her other two groups of BLs were not in the same dialogical space as this particular group. Although Itzpapalotl was proud of this moment she shared with her students, she also acknowledged with clarity the work needed to accomplish the same level of dialogue with her other BLs. The CCDLSTs accepted great moments with their students but always strived to do better by engaging in the constant process of growing and learning.

Likewise, CCDLSTs knew the importance of addressing pressing issues for local and global communities and taught science for transformation and liberation. Teaching for transformation and liberation required CCDLSTs to use an array of strategies and approaches. For instance, their own experiences as BLs in the K-12 system, as well as their teaching backgrounds, informed their pedagogy in their quest for ideological clarity. They were knowledgeable about science as a content area and constantly conducted research to strengthen their content knowledge and dual-language teaching practices, yet were also aware of literacy's transformative power in conjunction with science pedagogy. Many critical scholars throughout the years have considered the concept of literacy as transformative and having the potential to liberate (Cadiero-Kaplan, 2008; Darder, 2015; Freire & Macedo, 1987); however, this study built on prior work in how science, as a content area, was also used to transform and respond to oppressive practices in the science learning environment (Sammel, 2009). By their teachers

following this transformative approach, BLs saw themselves represented in science and as agents in making a difference locally and globally.

Practicing Pedagogical Perspective and Clarity

The CCDLSTs in this study planned and delivered bilingual and biliterate lessons where teachers and learners shared roles and co-constructed knowledge. Examples of shared roles included how CCDLSTs and BLs collectively prioritized current events related to scientific phenomenon, addressed local and global environmental issues, and practiced agency and advocacy. All CCDLSTs believed that problem-posing was key in the planning of units in their classrooms. Darder (2015) referenced Freire's problem-posing approach to education in the field of literacy, writing "he posited a problem-posing approach, anchored in dialogue and a radical principle of love, by which teachers and students can come to critically know [them]selves and the world" (p. 65). Furthermore, Darder (2018) categorized this approach as "the liberatory foundation for [Freire's] *methodology of conscientização*" (p. 131, italics in the original) where people are "critically engaged through a dialogical praxis of participation" (p. 132). In this study, CCDLSTs provided examples of problem-posing in the dual-language science learning environment that followed the same Freirean principles of love, hope, and dialogue.

The CCDLSTs and BLs engaged in the dismantling of hegemonic practices in science by acting as students, teachers, and researchers. As they were critically consuming information and data, a process guided by the CCDLST, both BLs and CCDLSTs built relationships with one another. Darder (2015) highlighted solidarity and the difference between teachers and students as a way to "embrace the powerful dialectic of teacher-student and student-teacher" because through these differences and tensions "teachers and students learn to construct knowledge together, discovering a powerful sense of oneness amidst difference even at the core of oneness"

(p. 57). At all moments throughout their time together, CCDLSTs and BLs were learning science content, planning to change the world, and discovering one another.

Creating Access for All in Dual-Language Science Classrooms

The CCDLSTs reclaimed and (re)created accessible science learning materials and environments for BLs with multilingual, scientific, and rigorous curriculum. One reason CCDLSTs must supplement curriculum is because, as Sammel (2009) reminded us, science has been a field that serves people of privilege and power and oppresses those without them. Ever since the arrival of the first White European colonizers, science has been a "socially constructed discipline that is temporarily situated and funded by those who have the resources" (Sammel, 2009, p. 651), and it has remained unneutral for centuries. To address the disparity, CCDLSTs co-created curriculum with BLs by planning topics for future study in their classrooms relevant to their local and global communities.

To create access for BLs, CCDLSTs had also reimagined science curriculum by deconstructing it and supplementing faulty and problematic curriculum. Various researchers have reported how politically and historically mandated curriculum has been faulty (Apple, 2004; Bartolomé, 2008; Darder, 2012; Kincheloe, 2008) and has hidden ways of oppressing groups of students (Darder, 2012; Elliott, 2008). Darder (2012) defined this hidden curriculum as a way "texts, workbooks, manuals, films, and other classroom artifacts utilized in American classrooms are implicated in producing, reinforcing, and perpetuating the dominant culture of privilege and power" (p. 21). This study builds on past research by providing examples of how CCDLSTs named their world (Darder, 2018) and supplemented science curriculum to stop perpetuating oppressive practices in science learning environments for BLs.

