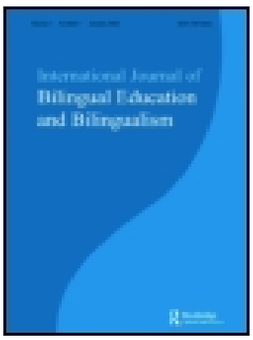

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Ciencias bilingües: how dual language teachers cultivate equity in dual language classrooms

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ABSTRACT

The purpose of this study is to document 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 paper is informed by the fourth tenet and research question: How do CCDLSTs create equitable spaces in science learning environments? 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 an understanding of what CCDLSTs are doing in classrooms to draw upon the assets of BLs while implementing the Next Generation Science Standards (NGSS). A phenomenological qualitative design was used to gather interview and observational data of how six CCDLSTs working in Southern California public schools employed a critically conscious pedagogy in a Spanish/English 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 to create equity while teaching science in dual language classrooms.

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Equity; critical consciousness; dual language; bilingual teachers; science education; critical pedagogy

Introduction

Students who bear the label 'English language learners' (ELLs), as I did for many years after immigrating to the United States (US) from México in the sixth grade, are frequently underserved (Callahan 2005; Olsen 2010) and viewed by educators, administrators, and policymakers through a deficit lens due to their inability, as the label suggests, to communicate 'well' in English. Despite the fact that they may be proficient in one or more languages, ELLs are repeatedly placed in classrooms where the urgency is for them to learn English quickly at the expense of content areas such as art or science (Gándara and Hopkins 2010). However, schools that follow dual language (DL) program models, programs in which the native and partner language should maintain equal status in the classroom, can serve as ideal learning environments when implemented correctly (Alfaro and Hernández 2016). DL programs allow for equitable classrooms, ones where students, regardless of their background, have access to various content areas and are not solely focused on English language development. In other words, DL programs provide access to powerful learning for all students due to their ability to develop bilingual, multicultural, and biliterate students (Baker 2011; Howard et al. 2018). Consequently, DL teachers have the responsibility of teaching language, literacy,

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and content in English and a partner language, such as Spanish, as is the case in this study. However, in the US, policies vary across states, and teachers are prepared differently to address students who are developing their biliteracies and learning content simultaneously.

In the US, each state is constitutionally responsible for educating its students in grade levels K-12, therefore, states have the liberty to enact their own education policies (Umansky 2018). In 2018, Dr. Tom Torlakson, State Superintendent of Public Instruction, announced an initiative called 'Global California 2030,' promising a multilingual California by the year 2030, possibly the most impactful to the over 40% of K-12 students who already have experience with at least two languages (CDE 2020).

As part of its mission, Global California 2030 plans to provide over half of all K-12 students with opportunities to be proficient in more than one language 'either through a class, a program, or an experience' (CDE 2018, 5). Something to consider is that to implement a successful DL program, equity-minded, well prepared bilingual/biliterate teachers are needed (Alfaro and Bartolomé 2018). To reach its goal, the California initiative advocates for 'more bilingual teacher education programs' by working with universities and investing 'in professional development resources for teachers and administrators to build capacity to deliver high-quality, effective biliteracy instruction' (CDE 2018, 9).

Since 2016, after California's citizens voted in favor of Proposition 58 eliminating oppressive language policies, there has been an abrupt growth in DL programs in the state, and with it, a growing need for bilingual and biliterate teachers (Santibañez and Luschei 2018; Umansky 2018). Bilingual teacher education programs in California are producing bilingual teachers; however, the number of teachers has not grown quickly enough to meet their demand (Harris and Sandoval-González 2017). Even still, newly credentialed bilingual teachers are not necessarily prepared to teach in DL programs, especially when considering teaching content such as science in a language other than English (Navarro Martell 2018). Building off these concerns, this study examines how a particular group of dual language teachers cultivates equity in dual language classrooms.

Review of the literature

Growing dual language teachers

In the bilingual teacher education field, ample research supports the fact that DL teachers need to have a specific skillset, language, and literacy to be able to teach content in two languages, but it is not always the case that they leave their bilingual teacher education programs and enter the teaching field with that particular skillset (Alfaro et al. 2014; Howard et al. 2018). Thus, faculty working in bilingual teacher credentialing programs have a very challenging job. When preparing teacher candidates to work with bilingual learners (BLs),[1] teachers need to develop different knowledge, disposition, and skillsets *prior to* having their own classroom and students. For example, the Department of Dual Language and English Learner Education at San Diego State University prepares DL teachers and describes five elements its program graduates should be able to demonstrate: (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 (e) global (linguistic and cultural) competence (Alfaro et al. 2014).

