

Stories from the Field:
Exploring Culturally Responsive Science Teaching in a Pilot Study

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(Please note, this is an early draft. Please keep this in mind as you read.)

Abstract

This qualitative study is designed to explore teachers' inquiry into and practice of culturally responsive science education in the high-needs schools in which they teach. Through collaborative inquiry with six teachers in a professional learning group, we explore what culturally responsive education (CRE) can look like in science classrooms. We employ ethnographic methods as participant observers and use a case study design. Data include group meeting notes and observations, teacher interviews, and collaboratively designed artifacts. Throughout the pilot year, the CRE group met regularly to study culturally responsive education, share and analyze teaching experiences, and develop culturally responsive instructional strategies. This paper focuses primarily on "Stories from the Field," a conversational routine at each meeting where teachers shared observations, thoughts, and insights about their classroom, instruction, and school settings in the context of CRE. We describe three emerging themes: 1) Positionality, 2) Systemic constraints and supports, and 3) Making science content and the science learning community culturally responsive.

Stories from the Field: Exploring Culturally Responsive Science Teaching in a Pilot Study

Some cultures have relied on the spoken word rather than the written word to convey, preserve, and reproduce knowledge... By telling stories and coding knowledge into songs, chants, proverbs, and poetry, groups with a strong oral tradition record and sustain their cultures and cultural identities by word of mouth. The oral tradition places a heavy emphasis on relationships because the process connects the speaker and listener in a communal experience (Hammond, 2015, p.28).

Introduction

In this paper, teachers are the storytellers, sharing their personal narratives and inquiries into their lives and experiences in their classrooms and schools. We explore the stories teachers tell as they study and grapple with culturally responsive education in their science classrooms. The stories shared are personal and of a sensitive nature, representing lived experiences and personal insights that are specific to their contexts. Told in the setting of a professional learning group as a conversational routine called Stories from the Field, the stories help to illustrate larger themes concerning learning about and implementing culturally responsive science teaching. This qualitative study is designed to explore teachers' inquiry into and practice of culturally responsive science education in the high-needs schools in which they teach. Through collaborative inquiry with six teachers in a professional learning group, we explore what culturally responsive education can look like in science classrooms.

Before delving into the stories, we acknowledge some of the premises or assumptions we have that are embedded in this paper and in our work. The members in the group in this paper are working through challenging, deep thinking and work that is extremely complex. Our lens as co-researchers with the teachers caused us to see their words, stories, and struggles in a positive light—we entered this study with the premise that all of the teachers have good intentions and are working deliberately and purposefully to make a difference, having their students' best interests at heart. Each member of the group recognizes that we are all still learning, in the context of trying to connect theory and practice, and approach this work with humility and care.

The role of the Stories from the Field routine in the process of the Culturally Responsive Education Professional Learning Group (CRE PLG) meetings was at least two-fold. It provided intentionality and focus to the beginning of the meetings, because members were expected to place their stories in the context of culturally responsive education. In turn, this provided a kind

of communal accountability to the ongoing project of making authentic connections between theory (represented by the literature study aspect of the group) and actual classroom instruction and other interactions with students. Therefore the routine was not a mere check-in, and certainly far different from a place to complain about daily teaching struggles. This routine turned out to be a core aspect of the work and of the power of the group, extending not only in time but in importance as teachers learned about each others' settings, experiences, and their varied implementations of culturally responsive approaches with their students and colleagues. In this context, the learning and application of culturally responsive education was not linear but continuous, complex, and organic.

Literature Review

In this paper, we draw upon two primary areas to explore theoretical perspectives that ground our work: *culturally responsive education* and *the role of stories*.

Culturally Responsive Education

Scholars have argued that culturally responsive education is necessary for classroom teaching and learning for students who have traditionally been shut out of academic success (Johnston *et al.*, 2017; ([Removed for blind copy] Department of Education, 2019). This perspective has undergone multiple iterations and modifications since it was introduced by Ladson-Billings (1995a, 2009, 2014) as culturally relevant pedagogy. A plethora of derivations continue to weave through the research base, such as culturally relevant teaching (Howard, 2001; Souto-Manning *et al.*, 2018), culturally responsive teaching (Gay, 2010; Hammond, 2015; Nieto, 2013), culturally sustaining pedagogies (Paris, 2012; Paris & Alim, 2017), culturally responsive education (Johnston *et al.*, 2017), and culturally responsive-sustaining education ([Removed for blind copy] Department of Education, 2019). Throughout these interpretations of culturally responsive education, several criteria remain central: students' academic success, cultural competence, and development of critical consciousness (Ladson-Billings, 1995), and the integration of students' lived experiences and cultural and language assets into instruction (Moll *et al.*, 1992; Johnston *et al.*, 2017; Lopez, 2017).

This study adopts the language of *culturally responsive education* (CRE) for two primary reasons—consistency and shared terminology within the city in which our teachers work, and to be inclusive of teaching practices, learning, and social-environmental components and contexts. For instance, while CRP has been a focus of discussion in education for decades (Ladson-Billings, 1995; Gay, 2002), studies are only starting to examine its effects empirically (Brown,

2017; Byrd, 2016; Lopez, 2017). Multiple studies have indicated that culturally responsive education is crucial for supporting effective teaching in high-needs schools (Santamaria, 2009; Villegas & Lucas, 2007). However, more research is needed to explicate what this looks like in classrooms, and what kinds of supports can help teachers bring visions of CRE to life, particularly in science. Much of the current research base is rooted in literacy (see Delpit, Ladson-Billings, Souto-Manning) and social studies, along with some math (see Gay, Greer). However, what culturally responsive science classrooms look like requires further exploration (Johnson, 2011). Through collaborative inquiry with teachers, we explore what CRE can look like in science classrooms in high-needs settings in our context.

Theoretical perspectives and recommendations concerning culturally responsive teaching have been available for decades (Brown-Jeffy & Cooper, 2011; Gay, 2010; Ladson-Billings, 1995b, 2017; Seriki & Brown, 2017). However, bringing the tenets of culturally responsive education (CRE) into classroom practice can be elusive, partly because CRE conceptualizes teaching as shaped to meet the strengths, needs, and localities of the particular students with whom teachers are working (Proposal Author, 2019). For the purposes of this project, we use the phrase “culturally responsive science teaching” to refer to classroom instruction that includes teaching practices to create science classrooms in which all students engage productively in rigorous science learning (Windschitl & Calabrese Barton, 2016). As summarized above, studies in CRE indicate that culturally responsive science teaching should exhibit these fundamental tenets:

- 1) the teacher values what students bring to the classroom as assets and uses these assets as resources for teaching and learning;
- 2) the teacher draws upon students’ cultures to strengthen their cultural connections;
- 3) the teacher holds high expectations for all students’ academic learning; and
- 4) the teacher adopts a critical stance toward sociopolitical structures and processes and helps students develop the same.

The role of stories

A common reflective practice, teachers often engage in Stories from the Field which they share with other teachers. Storytelling, a tradition embedded across cultures and histories throughout the world, can provide both a *window* into someone else’s lived experiences and a *mirror* to reflect on one’s own thinking and framing. The stories in this paper are ones that

teachers related during a conversational routine at the beginning of each meeting called Stories from the Field. We adopt a broad, open, and flexible definition of “stories,” drawing on literature on the anthropology of storytelling, to encompass that which teachers in this context and for this purpose tell as a story (Maggio, 2014). Stories contain characters, a place or setting, and a temporal dimension that captures an event or situation in context. By nature, storytelling includes both a storyteller and a listener; the interaction or exchange between the storyteller and the listener is part of what makes a story a story.

