Title

Exploring science teachers' efforts to frame phenomena in the community

Authors
Clark, Heather F
Gyles, Symone A
Tieu, Darlene
et al.

Publication Date
2024

DOI
10.1002/tea.21945

Peer reviewed

Received: 16 September 2022 | Revised: 14 March 2024 | Accepted: 31 March 2024

DOI: 10.1002/tea.21945

RESEARCH ARTICLE

JRST | WILEY

Exploring science teachers' efforts to frame phenomena in the community

Heather F. Clark[1] | **Symone A. Gyles**[2] | **Darlene Tieu**[3] | **Shriya Venkatesh**[3] | **William A. Sandoval**[4]

[1]College of Education, California State University, Carson, California, USA

[2]School of Education, University of California-Irvine, Irvine, California, USA

[3]Los Angeles Unified School District, Los Angeles, California, USA

[4]Department of STEM Education, North Carolina State University, Raleigh, North Carolina, USA

Correspondence
Heather F. Clark, College of Education, California State University, Dominguez Hills, Carson, CA, USA.
Email: hclark@csudh.edu

Funding information
UCLA Graduate Division

Abstract

This article examines two teachers' efforts to re-organize their science teaching around issues of environmental and food justice in the urban community where they teach through the pedagogical approach of community-oriented framing. We introduce this approach to teachers' framing of phenomena in community as supporting students' framing of phenomena as personally and locally relevant. Drawing on classroom observations of remote learning during the COVID-19 pandemic, we took an analytic approach that characterized features of classroom discourse to rate community-oriented framing at the lesson level. Results show that teachers framed phenomena as both social and scientific, and as rooted in students' lived experiences, with classroom activities designed to gather localized and personalized evidence needed to explain or model phenomena. We also share examples of how Black and Latinx students took up this framing of phenomena in their classroom work. By providing a detailed description of the launch and implementation of activities, findings illustrate how community-oriented framing supported teachers in posing local questions of equity and justice as simultaneously social and scientific, and helping students perceive science learning as meaningful to their everyday lives. Community-oriented framing offers a practical means of designing locally and socially relevant instruction. We contribute to justice-centered science pedagogies by conceptualizing transformative science learning environments as those in which students understand their goal in science class as understanding, and later addressing, inequities in how socioscientific issues manifest in their community.

KEYWORDS

framing, justice-centered science pedagogy, phenomenological framing, socially relevant science

1 | INTRODUCTION

School science is too often disconnected from the lived experiences of non-dominant, marginalized students (Bang et al., 2010; Rosebery et al., 2010). Part of this disconnect and feelings of irrelevance can be attributed to apolitical science instruction that divorces scientific phenomena and problems from the sociopolitical systems in which they are situated, and erases historical, ethical, and justice dimensions from science education experiences (Lee & Grapin, 2022; McKinney de Royston & Sengupta-Irving, 2019). This presentation of science disciplines as truth and fact, set apart from the lives of marginalized youth, may ask students to set aside their cultural practices and knowledge in favor of dominant, normative ways of knowing and doing science (Morales-Doyle, 2019). Combined, these barriers contribute to the ongoing injustices experienced by marginalized students to perpetuate systemic inequity in learning opportunities in science education (Bang & Medin, 2010; Basu & Barton, 2009).

Several teams of science education researchers and teachers have worked to re-mediate these inequities with various approaches to justice-centered science pedagogy (c.f. Basu et al., 2009; Davis & Schaeffer, 2019; Morales-Doyle, 2017). At its core, this work is committed to ensuring students develop sociopolitical consciousness alongside disciplinary competences to "equip students to survive in the world as it is while we inspire them to imagine and fight for the world in which they and others can thrive" (Morales-Doyle, 2019, p. 489). To continue developing practices that advance equitable science education, Morales-Doyle (2017) called for case studies of justice-centered science pedagogy (JCSP) that investigate how teachers address inequities in science education. We respond to that call with an investigation of how two teachers communicate to their Black and Latinx students that the purpose and focus of scientific work in school is to understand and respond to sociopolitical issues in the community.

Specifically, we present a case study of two teachers' efforts to re-organize their science teaching around issues of environmental and food justice in the urban community where they teach. We introduce the construct of *community-oriented framing*, a practice of positioning science as a tool for explaining, and potentially acting on, locally relevant socioscientific issues. Generally, framing refers to the meta-communication for interpreting how participants understand their actions by invoking certain expectations as the answer to the question "what is going on here?" (Goffman, 1974, p. 8). Framing has been applied to understanding pedagogical practices, as different frames shift the structure of classroom tasks and participation to organize the nature of classroom discourse (Engle, 2006; Erickson, 1982; Ford & Wargo, 2012; Kawasaki & Sandoval, 2019). The Next Generation Science Standards (NGSS) imply a phenomenological framing of science instruction to emphasize science as a tool for explaining the world (NGSS Lead States, 2013). Community-oriented framing extends this by locating phenomena of inquiry as connected to and situated in the same local, sociopolitical contexts of students' everyday lives. This re-organization can be described as reaching for horizontality (Warren et al., 2020) to recognize that learning is "infinitely deeper and broader than school" (p. 283) with connections to a diverse variety of people, places, and cultural contexts. We conceptualize these framing practices as "horizontal attunement" that pushes against the neutral framing of science learning to re-center the "histories, purposes, and places integral to students' ways of being" (p. 285). Community-oriented framing is designed to support educational equity and justice through horizontality by connecting science to sociopolitical dimensions of phenomena youth see and experience in their community, and by inviting in students' diverse ways of knowing and doing science to support relevance in learning. By documenting these framing practices, we contribute to JCSP by offering a tool teachers can use to re-organize marginalized students' science classroom experiences. In this study, we aim to understand two teachers' practices of community-oriented framing and their Black and Latinx students' responses. We ask:

1. What instructional practices did teachers use to frame phenomena in community?
   a. What were teachers' intentions for these framing practices?
   b. How frequently were these framing practices used in a unit?
2. How did students uptake frames of phenomena from their classroom experiences to make sense of the relevance of phenomena to their community?

1.1 | "Natural" phenomenological framing

The notion of framing was developed to characterize how people interpret the purpose of interactions and their expected roles in those interactions (Bateson, 1972; Goffman, 1974). In science education, research on framing highlights the crucial role that teachers' discursive interactions play in students' understanding of classroom tasks (Berland & Hammer, 2012). Teachers frame activities during the launch of lessons and throughout instruction in response to students' interpretation of instructional tasks (Kang et al., 2016; Rosenberg et al., 2006). Framing tasks in particular ways give different meanings and guidance to students on interacting with those tasks (Berland & Hammer, 2012; Engle, 2006; Greeno, 2009; Roth & Bowen, 1994). The default, dominant frame in science class is "doing school" or "complete the worksheet" which structures engagement in rote and shallowing learning (Jiménez-Aleixandre et al., 2000). In the absence of framing to explain a meaningful phenomenon, even hands-on or inquiry-based instruction can be understood by students as "doing school" rather than explaining the world.

The NGSS advocate that teachers orient their instruction to addressing questions or problems in the world. A phenomenological framing, or anchoring instruction in real-world phenomena and supporting students in explaining those phenomena, is one pedagogical practice used to achieve this goal (NRC, 2012; Quinn, 2021). In this approach, orienting student sensemaking to phenomena does not just offer a "hook" to launch instruction on otherwise fragmented concepts, rather, it creates coherence between concepts and relevance beyond the classroom task. A phenomenological orientation, combined with opportunities to engage in science practices, is intended to help students learn science concepts to explain the world around them (Lee, 2020; Osborne, 2014). Phenomenological approaches to framing orient the purpose of learning science and attempt to focus on epistemic aspects of science to increase opportunities to learn or transfer concepts (Engle et al., 2011, 2012; Roth & Bowen, 1994).

1.2 | Justice-centered science pedagogy

While the NGSS offer important motivations to orient instruction to phenomena, they fall short on issues of equity and socioecological justice and in guiding teachers on how to navigate phenomena that have social, political, and ethical dimensions. First, the standards maintain the status quo of science that excludes minoritized individuals and communities by defining equality as access without interrogating the structural barriers to access (Hoeg & Bencze, 2017; Rodriguez, 2015). In this status quo, science is rooted in positivist notions restricted to Western conceptions of knowledge. Science education is dominated by these notions, leaving science classrooms devoid of diverse epistemological perspectives, or viewing those diverse perspectives as deficits (Mutegi, 2011; Stanley & Brickhouse, 2001). The NGSS do not reckon with systemic racial inequities, the unspoken norms of Whiteness (Sleeter, 2001), or the role of education in perpetuating those inequities and norms. Second, the NGSS omit social and political aspects of phenomena leaving teachers to figure out for themselves how to fill the gap (Clark et al., 2020; Hufnagel et al., 2018). Combined, these features create what Lee and Grapin (2022) describe as contemporary approaches to science education that organize instruction around "sanitized" phenomena and problems that "remain silent about disparities that underlie pressing societal challenges" (p. 1304). Framing aligned to these sanitized phenomena is problematic because it ignores the histories and realities of many marginalized students. When teachers strive to learn the NGSS and align their instruction to them, they can adopt the problematic values embedded in those standards (Clark et al., 2020) and are positioned as promoters of the status quo of science and science education (Morales-Doyle et al., 2019). These problematic features of science education and the NGSS create an instructional gap that teachers must fill if they hope to orient their instruction to the world as minoritized youth experience it—that is, to a world full of inequity and opportunities for collective action.

Orienting science instruction to the world of marginalized students is also important because of the role of identity in learning (Kayumova & Tippins, 2021; Rahm et al., 2022). While dynamic rather than universal across marginalized groups, identity has a significant impact on how students engage with and frame science concepts. For example, Unsworth et al. (2012) found that Menominee children were more likely than European children to attune to ecological relations and psychological closeness based on their Indigenous cultural identity; the authors suggest that to build on this diverse knowledge, science education must be attuned to this cultural identity. For Latinx multilingual students in chemistry, Flores and Smith (2013) found that real-world examples and scenarios within the discipline made chemistry more manageable and engaging, demonstrating that instruction grounded in students' experiences is necessary to work against sanitized phenomena. Additionally, both Ireland et al. (2018) and Wade-Jaimes et al. (2021) found that it is important Black girls' cultural identities are leveraged in science as they often have to "negotiate being a good student with being a science person" (p. 873). These studies demonstrate the importance of attending to students' identities and experiences when considering how they may connect with a lesson.