Another aspect of teacher education involves preparing teachers to be accountable for teaching *all* students in their classroom by drawing on the assets of their BLs and their communities. These assets, or funds of knowledge (Moll et al. 2005), are valued and sought out in the DL classroom. DL teachers know their BLs and their communities and see them as a collective of community cultural wealth (Yosso 2005), which is recognized and welcomed in the classroom. Regardless of the student's and teacher's cultural background and race/ethnicity, multicultural BLs are better served by teachers who understand and value their diversity as an asset (Alfaro and Bartolomé 2017; Bartolomé 2008; Darder, Torres, and Baltodano 2017). However, before teachers can connect with

students, they need to understand their own identities by analyzing and reflecting on what informs their ideologies (Alfaro and Bartolomé 2017; Bartolomé 2008; Salinas and Blevins 2013).

When looking at DL teacher education in subject areas separately, science is an area that is not prioritized, especially in teaching children from vulnerable backgrounds in the lower grades (Navarro Martell 2018). The combination of inadequate DL teacher education and minimal professional development opportunities in newly released science standards and pedagogical approaches to teaching science to younger children contribute to inequities in language supports and science education for children in K-8 (Navarro Martell 2018). Besides language and literacy, K-8 DL teachers also need to deeply reflect upon what informs their ideologies to create equitable spaces for all children to learn in DL settings in general (Alfaro and Hernández 2016), but in science specifically (Navarro Martell 2018). Such a need is beginning to be addressed as there is a growing number of critically conscious, dual language, science teachers (CCDLSTs) who are actively working to address these language and science inequities (Navarro Martell 2018).

Cultivating critically conscious teachers

To create equitable learning spaces during science, DL teachers need to be critically conscious while teaching all students, especially students who are learning content and language simultaneously. Drawing from critical race theory (Solórzano 1997; Yosso 2005), critical pedagogy (Apple 2017; Freire 2000; Giroux 2017; McLaren 2017) and praxis (Darder 2015; Freire 2000), Valenzuela (2016) defined critically conscious teachers (CCTs) as the new generation of teachers with the courage and intelligence to stand up against injustices from a cultural- and community-oriented standpoint. 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. Not only is the CCT an agent of social change (Biesta, Priestley, and Robinson 2015), but the CCT also prepares students to be self-advocates, agents of social change and to engage in the transformation of education (Pantić 2015). As such, the CCTs must be strategic in addressing inequities to transform the school setting to serve diverse BLs, families and their communities (Douglas and Nganga 2017).

Due to its explicit purpose of fostering bilingual, biliterate and multicultural students (Howard et al. 2018), a DL classroom provides the ideal context – one that allows space for CCTs to incorporate BLs in a learning environment explicitly designed for their learning and prioritizes individual and class needs (Darder 2012; De Jong 2016). Thus, one-way teacher education programs in general, but those preparing DL teachers specifically, can increase the number of CCTs is by preparing more equity-minded DL teachers. But before informing teacher education programs, the pedagogical approaches and practices of CCTs must first be revealed. For instance, during designated science time, K-8 CCDLSTs can be instrumental in ensuring BLs are fully integrated into their classrooms, while developing language and understanding scientific concepts.

CCTs know their students and communities because they either live in the community or have learned about the community. Accordingly, CCTs serve as advocates for all students and their families, which is especially important when they are members of underserved populations (Alfaro and Bartolomé 2017; Gonsalves 2008) such as those related to language, sexual orientation, gender identification, socioeconomic background, immigration status, and other social justice considerations present in schools with high levels of language learners (Page 2017; Pérez 2011; Umansky 2018). CCTs must engage in the practice of reflection to be able to confront deficit personal/institutional practices and to better serve culturally, economically, and linguistically diverse learners (Jimenez-Castellanos 2010; Salinas and Blevins 2013). Lastly, CCTs are aware of BLs' needs and are able to address them in varying learning environments. Taken together, teachers must engage in the politics of education and see themselves as critical educators ready to challenge and transform the status quo approaches toward pedagogy and schooling practices into equitable and just

learning environments (Alfaro and Hernández 2016; Cadiero-Kaplan 2008; Darder 2012, 2015; Valenzuela 2016).

K-8 science education and teachers

California adopted the "*Science Content Standards for California Public Schools*" in 1998, the same year the damaging Proposition 227 passed, aiming to provide a 'world-class science education for all California students' (CDE 2003, vii), claiming that content was 'attainable by all students, given sufficient time, except for those few who have severe disabilities' (vi). When analyzing the last two decades of California's science test scores, these science standards failed to accomplish their goal while neglecting the needs of diverse students, and not just 'those few who have severe disabilities' (vi). Scholars have since criticized political administrations' failed attempts to recover public education through mandated curriculum (Bartolomé 2008; Elliott 2008; Kincheloe 2008). And because significant breakthroughs in science were made post-1990s about how people learn science, a movement began towards developing the Next Generation Science Standards (NGSS; NGSS Lead States 2013a).