Teacher stories have been studied for decades, as they provide a window into the lives of teachers, students, and other characters in which a way of knowing and making sense of the world unfolds (Connelly & Clandinin, 1994; Carter, 1993; Mitchell, 1981; Coulter et al, 2007). Stories can be told, retold, relived, constructed, reconstructed, and deconstructed (Connelly & Clandinin, 1994; Coulter et al, 2007). However, it’s not just the story itself that we investigate, but it’s the *act* of telling a story—the reflection, learning, and understanding that the teacher experiences when telling a story is equally important (Mensah, 2009; Connelly & Clandinin, 1990). As Connelly & Clandinin argue, “It is in the telling and retellings that entanglements become acute, for it is here that temporal and social, cultural horizons are set and reset” (1990, p.4). The act of telling a story causes the storyteller to relive the experience, teetering between the past and the present, and the retelling “shifts our knowing of experience, ourselves, and the meanings we hold of things like teaching and learning” (Pinnegar et al., 2018, p.56).

In the context of teacher learning, storytelling can be viewed as a pedagogical strategy (Coulter et al, 2007). Teachers often tell or exchange stories that replay or recount a situation that already took place or rehearse or act out something that has yet to transpire (Horn & Little, 2010; Segal, 2019). According to Segal (2019), teacher stories have been examined in the literature as both a representation of practice and/or means to explore identities. As Kainan (1995) asserts, “stories are part of teachers’ socialization to their group” (p.171) and thus often shed light on the group’s norms and patterns (Horn & Little, 2010).

In the context of the CRE PLG, teachers primarily tell stories during Stories from the Field, as a way in which to connect theory and practice, question what is and can be culturally responsive, and learn from one another while sharing images of what culturally responsive education might look like in classrooms. Stories provide opportunities to examine their own and fellow science teachers’ thinking and experiences regarding CRE in a safe and familiar

environment. In this setting, stories had a particular flow and group members asked questions probing and inquiring into practice, spurring reflection, clarifying details and specifics, and often provided suggestions or alternative options. And in terms of the flow of the Stories from the Field segment of our meeting routine, stories were often inspired by or otherwise connected to stories previously told by others. Also notable was something that arose more than once: One teacher would tell a story about a challenging student or administrative situation. While the story-teller likely benefited from merely telling the story in a safe and understanding environment, it rarely ended there. Group members would (gently) ask for more information, and either wait for the storyteller to come up with a solution or next steps on their own, or suggest possibilities for different perspectives on the situation. In this way, then, teachers gave each other support in the practice of culturally responsive education. Unexpectedly, Stories from the Field became a pedagogical tool for the group (Coulter et al, 2007).

Study Design

Research context and study setting

This study is grounded in a teacher residency program located in a complex urban setting. Unlike other teacher preparation programs, this one is located in an informal science institution (ISI) with multiple school-based partnerships where residents carry out a rigorous academic-long residency while taking academic courses at the ISI. The location is what Milner (2012) would call an “urban intensive” setting, based on the size and density of people and schools in the area with implications for resources and broader societal factors that inevitably feed back into the school system. In our state, while the student body is increasingly diverse in terms of race, ethnicity, gender, and age, the educators teaching the students are 80% white with teachers of color underrepresented ([Removed for blind copy] Department of Education, 2019). As we are seeing an expansion of the diversity of students, the diversity of teachers particularly in terms of race and ethnicity has remained stable and relatively unchanged, especially in regards to Black and African-American teachers ([Removed for blind copy] Department of Education, 2019). Thus, it is highly common for teachers to have racial, cultural, and linguistic backgrounds that are different from their students in our area.

Teacher participants are graduates of a Master of Arts in Teaching (MAT) program from the same cohort, and were in their third year of teaching Earth science in high-needs high schools

at the time of the pilot. Over the 2018-2019 school year, teachers met twice monthly in a collaborative Culturally Responsive Education Professional Learning Group (CRE PLG) at the ISI. Based in deepening understanding of research and theory in CRE and its applications in science classrooms, the CRE PLG was designed to support program graduates in the development of and inquiry into strategies and protocols that demonstrate culturally responsive education in their science classrooms.

Over the 2018-2019 school year, the CRE PLG met twice monthly to study culturally responsive education, share and analyze teaching experiences, and develop culturally responsive instructional strategies. This collaborative project is grounded in the assertion that effective professional development experiences for teachers are ongoing within a community of teacher learners (Wenger, 1999; Lave & Wenger, 1991), feeding off and feeding into their everyday classroom instruction (Borko, 2004; Loucks-Horsley *et al.*, 2009; Roth *et al.*, 2018). Additionally, research in teacher education (e.g., Darling-Hammond *et al.*, 2005; Feiman-Nemser *et al.*, 2014; Hammerness & Klette, 2015; Guha *et al.*, 2016; Zeichner & Conklin, 2005), indicates that linking theory with practice is made possible when professional development experiences provide opportunities for teachers to reflect upon their teaching in light of the theory they are learning, and to use their classroom experience to inform the theory itself.

Teachers' participation is central to this study, as their work draws upon their own perspectives and expertise as educators (Capobianco *et al.*, 2006). As teachers are working "on the ground," their voices and experiences are invaluable in the exploration of engaging in constructing shared images of science teaching practice that support culturally responsive instructional contexts. The group focuses on "the perspectives of those who do the work. The larger project is about enhancing educators' sense of social responsibility and social action in the service of a democratic society" (Cochran-Smith & Lytle, 1993, p.58).

The group is facilitated by two MAT program personnel who bring their teacher education and research expertise to the collaborative work of the group. All of the teacher participants are from the same graduating cohort, teach in the same city, and were in their third year of teaching Earth science in high-need high schools at the time of this study. Teachers' participation in the group is grounded in their own perspectives, expertise, and experiences as science educators in urban high-need schools (Capobianco, Lincoln, Canuel-Bowne, & Trimarchi, 2006; El Barrio-Hunter College PDS Partnership, 2011; Feldman, 1999).

The CRE PLG: Participants and positionality

During the time of the study, the CRE PLG was composed of six Earth science high school teachers (additional members have since joined) and two facilitators/educational researchers all connected with a teacher preparation program. All members of the group currently live and work in the same large urban area. While educational backgrounds vary across group members, all of the teachers received the same teaching certification and Master of Arts in Teaching (MAT) Earth science in secondary schools together as part of one cohort in a teacher preparation program. During the time of this study, teachers in the group were working on fulfilling a four-year teaching commitment in high-needs schools (classified as 60% free or reduced school lunch, at the time of their graduation). All of the teachers were employed by schools that serve populations of 81% economically disadvantaged or more. For the pilot year of the professional learning group, teachers from one particular cohort were invited and volunteered to participate. The majority of the participants in this study have English as a first language; Marigold is bilingual English-Spanish and Theo speaks Cantonese. The group is also mostly of white European background, part of the dominant culture, and comfortable with science content with several having had careers in science or engineering before they came to teaching. Teachers' self-reported background information is embedded throughout the paper. (See Appendix for tables on participants and school demographics.)