Justice-centered approaches challenge views of science and science education as a privilege and benefit for only some, partly by addressing what Mensah and Jackson (2018) describe as "science as White property." Drawing on Critical Race Theory (Ladson-Billings & Tate, 1995; Zamudio et al., 2010) that views Whiteness as a tangible aspect of life that White people claim as their own and therefore allow and deny access to, practices that perpetuate science as White property restrict the teaching, learning, use, and enjoyment of science to White communities and exclude marginalized groups like woman, students of color, and low-income students. Rather than position youth as part of the future labor force to advance this status quo of exclusionary, neoliberal science, JCSP positions youth as transformative intellectuals that use science to address inequities in their own lives (Morales-Doyle, 2017). As a framework, JCSP can help teachers work within the standards by prioritizing academic achievement while also pushing beyond the standards by positioning youth as credible experts of complex social justice science issues. In this paper, we show that community-oriented framing describes practices for centering justice and equity goals as part of scientific work in schools while also recognizing the unique identities of students.

1.3 | Community-oriented framing

We introduce the concept of community-oriented framing as a tool to center the focus of science learning on understanding and acting in students' community. We define community-oriented framing as a strategy to construct scientific phenomena as embedded in the physical, social, and historical context of a school's community. This approach to phenomena is aligned with Lee and Grapin's (2022) proposed future approaches to science education that "emphasize explaining and solving pressing societal challenges that directly impact students' lives, communities, and society" (p. 1304). Community-oriented framing positions phenomena of inquiry as both scientific and social, with permeable boundaries where scientific concepts and practices overlap with social, cultural, and political concepts and practices meaningful to students' community. This positioning is a goal of JCSP, and community-oriented framing offers practices for teachers to create those permeable, overlapping contexts with students.

This idea of community-oriented framing builds on Engle's (2006) concept of intercontextuality. Engle defined framing as intercontextual when teachers establish the learning context as relevant to other contexts of students' lives. In a series of studies, Engle showed that intercontextual framing can support the transfer of learning (Engle, 2006; Engle et al., 2011, 2012). Community-oriented framing supports intercontextuality by connecting classroom science learning experiences to the sociopolitical contexts of students' communities. Aligned with the values of other justice-oriented approaches to help teachers connect instruction to community (c.f. Ballard et al., 2023; Cachelin & Nicolosi, 2022; Murrell, 2000; Philip et al., 2013; Varelas et al., 2018), we aim to position community as an educational asset and to bring the power of science disciplines to youth.

Our conceptualization of community draws from place-based pedagogy and Dewey's idea that learning occurs most naturally when focused on the intersection of people, their local environment, and an authentic purpose (Buxton, 2010; Harms & DePencier, 1996). From this perspective, community refers to the neighborhood where students and their families live and evoke the notion of purpose as addressing the forms of injustice they encounter in their everyday lives. Community-oriented framing is designed to work against pervasive deficit perspectives and, instead, embrace epistemological, linguistic, and cultural diversity to disrupt power structures and invite non-dominant students' ways of knowing and being into classroom spaces (Gruenewald, 2003; Morales-Doyle, 2017; Vossoughi et al., 2016). This framing attunes instruction to student identities and positions identity as relevant to science learning to expand opportunities for engagement and for making generative connections to concepts.

As a strategy for framing, teachers' discursive interactions (routine speech patterns) of community-oriented framing can signal to students that epistemological diversity, personal or cultural experiences, and questions of politics, history, justice, and ethics are welcome in the science classroom (Hand et al., 2012; Vossoughi et al., 2016). In our team of teachers and researchers, we believe that part of how students should answer Goffman's (1974) question of "what is going on here?" should be that they are using science concepts and practices to explain historical and present injustices in their community and building their knowledge and skills to address those injustices.

2 | METHODS

2.1 | Context, partners, and positionality

This work took place at the Mann UCLA Community School, a grades 7–12 Title 1 public school located in the neighborhood of South Los Angeles, in Los Angeles, California, United States. Demographically, the students are 52% Black and 48% Latinx, with 22% bureaucratically designated as English Language Learners; all are from low-income families qualifying for the federal free and reduced-price meal program. The school and South Los Angeles are home to more low-income families and Black families relative to the district, which has 60% low-income students and 7.6% Black students. The school follows a community school model (Oakes et al., 2017) and has been in a partnership with UCLA since 2016. In this model, teachers have opportunities to engage in various professional development experiences oriented to collaborative leadership and practices. Data for this study were collected during the fall semester of 2020 while all instruction was remote due to the COVID-19 pandemic. The logistics and dynamics of remote learning resulted in less instructional time than a typical school year, with classes meeting for approximately 3 h a week, and different forms of engagement, specifically with students preferring to participate via the Zoom chat rather than speak.

The researchers on our team come to this work as visitors and allies to the community where students live and teachers work. Heather and Symone both have backgrounds as science teachers and researchers in the physical sciences, and along with Bill, are now dedicated to science education research. Heather is a White[i] woman, Symone is a Black woman, and Bill is a Hispanic man. We operate from the premise that research on the learning and teaching of science cannot be divorced from the historical and sociopolitical dimensions of schools, communities, and disciplines, and we are committed to re-mediating the ongoing harms of science education that perpetuates racism, sexism, and settler-colonialism. This position shapes our responsibility to students, and as such, we work to normalize, elevate, and nurture the expansive meaning-making practices and knowledge of students from non-dominant communities. Our partners and co-authors in this research are two science teachers. Shriya, or Ms. V, is an Indian American woman who partnered with Symone in teaching two sections of a 7th-grade science elective. Darlene, or Ms. T, is a Vietnamese American woman who partnered with Heather in teaching two sections of 10th-grade chemistry. As teachers of color, with immigrant backgrounds and intersectional identities different from, but akin to, many of their students, Ms. V and Ms. T were keenly aware of how school and science marginalize themselves and their students and were deeply committed to dismantling those forces.

We engaged in a teacher–researcher co-design process, a joint activity that draws on our diverse perspectives to design tools that are useful for students and teachers (Gomez et al., 2018). Our methodological approach was guided by the commitment of Participatory Design Research to attend "to the ways in which critical historicity, power, and relational dynamics shape processes of partnering and the possible forms of learning that emerge in and through them" (Bang & Vossoughi, 2016, p. 174). Specifically, our collaboration paid explicit attention to re-mediating the traditional roles of the researcher and researched such that Ms. V and Ms. T were co-equal partners. To share a brief relational history, our partnership began in 2018 when Heather, Symone, and Bill visited Mann UCLA Community School during an end-of-year professional development and met Ms. V and Ms. T. We shared common interests around equitable science education and were all interested in designing locally relevant innovations, and the teachers invited us into their classrooms. In the 2018–2019 year, we designed two short instructional units and each year expanded the units (Clark et al., 2022; Gyles & Clark, 2024).

Our conceptualization of community-oriented framing was collaboratively developed through a multi-step, iterative, reflective co-design process within our ongoing research-practice partnership (Penuel, 2017). One unit we designed and analyzed focused on nutrition guidelines, recipes of cultural significance to students, and food justice. This unit was taught by Ms. V in the 7th-grade elective class and addressed scientific questions of biochemical macronutrients and metabolism with social questions of nutritional guidelines, healthy eating, food justice, and lack of access to healthy food options in urban communities of color. The second unit focused on the carbon cycle, the lack of parks in the students' community, and students' everyday experiences in urban greenspaces. This unit was taught by Ms. T in 10th-grade chemistry and brought together the scientific phenomenon of the unbalanced carbon cycle with the social phenomena of urban land use and deforestation decreasing carbon reservoirs and inequitable access to greenspace in urban communities of color.

2.2 | Data sources

To answer our first research question on instructional practices to frame phenomena in community and question 1b on the frequency of these practices, Heather and Symone took detailed field notes while observing instruction, including descriptions of interactions and participants' verbatim speech or paraphrases of utterances (Erickson, 1986; Merriam & Tisdell, 2016). The discourse and interactions documented was improvised by teachers, or exogenous to design (Tabak, 2004), and became routine through enactment; our design approach conceptualized frames but did not script teacher talk moves. We focused on month-long units taught by each teacher, with 20 h of observation per teacher. These units are representative of the school year and were selected for analysis of framing because they were both organized around an issue of the local community and were taught at the same time by the two teachers (in November and December of 2020). We also collected instructional artifacts including lesson plans and slides.

To add context to our analysis of field notes and artifacts, we conducted document elicitation interviews with Ms. V and Ms. T. These interviews gave the teachers a chance to retrospectively reflect on their teaching, allowing us to answer research question 1a about teachers' intention. We developed our interview protocol by reviewing the lesson plans, slides, and teacher discourse and crafted open-ended questions intended to give Ms. V and Ms. T the opportunity to reflect on their instruction. We asked questions to elicit teachers' intentions and analysis of practice, such as "When you said this, what connections were you hoping students would make?" and "With this image you showed, what were you trying to signal to students about explaining the community?" Each interview was approximately 90 min, audio recorded, and then transcribed.

To answer our second research question about how students made sense of the relevance of their learning relative to their community, we collected samples of student-written work to analyze how they took up the frames of phenomena presented in their classroom experience. For Ms. V's 7th grade science elective, we collected three written assignments that explored types of, and access to, healthy food in the students' local community. For Ms. T's 10th-grade chemistry class, we collected students' end-of-unit tasks that asked them to explain how aspects of Los Angeles' Green New Deal plan would impact land use, climate change, the carbon cycle, and the community. These assignments were reflective, short answer responses that asked students to use science concepts and skills, as well as their observations and out-of-school knowledge, to explain issues of food or environmental justice in their community. For both 7th and 10th grade, assignments were designed to move away from narrow, correct responses, and instead, communicate that diverse ways of knowing and doing science, including community-based experiences, were welcome. We collected and analyzed work from 18 seventh-grade students and 16 tenth-grade students (every student who completed the assignments), representing approximately half of the students in the classes. We attribute this relatively low level of participation to the challenges multilingual and low-income students faced during the pandemic.

2.3 | Analytic approach

To provide a multidimensional analysis, we took a layered analytical approach that included first characterizing the discursive features at the level of the lesson to identify which lessons were most oriented to community, and second providing thick description of the pedagogical practices embedded in the identified lessons.