The NGSS were created with the intention of having teachers teach science with an inquiry approach, providing students with opportunities to conduct purposeful investigations around scientific phenomenon (Aguilar-Valdez et al. 2013; Bybee 2013; Quinn, Lee, and Valdés 2012). To implement the NGSS, K-8 teachers should have the ability to read and understand them. However, support of district personnel and administrators is necessary to obtain resources that provide access to science content, especially when content is delivered in a language other than English. If the goal of a science lesson is to understand 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 in the form of translanguaging[2] (García 2015; García and Wei 2014) assists in the meaning-making process. Stevenson (2013) cautioned teachers to be intentional in creating the scaffolds, spaces and opportunities for BLs to develop a rich vocabulary. Likewise, others have encouraged us to question what 'science' is, whose science is valued, and the role language, English particularly, has in defining science as a content area for the privileged (Mazak and Herbas-Donoso 2014; Sammel 2009).

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 and understanding science. In teacher education programs, K-8 teachers must be provided with opportunities to discover their identities as science educators by exploring their prior relationships with science (Avraamidou 2014a, 2014b; Kier and Lee 2017; Mensah and Moore 2018; Naidoo 2017). And while 'Appendix D' is an afterthought to making the NGSS accessible to all learners (NGSS Lead States 2013b), yet another level added to teaching to the NGSS entails teaching science for social/environmental justice to create globally conscious citizens. In terms of utilizing linguistic databases during science, scholars have addressed the intersection of science instruction and language usage in the form of translanguaging in the bilingual science classroom (Mazak and Herbas-Donoso 2014; Poza 2018; Stevenson 2013). However, in California the number of underprepared teachers teaching science is increasing at an alarming rate, revealing an important opportunity and need to rethink ways the field prepares CCTs in science (Carver-Thomas and Darling-Hammond 2017).

Conceptual framework

This study focused on documenting the experiences and pedagogical approaches of CCDLSTs and was conceptually grounded in Alfaro and Hernández's (2016) IPAE framework. Alfaro and Hernández (2016) proposed four tenets through which DL teachers can engage in the process of examining their critical consciousness with the ultimate goal of analyzing how their ideology informs their pedagogy in the DL classroom: (a) ideological clarity, (b) pedagogical perspective and clarity, (c) access for all and (d) equitable spaces. For each tenet, Alfaro and Hernández (2016) problem-

posed as teachers, schools and districts engaged in the process of questioning and reflecting on their pedagogy based on the 'tough questions' presented.

Figure 1 depicts the four IPAE tenets in diagram form. The figure centers the CCDLST surrounded by the tenets, linking to each other in a circular motion because of their fluidity and interconnectedness. The goal is for CCDLSTs to engage in the process of examining their critical consciousness via the IPAE framework while teaching science in a DL setting. Additionally, at the core of the IPAE tenets is the notion of creating equitable spaces – the central tenet guiding this study challenging CCDLSTs to maintain a balance of culture and language status in DL classrooms. Given the status and power of English in the US, critically conscious DL teachers must balance the power and status of *all* languages and respect language varieties, especially considering trilingual learners who may speak an indigenous language and learned Spanish and English, the language of colonizers, to communicate with others.

This paper is part of a larger qualitative study that examined and documented how CCDLSTs manifested the IPAE tenets in their classrooms as they created equitable learning opportunities for BLs (Navarro Martell 2018). While the larger study documented and reported on all four tenets, this manuscript focuses on equity and is guided by the research question: How do CCDLSTs create equitable spaces in science learning environments?

Methods, data sources and analysis

The focus of this phenomenological study was twofold: (a) to gain an understanding of how K-8-grade CCDLSTs in Southern California denounce inequities and promote educational opportunities