Our roles in this project are as teacher educators and educational researchers working collaboratively with six teachers over one academic year in a pilot study. We feel that it is important to recognize the positionalities that we bring to this work as facilitators/educational researchers and members of the group, as well as the lived experiences that inform and influence our perspectives and understandings. Much has been written in the literature about the criticality of addressing and reflecting on researchers' cultural and racial positionality, and it is our role as researchers and educators to acknowledge these (Merriam *et al.*, 2001; Milner, 2007). We both identify as white American females who currently live in a large metropolitan city. Elaine was raised as a liberal Protestant academic family of mixed European descent. Her family lived in a series of homes in both rural and suburban settings, eventually settling in a small midwestern town where her father taught history at the local college. Earning a degree in biology, she worked in research science; studying one aspect of the natural world gave way to a desire to work in education, where her interests in history, literature, philosophy, and the natural sciences

could work together. She has taught high school biology and many years of teacher education. Jamie was raised in a Jewish American family of Eastern European descent. She grew up in a large metropolitan city in the Northeast, and has spent years living and working abroad on several continents. Her educational background is in cultural and material anthropology and museum ethnography. She has teaching experience in the US and in Mali. She has spent more than a decade working in educational research and evaluation in formal and informal educational settings. Not surprisingly, positionality is also a theme that emerges throughout teachers' stories.

Furthermore, as Cochran-Smith and Lytle (2015) bring to light, when wearing two different hats as both researcher and teacher educator, boundaries between research and practice can blur when one's professional setting becomes the research site. And, oftentimes, it is in the convergence and intersection of the two roles that promotes critical reflection, innovation, tensions, opportunities, and predicaments (Cochran-Smith & Lytle, 2015). Some have critiqued this duality, citing that dilemmas or issues can surface particularly in terms of ethics, methodology, epistemology, politics, and personal/professional development (Cochran-Smith & Lytle, 2015). Learning to leverage these seemingly dichotomous tensions is what Cochran-Smith & Lytle (2015) refer to as "working the dialectic," producing blurred boundaries of research and practice instead of opposing forces. Merriam and colleagues (2001) discuss the complexity of being both an insider and outsider to the research group and how concepts of positionality, representation, and power become particularly useful to explore. Similarly, these tensions and complexities are common in the anthropological landscape when researchers conduct fieldwork in the familiar (e.g., within their own culture or environment), raising questions about the ethics of representation. The tensions explored here are ones that we've experienced and attempt to be transparent about in our work with the teachers.

Methods

As members and facilitators of the CRE PLG, we employ ethnographic methods as participant observers and use a single case study design (Yin, 2014) to investigate the research question: *What themes emerge in the stories that teachers tell about their practice in the context of culturally responsive science education?* To investigate this question, we use a qualitative approach. The case study approach to the collaborative inquiry of the CRE PLG allows for an in-

depth exploration of teachers' understanding of CRE and how it is represented in their instruction (Stake & Munson, 2008; Thomas, 2006).

The case study specifically focuses on the first year of the pilot of the CRE PLG. Multiple sources of data were collected throughout the 2018-2019 academic year during the time when the group met regularly to provide a rich, in-depth portrait of the CRE PLG as explored through Stories from the Field. As there is a large amount of data and the group has continued working together, we recognize the importance of bounding the timeframe of this study to investigate and examine the first year in particular (Miles & Huberman, 1994; Creswell, 1998). A case study allows for thick description of the group over a prolonged period of time, in which the researchers become participant observers immersed in the ongoing actions, behavior, and language of the CRE PLG (Creswell, 1998; Armstrong *et al.*, 2019).

Data sources include semi-structured teacher interviews in the fall and spring, observations and notes from CRE PLG meetings, responses to reflective questions following meetings, collaboratively designed artifacts (e.g., strategies and protocols, activities, video analysis tools), individual teacher artifacts (e.g., lesson plans, worksheets), and samples of student work. Although we employed multiple methods of data collection, we relied heavily on group meeting notes for this analysis. With more than 19 sessions throughout the year, the group convened consistently with an estimated 48 hours of meetings. Thus, we found meeting notes to be a rich data source to examine. In addition, we incorporated data from teacher interviews to help provide context and elaborate on the individual teachers in the group. The collaboratively designed artifacts were developed in the context of CRE PLG meetings and are integrated into some of the teachers' stories. Similarly, teachers shared artifacts that they used in teaching and samples of student work from their classrooms during meetings, thus these data sources also play a role in our understanding and interpretation of stories from the field.

With immersion into the group as participant observers and facilitator-researchers, we made efforts to enhance validity by conducting member checks. Teachers in the group were asked to review a draft of the paper for accuracy and trustworthiness, especially in terms of interpretation of stories, as well as to provide their thoughts and feedback as co-authors; and their feedback and suggestions were integrated into the paper. Teachers also provided their own background information and selected pseudonyms they wished to represent them and their schools. We recognize that with our role as facilitators and researchers who work with the

teacher preparation program in which these teachers graduated, there could be power dynamics in play. It was important for us to be open and transparent with the group about the research, especially given that historically research has been conducted *on* teachers as opposed to *with* or *by* teachers (Cochrane-Smith & Lytle, 1993). This is something that we intentionally shifted to during the subsequent year with the CRE PLG, emphasizing the importance of and need for teacher inquiries into culturally responsive science teaching with teachers as co-researchers. We had this intention for the first year as well, but it became evident to all of us in the group that there was a need to first review the literature and discuss what teachers were seeing and noticing in their classes and how this applies to them and their students.

Analysis

This paper focuses primarily on Stories from the Field, a routine at each CRE PLG meeting where teachers shared observations, thoughts, and insights about their classroom, instruction, and school settings in the context of CRE. While we initially thought that the Stories from the Field component would provide an entry point for delving into deeper discussion, we realized throughout the year that it offered a rich, descriptive opportunity for all members of the group to reflect and share current and changing understandings and experiences. Interviews and reflection questions following CRE PLG meetings provide supplemental data to further describe teachers' perspectives and experiences during this exploratory pilot.

Using the data analysis software Dedoose (SocioCultural Research Consultants, LLC, 2018), we uploaded meeting notes and interview transcripts and engaged in two rounds of coding interview transcripts. We use an iterative process of inductive and deductive coding techniques to identify themes that surfaced (Thomas, 2006), applying a grounded theory approach in constructing codes (Charmaz, 2006). Our experience informs what we saw surfacing in the data, while at the same time we also examined the data to see what was surfacing. We were open to, and in some respects searching for, contradictions to our assumptions and what we expected to see in the data. For instance, given our experience in the group, we were anticipating to see systemic challenges and constraints emerge in teachers' stories. However, we also noticed in the data instances of systemic supports where teachers were supported in engaging in culturally responsive work. Following coding, we wrote analytic memos and conceptual memos, talked

through our thinking together, and drew on our memos and notes from our discussions throughout the writing process.

Limitations

In order to portray and highlight some of the stories told over the course of the year, stories were extracted from their original flow. It is important to remember that while we have added background context to the stories, seeing each one in isolation can help to focus on a particular point but also separates one story from the flow of others during the same session and nuance from the group setting. In addition, as storytelling involves the unique interaction between the narrator and the audience, not all of the subtleties and nonverbal behavior can be captured.

By focusing primarily on Stories from the Field, we limit examination in this paper of other work that the group engaged in during the year. The work of the group included many projects and activities, including classroom video analyses, collaborative development of strategies, and leading presentations and workshops for teacher professional development. Stories is one lens in which to explore the group and does not represent or portray all of the work that the group did throughout the year.

Findings

In this paper, we describe three emerging themes amongst Stories from the Field: 1) *Positionality*, 2) *Systemic constraints and supports*, and 3) *Making science content and the science learning community culturally responsive*. Below, each theme is developed using evidence from the data.

Positionality. This theme explores teachers' efforts to intentionally learn about students' cultural groups while interrogating their roles as teachers. Questions that teachers regularly grappled with included, "How can I relate authentically to my students when I am a white person, and/or have different life experiences from my students?" and "What is my role in perpetuating the dominant society, and what can I do about it?" Importantly, as one member described it, "We're a group of not very racially diverse people talking about the issues around the concerns and ideas that we have about teaching students who have been historically unable to

succeed for various reasons. And we talk about how we incorporate the student to build up their own education.”