For our first phase, we used an analytical framework for classroom discourse developed to link specific patterns in teacher talk to patterns in student response and to explore how teacher talk structures the nature of student learning opportunities (Sandoval et al., 2021). Classroom discourse has been analyzed to understand how learning is socially organized and what it means to know in the disciplines (Lemke, 1990; Mehan, 1979) which has become increasingly important as NGSS-promoted practices, like explanations, are inherently dialogic (Kelly, 2014). Sandoval and colleagues' framework was designed to document qualitative differences between teachers' practice on three dimensions, or analytical categories, of ambitious science instruction (Windschitl et al., 2018)—framing, agency, and version of scientific practice—in a group of 25 teachers over 3 years of professional development. Derived from interaction analysis (Erickson, 1992; Jordan & Henderson, 1995), talk and other aspects of interaction, such as materials and gestures, were analyzed to compare how teachers aligned their instruction to the NGSS, and the struggles of organizing PD to support such changes. While Sandoval and colleagues relied on video data, here we relied on detailed observational field notes; this, combined with our design interest in framing, limits our study to just the one analytical category of framing.

In this study, we modified Sandoval and colleagues' (2021) approach to scoring a lesson in the analytical category of framing. The first step in this phase of our analysis was to identify and bound episodes of analytical interest in our field notes. We created content logs based on field notes to log segments of activity in terms of academic task structure (Erickson, 1982) which involved a description of participation and activity structures as well as interactions. Next, we analyzed these episodes with our a priori category of framing. Specifically, we scored an episode in relation to a positive or negative valence to capture dichotomous poles (−1 or 1), or between or ambiguous (0). After scoring episodes, we assigned an aggregate value to each lesson. Figure 1 presents the definition of each score and the activities we associated with each score.

The rating framework assigns a score of −1 to lesson that is framed as mastery of a canonical concept, and a score of 1 to a lesson that is framed as understanding and explaining a phenomenon in the world. A score of 0 represents a mix of the two endpoints where a lesson is oriented to a problem rather than mastery but is disconnected from the phenomenon. In reviewing classroom observations to assign codes, we looked for "salient differences in the valence of classroom discourse, namely, whether it is primarily oriented in toward disciplines students are meant to master or out toward the world in which students live and for which science concepts and practices may be useful" (Sandoval et al., 2021, p. 46).

Sandoval et al. (2021) described the malleability of the framework as allowing future work to include additional salient analytical categories; this study contributes a new analytical

Phase 1: Scoring lessons Identify which lessons had the strongest orientation to explaining the world and the community			
Phenomenon Score	**-1**	**0**	**+1**
Definitions (Sandoval et al., 2021)	Orients activity as a way to learn a science concept	Orients activity to solve a problem, but not explicitly relative to anchoring phenomenon	Orients activity as a way to understand and explain the anchoring phenomenon in the world
Observed activities that support score	Complete task to develop conceptual knowledge	Complete task to solve an unanchored problem	Gather evidence to explain phenomenon; test variables to explain phenomenon; create or revise model to explain phenomenon
Community Score	**-1**	**0**	**+1**
Definitions	Orients activity as a generic tool for use in an unspecified place and time	Orients activity to solve a problem, but at a global scale, an ambiguous time/place, or a time/place that is not meaningful to the community	Orients activity as a way to understand and explain the anchoring phenomenon as experienced by the students in their community
Observed activities that support score	Complete task that is disconnected from time and space	Complete task to solve a problem at a global scale or location that is not necessarily meaningful	Gather evidence to explain community or lived experiences; test variables to explain community or experiences; create or revise models to explain community or experiences
Example: "Our mini question for today is 'what is carbon?' We are going to use the periodic table for an activity called 'cracking the code' that will let us learn more about carbon and learn what it is made of and how it moves around." (Ms. T, Day 3 field notes) *Interpretive commentary:* This launch of an activity was not linked to a specific place or time (-1 community framing) and was oriented to solving problems about the chemical transformations of carbon but not explicitly to the anchoring phenomenon (0 phenomenon framing).			

FIGURE 1 Analytical approach to score lessons for framing with example of excerpt analysis procedure.

category that may be of interest to other equity-oriented science education teams. Specifically, we created a community-oriented framing category to look at whether phenomena were framed in students' community. We assigned a score of −1 to a lesson that was placeless or oriented to an ambiguous or abstract location, and a score of 1 to a lesson that was oriented to the specific place and time in which students live (Figure 1). Again, a score of 0 is a midpoint, here representing a global scale or oriented to a location other than the community. In assigning these community scores, we looked for explicit and implicit references to where, when, why, and how the questions of the phenomenon emerge and by whom they can be addressed. Only lessons that centered on understanding and explaining the community were given a score of +1; simply referencing community at the launch or creating coherence to past lessons framed to the community was not enough to receive this score. To support reliability in this step, Heather and Symone initially coded the same subset of data using the rating scheme described in Figure 1. We discussed areas of agreement and disagreement with Bill and refined scoring. We reached consensus after one round of calibration, member checked with Ms. V and Ms. T, and divided up the data set to complete the scoring. Sandoval and colleagues' framework, and our addition of a community-oriented category, was useful for our study because it enabled us to characterize discursive features at the level of the lesson without microanalysis of transcripts to reflect variation in teaching practices.

In our second phase, we further analyzed the observational field notes for the lessons that received a +1 score for community-oriented framing, as well as teacher interviews. The goal of this step was to describe how community-oriented framing was accomplished through pedagogical practices, as well as teachers' goals and intentions. While phase 1 looked at the lesson level with an a priori approach, phase 2 added depth to our study with inductive coding that identified utterances and interactions that framed science learning. We followed the describe-compare-relate process (Bazeley, 2009). Moving between the teachers' interviews, which spoke to their intentions and goals, and the observational field notes where their practices and routines were visible, we wrote descriptive interpretations of excerpts and compared within and between teachers to look for patterns of typicality and atypicality (Erickson, 1986), and related interpretations to relevant theories and literature. In this last step, we related our noticing to Engle's (2006) framework of context analysis for intercontextuality. This included relating our interpretation to two dimensions of intercontextuality: how time (learning builds on the past in hopes of contributing to the future) and participation (learners are ascribed as authors of knowledge and members of a larger community) were framed.

For this analysis, Heather and Symone initially completed the describe-compare-relate process on the same subset of data, discussed areas of agreement and disagreement with the other authors, and generated a preliminary set of themes and codes. We engaged in three more rounds of this calibration process using another subset of data until we reached consensus, and all definitions were refined. The remaining data were subsequently coded by Heather and Symone individually based on the consensually developed themes and codes.

In our coding, two framing practices emerged: "localizing phenomena" and "personalizing phenomena." In Figure 2, we present the framing practices and associated discursive interactions—the routine speech patterns of the teachers—as well as interpretive commentary for an example excerpt from field notes. Localizing a phenomenon is the practice of narrowing in on the specific ways a socioscientific issue manifests in a place. Gathering local evidence to explain or model phenomena gave students opportunities to explore data specific to Los Angeles to contextualize the problems, explanations, and solutions of the phenomenon. This evidence, connected to the past, present, or future of students themselves, people the students care for, or meaningful places, was used in explaining or modeling phenomena and in thinking about

Phase 2: Analysis of teacher framing practice
Identify practices used to frame phenomena in community in teachers' discursive interactions with the describe-compare-relate process (Bazeley, 2009), as observed in classroom observations, documented in field notes, and described in interviews

Framing practices	Discourse routines	Guiding definition for coding routines
Localize phenomenon	Connect to past, present, and/or future experiences and/or places	Teacher makes connections to past or present experiences of students, or to their imagined future, and/or places/characteristics that are meaningful in the community
	Position as member of systems	Teacher positions students as members of, or participants in, the everyday, present-day scientific and sociopolitical systems relevant to the phenomenon in the community
Personalize phenomenon	Connect to meaningful people	Teacher makes connections to people that are meaningful to the students or the community
	Position as agents of change	Teacher positions students as capable of contributing positively to their own future in the community or that of other meaningful people

Example: "Do you see our school on [on this carbon cycle diagram]? Do you even see our city? Do you see yourself? No. This diagram is too generic, and it doesn't help us. You can make a better one." (Ms. T, day 7 field notes)
Interpretive commentary: A useful diagram of the carbon cycle should include students themselves (position students as members) and meaningful places like the school and their city (connect to past experiences).

FIGURE 2 Analytical approach to describe teachers' framing practices with example of excerpt analysis procedure.

solutions to address the problems of phenomena. Personalizing a phenomenon is a practice of exploring, centering, and scientizing (Clegg & Kolodner, 2014) personal experiences and interactions within a socioscientific system. Organizing and using personal information as evidence in sensemaking encouraged students to consider their first-hand experiences, or relevant experiences from their family, community, or culture, as data to explain phenomena, and legitimize the relevance of these data in the science classroom.

Our third phase of analysis focused on student classroom artifacts. The goal of this step was to determine how students made sense of phenomena they explored in class and took up the frames offered by their teachers, which could have included adopting, appropriating, or rejecting their teachers' framing of phenomena. We know that teachers' framing has a significant impact on how students engage, so we began with a deductive approach to look for how students localized or personalized a phenomenon in ways similar to their teachers (Figure 3). This process involved identifying if and how student writing described phenomena as connected to themselves, to their local community, or to relevant social issues. We grouped excerpts into these themes, while also looking for counterexamples that did not fit, representing students sensemaking out of alignment with their teachers. Again, to support reliability, Heather and Symone coded the same subset of data. We discussed areas of agreement and disagreement and refined scoring. We reached consensus after one round of calibration, and we were able to divide up the data set and complete scoring.

3 | FINDINGS

We first present a summary of our scoring of lesson framings throughout the 7th-grade food unit and the 10th-grade chemistry unit. Then we trace how Ms. V and Ms. T framed specific lessons toward their students' community through localizing and personalizing practices. Finally, we show evidence from students' written work of how they took up those framings.

Phase 3: Analysis of student uptake of frames Identify discourse patterns in classroom work to understand how students took up the frames of phenomena from their classroom experiences to make sense of relevance of phenomena	
Discourse patterns	**Guiding definition for coding patterns**
Connect to past, present, and/or future experiences and/or places	Causes, consequences, and/or solutions of phenomenon are connected to me and my life experiences, or can be explained with meaningful community characteristics
Connect to meaningful people	Causes, consequences, and/or solutions of phenomenon are connected to a meaningful person in my life
Position as member of systems	I am part of the processes that explain the phenomenon
Position as agents of change	I can change the processes that explain the phenomenon
Example: "Cause there's not a lot of healthy food around here. Some people don't have money to buy food like this. People that have money always want fresh food, especially healthy food. But in my opinion, all people deserve fresh food" (7th grader) *Interpretive commentary:* The low socioeconomic status of people in the community (meaningful community characteristic) helps explain food injustice.	

FIGURE 3 Analytical approach to describe students' written work with example of excerpt analysis procedure.