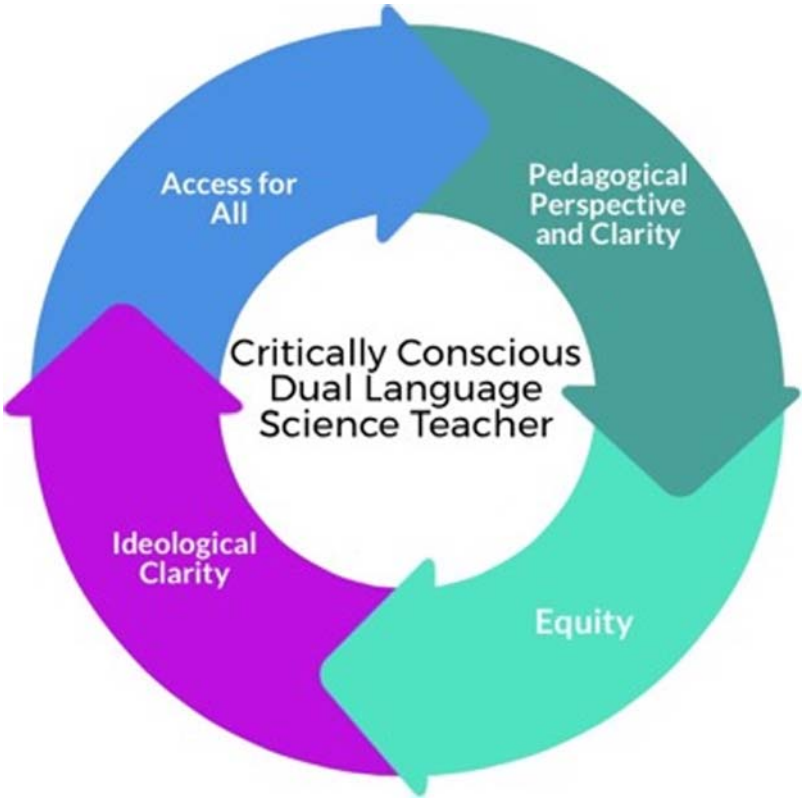

Figure 1. Four tenets of a dual-language science teacher's examination of critical consciousness.

and equitable spaces for linguistically and culturally diverse students, their families and communities and (b) to provide CCTs with a voice by focusing on their lived experiences as bilingual/bicultural educators serving BLs through an equity lens, one that encompasses social, racial, and language justice and access for all learners.

Drawing from Creswell's (2013) suggestion on qualitative phenomenological data collection methods, data collection in this study included classroom observations, field notes, analytical memos and multiple semi-structured interviews with the CCDLSTs. Participants for this study met the following criteria: (a) teaching in grade level K-8, (b) holding a bilingual multiple subject (elementary school) or single subject credential (high school), (c) teaching NGSS-aligned science and (d) teaching science in Spanish/English DL programs. Selection criteria helped ensure identification of information-rich cases (Patton 2002) of teachers who had experienced the phenomenon of teaching science in a Spanish/English DL classrooms and who could provide insights to better understand this phenomenon.

Six teachers who met the above-mentioned criteria were identified by experts in the field of DL education and critical pedagogy in the Southern California region. Both experts and CCTs recommended teacher-participants based on their understanding of a teacher encompassing the elements in the tool 'Critical Transitive Consciousness in Science Pedagogy' (see Appendix; Navarro Martell 2018). The interviews, an important tool for this phenomenological research study because it provided teachers a voice in the data, were conducted in the location and language the participants preferred.

Critically conscious, dual language, science teacher participants

Examination of Table 1 demonstrates that the majority of the teacher participants[3] self-identified as female, were in the age range of 25–39, held a multiple subject credential to teach K-8 grade levels and had been teaching 3–10 years. All CCDLSTs learned Spanish first and English as their second language. Additionally, all participants taught in Southern California near the border with México in schools with Spanish/English DL programs and most earned a master's degree. Three schools are located within 15 miles of the Tijuana/San Ysidro border, one is located within 23 miles, and the other within 45 miles. Two participants taught at the middle school level and four at the elementary school level. Six total classrooms in five different schools were visited to conduct classroom observations and interviews. Half the CCDLSTs taught at schools that had fully implemented a DL program, while the other half taught at schools that had a strand of DL. Three different districts are represented, two were charter schools, and all schools served a majority of students of color from low socioeconomic backgrounds.

Data analysis consisted of recognizing consistent interview themes using initial and focus coding and the constant comparative method to categorize codes into themes. Charmaz's (2014) 'initial coding' method was employed on interview transcripts to begin engaging with data.

Table 1. Participant demographics.

CCDLST demographics								
Participant	Grade-level taught	Gender	Age	1st language learned	2nd language learned	Self-identified race/ethnic background	Credential type	Teaching experience (yrs)
Antonia	8th	F	30–39	Spanish	English	Latino	SS	6–10
Carmen	1st	F	30–39	Spanish	English	Mexican	MS	6–10
Itzpapalotl	7th	F	25–29	Spanish	English	Latino/Pacific Islander	MS	3–5
Ana	2nd	F	25–29	Spanish	English	Latina	MS	3–5
María	4th	F	30–39	Spanish	English	Latina	MS	6–10
Juan	5th	M	30–39	Spanish	English	Latino	MS	3–5

Note: Credential type 'MS' is multiple subject and 'SS' is single subject.

Successively, 'focused coding' deductively grouped codes into four themes after the conceptual framework, IPAE, guiding this study (Charmaz 2014). Three primary methods were utilized to establish credibility and trustworthiness: peer debriefing, member checking and triangulation with field notes and analytic memos and interviews. The CCDLSTs had opportunities to clarify findings and how these were reported to ensure accuracy of themes and interpretation of interview transcripts.