The CCDLSTs also used language to create access in the dual-language science learning environment. They were purposeful in providing opportunities for translanguaging that occurred during science instruction time, which gave BLs choice in language use as they made meaning of science content. Previously, scholars have studied different ways students use their linguistic repertoires during science instruction (Mazak & Herbas-Donoso, 2014; Poza, 2018; Stevenson, 2013). While Poza (2018) supported the idea of translanguaging in the science classroom as a tool, he also cautioned and reminded readers of the risks and that translanguaging should be employed through authentic and meaningful interaction. However, all CCDLSTs were purposeful in supplementing curriculum and used language choice with their BLs as a vehicle to acquire science content, avoiding Poza's pitfall.

Creating Equitable, Safe, and Democratic Spaces

The CCDLSTs engaged in a variety of practices to create equitable, safe, and democratic spaces where all learners could feel successful in dual-language science learning environments. For instance, CCDLSTs built community and respected diversity by spending time outside of instruction conducting home visits and learning about BLs, BLs' families, and BLs' communities. Ochoa's (1979) work on conducting community scans supported the recognition and integration of teachers, communities, and BLs' culture in the curriculum. One of the schools that employed a CCDLST had a system where food left from student lunches would go to families in need. Because this school's staff knew the families and was aware of their SES, they were able to create a system to support this specific student population. The CCDLSTs in this study provided multiple examples of how communities and cultures were integrated both during science instruction time and outside the classroom.

To create democratic spaces, CCDLSTs practiced equity in how they assessed BLs' learning. Most CCDLSTs shared they had rubrics they provided to their students before assigning a task. The BLs had opportunities to first see how they would be assessed, then provide each other with written feedback on assignment drafts using the same rubric. Finally, the CCDLST used the same rubric with personalized feedback to each BL to report final grades. Cox Suárez (2008) considered the concept of providing personalized, detailed feedback to students about their writing as an important part of the learning process. As practiced by CCDLSTs, providing individualized feedback is a practice in science instruction that can provide BLs with the opportunity to clarify their thinking about science.

The CCDLSTs and BLs engaged in dialogue to create safe and democratic spaces. For example, CCDLSTs used dialogue to engage with science content and to reflect on their own and with their BLs about their progress and learning. The dialogue process was evident across all CCDLSTs in their culminating tasks and how they engaged communities outside their schools to transform and improve their world, as seen in María's class. And because the BLs were in dual-language settings, they were able to develop their bicultural voice and engage in bicultural dialogue (Darder, 2012).

Although prior research in individual fields has documented teachers' experiences, the results from this study consider the intersectionality of the following areas as they manifest in the dual-language science classroom: critical consciousness, dual-language education, and science pedagogy. While this study contributes examples of how theories can be put into practice in the K-8 dual-language science learning environment, more research is needed that applies the critical model of examining how ideology informs a teacher's pedagogy (Alfaro & Hernández, 2016) and creates access and equity in the dual-language science classroom.

Implications

Findings from this intersectional research study can contribute to a better understanding of the significance of having critically conscious K-8 teachers in dual-language settings, and more specifically in teaching science for social justice. Data from this study provide examples of how CCDLSTs implementing the NGSS enacted their critical consciousness in the science learning environment. Given the adoption of the NGSS in 2013, now is a critical time to start implementing and introducing new ways of how we frame and teach science. The results from this study are especially relevant in California as in 2016 a ban on bilingual education was lifted with the passage of Proposition 58. Findings from this study also support new ways of framing multilingual education. As such, implications for policy, future research, and practice should be considered in conversations about the success of BLs and their CCDLSTs.

Implications for Policy

Next Generation Science Standards. The NGSS have been adopted and adapted by some states, including California. Moreover, the California Science Test (CAST), according to policy makers, presents the best way to assess student performance. Michelle Center, Director of Assessment, Development, and Administration Division at the CDE, addressed in a video how test questions for the CAST have been piloted to ensure the exam is a "valid, fair and reliable" way to assess students in California (CDE, 2017). Given that the majority of students in California are Latinx, and at least a third are BLs (CDE, 2018), the CAST has the potential of becoming another English literacy test that touches upon scientific phenomenon but perpetuates existing inequities in the education system. Furthermore, since the science test is only given in the fifth and eighth grades, schools as a whole may tend to disregard science until one of the two testing grades.

Policies need to be put in place that address the needs of BLs as the CAST is implemented. For example, professional development for teachers on teaching to the standards and learning the expectations for the CAST could be offered, especially for teachers of earlier grades as they prepare students to take the first statewide science assessment in fifth grade.