Teachers used what they learned (or wondered) about their students to construct strategies and activities to recognize the cultures and languages that they bring to their classrooms. For example, Bennett (pseudonyms used for all teachers and schools) was developing games for teaching Earth science. In thinking about students’ engagement with these games, he said that he “immediately thought about my student from Central Africa. What kind of game would she create? I mean we would have no idea. We’re so used to Monopoly or Life or Stratego. I guess [I could give students] the prompt of ‘think about games that you’ve played’” (Bennett, Session 11, 3.23.19). Here Bennett, who identifies as a white cisgender male in his mid-thirties and grew up in rural northeast United States, is recognizing his own lack of knowledge concerning his student from Central Africa, and figures out a way to potentially learn more about one of his students.

Theo emigrated from Hong Kong at a very young age to the city and fully participates in his family’s traditional holiday customs. At the time of this study, Theo was teaching at Einstein International, a large public high school explicitly designed for students who immigrated to the country within the past year or two. Theo found it challenging to relate to his adolescent students’ more recent immigration experiences and learning English as a new language, and was concerned that he might be providing a disservice to his students in that regard. As he said, “because while I am Asian, it’s not something that I really grew up with. ... And ... I’m in a very multicultural school, how do I address everybody’s culture in some way, shape, or form? How do I make sure that everybody feels like they are an important part of the class?” (Theo, Fall interview).

To address his concern to attend to students’ cultures and help all students feel a part of the class, Theo told the CRE PLG that he asked students to describe how the countries they had come from “have historically prepared for [a natural hazard]. So one of my students was like ‘in this river in my country we used to have these really weird thunderstorms and we used to have to hide here so that way we don’t get hit or anything like that.’ So that went surprisingly well.” Additionally, it seemed to Theo that the school’s approach to helping students learn English was based in note-taking and memorization. Theo went beyond this traditional academic approach by applying a strategy to show that all of his students’ languages were valued. Continuing in their

natural hazards unit, students developed pamphlets using “their own language as well as in English so that way you ... could see how they translated the information from something that they did understand from the language that they are more familiar with to the language that they are less familiar with.” Theo treated his students’ experiences and multiple languages as academic strengths and assets—rather than submitting them to rote instruction to help them learn English, he encouraged them to use their experiences and express their science knowledge in the language in which they were most adept, and then translate it into English (Theo, Session 5, 12.3.18).

Despite his apparent success in welcoming all of his students into his classroom (as evidenced by the activity above), Theo expanded on his belief that he would be more effective in another school cultural setting, contrasting a previous school position in which he had interacted regularly with Black male adolescents with his current position working with students who had recently immigrated to the U.S.:

The reason why I was going to look for another place [to teach] is because I don’t feel I connected with [students at my current school]. Yes I understand there are certain things I can do in the classroom that can help make the cultural relevancy and the transitions so much easier for them, but it’s not the same if I can’t connect to their experiences as well. In my old school, yes I am not a Black male but I grew up in that type of environment, I grew up in that kind of neighborhood, so I could relate a lot more to the stuff they were talking about than [my Black students] expected. It also helps that I was one of the few male teachers there ... and I wasn’t a white male, which helps because several of the white males were like, ‘yeah they don’t tell us these things.’ (Theo, Spring interview)

It appears that Theo’s experiences growing up in the same urban setting as his students pulls more weight with him than the fact that he is categorized as Asian American. Seeing authentic connections with his students as an important aspect of cultural responsiveness, he deems his experiences growing up where his students are growing up as more useful than his ethnic background.

For Lily, who describes herself as a white, female, and cisgender, and grew up in rural - suburban northeast town outside of a large cosmopolitan city, these questions emerged in a

different way. Lily teaches at Maya Angelou, a public high school with a high percentage of overaged, undercredited students. She described her confidence in her abilities to connect with her students and teach in culturally responsive ways, commenting “I can speak my kids’ language and understand what’s going on.” However, one day when engaging her students in an advisory group meeting, Lily noticed she could not authentically engage with their discussion about what was happening in their lives outside of school, and suddenly she felt very humbled and said “I don’t know what they’re saying and it’s so obvious and it really pushed me back on my heels that I don’t speak the same language as my children When they’re talking about what they do when they go home, what they’re watching, what they’re doing ... It took me down a notch in my ego” (Lily, Session 15, 5.11.19).

Shortly after relating this description of her failure to understand her students’ lives out of school, Lily shared what she called a “success story” concerning a student who needed only Lily’s class to graduate. As Lily tells it,

[She] was in my first class I ever taught at Angelou. She was supposed to graduate last year, but I’m the only class she needs to graduate. She’s been really disengaged in school for an entire year. I’ve been really hard on her—I’ve been like take agency, what do you want to do with this. She meets me at 7:45 [in the morning] all this week at the [river], she does the experiment with me and then we go to school together. She’s super chipper. 100% attendance all week. Feeling really good about that. (Lily, Session 15, 5.11.19)

Lily ended her story with, “Although I can’t understand what my crew is saying, I’ve got her meeting me at 7:45 in the morning.” Here two aspects of Lily’s identity—white woman and science teacher—pushed her “back on her heels” in recognizing what she needs to learn, but also to use what she knows as a science teacher with a deep understanding of the local environment to support a student in doing authentic science and earning her high school diploma.

Zen openly shared her struggle “with what it is to be truly culturally relevant.” Much of her struggle was focused in creating a culturally responsive learning environment in her science classroom at IWD High School, where she worked with students who, like Lily’s students, had come to IWD from schools that did not support their academic success. Zen said that she was “working on what is my purpose in the classroom, how do I facilitate an environment of

learning.” She wanted her classroom to be a place where all students could work together to solve science problems, modeled on her first career as a leader in civil engineering; as she put it, “I’m asking my kids to code switch ... I’ll be totally honest with them but I’ll ask them to come into the room and let’s be scientists” (Zen, Session 15, 5.11.19). She wove together her recognition of her whiteness with her identity as a scientist in further describing her thinking about her ideal science classroom: “If I really think about it, I’m so white, but I think about that we’re people and we got to make it in the world. ... What I love about science is that it allows you to go to a space and fixate on a problem that has meaning that could help a lot of people.” She wonders, though: “Is that culturally relevant?”

Zen is not at all rigid in her expectations that students speak and act like mainstream scientists and engineers at all times. She welcomes the creativity, energy, and social savvy that her students bring to the classroom. In the story below, Zen places her description of a vocabulary activity in the context of something she had read in Hammond’s text (2015): that “storytelling” was widely used in many cultures as a way to express knowledge. As is often the case in *Stories from the Field*, Zen connects a classroom experience with the group’s ongoing research-based discussions to help her puzzle through what culturally responsive education could mean for her teaching.

[Students] take a list of astronomy words Table teams take all words and [put them in the] four categories ... of objects, motions, theories, or question marks. Then when they finish, they come up with three words and tell me how they relate. ... One of my students really got to me on the cultural relevance of this whole thing. I’ve been trying to get my head around storytelling. ... So I went over and said ‘that’s an interesting grouping. Can you explain?’ When she did it blew my mind. ... ‘An asteroid hit the Earth and killed the Earth before. Then the Big Bang theory happened causing the Earth to reset. Finally revolution took place where the earth changed for the better.’ Isn’t that wonderful. It makes perfect sense. The word revolution here... it’s the theory of revolution. We’ve come up with a new theory—not evolution, revolution. That dinosaurs died. Asteroid hit with such force. I went, ‘Wow, that could be the storytelling’; she in her mind linked it to a story that made perfect sense and also helped me in my mind with the struggle my

students have with vocabulary. That's a perfectly legitimate use of the word revolution.
(Zen, Session 11, 3.23.19)

Zen's excitement about what her student did with these new vocabulary words, and her own ability to step outside of her science understanding to appreciate her students' thinking, is clear. She provides us with an example of how teachers might authentically welcome students' ways of speaking and knowing into the science classroom. She does not correct the student—although certainly she will introduce her to the canonical scientific explanation of the Big Bang.