Findings

Data are presented to construct an understanding that responds to the research question addressing how CCDLSTs created equitable spaces in science learning environments. Based on careful bilingual/translanguaged transcription, results were categorized by the way CCDLSTs created brave and democratic spaces – though there is overlap between these categories, some distinctions can be made. In the examples that follow, evidence is provided that demonstrates the various ways CCDLTs honored and valued their students during science instructional time and created access to science content in their Spanish-English DL learning environments.

Defining spaces

Equitable spaces refer to the general spaces, or learning environments, that were created by the CCDLSTs during designated science instructional time where BLs' cultural and linguistic backgrounds were valued and where all students had opportunities to teach, learn and grow from and with each other and their teachers. Within these equitable spaces, CCDLSTs developed *brave spaces,* as suggested by Arao and Clemens (2013). Unlike 'safe' spaces, brave spaces require risk-taking; 'authentic learning about social justice often requires the very qualities of risk, difficulty, and controversy that are defined as incompatible with safety' (139). *Democratic spaces* refer to the CCDLSTs' ability to create spaces, including modifying the physical space, where assessment and dialogue are presented in a way that includes, respects and honors the students.

Creating democratic spaces

Democratic spaces are those where CCDLSTs and BLs can be themselves and be evaluated according to their contributions to their learning environment. CCDLSTs used rubrics, fostered dialogue and modified the physical learning space as a way to build community and create equitable learning science environments. For instance, the two middle school teachers Antonia and Itzpapalotl provided rubrics during observation data collection as they and their students prepared and gathered evidence for assessing their assignments. In Antonia's eighth-grade class, BLs had opportunities to prepare their assignments according to the rubric (Figure 2).

On the assignment due date, BLs exchanged their homework and used the rubric to assess each other. While BLs were highlighting their partners' work for rubric evidence, Antonia walked around stamping work and visiting students to see how they were doing in general and in relation to their assignment. In this classroom, BLs used rubrics as they engaged in the task to peer evaluate, then Antonia used the same rubric to calibrate grades and provide individual feedback. Antonia's BLs were evaluated equitably and were familiar about the assignment expectation.

In democratic spaces, CCDLSTs had various ways to ensure all students' voices were centered and equitably valued. In preparation for a unit of study, Itzpapalotl presented a new topic to her students related to fossil fuels and the impact synthetic materials have on society. Together, the students and Itzpapalotl brainstormed ways the environment continues to be contaminated. Their final list consisted of seven topics: oil spills, pollution, rise in sea levels, acid rain, greenhouse effect, illnesses and solid waste. Then students were divided into seven groups according to each topic. BLs conducted research and created presentations to inform the rest of the class about their area 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 2. Antonia's rubric.

study. Itzpapalotl took the information presented by the students to create the assessment for that unit. After the presentations, students engaged in a hands-on engineering process to find a solution to their topic. BLs had a say on what they wanted to study in class, and Itzpapalotl took their information to create the evaluation and expand on their learning.

Dialogue was another way to create democratic spaces that varied according to the purpose of the science lesson. Juan's fifth-grade students engaged in dialogue during the observed class period. From the beginning of class, as they engaged in conversation about what they thought was the best geósfera (*geosphere*), through the moment when they were lining up to go to lunch, BLs continued discussing which geosphere was the best and why. Juan used dialogue with his students to address science concepts, a commonality across CCDLSTs in this study to promote equity in their instructional settings.

CCDLSTs also created equitable democratic spaces by diversifying the physical classroom space. They were intentional about the appearance of the learning environment for particular lessons and challenged traditional learning settings. For example, Juan's use of the Socratic method with fifth graders required him to change the physical learning space as needed. Juan provided the time, organization and space while the students engaged in and led the dialogue.

Additionally, the most common strategy across all CCDLSTs to create democratic spaces was intentional grouping. In some classes, BLs collaborated in pairs based on reading level or language. CCDLSTs also had students rotate in the classroom to engage in dialogue with different peers. Itzpapalotl played music during a lesson while her students walked around. When she stopped the music, students would have a conversation with the closest person to them as they revised their 'first five' science warm-up. At the elementary level, Ana, María, and Carmen created small groups of 3–4 students where students would alternate between sitting on the rug in pairs or triads and returning to their table groups of four students to provide them with mobility. María stated: '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 academics, who their partner would be. So, we have pairs, triads and we have a group of four.' Depending on María's purpose and objective, BLs would be grouped with specific peers who would challenge each other to speak and think critically.