3.1 | Patterns of framing in each unit

In Ms. V's 7th grade unit, students investigated how their favorite cultural recipes could be made more nutritious without losing cultural significance, addressing concepts of nutrition, healthy eating, and issues of food justice, and lack of access to healthy food options in urban communities of color. In Ms. T's 10th-grade chemistry unit, students modeled the local carbon cycle, connecting issues of land use change and deforestation to decreasing carbon reservoirs and inequitable access to green space in urban communities of color. Table 1 shows that teachers consistently oriented their lessons to the real-world with no lesson for either teacher scoring a −1 for phenomenological framing.

Table 1 shows that most of Ms. V's lessons (5 of 8) were community oriented and that Ms. T was less consistent in maintaining a community orientation from lesson to lesson (4 out of 11). In the supplementary material, we present Tables S1 and S2 with a summary of the lessons and description of the activities to illustrate the scoring. Challenges maintaining a community-oriented framing were partly expected in Ms. T's class because the carbon cycle phenomenon was taught as global as well as local and because, as a core NGSS-aligned course, there were demands to teach various performance expectations that were disconnected from place. The classes that received a score of +1 on community framing oriented instruction to the community with practices that included gathering evidence, testing variables, and creating/revising models to localize and personalize phenomena (as described in Figure 1). For example, on day 3 Ms. V's students examined maps to investigate food access points in connection to racial and economic demographics, and transportation access across three zip codes in Los Angeles. Gathering local evidence allowed students to investigate inequities in food access based on social groups across the city. Then on day 5, students conducted interviews with community members positioned as experts in nutrition and food (in)justice; the interviews were personalized data based on the stories of a meaningful person to help students analyze food access. For Ms. T, on day 1 of the chemistry unit, students gathered local evidence on land use by examining maps and organizing their observations on the distribution of greenspace in their neighborhood. On Days 8 and 9, they personalized their explanatory models of the carbon cycle to include their experiences with carbon emissions; these activities oriented explanations of the carbon cycle to their community.

TABLE 1 Score of phenomenon framing and community framing for each day of the instructional unit in Ms. V's 7th-grade elective and Ms. T's 10th-grade chemistry class.

Day	Ms. V phenomenon framing score	Ms. T phenomenon framing score	Ms. V community framing score	Ms. T community framing score
1	+1	+1	0	+1
2	0	0	+1	−1
3	+1	0	+1	−1
4	+1	0	+1	−1
5	+1	+1	+1	0
6	+1	+1	0	0
7	+1	+1	−1	0
8	+1	+1	+1	+1
9		+1		+1
10		+1		0
11		+1		+1

In summarizing these findings, we do not suggest that every lesson can or should be framed as community-oriented. These scores represent our judgment on the nature of teaching practice rather than being prescriptive of the how frequently a community orientation should occur in a unit. As will be seen below, both Ms. V and Ms. T intended for lessons coded as oriented towards the canon to provide explanatory concepts their students could apply to the broader phenomenon of the unit. Moreover, we do not intend the positive and negative valence of these scores to connote anything other than a framing orientation (Sandoval et al., 2021). We simply argue that a community orientation should provide students opportunities to understand scientific work as relevant to themselves and to community concerns. Next, we show what community-oriented framing looked like in the classrooms and then how students responded.

3.2 | Community-oriented framing intentions and practices

In this section, we present how Ms. V and Ms. T accomplished community-oriented framing in these lessons by localizing and personalizing phenomena. We start by presenting interview data to explain the teachers' goals of localizing and personalizing phenomena. Then, we present and analyze examples of both teachers' talk routines and actions associated with each practice to demonstrate how community-oriented framing was accomplished. All examples are representative of routines for both teachers.

3.2.1 | Localizing phenomena

Goals and intentions

In their interviews, Ms. V and Ms. T reflected on their practices of localizing phenomena as helping them make the scientific concepts in each phenomenon visible and relevant to students. Ms. V contrasted localized phenomena with generic or global phenomena as making more sense to her when teaching concepts that are meaningful to the community. She said,

> Curriculum sometimes tries to take any real-world concept, like oh let's learn about tectonics, and let's talk about this possible volcano on Mars, rather than being like Los Angeles is on a fault. We should be talking about which communities are going to be affected by tectonic movements.

Ms. T also highlighted localized phenomena as helping her overcome a pedagogical obstacle unique to chemistry. She said in her interview, "especially in chemistry where a lot of what we're learning is invisible, it's cool to make it visible where you live." To further explain the value of localizing phenomena, Ms. T said

> It allows me to apply visuals, real people, and real places to complex concepts. I like that we can talk about Councilman Harris-Dawson, Los Angeles community groups, Los Angeles Green New Deal, Mayor Garcetti, Los Angeles neighborhoods, etc. It kind of saves me the step of having to prove to the students that what we are learning is relevant and important. Also, it gets students to be like 'oh yeah, I've seen that' i.e. the oil rigs by Kenneth Hahn Park or the oil refinery in Wilmington. Also, my hope is that even outside of class, this year or in their future, when they continue to see the people, places, and things we have talked about in class they will be reminded of stuff we've talked about.

Collectively, both teachers positioned localized phenomenon as supporting them in grounding science concepts in relevant contexts, and as Ms. T pointed out, in their future experiences. The teachers' intention was to support engagement with science concepts both in the moment in the classroom and in students' futures outside of the classroom. In-school experiences are ephemeral, but students will remain community members; the teachers hoped that local relevance would continuously support connections between science and everyday experiences as youth imagine and build their futures. The goal of localizing is to move beyond just understanding a concept now but to support students making more expansive connections between science and their community across temporal horizons.

Examples of teacher pedagogy and talk routines

In the 7th grade elective, Ms. V used this practice on Days 3 and 4 in an activity that had students examine Google maps of food access points, including grocery stores, farmers markets, and fast-food restaurants across three different zip codes in Los Angeles: one predominately wealthy White community, one predominately middle-class White community, and their own predominately low-income community of color. She started the class by asking students, "What kind of food do you see around here?" Students shared a variety of fast-food and mom-and-pop restaurants present in their community and that they had visited. She went on to elicit students' experiences in these food access points. For example, she said "So let's start with, oh I don't know, Jack-in-the-Box, right, the one that's on the corner of Western Ave. Pretty sure some of y'all have been there (chuckles). I ate there." Ms. V then had students analyze the maps to answer the question, "what trends in food access do you see across zip codes?" She launched this activity by saying, "So we can start thinking about what types of food is accessible to the people who go to our school, to people who live around our school, meaning us." To wrap up these activities and to move from analyzing the problem to exploring solutions, Ms. V worked to make visible the connections between food systems and students' futures by asking, "What can we do as a community to try and fix this problem?"

In these interactions, we see various examples of the discourse routine that made the activities of gathering and using localized evidence possible, specifically by connecting learning to ongoing and past experiences and to experiences in meaningful places like familiar local food access points. These talk routines localized issues of food inequities by structuring interactions around localized data and framing these data investigations as opportunities to bring the students' experiences with food access into the science task. These routines frame their experiences as relevant to explaining food injustice. We also see Ms. V using the discourse routine of positioning students as members of the food system when she elicited their roles as consumers, like eating at the local Jack-in-the-Box, and as participants in the systems from which solutions can emerge. In scaffolding student imagination of a different future, she positioned students as part of the food systems in their community and capable of positively contributing to the future of their community (overlapping with the personalizing practice of positioning as an agent of change). Through these discourse routines that connected student experiences to meaningful local contexts, Ms. V centered questions of equity and justice with the practice of localizing to frame gathering localized evidence as required for explaining and acting on local challenges of healthy eating.

In chemistry, Ms. T worked to localize the phenomenon of the unbalanced carbon cycle on day 1 by encouraging students to gather evidence about how land is used in their neighborhood. She asked “what are some ways land is used around school and around your house? And what other ways have you seen land used maybe as you've moved around different neighborhoods?” Students initially described their observations in everyday language and, then, Ms. T provided the academic vocabulary for land use categorizations. This warm-up activity helped Ms. T launch an activity comparing the students' neighborhood with a wealthy, White area of the city and to analyze the distribution of parks across the city. To invite an equity lens to analyze these local data, Ms. T later said,

> The way land is used in Los Angeles is not equal. I know you've talked in history class about issues like redlining to learn about how land is used, and I want you to think about that too, but today we are going to use chemistry to think about different types of land use in different neighborhoods of Los Angeles.

Here Ms. T connected students' knowledge of the political history of the community to their chemical investigation of the carbon cycle; she framed students' place-based experiences and observations of unique community characteristics as needed in classroom tasks. Through the talk routine of connecting classroom tasks to local places, Ms. T positioned the carbon cycle as simultaneously a social and scientific process as she encouraged students to use localized evidence about urbanization and park distribution alongside their critical awareness of unjust residential policies.

In addition to connections to students' and the community's past, Ms. T scaffolded student imagination of the future of their community as she localized the phenomenon. On day 11 she framed the lesson on local climate change mitigation with a reminder of the classroom routine to focus on solutions. She said, “Like we always ask, try to imagine Los Angeles in the future. I love Los Angeles, but we can always improve it, especially for people that need extra help.” She went on in this class to discuss issues of equity related to specific solutions to climate change. For example, in discussing energy-efficient technology as a solution to climate change, she said, “The new technology that we're going to have is going to be cool and, we know that Teslas right now are super expensive but in the future electric cars are going to be affordable.” Here we observe the discourse routine of connecting classroom learning to an imagined future when electric vehicles are accessible to these youth. Ms. T centered (in)equity, specifically the sociopolitical reality that electric vehicles are unaffordable to the families in students' community, and therefore students are constrained in participating in climate mitigation. In a way, she positioned students as excluded from the processes of climate mitigation because electric vehicles were largely not present in South Los Angeles in 2020. This inequitable access to energy-efficient technology is a meaningful feature of the community and localizing issues of electric vehicle access communicated to students that addressing climate change will require localized knowledge. Ms. T positioned student agency within the power dynamics relevant to the sociopolitical processes of climate change mitigation and scaffolded students' imagination of a future when they would be able to positively contribute to climate change by using electric vehicles.

3.2.2 | Personalizing phenomena

Goals and intentions

Teachers described their work of personalizing phenomena as connecting classroom learning to diverse contexts that would be meaningful to students. In her interview, Ms. V reflected on the opportunities she gave students to make personal connections to phenomena across lessons by saying, "I always wanted kids to take something that's important to them, and just use their own critical thinking and think about what actually fits in here." Reflecting on Day 3 of the food unit, where students investigated healthy food access across Los Angeles, Ms. V described in her interview student stories of their everyday challenges navigating transportation access to get to a grocery store. She recalled how some students shared that they only went to the grocery store every 2 weeks and could only get whatever they could carry with them on the bus. She said in her interview, "[this] is something that they brought from their lives to analyze the data that they were seeing." For Ms. V, her intention was to position personal experiences as data and resources for sensemaking about food injustices.