The stories that teachers tell indicate authentic struggles that intertwine theoretical perspectives with actual classroom practice. This is where a great deal of their power lies. Teachers certainly do talk about their own lived experiences, and their identities as members of society and as teachers. But this talk is grounded in actual classroom teaching, and therefore the examples they relate provide heft and reality that takes us beyond reflection that does not include such efforts and experiences.

Systemic constraints and supports (school, administration, city, state). This theme emerges in stories both in terms of supports and constraints associated with system wide issues and structures that are embedded in the places where teaching and learning happens and part of the larger educational context. This theme surfaces in teachers' stories in regards to what they discuss and implement in the context of culturally responsive education at four particular levels: school, administration, city, and state. This theme deals with issues of power and inequities in different aspects of society as they are revealed through the stories teachers tell about their experiences in classrooms and the wider educational context.

Systemic constraints

Through teachers' stories, systemic constraints emerged in unique and distinct ways. For some, expectations of school administration were perceived as a challenge to implementing culturally responsive instruction and strategies. For others, the statewide standardized assessment was perceived as a challenge or barrier to integrating CRE, particularly regarding the amount of time and focus on required predetermined content. With one exception, the schools in which the teachers work aim to prepare students for a statewide assessment in Earth science. Therefore,

teachers are responsible, and often accountable, for their students' performance on the high-stakes test.

Teachers frequently questioned how to make test review more culturally responsive, and many voiced that they perceived an inherent contradiction between standardized testing/test review and science teaching in a culturally responsive way. For instance, Seamus, who identifies as a white, cisgender male in his early thirties, teaches at Sunrise Garden High School. Sunrise concentrates on the statewide assessment, and Seamus spends a lot of time in class reviewing and helping to prepare students for the test. Throughout several of his stories, Seamus emphasized an uncertainty in ways to bring together test review with CRE. Toward the end of the year, he shared, "I'm starting [statewide test] review... I'm thinking of a wide range of different abilities and levels and kids not taking it seriously... I'm not sure how to make [statewide test] review culturally responsive" (Seamus, Session 17, 5.20.19).

The next story highlights how one teacher attempted to reconcile this contradiction by resisting what was expected of her as a science teacher in her school early in the year. Marigold, who identifies as a white cisgender Jewish female, teaches at Explorer's High School. In efforts to bring more of a CRE focus into the classroom, Marigold sought to confront or push against school's and administration's expectations through providing alternate options for students to demonstrate learning through project-based assessments instead of periodic standardized assessments. In her story, Marigold shares her thinking with the group about her school's approach to testing and describes her plan to combat this for herself and her students through project-based learning. Marigold's story highlights an example of opposition to and action against systemic structures and factors in play. This particular story resurfaced in several meetings at different points as the teacher recounted what was taking place in her classroom and in school. Marigold shared:

Another thing that I have officially committed to is that my school does periodic assessments five times a year. So they shut down the school and have double period testing. Over the course of three days, students will have double periods in all of their classes and then another extra period of testing for three days straight. It's [statewide test]-based multiple choice as well as [statewide test]-based short answer and long answer writing and it's just brutal. It's tortuous. All the kids fail because either their testing

stamina isn't there, nor should their testing stamina be there. They'll never again be in a situation like this ever in their lives. So I decided—the reason that our school does it is to expose students to the tests but also we collect very very rigorous data on it. We have a program that you can evaluate from all of the multiple choice proficiency in different learning standards. I can tell test content proficiency as well as see how many of my kids are able to make inferences, how many of my kids are able to apply concepts, which is really powerful. So I'm still going to have to give a multiple choice test at some point.

But I decided that, instead in the blocked double period sessions, I'm just going to do a project and give the kids a break from the testing during that time period. So I'm nervous ... It'll be a time for them to do a rigorous scientific activity that's more similar to what scientists actually do and that is more compassionate than what my school is doing ... To make a meaningful and worthwhile project for my kids to do in that time ... It's very strictly not what my school does. Like I'm very much going against what I'm supposed to be doing... I'll still give them a multiple choice and full answer and I'll still analyze it, but I'm not going to do it in those three days. I can't do it—it's also tortuous for me. These kids don't want to sit quietly and take a test for three days in a row and it sucks to have to make them (Marigold, Session 5, 12.3.18).

As the story unfolded over several meetings, we learned that Marigold had her students engage in a project on conflict minerals, drawing on a unit that Lily uses with her students. The project was research-based and students worked in groups to develop presentations for the class. Reflecting on how the project went in her class in a story a few sessions later, Marigold shared, “It was definitely a new thing for the students to do that kind of research and have that freedom. It wasn't perfect, which things never are for the first time, but it was cool. Some kids got interested. [The students prepared] presentations. We didn't have enough time to actually present but it was a good thing to do” (Marigold, Session 8, 1.24.19).

One of the stories that Bennett tells and expands on over time relates to systemic structures both at the school and city levels. Closer to the end of the year, Bennett shared about his school's expectation for him to teach a pre-Advanced Placement (AP) course the next year as part of an AP for All initiative through the city's department of education. This story is another

example of a teacher negotiating his role and responsibility in terms of this perceived contradiction with culturally responsive science teaching, and confronting systemic structures that are playing a role in his school. One of the primary issues for Bennett was that students would be required to take the course and the exam, and he felt that he would be responsible for “teaching to the test” and in tension with culturally responsive science teaching.

My school is doing a push for AP for All as a way to respond to feedback that our school hasn't been rigorous enough. I feel weird because rigor is different for each person ... They want me to teach a course. I've been fighting with my admin. The idea is to make it more challenging for students, but AP doesn't do that for students ... Why are we doing AP if the kids aren't passing? Why AP for All? ... I don't want to teach another class for the test ... For the interest for the kids, should I be like screw it [and do my own curriculum]? I'm in a fight right now and it's kind of relevant because the school wants this to look good but to be responsible to students. It should be available to whoever wants it. It's really irresponsible ... the idea of a pre-AP course ... Why another test? ... It's irresponsible to make the school look good at the cost of the students (Bennett, Session 17, 5.20.19).

Upon hearing this story, Zen shared a similar feeling of a contradiction that she was experiencing at her school concerning standardized testing. She shared, “I'm trying to deal with the fact that [the school] wants authentic assessments in school but [students] prepared for the [statewide test]”.

As is evident above, a common theme throughout the group's work together was the apparent clash between preparing students for a standardized, statewide science exam necessary for students' high school success and potential college entry, and the demands of culturally responsive pedagogy. School administrators were sometimes supportive of teachers' CRE efforts, as we will see below in the next section with Seamus's story. Nonetheless, Seamus is still “not sure how to make [statewide test] review culturally responsive,” while Marigold sees her school leadership requiring instruction that is “anti-culturally responsive.” Bennett tells a story that describes a well-functioning school community that still seems to marginalize culturally responsive education (Sleeter, 2012):

So we just finished a first session inquiry cycle of our science department and have been focused on making student materials tangible ... We're trying to figure out what our next move is for the next half of the year. So I made the suggestion that we try to focus on culturally responsive teaching practices to see if we can get some buy-in from some of the teachers ... I guess some of the teachers think that there's other more basic needs for some of the other teachers that they have to focus on before that. And my argument is it shouldn't be a separate thing but it should be an "and," it should be included. (Bennett, Session 6, 12.15.18)

Here, Bennett is actively trying to focus on culturally responsive teaching in science with his fellow teachers, arguing for its importance and accessibility for students, but encountering push back as something that is not as highly prioritized.