California Commission on Teacher Credentialing. Given the passage of Proposition 58, the CCTC needs to update its 2008 teaching authorization pathways. Currently, the "bilingual authorization" is listed under the "English learners" section (CCTC, 2018d). However, dual-language programs serve a larger population than students learning English. For instance, trilingual learners who speak indigenous languages are learning Spanish and English as second and third languages. Also, there are children whose home language is English learning Spanish in dual-language classrooms. Because learning additional languages is an asset, perhaps CCTC could also change its credentials to reflect an asset view of language-learning and create a "Dual Language Education" credential or authorization that can be added under "General education authorizations" and that considers the qualifications of dual-language teachers instructing all BLs.

Implications for Practice

Teacher education programs. Recalling the long-lasting effects of California Proposition 227, many in the new generation of credential candidates were likely not exposed to bilingual education and are new to teaching in academic Spanish. Teacher education programs that focus on preparing Spanish/English dual-language educators should therefore teach content area methods courses in Spanish. Specifically, programs that prepare multiple subject teachers should offer instruction in Spanish given teachers' responsibility for teaching in a variety of content areas (e.g., math and science). Credential programs are ideal places where methods

instructors can model teaching content in Spanish and use specific instructional strategies that are successful in teaching BLs.

Furthermore, both the CA NGSS and the GPDL may serve as guides for dual-language and science teacher education curriculum. Teacher education programs should integrate these into credential classes through assignments and assessments. These recommendations would allow for newly credentialed dual-language teachers to gain exposure in implementing science education while following the three pillars of dual-language education: bilingualism and biliteracy, academic achievement, and cross-cultural understanding for all students (Howard et al., 2018).

Teachers. As the CA NGSS begin to be implemented, K-8 CCDLSTs could benefit from more practice in developing equitable science units that center around problem-posing (P. Freire, 2000) and delivering lessons that incorporate other content areas to promote BLs' success. Given how time-consuming it is for CCDLSTs to create and translate materials, classrooms that practice equity should have appropriate materials in both languages of instruction. As BLs are investigating scientific phenomena in a democratic space, they will naturally pick up the language of science, whether in English or Spanish, and select the language of their choice to learn science content. Since they are making meaning of their investigations, language selection is not as critical to learning content. CCDLSTs may allow translanguaging by not policing language (Poza, 2018). Ultimately, teachers are preparing bilingual and biliterate students who can purposefully navigate between two languages; otherwise they are simply preparing double monolinguals in undemocratic dual-language science learning spaces.

Administrators of dual-language schools. Given the many factors that play a role in successful dual-language programs, school-wide support is critical for the success of dual-

language schools. School and district administrators can provide ongoing professional development opportunities for teachers, especially those who have recently graduated from credential programs. These professional development opportunities can address the areas of critical pedagogy in dual-language classrooms, as well as reading, implementing, and planning to the CA NGSS while following the GPDL. Also, professional development should be attended by administrators since they, too, must be knowledgeable in all areas that support a successful dual-language school.

Teacher education programs and teachers. Cooperation between universities and districts when selecting student teacher placements is crucial as it provides an example of what good teaching may look like to the student teacher. Teacher education programs can create and foster relationships with local dual-language schools and districts that will allow for ideologically and pedagogically aligned student teaching placements where CCDLSTs are implementing the NGSS. These placements would expose teacher candidates to quality dual-language environments and equitable approaches to science education. As Clarke, Triggs, and Nielsen (2014) suggested from their review of the literature on cooperating teachers, student teachers have commented on their critical influence on novices entering the teaching profession; cooperating teachers have acknowledged this influence as well. Moreover, TEPs and teachers can also build partnerships with community organizations. These could be centered around science and the environment or on embracing diversity, which aligns with the findings of this study of collectively addressing local and global issues as they relate to the IPAE framework and social justice lens.

Furthermore, CCDLSTs themselves can be aware of and foster community partnerships that will enhance their pedagogy. As evident in this study, Itzpapalotl spent some of her

weekends visiting community organizations to bring "expert" visitors to her BLs. Since CCDLSTs are preparing the next generation of community leaders, it is important for them to collaborate with existing community organizations to address the needs of BLs. In partnerships with local universities, BLs and CCDLSTs can share learning environments like laboratories with faculty and/or university students. Undergraduate and graduate students can organize science days and visit local elementary and middle school students to co-construct knowledge about a particular area of science that interests them. And depending on the diversity and demographics of the community, this is work that can be done in various languages. Lastly, TEPs can serve as university liaisons and connect faculty who can serve as guest speakers at their local K-8 schools, sharing and co-constructing knowledge with teachers and students.