In her interview, Ms. T reflected on a specific instance of helping students use their first-hand experiences as evidence in modeling and her goals of those types of interactions. Specifically, on Day 9 of the unit, she recalled giving one-on-one help to students creating their carbon cycle models in digital notebooks that both Ms. T and students could edit. She described an interaction where a student was doubtful that their knowledge of carbon transfers and transformations, based on everyday experiences in parks, belonged in science class or on the model. Ms. V communicated that these experiences did belong by adding the students' ideas directly to the model. She said in her interview "[the students] were just talking, and they were watching me put their words on this model. And I didn't edit anything they said, and they were like 'oh damn, that's actually right'." Ms. T's intention in these interactions with students, recalled in the interview, was to position personal experiences as a relevant tool for their classroom tasks and for understanding their community and the world.

The teachers' intention for personalizing phenomena was to show students how their lives, their experiences, and the people in their lives can be both sources of scientific data and data themselves. In contrast to decontextualized, objective, or generalized views of evidence and data that ignore personhood, identity, positionality, and stories, Ms. V and Ms. T wanted students to know that their experiences count as valid and valuable evidence in scientific sensemaking. The teachers' goal for this practice was to position classroom learning and everyday experiences as firmly connected.

Examples of teacher pedagogy and talk routines

Ms. V used the discourse routines of personalizing phenomena on Day 3. While moderating students' work considering collective actions as solutions to food access and hunger, Ms. V said,

> Not all of us are billionaires where we can solve world hunger with our extra money, but even little bits of kindness and help really make a difference for people who are hungry. But right, it also means that we don't all have to do our little bit separately, right? Like August was mentioning earlier, if we all come together and take all our little bits of kindness and put them together, they make a really big difference, right?

To wrap up the lesson, Ms. V summarized the goal of the day by saying, "This is about all those things you've learned and how you can use that information to help your family, your community, in the future." In these examples, Ms. V personalized food justice issues with the discourse routines of connecting classroom tasks to meaningful people, specifically family that would be helped by the concepts explored (this information), and by positioning students as agents of change capable of impacting the future through their actions ("little bits of kindness").

In another example from Ms. V, on day 5 she connected meaningful people to classroom tasks. To scaffold students' work writing their food narratives, Ms. V developed an activity in which students interviewed an expert on nutrition, food access, and personally or culturally significant recipes. To explain what kind of expert she meant, she said, "It's important that you interview someone who is going to be able to give you genuine answers. It's someone who lives in your community." This framing of expertise as rooted in the community, positioning authority in the meaningful people in students' community, connected the classroom investigations to people students know and communicated that personal knowledge can also be expert disciplinary knowledge. Personalizing practices supported Ms. V in framing food justice as relevant to students' families and in connecting classroom tasks to the sociopolitical systems that students can shape through their daily actions.

In chemistry, Ms. T used personalizing discourse routines on days 8 and 9 in activities to revise carbon cycle models with personalized evidence. These lessons were dedicating to creating diagrammatic, explanatory models of the local biogeochemical cycle that included students' observations of urbanization, their experiences in local parks, and their desires for access to greenspace. Ms. T launched lesson 8 by showing a textbook image of the carbon cycle and asked, "Do you see our school on here? Do you even see our city? Do you see yourself? No. This diagram is too generic, and it doesn't help us. You can make a better one." She went on to encourage students to "use your experience in your neighborhood to think of land use that you've seen." These questions connected the task of modeling to students themselves, an example of connections to meaningful people. By pointing out the absence of the youth themselves, and other locally relevant people and places in the generic carbon cycle diagram, Ms. T encouraged students to model their experiences in explaining the unbalanced carbon cycle, and centered students' personal experience as required for a "better" representation. Additionally, encouraging students to put themselves in the models positioned students as part of the systems and processes that explain the carbon cycle (overlapping with localizing practice of position students as part of the relevant systems).

Later during these lessons, while students were revising their carbon cycle models, Ms. T explained that the municipal government was partnering with local grassroots organizations to address climate change inequities. To elevate students' personal experiences and the experiences of local community members as authorities, she said,

> The mayor is not trying to know everything all by himself. He wants to find local groups that can help him and can help his team make more parks happen and he needs to know what you guys know about parks around here.

This interaction is an example of positioning students as agents of change which framed students' personal knowledge about and experiences in parks as a valuable sensemaking resource for the classroom task of modeling and for the real-world work of ensuring equitable greenspace access in Los Angeles. Throughout days 8 and 9 of the unit, Ms. T guided students in identifying where personal experiences and sociopolitical systems were absent from textbook diagrammatic representations of the carbon cycle and she situated personalized evidence as necessary to explain the past, present, and future carbon cycle in their community. By encouraging students to gather evidence to personalize the phenomenon of the carbon cycle, Ms. T opened opportunities for students to understand the carbon cycle as connected to their personal experiences and to the experiences of people that matter to them.

3.3 | Student uptake of frames

We found that most students, 14 out of 18 in Ms. V's class and 12 out of 16 in Ms. T's class, explained the phenomena of inquiry as personally and locally relevant issues and that they framed the scientific and social systems as inherently connected. Below we present excerpts of student writing to demonstrate, first, examples of localizing a phenomenon by drawing on knowledge of the community, second, examples of personalizing a phenomenon with connections to themselves or people that matter to them, and third, examples that combined these two frames where local and personal knowledge were used as evidence in classroom work.

3.3.1 | Localizing phenomena

Student writing suggests that they perceive phenomena as local events that could be understood and addressed with their first-hand knowledge of the community. One example of local knowledge of the community, or a meaningful feature of community, that students in both 7th and 10th grade drew on was the socioeconomic status of the neighborhood. Students were critically aware that their community is low-income and explained phenomena as related to this feature. Below are three examples of student writing that illustrate this practice:

> [More parks] would be helpful to my neighborhood because you can grow like fruit trees so people who can't afford a bag of apples, oranges, or lemons and other fruits can literally walk outside and grab some fruit.—10th grader

> [A park] helps the neighborhood because if you don't have or can't afford an air conditioner or a fan going under the trees can cool you down.—10th grader

> Cause there's not a lot of healthy food around here. Some people don't have money to buy food like this. People that have money always want fresh food, especially healthy food. But in my opinion, all people deserve fresh food.—7th grader

These examples include connections to people "who can't afford" and "don't have money" for fresh food or air conditioning as a feature of the local community that is relevant to explaining and addressing the phenomenon of inquiry. Another type of local knowledge that students drew on was observations of inequalities or hazards located in their community. Below are two examples of student writing that illustrate this practice:

> The trees in the park are fighting to keep the air fresh and non-toxic even when there's machines getting oil from the land and expelling carbon to the air and making it look dark.—10th grader

> In some neighborhoods to like order food online and to like get groceries delivered or stuff like that and it's a lot harder for people closer to here to do that, because like you need to have internet or because, like, you'd have to use a computer for that, that makes it more difficult.—7th grader

In the example from the 10th-grade chemistry student, the youth explained the ecological benefits of parks, in absorbing excess carbon dioxide and purifying air, as needed in the community because of the disproportionate burden of environmental hazards like urban oil extraction. For the 7th graders, they explained that accessing healthy food is harder because of the distance to stores or restaurants combined with transportation (delivery) challenges. Student writing indicates that, like the teachers, the youth understood phenomena as manifesting uniquely in the local community, and that explaining or addressing the phenomena requires localized data and first-hand knowledge of the community.

3.3.2 | Personalizing phenomena

Students' written work suggested that by connecting phenomena to themselves personally, and to people they care about, that they understood the phenomena as personally meaningful. Students also drew on personal knowledge as evidence in explaining phenomena. Below are two examples of how students shared about food and people that matter to them:

> My grandma would make these foods 24/7 so I'll always eat them. They will always remind me of my childhood.—7th grader

> What birria is made out of [is] beef the way me and my family makes it, but in Mexico [it's] made out of sheep. When me and my mom make it we use different chilies that you have to boil.—7th grader

In these examples, students responded to Ms. V's framing of personal experiences and stories as belonging in science class. This framing welcomed and invited students' culinary heritage and families into the science classroom. For Ms. T's chemistry class, 10th-grade students also connected issues of the carbon cycle to people that matter to them. Below are two examples of students' personal experiences with air quality that they drew on in sensemaking:

> We don't have enough air quality our future generation our children will not have good air quality and the Earth is just going to die because there is not going to be enough air quality and us humans need good air quality.—10th grader

> [More parks] would change my life because there will be a less risk of me getting even more health problems than I already have if there was less air pollution.—10th grader

In these examples, students wrote about "me", "my family", "us" and "future generations of children" as meaningful and connected to the issues of the phenomenon.

3.3.3 | Localizing and personalizing

Students also blended and merged local and personal frames in their writing. Below are examples from three 10th grade students explaining the issues of the carbon cycle as both locally and personally relevant, and a 7th grader describing challenges accessing healthy food:

> The poorest communities are the most impacted with [land use] decisions, it impacts me directly because I love Kenneth Hanh Park but there's a lot of machines that extract oil near there so my mom told me to not go there again and that's not justice.—10th grader

> People living near oil drilling had bad health from breathing bad air—some of us live in bad air quality neighborhoods and some of us live in better air quality neighborhoods.—10th grader

> Mostly people from low-income neighborhoods are being impacted by [land use] choices and actions. The low-income neighborhoods have less parks, trees, and sometimes less resources so the negative impacts of the land use affect us the most.—10th grader

> Some neighborhoods have a lot more like chain restaurants, and there's some neighborhoods that have a lot more like independent restaurants… but more independent local restaurants are kind of further away from us, compared to in the Mann neighborhood where there's a lot more like fast food or chain stores.—7th grader

In these examples, students explained demographic features of the local community (environmental hazards of oil extraction, poor air quality, low socioeconomic status, and abundance of fast food and chain stores) combined with personal connections (a mother's warning and the pronoun "us" to situate themselves as experiencing the negative environmental impacts and social consequences). In summary, these excerpts illustrate that students localized and personalized food and environmental justice as they expressed the relevance of these phenomena to their community.