Systemic supports

As described earlier, given our experience in group meetings over an extended period of time, we anticipated seeing systemic constraints appear in teachers' stories. However, unexpectedly, we noticed that supports for teachers in engaging in culturally responsive work also surfaced in the data. For instance, over several stories, Seamus recounted conversations he had with his administrator around CRE and the work of the group.

Since last time we met, I had my first observation from my AP and ... we were talking about how to ... relate it more to [students'] lives or society in general. ... Not super culturally responsive but right now in the landscapes unit [we] talked about how groundwater is a natural resource for a lot of communities. Which isn't really culturally responsive to these particular kids because [groundwater is] not their source of water ... And talking about urbanization, how [our neighborhood] used to be blue color and now is built up. Why when it rains we have disgusting puddles and kids seemed to relate to that. (Seamus, Session 5, 12.3.18)

In this story, Seamus is relating an experience attending to his students' lives and society in general, a practice that was encouraged by his administration. He is not certain that teaching

them about groundwater is culturally responsive, since it is not how his students' city gets its drinking water. However, Seamus brings the content back to his students' city in talking about its geographic history, and to their own experiences in talking about the puddles they encounter when it rains in their city. So while he may not be relating to their *cultures*, he is relating to their everyday lives and to their community. He also implies that he believes that relating to students' lives and to society in general are aspects of culturally responsive pedagogy.

In a story that Seamus told a few months later, he replayed a conversation with his principal in a meeting to discuss applying for tenure. While he was expecting to discuss what he should be working on and strengthening, Seamus expressed pleasant surprise that his principal agreed with his interest in dedicating attention to CRE as an area he can focus on for the upcoming year. This highlights another example of supportive structures in place in regards to culturally responsive education that surfaced, in this case coming from the school leadership.

Lily also shared a story, relating how other teachers and colleagues at Angelou provided support during a particularly loaded experience with a student in her class, who was trying to process discovering something new about her identity. Together, Lily and her colleagues discussed how drawing on their school's core values of respect for diversity and respect for humanity could help provide support to address the issue directly with the student, Tiffany (a pseudonym). Lily shared:

I had this girl who's processing this genetic testing she's done on herself. We're doing data collection. There's a lot of free time where kids are just talking and doing lab, it's fun, they're connecting to each other. She's been processing that she's Prussian, which is European ... She appears very much black however that's not how she identifies. She is processing out loud that she is excited to go to college, she's European, she's going to Europe to college, she's going to Germany, she doesn't want to date any more "N-words," only date Europeans because they're hot. I was thinking about it while reading this *Ready for Rigor* framework and the learning partnerships and how I want my students to be in a "community of learners," being safe, "making space for student voice and agency" (Hammond, 2015, p.17), but she's like totally stereotyping and all these microaggressions ... and some of my students, especially black males, are shutting down. And one of them had a really wonderful response, a lot of them aren't able to formulate

why they're feeling so angry towards her. What one of them, the greatest retort, he walked in, she was going on and on again, I was like 'Tiffany, let's talk about this later,' and trying to redirect her... I want her to process, just not out loud in the classroom [laughs]. Marco goes, 'Europeans have no toes.' She got really upset, she was like 'I have toes' and got really defensive and taking off her shoe and telling me to take off my shoe. And he was like, 'You're not European if you have toes'. ...

This has been going on for weeks, weeks. Social workers called home, her advisor has called home, this is coming from mom, and child is trying to process this in a space which is called Maya Angelou ... The crew advisor, me and my co-teacher, trying to meet, try to plan what to say when Tiffany starts to process. We go like, 'Hmmm let's try to think about this. What's our core value, respect for diversity.' We just came up with that's what we want to say because we want her to process, just in a separate space, and it's just been really hard on this one class. It's so hard to get her to focus. I don't know what to do. (Lily, Session 6, 12.15.18)

During the story, other members of the group asked clarifying questions and helped Lily think through what the student was experiencing, offering support and suggestions. For instance, Marigold suggested, "Sounds like she's trying to distance herself from all the things that have applied to her her entire life." Lily affirmed, "Yes exactly. Yes I think that's what's coming from her mother and she's internalizing that, exactly. It is so strange and to be in there as a white teacher."

This story is packed with areas prime for analysis. We could examine it from the perspectives of the students in the room and look at the microaggressions and internalized racism that was taking place in the classroom. Alternatively, we could explore what Lily did as a white teacher in the room, such as giving students the time and space to process race and internalized racism or trying to protect Black male students in the class from a young woman's internalized racism. However, for our present purpose, we concentrate on the systemic supports in place at her school that assisted Lily in dealing with the situation. Lily's co-teacher and colleagues provided support to help her address the situation with Tiffany, collaborating on steps to take and planning for anticipated conversations and what to do in the moment when this happens. They

also drew on the institutional structure of the school itself, emphasizing Angelou’s core values of “respect for diversity” and “respect for humanity.” Bringing the school’s core values into the conversation helped to reinforce the teacher’s stance and the attitudes and beliefs that the school holds dear. It also reinforces to the student the importance of continuing to process this new aspect of her identity, but processing in a separate space to make sure that the classroom and community of learners remains a safe, welcoming, affirming, and respectful environment. Thinking about how to be culturally responsive in a situation like this is complex and challenging in myriad ways.

In this theme, teachers’ stories surface systemic issues, both constraining and supportive, that they deal with at multiple layers of school, administration, city, and state. The tensions between expectations and responsibilities regarding standardized testing and teaching science in culturally responsive ways echo previous studies (Achinstein & Ogawa, 2012). The tensions that emerge highlight the contrast between standardized testing and the tenet of CRE concentrating on teachers adopting a critical stance toward sociopolitical structures and processes and helping students to develop the same, a social justice component that recognizes and actively addresses issues of inequities. Another important consideration is the question of “standardized” for whom? Standardized assessments currently are based on what is considered as the “norm” of the dominant culture, and is not *standard* for all individuals, cultures, or languages (Milner, 2007; Achinstein & Ogawa, 2011). Whether or not teachers’ schools explicitly supported their work in culturally responsive education, teachers strived to make their classroom communities and their curriculum and instruction culturally responsive. In this work, they focused on the importance of knowing the students in front of them, and made learning about their students an early focus of the group’s work together.

Making science content and the science learning community culturally responsive. This theme emerges in several ways, including exploring what distinguishes culturally responsive teaching from “just good teaching” (Ladson-Billings, 1995). Emerging in this area is also teachers’ wonderings in their individual contexts and settings if what they are doing is in fact culturally responsive. Subthemes include components of CRE discussed by the group, and the concept of CRE as student and classroom specific. This theme also draws upon teachers’ work in making students’ needs and ideas more central to their instruction.

CRE as student and classroom specific

As they teach in one of the most pluralistic and diverse urban centers in the United States, each of the teachers in the group worked with students who could not be categorized simply into one culture or another. Accordingly, they took up the challenge to create classroom strategies that recognized and drew upon what specific individuals and groups of students brought to their classrooms. As Bennett put it,

My population tends to be ... Puerto Rican heavy, Black and Latino community ... So I can see myself planning lessons in advance to be culturally relevant to that group. But I'm wondering how it can be, how you could make a broad plan like that, that would be usable anywhere else. ... And so it looks like ... it's very site-specific, it's very classroom-specific (Bennett, Session 1, 9.26.18).