Implications for Research

Ideological clarity. Ideological clarity, the first tenet of the IPAE framework (Alfaro & Hernández, 2016), is an area that future research should consider, especially the role of ideological clarity of dual-language administrators, teachers, and teacher educators as they serve BLs. Given the California K-12 Latinx bilingual student population and its SES, almost all of these students fall below the poverty line. Teachers may hold biases about the capabilities of this particular group of students in the classroom. Therefore, educators need clarity to persist in economically disadvantaged environments. One potential study could look at persistence of teachers who have been identified as seeking, and not seeking, ideological clarity, as defined by various authors (Alfaro, 2008, 2017; Alfaro & Bartolomé, 2017; Alfaro & Hernández, 2016). And since students are the ones most impacted, BLs' perspectives should also be sought and considered when examining the role of ideological clarity. This suggested study could also ask BLs about how their teachers make them feel valued or how their cultures are valued in class.

Similarly, the GPDL, although a crucial guide for all dual-language programs at any stage of development, are missing this important piece of dual-language teachers' ideological clarity. A suggestion would be to research on how to infuse Alfaro and Hernández's (2016) IPAE framework as a lens within the GPDL. This could be incorporated to the fifth strand, "Staff quality and professional development," in the first principle that discusses the recruitment and retention of high-quality dual-language staff.

Funding. More research is needed to determine if and how reallocation of funds towards bilingual/biliterate materials, technology equipment, and professional development would support CCDLSTs as they teach for social justice using NGSS-aligned lessons. The CCDLSTs in this study were committed to serving BLs and their communities and spent significant time translating and creating differentiated, accessible materials in Spanish. Additionally, they supplemented curriculum to make it culturally relevant, while ensuring their lessons were aligned to the CA NGSS. Future research could consider how funds for Spanish language materials would make a difference in how dual-language teachers allocate their time to better serve their students.

Given the new era of computer tests, technology also plays a role in creating equitable spaces. Since the CAST is tested on computers, teachers and students must have access to technology in preparation for the state tests because familiarity with these tools increases equity across SES. Affluent students who may have computers at home gain an unfair advantage that the 91.6% of Latinx BLs do not have (CDE, 2018). However, simply having the equipment might not be enough because although teachers can have the technology, like SmartBoards or iPads, they may not know how to use it; that investment is not maximized. Purchasing materials without proper training is a disservice to BLs and their teachers.

As such, professional development and funding in multiple areas could be researched to determine which investments result in better outcomes for BLs. In addition to technology training, ongoing professional development in planning NGSS-aligned units could help teachers prepare BLs for success on the CAST; however, teacher professional development around science lessons aligned with social justice science could prepare BLs beyond what the state test assesses. If the goal is to have democratic, just, and equitable environments for all students, teachers need continuous professional development beyond their preparation in teacher credentialing programs.

Critically conscious teachers in other contexts. Because this study is particular to the Spanish/English dual-language science learning environment in California, future research may consider how the experiences of critically conscious dual-language teachers compare and contrast across various languages, program types, and content learning environments. For example, research may consider what teaching critically conscious dual-language math looks like, as well as other content areas like history or art. Also, researchers may consider what critically conscious teaching looks like across different grade levels from preschool and transitional kindergarten through the end of middle and high school. Another difference to consider relates to the language learning environment (i.e., various dual immersion models). Would there be a difference in the way CCDLSTs teach science in 90/10 models versus 50/50 models? What would the ideal pipeline look like for BLs across their entire P-20 careers? Although the themes with regard to pedagogy and instructional practices that emerged from this study may be applied to other languages and content areas, more research is needed that can document the experiences of CCTs teaching in dual-language programs, in languages other than Spanish, and in other contexts.

Next Generation Science Standards in Spanish. Future research may also consider if translating the NGSS to Spanish is a worthwhile investment of time to support dual-language teachers. In 2013, the Common Core en español were officially launched at the National Association for Bilingual Education (NABE) conference in Orlando, Florida (Ada, Campoy, & Dorta-Duque de Reyes, 2013). To determine if the NGSS should be translated into Spanish, or other languages, future research could examine the effectiveness of the Common Core en español to determine how to move forward; in other words, what has worked? Through interviews, the experiences of dual-language teachers who plan lessons using the Common Core en español could be compared to those of dual-language teachers unaware of the translated standards. For those previously unaware, the translated standards could be provided with professional development, and then follow-up interviews could inquire about the difference in having the translated standards. The NGSS en español could begin by creating a set terminology that connects to the CA NGSS so teachers may have standardized science terms in Spanish across the state.