The CCDLSTs were also intentional about diversifying spaces for instruction for community building purposes. In an interview, Juan shared:

> The beginning three days it's all about creating community … everything's based on community and how each student contributes to our community in a positive or a negative way … They have lessons … in the other homerooms about mindset. About growth mindset and fixed mindset … we all do a lesson that at the end … contributes to … the wellbeing of our community. I did "what is critical thinking?"

Juan's example is of how his school was committed to building community. Each fifth-grade level homeroom had a focus related to growth mindset, and Juan was the lead in teaching about critical thinking. He had a space reserved on his classroom wall for what critical thinking meant and looked like as interpreted and defined by his students. The other CCDLSTs also shared various ways they spent the initial days at their school sites building community, though these were not schoolwide expectations but rather CCDLSTs practices they felt were necessary to open with before they could start teaching and learning science content alongside their students.

Creating brave spaces

When creating brave spaces, those that require risk-taking as part of authentic learning, CCDLSTs enacted their role as social/racial justice facilitators considering their own power, oppression and privilege to set the tone for their BLs and communities by leading by example. One commonality across all CCDLSTs is that each one had a personalized workspace in their classroom that depicted their interests. In addition to classroom supplies, CCDLSTs had symbolic images illustrating social justice themes, such as resistance, that they connected to student empowerment. Itzpapalotl displayed a poster with a definition of social justice (Figure 3) 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 by her desk next to student seating. Steps away were two posters (Figure 3) Itzpapalotl shared with her students at the start of the academic year. All CCDLSTs used their learning environments intentionally for the purpose of creating brave spaces, as they were the first ones to take risks.

Additionally, CCDLSTs mentioned other ways they developed brave spaces with BLs, such as creating welcoming communities the first few days of the academic year. Community building activities consisted of those in which CCDLSTs and BLs learned about each other's similarities and differences, which allowed them to learn with and from each other in a respectful way as they eventually shifted to learning science content. Itzpapalotl's school was aware of which BLs families needed additional support and created a program where food left from the day's breakfast/lunch would

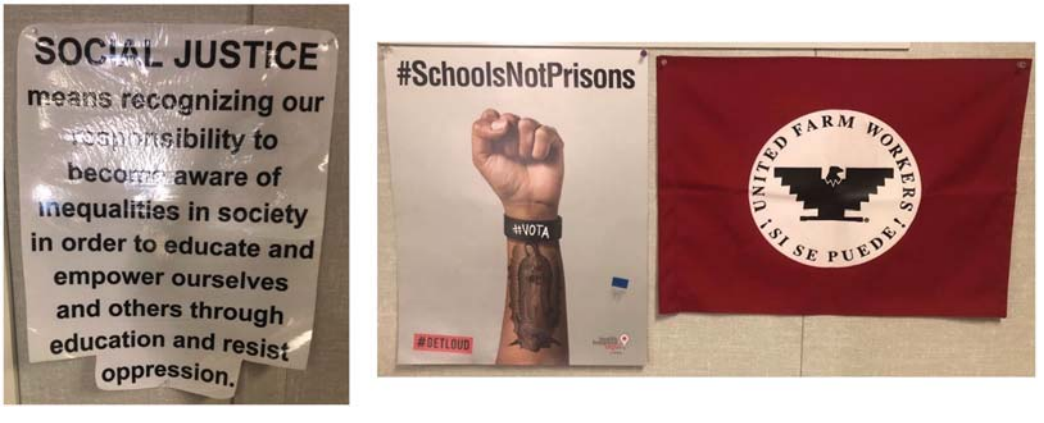

Figure 3. Posters displayed in Itzpapalotl's classroom.

go to families in need. This school compensated teachers who spent time outside of instruction to conduct home visits[4] to learn more about BLs, BLs' families and their communities. Other times, teachers would take the student out for an after-school meal, then drop them off at home. BLs and their families took risks in these brave spaces to accept assistance from the school and to have teachers enter the privacy of their homes.

Creating equitable spaces for access and inclusion

The following examples consist of overlapping areas in the ways CCDLSTs created democratic and brave spaces leading to BLs having access to science material, addressing representation and inclusion. Itzpapalotl recalled teaching a science lesson in English and shared her experience with creating brave spaces and access to content for three students who were new to the US from México. The three BLs were learning science content while learning to speak English. Itzpapalotl commented:

> 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 … [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" ["now tell me in Spanish what you understood"]. 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's 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. Aware of their needs, she 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 a teacher. During another part of her interview, Itzpapalotl highlighted the importance of creating space for students who are native English speakers learning Spanish and provided BLs with various forms of technology to encourage them to be resourceful. At no point in the observation or interviews was there evidence of any CCDLSTs policing the students' language; on the contrary, BLs were encouraged to translanguage and use their entire linguistic databases to communicate and learn science.