4 | DISCUSSION

A community-oriented framing of science was designed at the intersection of justice-oriented and place-based pedagogy, a combination that Davis and Schaeffer (2019) suggest "emphasizes the interconnectedness of physical/spatial, social, political, and domain knowledge at a particular moment" (p. 369). These framing practices politicize, rather than sanitize, phenomena in the science classroom by engaging honestly with the students' relationships to and within systems and processes of phenomena as they manifest in their community. In our findings, we have shown that teacher framing honored their Black and Latinx students' diverse relationships to and within systems, including (a) historical and political dimensions of phenomena, like how redlining shaped the distribution of urban parks, (b) personal and public health dimensions, like students' families experiencing respiratory illness that they attribute to proximity to environmental hazards, (c) economic dimensions, like low-income families' challenges accessing fresh food, and (d) cultural dimensions, like the experiences of immigrant families maintaining culinary heritages. Honoring these diverse interactions is not only dignifying but is important because helping students perceive science learning as meaningfully connected to their everyday lives can support educational equity.

Different frames shift the structure of and participation in science classroom tasks by guiding student interactions and giving those tasks different meanings (Ford & Wargo, 2012). Our findings show that the political, local framing of phenomena shifted student interactions toward the socially, personally, and locally relevant questions of socioscientific phenomena with multiple connections to their everyday lives. A teacher's discourse patterns signal what is welcome in the classroom, and teachers in this study welcomed epistemically diverse sensemaking resources thereby supporting epistemic justice. Rejecting problematic presentations of science that marginalize non-dominant students' ways of knowing and being, this framing pushes toward Lee and Grapin's (2022) proposed future approaches in science education that "center the interests, strengths, and needs of diverse students" and "reflect the experiences and realities" of minoritized student groups (p. 1306).

These framing practices helped the teachers to work within the mandates of the standards while also pushing beyond the standards for bolder goals of equity and justice. Research from professional development efforts to support NGSS-aligned teaching has documented how hard phenomenological framing is for teachers (Kawasaki & Sandoval, 2019; Reiser et al., 2017; Ribay, 2024; Windschitl & Stroupe, 2017). Our analysis illustrates that Ms. V and Ms. T consistently oriented their lessons to the real-world with all lessons phenomenological framed. We attribute the teachers' success in this challenging task to their intercontextual, expansive framing (Engle, 2006) in which they connected classroom learning to relevant contexts, be them in the world or in the community. Intercontextual community-oriented framing helped the teachers fill an instructional gap left by the standards, specifically exploring the sociopolitical and local dimensions of phenomena that are important for explaining the world as marginalized students experience it. Our analysis highlights the pedagogical practices of localizing and personalizing phenomena as strategies to organize instruction around local questions of equity and justice, and the histories and realities of minoritized students, to help students construct expansive frames of food and environmental justice.

Engle's (2006) original conception of intercontextuality in framing did not center on the experiences of nondominant students and did not foreground equity and justice, but her framework holds space for equity-oriented work. Community-oriented framing adds to the intercontextuality framework by foregrounding the commitments of justice-centered science pedagogy

(JCSP). Specifically, community-oriented framing ensures that community is an educational asset. This orientation foregrounds the sociopolitical, ethical, and justice dimensions of phenomena in science education to push against neutral, apolitical versions of science that erase students' experiences with these dimensions of phenomena. Supporting Hand and colleagues' (2012) claim that framing can expand learning possibilities through more equitable practices, community-oriented framing signaled to students that their personal and cultural experiences, including those experiences related to politics, history, and justice, were not only welcome in the classroom but necessary to explain a phenomenon. We can ask: is modeling the carbon cycle of South Los Angeles complete without including inequitable access to the socioecological benefits of greenspace? Is explaining nutrition during the pandemic lockdown complete without discussing the distance South Los Angeles residents had to travel to access healthy food? Ms. V, Ms. T, and their students said no. Their work in science class was incomplete without these sociopolitical dimensions. In this way, we offer community-oriented framing as a horizontal attunement, or practice of horizontality (Warren et al., 2020), to support the outcomes of JCSP. These frames offer a practical means for teachers to connect science learning to a diverse variety of people, places, histories, purposes, and cultural contexts to help students see their goal in science class as understanding and addressing socioscientific issues in their everyday lives.

While we found that our semi-quantitative rating of classroom discourse has many strengths, we acknowledge that phase 1 of our analytical approach, used to assess the frequency of community-oriented framing in a unit, created binaries that flatten the richness of interaction. These scores are not a judgment of the teachers; instead, the scores represent the challenges of designing for local and personal relevance, as well as the lack of theoretical and empirical guidance on the appropriate frequency of community-oriented learning to support different student outcomes. The optimal balance of lessons that are community-oriented with those that are not, and the associated affordances and constraints for teachers and students, remains an open question. Given the multiple constraints and tensions of teachers' work, it is important for other teams of teachers and researchers interested in exploring community-oriented framing to know that this framing does not have to happen every day to be impactful. Future work supporting students in developing layered explanations of socioscientific issues—that frame a phenomenon like climate change as a scientific and sociopolitical issue (Windschitl, 2023)—can explore the ratio of lessons in a unit oriented to explaining the community or the world with lessons oriented to mastery of disciplinary concepts. Additionally, we are acutely aware that framing is not "given" to students by teachers, but rather is co-constructed in interaction with each student coming to their own frame (Hand et al., 2012). Our analysis of students' writing is unable to assess that dynamic co-construction process; additional work is needed to demonstrate the co-construction process when community-oriented framing is used in an in-person classroom setting.

4.1 | Recommendations for research and practice

With consideration of the limitations of our findings, we offer recommendations on science teaching and research to address the problem of apolitical science instruction and the need for equitable, justice-oriented teaching practices for minoritized students. We offer community-oriented framing as flexible and responsive to the needs and characteristics of different students, communities, phenomena, and teachers, and therefore can be adapted for a wide range of contexts.

First, our findings suggest that resources are needed to support teachers' capacity to include the sociopolitical and local dimensions of phenomena in instruction alongside the scientific dimension. Foundational to this capacity, we recommend professional development opportunities and sustained communities of practices oriented to nurturing teachers' (a) reflection on their and their students' positionality and (b) political clarity. Regarding positionality, educators must consider power dynamics, identity, and history within their classrooms to ensure that marginalizing practices are not perpetuated. One's own positionality relative to a socioscientific issue creates a unique starting point for each educator (Sover & Walsh, 2022). Studies that take identity seriously illustrate the importance of positionality. For example, comparing the instructors in Madkins and McKinney de Royston's (2019) study—Mr. Kendric Coles, a Black man teaching an engineering design unit—and Davis and Schaeffer's (2019) study—Ms. Janelle Schaeffer, a White woman teaching a water justice unit—we read evidence that both teachers extensively reflected on differences and similarities in their experiences and their students' to enact units in culturally-relevant, justice-centered ways. Similarly, Ms. V and Ms. T deeply reflected on their relationships to and within systems of food and environmental justice and brought those experiences to their teaching. Failure to interrogate positionality and power in teaching can harm students, such as when narratives of grit to overcome hardship are centered, rather than problematizing systemic racism (Miller, 2018).

Relatedly, we recommend supporting teachers' political clarity, or understanding and critiquing social inequities, students' multiple identities, and teaching as a political endeavor (Beauboeuf-Lafontant, 1999; Madkins & McKinney de Royston, 2019). Teaching with political clarity results in instruction that reflects understanding how schools and society reproduce inequity, how students' achievement is related to their experiences, and how students' interests and resources can be positioned for science achievement (Madkins & McKinney de Royston, 2019). While enacting political clarity is shown to be challenging for teachers (Rivera Maulucci, 2013; Young, 2010), we view this work as essential to Ms. V and Ms. T's efforts in enacting community-oriented framing and in helping their Black and Latinx students explain scientific issues as personally and locally relevant. Specifically for the teachers in this study, Ms. V and Ms. T developed political clarity in two important ways: broadly around the structures that constrain their Black and Latinx students' opportunities to learn science, and specifically around the unique injustices of the phenomena they taught (climate change and food deserts/swamps in South Los Angeles). These two types or scales of political clarity—on structural inequities in education and an anchoring phenomenon—made it possible for the teachers to center justice and equity goals as part of the scientific work of schools. We recommend reflection on positionality and political clarity because this work makes possible a variety of justice-centered pedagogies that can help teachers explain what is being learned and why so that students can develop critical perspectives (Milner, 2011).

Second, we recommend implementing and studying community-oriented framing practices as part of a broader framework oriented to explaining and then acting on issues students face in their lives. To move toward such a framework, practices spanning planning, instruction, assessment, and critical action outside of the classroom are needed to compliment the framing practice we documented. Beginning with planning and instruction, researchers and educators can consider the noticing practices (Louie, 2018; Luna, 2018) that teachers need to elicit students' everyday experiences with socioscientific phenomena and plan instruction around that noticing. Our study highlights the need for sustainable classroom practices of listening to students to learn what issues matter to them (Gyles & Clark, 2024), and systems-level (school and district) support for teachers to have the autonomy and flexibility to plan around what they learn. This planning and instruction phase also requires that teachers have structured opportunities to learn about the community that students live in to bring authentic questions and artifacts into the classroom beyond what students share. Next, appropriate assessments are needed that match the learning experience that students had through this curriculum. These assessments need to be flexible enough for students to share individual experiences with phenomena and must communicate that diverse ways of knowing and sociopolitical dimensions of phenomena truly belong in the science classroom.

Last, a framework can include taking school learning out into the community. Aligned with the tenets of critical and culturally relevant pedagogy that support students in developing sociopolitical consciousness (Freire, 1970; Jones & Donaldson, 2022; Ladson-Billings, 1995, 2006), students can be supported in building a desire and commitment to act. The sense of relevance that students expressed when explaining local issues of food and environmental justice, and their awareness of inequitable systems that help explain food and environmental injustices, could be the foundation of action; such relevance and awareness, conceptualized as part of critical consciousness, can help people engage in broader collective action (El-Amin et al., 2017). We recommend future work that integrates a community-oriented framing approach to instruction with a framework of science education for sociopolitical action (c.f. Bazzul & Tolbert, 2019; Valladares, 2021) to explore how to support youth in seeing "themselves as change agents who can challenge the status quo and inequities in schools, communities, and society" (Madkins & McKinney de Royston, 2019, p. 6).

Community-oriented framing is a major departure from standardized learning environments, but our case study and others of JCSP justify the work toward this transformation and show that it is possible. We contribute to the practices and motivation of framing phenomena in community as part of the move away from normative science learning of "doing school" that excludes minoritized students, and toward justice-centered science for problem-solving in communities that welcomes diverse youth. Our hope for community-oriented framing is that it can be an approach to help teachers align with the NGSS while pushing beyond the standards to disrupt injustice and support equity.