Bennett here is drawing on a concern that also besets curriculum and standardized examination creators: Cultural relevance requires attention to individual students and to culturally specific ways of knowing and communicating. Thus Bennett can imagine how to plan “culturally responsive/relevant” lessons for his own classes, which tend to represent a “predictable” population—but how to do this so they are “usable anywhere else” remains at question.

Within this context of classroom specificity, teachers made changes to their classrooms to make them more culturally responsive and inclusive. For instance, late in the year under study here Bennett said that “some culturally relevant stuff” was “happening in my classroom.” He told the group that he had decided to have the students choose music to play when they were working well together. This led to a situation in which he was “listening to music” he never would have thought to listen to otherwise. He was also letting students choose their own groups, which he was concerned might lead to “chaos,” but instead noted that these groups were working well together. He continued to describe the effects of this choice on a particular group of his students, the Black male students:

In letting them pick their own groups, I noticed that none of my Black [students], males of color [were] assuming [the group leader role] at all—always someone else. This last week, I [assigned them that role]. One student felt empowered by it. Small steps that built the classroom so they feel like they're working together. (Bennett, Session 15, 6.10.19)

Bennett intervened when he noticed the students' choice of groups was leading to a situation in which not all students were provided with the opportunity to lead. He then put his male students of color in leadership positions, thus exercising his power as the teacher to provide the practice of leadership to students who might not otherwise experience it when students choose their own groups.

Marigold described a physical change in her classroom environment, which she didn't consider explicitly pedagogical, although she did notice an interesting shift in the power dynamic between teacher and students:

I haven't done anything particularly pedagogically in terms of my instruction in terms of culturally responsive education [since we last met], but one thing that I did do is that I changed the organization in my classroom of the desks so that it's a big U shape which has led to ... increased distracted behavior because the kids are looking at each other now. But it definitely makes it more of a group classroom rather than everyone facing me. So that was just a neat change to have and I think everyone feels a little more comfortable—I feel more comfortable because kids are looking at each other instead of at me and it feels more like a community and less of a teacher-centered classroom. (Marigold, Session 5, 12.3.18)

While Bennet provides his students with more choice, both in altering their classroom environment to include music they liked and in forming groups with the classmates with whom they wanted to work, Marigold shifted the physical environment to create a social space that felt “more like a community and less of a teacher-centered classroom,” in which both she and the students seemed to be “a little more comfortable.” Each of these shifts in classroom environments represent efforts to place the control of classroom activity and discussion more in the students' hands, and to create a community respectful of students' needs and preferred modes of interacting.

Zen makes her efforts to attend to her students' preferences especially explicit. She notes that she works with students, many of whom are “literally adults,” and have “not had a good relationship with school.” So she wants to know, “When we're struggling with creating culturally relevant, what do they need? What does it mean to them? We don't want to be going

down a path that doesn't meet their needs and so it may be different for different populations" (echoing what Bennett said about being able to create cultural relevance for his own students, but not for others). She describes below what she has learned from her students:

Some of the feedback that my students have given me is that ... 'We like that you listen to us.' So it's like when they make a suggestion, examples would be, 'Don't treat us like children, we're adults,' [and] 'We're not going to do that assignment.' Then I think about: What could I do that might change that? Could I provide you with more choices? What can I change? So instead of just saying, 'No this is it, you either do it or you don't.' It's like, 'What would work for you?'

Zen works with her students to figure out how to match their needs and favored ways of working with the science content that she hopes to help them learn. Possibly because so many of her students are legally adults, she sees her role as adapting to their stated needs rather than coercing them into fulfilling traditional student roles wherein they would do what they are told.

Encouraging student talk in the classroom

The group's efforts to shape their instruction as well as their classroom environments in ways that would suit their students was informed by a shared desire to encourage more discussion in their classrooms. As mentioned above, Theo chose to revise an assignment so that students could create their "hazards pamphlets" in the language with which they were most comfortable, and then translate them into English. Theo shared this assignment and the students' work to illustrate it. This was a regular occurrence in the group's meetings: Teachers shared, analyzed, and adopted other group member's instructional design choices to their own contexts. Importantly, such discussions integrated teachers' learning about culturally responsive education in a dialectic that continually applied and examined the tenets of CRE to actual teaching, and concomitantly, used these tenets as a lens to design new forms of instruction.

While teachers often implemented and discussed CRE-informed activities shared by individuals, some instructional strategies were designed collaboratively early in the group's time together. The first of these was a survey teachers designed to learn more about their students, and about their students' perspectives about their own cultures and the role of these in the classroom. The second strategy was based on a protocol teachers had encountered through a professional

development experience¹ and modified, designed to encourage but also structure students' talk in the science classroom. This was the "Idea Exchange," in which students were given a question or multiple questions, and asked to respond to these questions in writing, on post its. Students then get up out of their seats, and share their post its, one at a time, with another person and rotate around the classroom to speak with others. Ideally, students read out loud what their partners have written on each post it. Because teachers' classrooms varied in terms of culture, age, and language, and because they were teaching difference science content at different times, the group decided that this protocol, adaptable to all kinds of content, would be a good way for them all to try something in their individual classrooms and so have a common point of discussion.

Marigold described a lesson she designed to engage her students in learning about what causes the seasons through their interest in the Hallowe'en holiday. She also incorporated the Idea Exchange protocol.

I'm doing seasons right now. Trying to make it Hallowe'en friendly, my lesson was spooky seasons: Alaska's endless night. So the question was why does Alaska have a night that lasts for 67 days? We started the whole lesson by reading a paragraph about what it's like to be there and get ready for that long night and watched the time lapse video [showing how little the Sun moves], and I followed the [Idea Exchange] protocol that we had written up, I think largely promoted by Theo. And it was awesome! I wasn't sure, Bennett and I were talking about it in the car in the morning, I wasn't sure how culturally relevant it can be considered. ...But at the same time the kids were so excited. And I think it was a really engaging question because even though it's not something relevant to their lives, it's still something they can imagine. Like they can't necessarily imagine Earth's tilt, like making it so that Alaska doesn't get sunlight, but they can imagine what it would be like to be dark for that long. And I think it was really beneficial for the kids to have a protocol to follow. ... So I think it was a fun form of communication. (Marigold, Session 3, 11.3.18)

To bolster Marigold's claim that her class found this lesson engaging, she talked about an individual student who clearly demonstrated that he was intrigued by the "endless night" lesson:

¹ <https://curriculum.newvisions.org/middle-school/getting-started/professional-developmentpas-workshops/>

I had a kid who is in my first period class and he hasn't been in class for about a month and he was there that day, and he's been there every single day since. And he told me that he went home and was playing PS4 on one of those games where you talk to people around the world when you're playing and he met someone in Alaska and asked him if it was true. So he came back the next day actually telling me about it. And then was asking me all about time zones and everything. So that was pretty cool.

Marigold's story reveals how choosing an intriguing question and utilizing an engaging discussion protocol can engage students in learning Earth science content—even beyond that included in the lesson's content, as evidenced by the student who talked with an acquaintance from Alaska, and inquired about time zones. In addition, her story indicates how the work of individual teachers is tightly tied to the group's work: Theo played a large part in the development of the Idea Exchange, and Marigold discusses her impressions of the lesson with another group member on the way to work: "Bennett and I were talking about it in the car in the morning, I wasn't sure how culturally relevant it can be considered." Throughout these stories, self-questioning and reflection were much more common than certainty in terms of culturally relevant education.