In equitable learning spaces, BLs are valued and have opportunities to learn and persist. The CCDLSTs also created spaces where all students and students' families were valued for what they brought to the classroom and denounced problematic curriculum. Valued assets included language and religious backgrounds, as well as being mindful of gender inequities and students' socioeconomic background. During an interview, Antonia stated:

> 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.

In the quote, Antonia highlighted that she acknowledges gender roles with her eighth-grade class. Being the only CCDLST with a single subject credential in science, Antonia is very proud to identify as a Latina with a science degree, especially given her background as a first-generation college student who held the detrimental English learner label. Because of her experience as a woman of color, Antonia makes sure she does not perpetuate hegemonic ideologies in her classroom and intentionally addresses conversations around gender(s). CCDLSTs collectively strived for BLs to be aware that they could do science and be someone who engages with science because all BLs have the potential to access and pursue a career in a science, technology, engineering or mathematics field.

Another topic that came up as a way to create equitable spaces was to introduce students to various science fields in class (i.e. geology, oceanography, marine biology, etc.) so that no one was prioritized over another. For example, Itzpapalotl introduced her seventh-grade students to various career possibilities if they considered studying science, which she pointed out, goes beyond becoming a physician:

> There's just so much to explore in science because, I think especially 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 … because as a kid … I knew *doctora y maestro* [doctor and teacher] … But … there's so much!

Itzpapalotl was extremely passionate about sharing her experiences going through the US education system and the lack of representation of students of color in higher education.

Growing up she had very little information about the different science areas that are currently valued and acknowledged as science.

Another example of a CCDLST creating an equitable space was María who was the only CCDLST with a school-bought, prescribed science curriculum. During her second interview, a class example came up that addressed the existence of curriculum perpetuating heteronormative family practices that considered a male and female parent as the only parental role types. María shared how her entire school came together to start a conversation with students and families about being inclusive of families that identify as LGBTQIA+:

> 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 learning about the students and families in her classroom and school, she shared how she planned ways to inform herself to incorporate and celebrate differences and exceptionalities amongst students and families as a way to teach about respect and create equitable representation for all students from varying backgrounds.

Lastly, CCDLSTs were aware of the value and importance of knowing and addressing BLs' language abilities both in English and Spanish and beyond, since some students are trilingual/multilingual learners. An example of how students are valued in the classroom arose when María shared that her school had 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 (from similar colonizers) are celebrated during a teachable moment that came up while teaching science. In her second interview, while debriefing the classroom observation, María mentioned: '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's clear understanding of her students' multiculturalism consisted of her incorporating her students in both the general and the science learning environment. Her flexibility during the science lesson was key, as she made time to address an opportunity for her students to make a cultural connection. CCDLSTs were aware of when and how students were represented, or not, in the science field and were proactive about including their students' perspectives and cultural richness in their classrooms.

Discussion

This study gives a glimpse of what CCDLSTs have done in K-8 DL classrooms to create access and equity during science instruction time. Currently, we do not know much about how K-8 DL science teachers teach science from a critically conscious perspective, and we need to know, given the way structural oppression has been perpetuated and continues to oppress and push

out our most vulnerable student populations. Findings from this study will help teacher educators better prepare future DL teachers. As Alfaro and Hernández (2016) conveyed through their four tenets of DL education – ideological clarity, pedagogical perspective and clarity, access for all, and equitable spaces (IPAE) – CCDLSTs must be reflective practitioners and examine their critical consciousness in order to plan and create equitable spaces where all students can thrive regardless of their background. Collectively, the IPAE leads to the process of the teachers' self-examination in the general DL classroom as we saw in María's experience with her student who has two parents of the same gender and would have been excluded from her genetics lesson.

When planning for science instruction, the most important IPAE tenet for DL science instruction is creating equitable spaces for BLs. For this tenet to best be enacted, schools with a diverse student population of BLs should be teaching science bilingually, inclusive of translanguaging, utilizing language as a tool for learning content and not just teaching English. Thus, this study highlights examples of how CCDLSTs can create democratic, brave, and equitable spaces where all students participate and engage in the collective learning and questioning of traditional science.

In this study, democratic spaces allowed for shared governance in the classroom where the CCDLST shared power with the BLs. Data were presented on how both CCDLSTs and BLs were counterparts in decision making. As we saw in Antonia's evaluation approach of providing rubrics to BLs ahead of time, CCDLSTs employed a variety of ways to assess students. However, democratic spaces can look different depending on the grade level and content area. Darder (2012) discussed how educational testing is a way to perpetuate hegemonic practices that keep dominant people in power and to continue to oppress and blame students who come from less economically advantaged families. She asserted that educational tests are not a measure of intelligence. I urge those working with BLs to consider opportune moments during the day where teachers and students can make collective decisions about what is learned in classrooms, how evaluation takes place, and ways BLs can be supported as they develop as agents of social change within their communities, inclusive of diverse linguistic repertoires.