Geographic region. Lastly, future research may expand to different regions of the United States. Student and teacher demographics vary depending on region and proximity to the United States- México border. Therefore, experiences of CCDLSTs and BLs will differ based on geographic location. Also, the challenges CCDLSTs encounter need to be researched; no matter how critically conscious the teacher, if a CCDLST is teaching in a school or district that does not prioritize science as a content area, and if the school or district is not known for practicing critical consciousness, does not believe in dual-language, or is indifferent about the research, BLs will be at a loss for quality education in equitable learning environments.

Limitations of the Study

The following section focuses on three main limitations related to this study: (a) sample population, (b) collection techniques, and (c) research design and researcher bias.

First, participant selection was difficult given the small number of teachers who openly implement a critically conscious pedagogy, teach in schools with Spanish/English dual-language programs, teach NGSS-aligned curriculum, and teach science in Spanish. Given the limited population, only six CCDLSTs from five different schools participated in this study, representing three school districts in the southern California border region. Given the purpose of the study in documenting the experiences of CCDLSTs, a sample of six participants was adequate to provide depth. Because two districts were within 20 miles of the United States border with México and the other district within 50 miles, location adds to the limitation of the study being context bound. Also, the majority of the participants were female, which could be viewed as a limitation, but also reflects the teacher gender demographics in California (Gándara et al., 2005). This study only considered Spanish and English dual-immersion programs.

Second, there were limitations related to collection techniques for this phenomenological study. Since the sample only included those who experienced the phenomenon and who were identified by experts as practicing a critical consciousness, selection bias was in effect. Also, the current study did not include the experiences of dual-language science teachers who do not consider themselves critically conscious or who are emerging as critically conscious dual-language science teachers. However, given the benefits of having information-rich cases (Patton, 2002), the advantages outweighed the drawbacks. Although pictures and images were used in field notes and data collection, they were not the primary data source. Perhaps visual data

methodology would have added another interpretation of the IPAE tenets as reflected in pedagogical practices and student work.

Third, researcher bias is a limitation given that qualitative researchers "are not passive receptacles into which data are poured" (Charmaz, 2014, p. 27). In this study, the researcher had first-hand insight on what it is like to be a CCDLST and experienced the frustrations of creating and translating science materials. Furthermore, as the researcher was a Spanish-speaking immigrant and former K-8 Spanish dual-language science teacher, many assumptions were made between the CCDLST participants and the researcher about what knowledge to share and report during semi-structured interviews. Some potential assumptions related with my experiences as a science dual-language educator, such as having an understanding of the process of translating and creating materials. Also, for those participants who were familiar with my journey as a K-8 educator, the assumption that I understood what it was like to have a supportive and unsupportive administration, they could have shared experiences that empathized with mine or that the CCDLSTs thought I might want to hear.

Recomendaciones y Últimas Palabras

The purpose of this study was to explore and document the experiences and practices of CCDLSTs through four tenets of dual-language education: ideology, pedagogy, access, and equity. The findings demonstrated the various themes and subthemes that allowed for CCDLSTs to best serve and co-construct knowledge with their BLs. This study's main contribution is providing a portrait of what it looks like to teach for equity and social justice in a dual-language environment during science instruction aligned with the NGSS. The main highlight is that CCDLSTs created and designed lessons with the ultimate goal of impacting global and local communities and instilling in their BLs a sense of agency and independence to make changes to

their world and their reality. So long as teachers have a critical mind and are provided the right spaces and materials to exercise their critical consciousness to reach ideological clarity, K-8 BLs will be empowered to change current STEM demographics in higher education but most importantly, will be able to change their world by manifesting the four tenets of dual-language education: ideology, pedagogy, access, and equity.