Lily also reported on a lesson in which she utilized the Idea Exchange. She related that it was challenging to get the students "up and moving" but "once they get up and moving they like it." She continues,

And what I did, because kids didn't want to move, I had one of the students choose one song. He tried to find the shortest song he possibly could which was like a 2.5 minute song and that got more people up and moving. So there is super-intense rap music blasting in my classroom but kids finally got moving. How effective it was at creating student voice around questions and the ability to socialize that asking questions are okay and no ideas are stupid, I don't know if it was effective but it definitely broke up the cliques. It got students talking to each other who never spoke to each other before so that was a benefit. (Lily, Session 3, 11.3.18)

Lily reminds us with her story that the Idea Exchange carried multiple intentions: It was to get students' ideas out into the classroom space; it was to help students talk to one another, especially to classmates with whom they wouldn't otherwise interact, and it was to help them believe that "asking questions are okay and no ideas are stupid." It is evident that the group considered this activity to be culturally responsive, in multiple ways. As Bennett said, in reference to the Idea Exchange: "What I'm saying for culturally responsive, [the Idea Exchange is] really promoting diverse social interactions in a safe environment. So I think this type of activity is really, no matter how you apply, it is engaging because it gives everybody a voice, it keeps everybody in an engaged safe space, and I think that's a fundamental pillar of what we're trying to do." (Bennett, Session 3, 11.3.18)

We wrap up this theme with a quote from Zen, who states that "I'm seeing I'm starting to change but I want to know for [my students]—I would like to know in their minds when they hear us as ... educators wrestling with this term culturally relevant, what do they think of when they think cultural—what does that mean for them? Again, it's that student voice. In the end, we're not teaching for our own sake, we're teaching trying to figure out how to best help them thrive in a world that's very diverse." (Zen, Session 3, 11.3.18)

Discussion and Implications

Our analysis in this paper does not claim to come to a final resting place where we can say, "We are done. We've decided what CRE looks like in the classroom." All of the authors of this paper continue to learn from theorists, emerging research, and teaching in secondary and in college-level classrooms. We began the pilot study wanting to see what culturally responsive science education "looked like" in classrooms, which remains an important goal. Teachers' stories helped us consider what it can look like, and what it takes, from teachers' perspectives. Considering Stories from the Field as a pedagogical tool, teachers relate and reflect on situations, events, and instances that they experienced in their unique settings, as representations of practice (Segal, 2019; Horn & Little, 2010). Unlike concrete images on video, stories by nature are opaque—they are expressed through the perspective of the narrator, who holds the reins and guides the listeners (Segal 2019). As we delved deeper into the data, we noticed that teachers regularly used stories to illustrate relationships between the theory they were reading and their classroom practice. Additionally, several unique stories re-emerged over time, as teachers

brought in continuations of stories or asked others to update them on the current state of a situation related previously.

As we could see in the stories, teachers in the group recognized the necessity of finding out more about their students' cultures, and they continued this effort through video and reading. But they also took a perspective that more directly aimed to aid them in learning about the unique individuals and groups of students in their classrooms. Learning about one's students could be an example of "just good teaching" (Ladson-Billings, 1995), a concept that teachers brought up regularly throughout the year. It can also be considered culturally responsive, in the sense that if teachers do not learn about the students in their schools and classrooms, directly, they will potentially hang on to harmful stereotypes that they bring with them. Additionally, learning about one's students allows teachers to create curriculum and instruction that authentically engages students in science content.

As articulated by teachers in the CRE PLG, little currently exists in the literature to provide insight into what culturally responsive science teaching looks like in science classrooms. This group was initially formed because teachers had been hearing references to culturally responsive education (and its relatives) from their administration and from other teachers—it was "in the air" and they wanted to learn more. In their explorations of the literature, teachers came to believe that there was a great need for strategies and activities especially in science, concrete items to help teachers implement culturally responsive approaches in their unique contexts and classroom settings. We emphasize that this is *not* a checklist of strategies, or list of steps that will automatically make science teaching culturally responsive. The strategies that teachers discuss and implement are grounded in their practice, the research, and what they are learning about their students.

In this paper, we provide images of the work involved in moving toward culturally responsive science teaching in high-needs, demographically diverse urban settings as illustrated and articulated by the teachers doing the work through the stories they tell. The CRE PLG work in learning about culturally responsive science education contributes not only to our theoretical understanding of teacher learning but to implementation of CRE. This study has also helped to clarify our thinking around CRE as teacher educators and researchers, and provided the foundation to expand the CRE PLG to include a larger number of graduates in our community. As we work together in this effort with our teacher graduates, we also reflect upon and

reconsider ways in which we are preparing our preservice teachers to teach science in diverse high-needs settings throughout the state.

Conclusion

After the first year of the pilot, two of the teachers in the CRE PLG changed schools, and all have continued to teach Earth science in high-needs schools in the city. The CRE PLG has continued to work together and Stories from the Field has remained an integral routine in our sessions. Throughout the second year, the group has been moving from an explicit focus on culturally responsive science education to culturally responsive-sustaining science education. This mirrors new policies in the shifting landscape with the state department of education's release of a culturally responsive-sustaining education (CR-SE) framework ([Removed for blind copy] Department of Education, 2019).

During the second year of the pilot, the CRE PLG has concentrated on individual teacher inquiries into their own classrooms and practice in the context of CR-SE. Social justice and developing a sociopolitical consciousness has become a very strong thread in the second year of our work together. In addition, the group has been taking steps to increase its size. Another cohort member joined at the beginning of the second year, adding to the size and diversity of the group, and we are working to continue to expand with teacher graduates from other cohorts of the program.

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Appendix

Table 1. CRE PLG Participants

Teacher	Background information
Marigold	White, female, cisgender, Jewish, English/Spanish bilingual, 29 years old
Seamus	Male, cisgender, white, early 30s
Theo	Chinese, Male, grew up in urban setting
Lily	White, female, cisgender, grew up in rural-suburban northeast town outside of a large cosmopolitan city
Bennett	White, male, cisgender, German-Albanian, English speaker, grew up on rural farm, went to college for 12 years, Spanish language learner, 36 years old
Zen	Genderfluid; Swiss-English heritage North American; general professional proficiency in Spanish

*Pseudonyms have been applied to all teachers to protect identities.

Table 2. CRE PLG School Demographics

Teacher	School	Enrollment	School Demographics (using the 2018-19 State's enrollment data and language)									
			American Indian or Alaska Native	Asian or Native Hawaiian	Black or African American	Hispanic or Latinx	White	Multiracial	ELL	Special needs	Economically disadvantaged	Homeless
Marigold	Explorer's High School	310	1%	2%	19%	76%	1%	1%	26%	28%	95%	17%
Seamus	Sunrise Garden High School	1217	0%	10%	8%	74%	8%	0%	22%	24%	86%	6%
Theo	Einstein International High School	823	NA	28%	1%	64%	6%	NA	78%	1%	88%	17%
Lily	Maya Angelou High School	241	0%	2%	38%	55%	5%	0%	8%	32%	82%	6%
Bennett	Chopin School of Music and Performing Arts	423	1%	1%	27%	66%	1%	4%	6%	24%	87%	7%
Zen	IWD High School	172	NA	1%	36%	61%	2%	NA	6%	15%	81%	6%

*Pseudonyms have been applied to all teachers and schools to protect identities.

** Table 2 provides a summary of the schools' demographic data made public by the state's Department of Education. "ELL" refers to the number of students in each class who have been officially designated as English Language Learners.