ACKNOWLEDGMENTS

We thank our outstanding students for their participation and Karen Hunter-Quartz for supporting this research–practice partnership. This research was supported by funding from the UCLA Graduate Division.

CONFLICT OF INTEREST STATEMENT

The authors have no competing interests to declare that are relevant to the content of this article.

ORCID

Heather F. Clark https://orcid.org/0000-0001-5411-5768
Symone A. Gyles https://orcid.org/0000-0002-8444-149X
William A. Sandoval https://orcid.org/0000-0003-1667-6163

ENDNOTE

[i] There are many views on capitalizing White and based on Heather's positionality, and my partnerships with people of color, it is important to state my intentions with this choice because language has power. In addition to aligning with APA 7th edition guidelines, Heather chooses to capitalize White to disrupt the standard that

normalizes Whiteness, to call out Whiteness as a social construct and as its own race that practices oppression, and to invite other White people into conversations about race.

REFERENCES

Ballard, H. L., Calabrese Barton, A., & Upadhyay, B. (2023). Community-driven science and science education: Living in and navigating the edges of equity, justice, and science learning. *Journal of Research in Science Teaching*, *60*(8), 1613–1626. https://doi.org/10.1002/tea.21880

Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, *94*(6), 1008–1026. https://doi.org/10.1002/sce.20392

Bang, M., Medin, D., Washinawatok, K., & Chapman, S. (2010). Innovations in culturally based science education through partnerships and community. In M. S. Khine & I. M. Saleh (Eds.), *New science of learning: Cognition, computers and collaboration in education* (pp. 569–592). Springer. https://doi.org/10.1007/978-1-4419-5716-0_28

Bang, M., & Vossoughi, S. (2016). Participatory design research and educational justice: Studying kearning and relations within social change making. *Cognition and Instruction*, *34*(3), 173–193. https://doi.org/10.1080/07370008.2016.1181879

Basu, S. J., & Barton, A. C. (2009). Critical physics agency: Further unraveling the intersections of subject matter knowledge, learning, and taking action. *Cultural Studies in Science Education*, *4*(2), 387–392. https://doi.org/10.1007/s11422-008-9155-4

Basu, S. J., Barton, A. C., Clairmont, N., & Locke, D. (2009). Developing a framework for critical science agency through case study in a conceptual physics context. *Cultural Studies of Science Education*, *4*, 345–371. https://doi.org/10.1007/s11422-008-9135-8

Bateson, G. (1972). *Steps to an ecology of mind: Collected essays in anthropology, psychiatry, evolution, and epistemology*. Candler Publishing Co.

Bazeley, P. (2009). Analysing qualitative data: More than 'identifying themes'. *Malaysian Journal of Qualitative Research*, *2*(2), 6–22.

Bazzul, J., & Tolbert, S. (2019). Love, politics and science education on a damaged planet. *Cultural Studies of Science Education*, *14*, 303–308. https://doi.org/10.1007/s11422-019-09913-2

Beauboeuf-Lafontant, T. (1999). A movement against and beyond boundaries: "Politically relevant teaching" among African American teachers. *Teachers College Record*, *100*(4), 702–723. https://doi.org/10.1111/0161-4681.00013

Berland, L. K., & Hammer, D. (2012). Framing for scientific argumentation. *Journal of Research in Science Teaching*, *49*(1), 68–94.

Buxton, C. A. (2010). Social problem solving through science: An approach to critical, place-based, science teaching and learning. *Equity & Excellence in Education*, *43*(1), 120–135. https://doi.org/10.1080/10665680903408932

Cachelin, A., & Nicolosi, E. (2022). Investigating critical community engaged pedagogies for transformative environmental justice education. *Environmental Education Research*, *28*(4), 491–507. https://doi.org/10.1080/13504622.2022.2034751

Clark, H. F., Gyles, S. A., Tieu, D., & Venkatesh, S. (2022). Community science teaching at Mann UCLA Community school. *UCLA Center for Community Schooling*, *2*. https://communityschooling.gseis.ucla.edu/journal-issue-2-teachers/

Clark, H. F., Sandoval, W. A., & Kawasaki, J. N. (2020). Teachers' uptake of problematic assumptions of climate change in the NGSS. *Environmental Education Research*, *26*(8), 1177–1192. https://doi.org/10.1080/13504622.2020.1748175

Clegg, T., & Kolodner, J. (2014). Scientizing and cooking: Helping middle-school learners develop scientific dispositions. *Science Education*, *98*, 36–63. https://doi.org/10.1002/sce.21083

Davis, N. R., & Schaeffer, J. (2019). Troubling troubled waters in elementary science education: Politics, ethics & black children's conceptions of water [justice] in the era of Flint. *Cognition and Instruction*, *37*(3), 367–389. https://doi.org/10.1080/07370008.2019.1624548

El-Amin, A., Seider, S., Graves, D., Tamerat, J., Clark, S., Soutter, M., Johannsen, J., & Malhotra, S. (2017). Critical consciousness: A key to student achievement. *Phi Delta Kappan*, *98*(5), 18–23.

Engle, R. A. (2006). Framing interactions to foster generative learning: A situative explanation of transfer in a community of learners classroom. *Journal of the Learning Sciences*, *15*(4), 451–498. https://doi.org/10.1207/s15327809jls1504_2

Engle, R. A., Lam, D. P., Meyer, X. S., & Nix, S. E. (2012). How does expansive framing promote transfer? Several proposed explanations and a research agenda for investigating them. *Educational Psychologist*, *47*(3), 215–231. https://doi.org/10.1080/00461520.2012.695678

Engle, R. A., Nguyen, P. D., & Mendelson, A. (2011). The influence of framing on transfer: Initial evidence from a tutoring experiment. *Instructional Science*, *39*(5), 603–628. https://doi.org/10.1007/s11251-010-9145-2

Erickson, F. (1982). *Classroom discourse as improvisation: Relationship between academic task structure and social participation structure in lessons*. Communication in the Classroom. https://ci.nii.ac.jp/naid/10020917973/en/

Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 119–161). Macmillan.

Erickson, F. (1992). Ethnographic microanalysis of interaction. In M. D. LeCompte, W. L. Millroy, & J. Preissle (Eds.), *The handbook of qualitative research in education* (pp. 201–225). Academic Press.

Flores, A., & Smith, K. C. (2013). Spanish-speaking English language learners' experiences in high school chemistry education. *Journal of Chemical Education*, *90*(2), 152–158. https://doi.org/10.1021/ed300413j

Ford, M. J., & Wargo, B. M. (2012). Dialogic framing of scientific content for conceptual and epistemic understanding. *Science Education*, *96*(3), 369–391. https://doi.org/10.1002/sce.20482

Freire, P. (1970). *Pedagogy of the oppressed*. Bloomsbury.

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Harvard University Press.

Gomez, K., Kyza, E. A., & Mancevice, N. (2018). Participatory design and the learning sciences. In *International handbook of the learning sciences*. Routledge. https://doi.org/10.4324/9781315617572-39

Greeno, J. G. (2009). A theory bite on contextualizing, framing, and positioning: A companion to son and goldstone. *Cognition and Instruction*, *27*(3), 269–275. https://doi.org/10.1080/07370000903014386

Gruenewald, D. A. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher*, *32*(4), 3–12. https://doi.org/10.3102/0013189x032004003

Gyles, S. A., & Clark, H. F. (2024). (Re)defining expert in science instruction: A community-based science approach to teaching. *Cultural Studies of Science Education*, *19*, 117–140. https://doi.org/10.1007/s11422-023-10202-2

Hand, V., Penuel, W. R., & Gutiérrez, K. D. (2012). (Re)framing educational possibility: Attending to power and equity in shaping access to and within learning opportunities. *Human Development*, *55*(5–6), 250–268. https://doi.org/10.1159/000345313

Harms, W., & DePencier, I. B. (1996). *Experiencing education: 100 years of learning at the University of Chicago Laboratory Schools*. University of Chicago Laboratory Schools.

Hoeg, D. G., & Bencze, J. L. (2017). Values underpinning STEM education in the USA: An analysis of the next generation science standards. *Science Education*, *101*(2), 278–301. https://doi.org/10.1002/sce.21260

Hufnagel, E., Kelly, G. J., & Henderson, J. A. (2018). How the environment is positioned in the next generation science standards: A critical discourse analysis. *Environmental Education Research*, *24*(5), 731–753. https://doi.org/10.1080/13504622.2017.1334876

Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., McDonald Lowe, S., & Woodson, K. M. (2018). (un)hidden figures: A synthesis of research examining theintersectional experiences of black women and girls in STEM education. *Review of Research in Education*, *42*(1), 226–254. https://doi.org/10.3102/0091732x18759072

Jiménez-Aleixandre, M. P., Bugallo Rodríguez, A., & Duschl, R. A. (2000). "Doing the lesson" or "doing science": Argument in high school genetics. *Science Education*, *84*(6), 757–792. https://doi.org/10.1002/1098-237X(200011)84

Jones, B. L., & Donaldson, M. L. (2022). Preservice science teachers' sociopolitical consciousness: Analyzing descriptions of culturally relevant science teaching and students. *Science Education*, *106*(1), 3–26. https://doi.org/10.1002/sce.21683

Jordan, B., & Henderson, A. (1995). Interaction analysis: Foundations and practice. *Journal of the Learning Sciences*, *4*(1), 39–103.

Kang, H., Windschitl, M., Stroupe, D., & Thompson, J. (2016). Designing, launching, and implementing high quality learning opportunities for students that advance scientific thinking. *Journal of Research in Science Teaching*, *53*(9), 1316–1340. https://doi.org/10.1002/tea.21329

Kawasaki, J., & Sandoval, W. A. (2019). The role of teacher framing in producing coherent NGSS-aligned teaching. *Journal of Science Teacher Education*, *30*(8), 906–922. https://doi.org/10.1080/1046560X.2019.1657765

Kayumova, S., & Tippins, D. J. (2021). The quest for sustainable futures: Designing transformative learning spaces with multilingual black, Brown, and Latinx young people through critical response-ability. *Cultural Studies of Science Education*, *16*(3), 821–839. https://doi.org/10.1007/s11422-021-10030-2

Kelly, G. J. (2014). Discourse practices in science learning and teaching. In N. G. Lederman & S. K. Abell (Eds.), *Handbook of researh on science education* (Vol. 2, pp. 321–336). Routledge.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, *32*, 465–491. https://doi.org/10.2307/1163320

Ladson-Billings, G. (2006). "Yes, but how do we do it?" practicing culturally relevant pedagogy. In J. Landsman & C. W. Lewis (Eds.), *White teachers/diverse classrooms: A guide to building inclusive schools, promoting high expectations, and eliminating racism*. Stylus Publishing, LLC.