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Appendix A

Table 1: DLE Teacher's Examination of Critical Consciousness

IPAE Tenets of DLE	Don't be afraid to ask yourself the tough questions
Ideological Clarity BEACON Teacher announces or denounces teaching for equity and social justice.	• What beliefs, values, and epistemological theories inform my thinking? • What are the political, social, cultural, linguistic, gendered, and emotional circumstances in which I have learned? • Do I have the courage to speak up for the benefit of my students? • What kind of teacher do I want to be? • What do I want my students to know and do well? • What kind of changes do I need to make to my teaching that will enhance my students' bicultural identity and biliteracy development?
Pedagogical Perspective and Clarity CLARITY Focusing on critical consciousness	• What core values and research inform my practice? • What messages do I send to my students? • How do I demonstrate respect for my students' cultural and linguistic wealth? • Have I created a dialogical classroom environment or do I deposit knowledge? • Do I build on my students' assets/funds of knowledge? • Do I honor my students' non-standard language use while teaching standard language? • Do I co-construct knowledge with my students?
Access for All ACCESS FOR ALL How language and power fit into the DLE classroom.	• Who is getting my attention? • Am I strategically creating universal access for all students? • Who do I call on first to answer questions? • Who are my thriving students? • Who requires additional scaffolding? • Am I watering down the curriculum? • Am I applying rigor and high expectations for all learners?
Equitable Spaces core IPAE Equity is the core of IPAE	• What kind of language role model am I, honestly? • Who is dominating class discussions? • How am I navigating the status of languages and cultures in the classroom? • How is English perceived by my students? • Are some of my students conforming to subordinate roles? Why? • How am I keeping the students engaged in the language of instruction (e.g., Spanish)? • How are assessments positioning languages in my classroom? • How are school or classroom activities influencing the power of the dominant language or group?

Appendix B

Interview and Classroom Observation Consent Form

You are being invited to participate in a research study titled "A Critical Examination of Dual-language Science Educators: Ideology, Pedagogy, Access, and Equity." This study is being done by Melissa A. Navarro, Ph.D. candidate and bilingual science methods instructor from San Diego State University (SDSU). You were selected to participate in this study because this academic year, you are teaching science in a K-8 Spanish dual-language setting.

The purpose of this research study is to examine and document how critically conscious dual-language science teachers practice equity in their classroom through their teaching of science. If you agree to take part in this study, you will be asked to participate in two interviews and one classroom observation. During the first interview you would be asked 7-10 questions about your teaching background, your teacher education program and your experience and ideas about teaching science and incorporating social justice in general. The second interview and science lesson observation would be on the same day, based on when you will be teaching a science lesson. This second interview will consist of 14-18 questions related to your ideology and pedagogy as it relates to teaching science in the classroom and creating equitable spaces for your students.

You will not directly benefit from this research; however, your participation in the study may improve future teacher education.

There is a potential risk for discomfort while answering interview questions. The questions are based on your own opinion, and there is no wrong or right answer. Should you become uncomfortable you are free to skip any question that you choose or may quit the interviews at any time by letting me know prior to either interview/observation or during the interview/observation.

To the best of my ability, your answers in this study will remain confidential. Any information that would be used to identify you will be kept in a handwritten notebook log, locked in a cabinet that will be destroyed upon study completion. At this point, a pseudonym will be assigned to you that will be used for study purposes. I will minimize any risks to breach of confidentiality by continued usage of the pseudonym. De-identified data will be kept in a password protected laptop computer. Research records will be kept confidential to the extent allowed by law and may be reviewed by SDSU's Institutional Review Board.

Your participation in this study is completely voluntary and you can withdraw at any time.

If you have questions about this project or if you have a research-related problem, you may contact the researcher, Melissa A. Navarro (619) XXX–XXX; email: XXXXX@gmail.com. If you have any questions concerning your rights as a research subject, you may contact the SDSU Division of Research Affairs at (619) 594-6622; email irb@mail.sdsu.edu.

Your signature below indicates that you have read the information in this document and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to be in the study and have been told that you can change your mind and withdraw your consent to participate at any time. The investigator has provided you with a copy of this consent for with information about who to contact in the event you have questions.

_____

Name of Participant Date

Signature of Participant Date

Signature of Investigator Date

As part of this project, an audio recording will be made of you during your participation in this research project. Please indicate below with your initials if you are willing to consent for this audio recording to be studied by the researcher, Melissa Navarro, for use in the research project. You have the right to request that the recording be stopped or erased in full or in part at any time.

Participant Initial: _____

Appendix C

Recruitment Letter

Announcement!

I am looking for K-8 teachers who hold a multiple subject credential with Spanish authorization and meet the following criteria during Fall 2017/Spring 2018:

- Experience teaching in Spanish dual-language classrooms
- Hold multiple subject credential with bilingual authorization
- Experience teaching science in Spanish (current or prior)
- Currently teaching in a K-8 classroom
- Teaching science lessons this fall (preferably in Spanish)

You will be asked to participate in two interviews and one science lesson observation. During the first interview you would be asked 4 questions about your teaching background, your teacher education program and your experience and ideas about teaching science and incorporating social justice in general. The second interview and science lesson observation would be on the same day, based on when you will be teaching a science lesson. This second interview will consist of 12 questions related to your ideology and pedagogy as it relates to teaching science in the classroom and creating equitable spaces for your students.