Furthermore, Darder (2015) discussed democratic participation through Freire's (2000) notion of 'problematization' as spaces where teachers create pedagogical situations in which students can engage in critical thinking to deconstruct and recreate knowledge without fear and for the betterment of themselves and their communities. This study also demonstrated that not only is this a possibility during science learning instructions but that this learning can be taken outside the classroom where students can take ownership of their learning and come up with solutions to issues in their environment, as evidenced by Itzpapalot's seventh-grade globally conscious citizens.

Brave spaces, in turn, allowed for CCDLSTs and BLs to take risks and share their backgrounds so they may build trust and community, but also so CCDLSTs incorporate their students' experiences in the classroom and create access during science time. In other words, CCDLSTs learned about their students' funds of knowledge (Moll et al. 2005) and community cultural wealth (Yosso 2005) and modeled the risk-taking that accompanies trust and community building. This is especially important in a particular political moment characterized by an emboldened White supremacy and racist nativism fueling language hegemony. CCDLSTs spent time at the beginning of the year introducing themselves and sharing information. In return, most BLs and their families understood the CCDLSTs' intention of building trust, and slowly, BLs and their families opened up. However, it is not enough to simply be aware of what assets students bring to the classroom. These assets need to be utilized regardless of what language science is taught in and in all content areas.

Altogether, CCDLSTs created equitable spaces where students had access to science content and curriculum. Darder (2012) discussed the 'hidden curriculum' as a way for oppression to be perpetuated due to curriculum's misrepresentation (or lack of representation) of some, while elevating the dominant cultures of power and privilege. CCDLSTs not only acknowledge and are aware of this hidden curriculum, but they take it a step further by engaging their entire school community in conversations about how to address the lack of representation of some families, as María did during her lesson on genetics. Educators serving BLs and their families can continue analyzing and reflecting on

instructional practices, curriculum, and other forms of existing systematic oppression. This way, BLs can be included as agents of social change and advocates for their communities.

Recommendations and conclusion

The following recommendations are suggested for elementary teacher education programs. Teacher credential programs are the ideal spaces where teacher educators can model what teaching in DL settings can look like. Teacher candidates can develop their critical consciousness through assigned readings from minoritized scholars whose work further pushes back on the mainstream literature in science education. Additionally, discussions can take place that challenge hegemonic practices such as who is represented in science and who is missing and whose languages and cultures are valued. This challenges teacher education programs to also consider the ways teacher educators are doing self-reflective work to further develop their practice against changing demographics from when they were in school. Aspiring teachers would greatly benefit from being placed in DL classrooms with teachers at schools who utilize the NGSS and model the Guiding Principles for Dual Language (Howard et al. 2018). These placements could expose teacher candidates to quality DL environments and, presumably, equitable approaches to science education.

Lastly, the following recommendations are suggested for K-8 DL teachers and school administrators. Teachers and administrators can practice being reflective practitioners by self-assessing how equitable spaces are created during science, especially with the students and communities their schools serve in mind. This process for both teachers and schools can be guided by Alfaro and Hernández's (2016) IPAE and their 'tough questions.' To create democratic spaces, having alternate forms of assessments and rubrics are useful to inform students of the expectations. These steps can lead to BLs feeling successful in DL science learning environments, taking ownership of their learning, and transforming their own education.

This study advances an understanding and provides specific examples of what critically conscious teachers are doing in DL classrooms to teach science for equity by intentionally creating inclusive spaces. Results from this study can be situated at the nexus of the following three areas as they manifest in the DL science classroom: critical consciousness, DL education, and science pedagogy/learning. Somewhere along their trajectories, CCDLSTs accepted, enacted, and encouraged students to use their linguistic repertoires and language varieties during science instruction time because it helped students learn. CCDLSTs embraced students making decisions with them about various class aspects. While many schools adopt mission and vision statements utilizing words such as 'equity,' 'democratic,' and 'brave,' CCDLSTs have provided us with ways these terms can be enacted in DL science settings by providing us with concrete examples of what this may look like in the general classroom, but especially during science time.

Notes

1. Bilingual Learners: the term 'bilingual learners' is utilized by the author to refer to the student population in dual language classrooms learning both English and a target language, and thus developing their bilingualism (Navarro Martell 2018).
2. Translanguaging: BLs' use of their entire linguistic repertoire without forced separation of languages.
3. All names used in this paper are pseudonyms self-selected by the participants.
4. At this school, a home visit was when the teacher visited the student's home, interacted with family members and learned about the space where homework was done. Sometimes, the teacher was invited to eat at the student's home.

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No potential conflict of interest was reported by the author(s).

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Appendix. 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, 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)