Ladson-Billings, G., & Tate, W. F. (1995). Toward a critical race theory of education. *Teachers College Record: The Voice of Scholarship in Education*, *97*, 47–68.

Lee, O. (2020). Making everyday phenomena phenomenal: Using phenomena to promote equity in science instruction. *Science and Children*, *58*(1), 56–61.

Lee, O., & Grapin, S. E. (2022). The role of phenomena and problems in science and STEM education: Traditional, contemporary, and future approaches. *Journal of Research in Science Teaching*, *59*(7), 1301–1309. https://doi.org/10.1002/tea.21776

Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Ablex.

Louie, N. L. (2018). Culture and ideology in mathematics teacher noticing. *Educational Studies in Mathematics*, *97*(1), 55–69. https://doi.org/10.1007/s10649-017-9775-2

Luna, M. J. (2018). What does it mean to notice my students' ideas in science today?: An investigation of elementary teachers' practice of noticing their students' thinking in science. *Cognition and Instruction*, *36*(4), 297–329. https://doi.org/10.1080/07370008.2018.1496919

Madkins, T. C., & McKinney de Royston, M. (2019). Illuminating political clarity in culturally relevant science instruction. *Science Education*, *103*(6), 1319–1346. https://doi.org/10.1002/sce.21542

McKinney de Royston, M., & Sengupta-Irving, T. (2019). Another step forward: Engaging the political in learning. *Cognition and Instruction*, *37*(3), 277–284. https://doi.org/10.1080/07370008.2019.1624552

Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Harvard University Press.

Mensah, F. M., & Jackson, I. (2018). Whiteness as property in science teacher education. *Teachers College Record*, *120*(1), 1–38. https://doi.org/10.1177/016146811812000108

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Miller, H. K. (2018). Developing a critical consciousness of race in place-based environmental education: Franco's story. *Environmental Education Research*, *24*(6), 845–858. https://doi.org/10.1080/13504622.2017.1357802

Milner, H. R. (2011). Culturally relevant pedagogy in a diverse urban classroom. *The Urban Review*, *43*(1), 66–89. https://doi.org/10.1007/s11256-009-0143-0

Morales-Doyle, D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. *Science Education*, *101*(6), 1034–1060. https://doi.org/10.1002/sce.21305

Morales-Doyle, D. (2019). There is no equity in a vacuum: On the importance of historical, political, and moral considerations in science education. *Cultural Studies of Science Education*, *14*, 485–491. https://doi.org/10.1007/s11422-019-09925-y

Morales-Doyle, D., Childress Price, T., & Chappell, M. J. (2019). Chemicals are contaminants too: Teaching appreciation and critique of science in the era of next generation science standards (NGSS). *Science Education*, *103*, 1347–1388. https://doi.org/10.1002/sce.21546

Murrell, P. C. (2000). Community teachers: A conceptual framework for preparing exemplary urban teachers. *The Journal of Negro Education*, *69*(4), 338–348. https://doi.org/10.2307/2696249

Mutegi, J. W. (2011). The inadequacies of "science for all" and the necessity and nature of a socially transformative curriculum approach for African American science education. *Journal of Research in Science Teaching*, *48*(3), 301–316. https://doi.org/10.1002/tea.20410

NGSS Lead States. (2013). *Next generation science standards: For states, by states (vol. 1: The standards)*. The National Academies Press.

NRC. (2012). *A framework for K-12 science education: Practices, crosscutting concepts and core ideas*. T. N. A. Press. https://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts

Oakes, J., Maier, A., & Daniel, J. E. (2017). *Community schools: An evidence-based strategy for equitable school improvement*. National Education Policy Center. http://nepc.colorado.edu/publication/equitable-community-schools

Osborne, J. (2014). Teaching scientific practices: Meeting the challenge of change. *Journal of Science Teacher Education*, *25*(2), 177–196. https://doi.org/10.1007/s10972-014-9384-1

Penuel, W. R. (2017). Research-practice partnerships as a strategy for promoting equitable science teaching and learning through leveraging everyday science. *Science Education*, *101*(4), 520–525. https://doi.org/10.1002/sce.21285

Philip, T. M., Way, W., Garcia, A. D., Schuler-Brown, S., & Navarro, O. (2013). When educators attempt to make "community" a part of classroom learning: The dangers of (mis)appropriating students' communities into schools. *Teaching and Teacher Education*, *34*, 174–183. https://doi.org/10.1016/j.tate.2013.04.011

Quinn, H. (2021). The role of curriculum resources in promoting effective and equitable science learning. *Journal of Science Teacher Education*, *32*(7), 847–851. https://doi.org/10.1080/1046560X.2021.1897293

Rahm, J., Gonsalves, A. J., & Lachaîne, A. (2022). Young women of color figuring science and identity within and beyond an afterschool science program. *Journal of the Learning Sciences*, *31*(2), 199–236. https://doi.org/10.1080/10508406.2021.1977646

Reiser, B. J., Michaels, S., Moon, J., Bell, T., Dyer, E., Edwards, K. D., McGill, T. A. W., Novak, M., & Park, A. (2017). Scaling up three-dimensional science learning through teacher-led study groups across a state. *Journal of Teacher Education*, *68*(3), 280–298. https://doi.org/10.1177/0022487117699598

Ribay, K. (2024). Lessons from a professional learning community: Navigating tensions while moving between theory and practice in teaching chemistry for social justice. *Science Education*, *108*, 734–761. https://doi.org/10.1002/sce.21854

Rivera Maulucci, M. S. (2013). Emotions and positional identity in becoming a social justice science teacher: Nicole's story. *Journal of Research in Science Teaching*, *50*(4), 453–478. https://doi.org/10.1002/tea.21081

Rodriguez, A. J. (2015). What about a dimension of engagement, equity, and diversity practices? A critique of the next generation science standards. *Journal of Research in Science Teaching*, *52*(7), 1031–1051. https://doi.org/10.1002/tea.21232

Rosebery, A. S., Ogonowski, M., DiSchino, M., & Warren, B. (2010). "The coat traps all your body heat": Heterogeneity as fundamental to learning. *Journal of the Learning Sciences*, *19*(3), 322–357. https://doi.org/10.1080/10508406.2010.491752

Rosenberg, S., Hammer, D., & Phelan, J. (2006). Multiple epistemological coherences in an eighth-grade discussion of the rock cycle. *Journal of the Learning Sciences*, *15*(2), 261–292. https://doi.org/10.1207/s15327809jls1502_4

Roth, W. M., & Bowen, G. M. (1994). An investigation of problem framing and solving in a grade 8 open-inquiry science program. *Journal of the Learning Sciences*, *3*(2), 165–204. https://doi.org/10.1207/s15327809jls0302_2

Sandoval, W. A., Kawasaki, J., & Clark, H. F. (2021). Characterizing science classroom discourse across scales. *Research in Science Education*, *51*(1), 35–49. https://doi.org/10.1007/s11165-020-09953-7

Sleeter, C. E. (2001). Preparing teachers for culturally diverse schools: Research and the overwhelming presence of whiteness. *Journal of Teacher Education*, *52*(2), 94–106. https://doi.org/10.1177/0022487101052002002

Sover, K., & Walsh, E. M. (2022). Climate change education must be education for justice: Historical and conceptual foundations for centering equity in climate change education. In E. M. Walsh (Ed.), *Justice and equity in climate change education: Exploring social and ethical dimensions of environmental education* (1st ed., pp. 1–38). Routledge. https://doi.org/10.4324/9780429326011

Stanley, W. B., & Brickhouse, N. W. (2001). Teaching sciences: The multicultural question revisited. *Science Education*, *85*(1), 35–49. https://doi.org/10.1002/1098-237X(200101)85

Tabak, I. (2004). Reconstructing context: Negotiating the tension between exogenous and endogenous educational design. *Educational Psychologist*, *39*(4), 225–233. https://doi.org/10.1207/s15326985ep3904_4

Unsworth, S. J., Levin, W. E., Bang, M., Washinawatok, K., Waxman, S. R., & Medin, D. L. (2012). Cultural differences in children's ecological reasoning and psychological closeness to nature: Evidence from Menominee and European American children. *Journal of Cognition and Culture*, *12*, 17–29.

Valladares, L. (2021). Scientific literacy and social transformation: Critical perspectives about science participation and emancipation. *Science Education*, *30*(3), 557–587. https://doi.org/10.1007/s11191-021-00205-2

Varelas, M., Morales-Doyle, D., Raza, S., Segura, D., Canales, K., & Mitchener, C. (2018). Community organizations' programming and the development of community science teachers. *Science Education*, *102*(1), 60–84. https://doi.org/10.1002/sce.21321

Vossoughi, S., Hooper, P. K., & Escudé, M. (2016). Making through the lens of culture and power: Toward transformative visions for educational equity. *Harvard Educational Review*, *86*, 206–232.

Wade-Jaimes, K., King, N. S., & Schwartz, R. (2021). "You could like science and not be a science person": Black girls' negotiation of space and identity in science. *Science Education*, *105*(5), 855–879. https://doi.org/10.1002/sce.21664

Warren, B., Vossoughi, S., Rosebery, A. S., Bang, M., & Taylor, E. V. (2020). Multiple ways of knowing: Re-imagining disciplinary learning. In N. S. Nasir, C. D. Lee, R. Pea, & M. McKinney de Royston (Eds.), *Handbook of the cultural foundations of learning* (pp. 277–294). Routledge.

Windschitl, M. (2023). *Teaching climate change: Fostering understanding, resilience, and a commitment to justice*. Harvard Education Press.

Windschitl, M., Thompson, J., & Braaten, M. (2018). *Ambitious science teaching*. Harvard Education Press.

Windschitl, M. A., & Stroupe, D. (2017). The three-story challenge: Implications of the next generation science standards for teacher preparation. *Journal of Teacher Education*, *68*(3), 251–261. https://doi.org/10.1177/0022487117696278

Young, E. (2010). Challenges to conceptualizing and actualizing culturally relevant pedagogy: How viable is the theory in classroom practice? *Journal of Teacher Education*, *61*(3), 248–260. https://doi.org/10.1177/0022487109359775

Zamudio, M. M., Russell, C., Rios, F. A., & Bridgeman, J. L. (2010). *Critical race theory matters: Education and ideology*. Routledge.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Clark, H. F., Gyles, S. A., Tieu, D., Venkatesh, S., & Sandoval, W. A. (2024). Exploring science teachers' efforts to frame phenomena in the community. *Journal of Research in Science Teaching*, 1–29. https://doi.org/10.1002/tea.21945