The research study should take you approximately 30 minutes for the first interview to complete and approximately 40 minutes for the second interview. The classroom observation will be as long as your science lesson is. I will not be interfering with the lesson; my role would consist of sitting in a location of your choosing and taking notes.

Participation in this study is voluntary. Your choice on whether or not to participate will not influence your future relations with San Diego State University. If you decide to participate, you are free to withdraw your consent and to stop your participation at any time by letting me know over email prior to the start of the study, or in person during any portion of the study (interviews or observation).

If you are interested in participating, please send me an email or call me to schedule the first interview. I will be happy to answer any questions about this study if you have them.

Any questions regarding the study can be emailed to the Principal Investigator Melissa Navarro (email: [redacted]) or addressed by calling [redacted].

Thank you for your time and attention.

Melissa A. Navarro
SDSU/CGU Joint Ph.D. Program in Education

Appendix D

Critical Transitive Consciousness in Science Pedagogy

Critical transitive consciousness	"…characterized by greater dialectical depth in our interpretation of problems and the world, increasing our capacity for critical engagement, the problematizing of commonsensical notions and conditions, an openness to enter into the practice of critical reflection and dialogue. The process . . . is propelled through participation in critical dialogue and ongoing emancipatory actions, in the name of social transformation" (Darder, 2015, p. 83).
Teaching Strategies	• Teacher raises questions or problems and elicits responses that uncover students' current knowledge about the concept/topic • Teacher observes and listens to students as they interact and acts as a consultant for the students • Teacher encourages students to explain concepts and definitions in their own words • Teacher asks for justification (evidence) and clarification from students • Teacher encourages students to apply concepts and skills in new situations • Teacher asks open ended questions • Teacher observes students and gathers evidence of student understanding • Teacher provides a variety of assessments (NRC, 2015; Spiegel, 2013)
Student Behaviors	• Students read from multiple sources, including science-related magazines and journal articles and web-based resources while developing summaries of information • *All* students engage in sophisticated science and engineering practices • Students listen critically to, and question, other explanations • Student write in journals to record information • Students create reports, posters, and media presentations that explain and argue • Students learn facts and terminology *as needed* while developing explanations and designing solutions supported by evidence-based arguments and reasoning • Students discuss open-ended questions that focus on the strength of the evidence used to generate claims and make conclusions from evidence • Students conduct investigations, solve problems, and engage in discussions with teachers' guidance • Students engage in multiple investigations driven by students' questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas • Students draw reasonable conclusions from evidence • Students give each other feedback, evaluate their own progress and may check their work with a rubric (NRC, 2015; Spiegel, 2013)

Appendix E

First Interview Questions

1. Why did you decide to become a bilingual teacher?
2. In your teacher credentialing program, how well prepared did you feel to teach science in general?
    a. Science in Spanish?
    b. Standards (NGSS) (whether PD or TEP)
3. Imagine the science classroom of your dreams (hypothetically)
    a. What are the students doing?
    b. What are you doing?
    c. What goes on in the classroom during a lesson?
    d. What kind of discussions/conversations would go on?
4. How do you define social justice?
    a. How do you incorporate social justice in your lessons?
    b. Can you provide me with examples of how you put this into practice?

Appendix F

Second Interview Questions

1. How do you define being a critically conscious teacher?
    a. Can you provide an example?
    b. Does this definition change when you consider your role as a DL teacher?
        i. Why or why not?
    c. Does this definition change when you consider your role as a science teacher?
        i. Why or why not?

Ideological Clarity

2. What beliefs, values and experiences inform your teaching of science?
3. Describe your dream dual-language science teacher
    a. Is this the type of science teacher you aspire you aspire to be?
    b. What steps do you need to take to being this science teacher?
4. What do you want your students to know and do well in science?

Pedagogical Perspective and Clarity

5. What core values, research, and experiences inform your practice in teaching science?
6. Describe the steps that you have taken to create a dialogical classroom environment?
7. Do you co-construct knowledge with your students during science instruction? (co-constructs means…)

Access for All

8. How do you ensure that your students are receiving a rigorous science curriculum?
9. How do you hold high expectations and differentiation for all learners?
    a. Can you provide an example?

Equitable Spaces

10. How do you address students who tend to dominate science discussions?
11. How do you address cultural and linguistic diversity within your science lesson?
12. In your opinion, is the issue of language status something that concerns you, Spanish vs. English? If so, how do you address it?

Appendix G

Themes and Subthemes of Theme 1: Ideology

How do CCDLSTs practice developing their **ideological clarity** in relation to science pedagogy?

1. Valuing bilingual learners' backgrounds
    a. Gender, race, SES (social capital)
    b. Students are culturally represented in the classroom (resistant capital)
    c. Accesses student prior knowledge for planning (navigational capital)
    d. Has high expectations/aspirations for all students (aspirational Capital)
    e. Knows and values families (familial Capital)
    f. Language background (linguistic Capital)
2. Teaching Science for Transformation and Liberation
    a. Teacher background
    b. Teaching Strategies
    c. Content knowledge
    d. Research
3. Reading the scientific world before reading the word
    a. Reading the local community
    b. Reading the global community
4. CCDLST practice and praxis
    a. Knowledge
    b. Advocacy
    c. Agency

Appendix H

Themes and Subthemes of Theme 2: Pedagogy

How do CCDLSTs practice **pedagogical perspective and clarity** in the science classroom?

1. Teaching and learning with bilingual learners
    a. Teacher as a researcher
    b. Teacher as a student
    c. Teacher as a student guide
2. Planning for teaching and learning with bilingual learners
    a. Unit goals in mind
    b. Teacher constructed/developed curriculum
        i. Cross content / interdisciplinary
        ii. NGSS
    c. Teacher priorities
    d. Teaching Strategies
3. Learning as bilingual learners – the biliteracy process
    a. Student as a researcher
    b. Student as a teacher
    c. Critical consumers of information/data

Appendix I

Themes and Subthemes of Theme 3: Access

How do CCDLSTs create access for all students of various cultural and linguistic repertoires in terms of curriculum, instruction and materials in a science class?

Supplementing and Creating Critical Curriculum

1. Teacher Created
    a. Considers geographical location (in relation to school)
2. Textbook Enhancement (filling in the gaps)
    a. Incorporates "differences" to teach respect of diversity
    b. Considers student background and interest to provide access to concepts
3. Teacher cultural wealth to provide access
    a. Storytelling
    b. Religion

Instructing Bilingual Learners With Rigorous Curriculum

1. The role of time
2. Teacher goals consist of
    a. Student choice
    b. Make content/language accessible through differentiation
    c. Providing students with access to future paths
    d. Teacher makes use of various languages to provide access
    e. Space during instruction with language brokers
    f. Access to innovative and creative learning spaces
    (Students have access to spaces where they can own their learning
3. Biliteracy/bilingualism/biculturalism
    a. Students have space to build their biliteracy/bilingualism/biculturalism

Reclaiming and Recreating Access to Bilingual Materials

1. Students have access to tangible materials
2. Teacher has access to financial support
    a. One-to-one technology
    b. Curriculum preparation
    c. PD Teacher applies for grants for materials
3. Class materials are in more than one language
    a. Videos from different parts of the world
    b. Posted sentence frames for different purposes
        i. Content
        ii. Reflection
        iii. Collaboration

Appendix J

Themes and Subthemes of Theme 4: Equity

How do CCDLSTs create equitable, safe, democratic spaces that examine group membership and balance language status in the science classroom?

Equitable Space

1. All students are valued and have the opportunity to learn and to persevere
    a. Cultural background
        i. Teachers create space where all students are valued for what they bring to the classroom (funds of knowledge?)
        ii. LGBT families
    b. Language background
    c. Religious background
    d. SES
        i. Poverty
    e. Gender
2. Group membership
    a. All science fields are treated equitably
    b. All students' can BE in science (potential in the field of science?)
    c. All students' needs are met
    d. All students' engage in critical dialogue
        i. Especially those who haven't shared (teacher keeps track)

Safe Space

1. Community Circles and classroom culture
    a. Respect
2. Diversifying Spaces for instruction
    a. Physical
    b. Purposeful grouping

Democratic Space

1. Teacher assessment
    a. Rubrics
    b. Teacher check in
        i. Walking around
2. Dialogue
    a. All students voices are valued
        i. Teachers have various ways to ensure all students voices and opinions at the center
    b. Dialogue about
        i. Content
        ii. Emotions
        iii. Mindset
        iv. Reflections