SCIENCE (SENSE)MAKING: INTERROGATING DEFICIT CLASSROOM NORMS
WITH SENSORIALITY AND CRITICAL FRAMES

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by

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**ABSTRACT**

Schools in the United States discipline students and families, particularly those who are intentionally marginalized (e.g., emergent bilingual, new immigrant Latino/Hispanic families), to be still and quiet in classrooms. Systems of white supremacy and racism pervasive in school systems foster teachers’ uninterrogated, habitual, and often hidden, deficit perspectives and their resulting dehumanizing interactions with students and families. My research explores this reality within a 2nd grade science sensemaking space. Along with scholars of sensory ethnography and Critical Race Theory, I assume that our sensorial ways of being are racialized but often unexamined. This dissertation presents three manuscripts which leverage the sensoriality of science sensemaking to de-familiarize deficit-aligned school norms. The manuscripts explore in different ways how engaging with students and families through phenomenon-rich, sensorial, equitable, science sensemaking practices surface deficit norms that discipline families and students to stay still and silent. Each paper unpacks how this disruption creates space for the author and a 2nd grade teacher (both of whom are white and English-dominant) to move toward expansive, asset-aligned, and critical perspectives and practices through iterative cycles of dialogue and praxis. Findings from the studies suggest that sensorial-rich science sensemaking, when paired with a Freirian praxis, can be used to critically examine school norms that position students and families as still and silent. These studies also show the importance of disrupting researcher/teacher hierarchies. In all three studies, the researcher’s move toward self-reflexivity, transparency, and vulnerability with the teacher led to fruitful collaboration and critical awareness for both individuals.
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Chapter 1

Introduction

Long before I set foot in Sally Matthews’ 2nd grade classroom at Douglas Elementary School, my body knew the rules of school. As a child, I sat quietly on the carpet of my Kindergarten class. I sat quietly at every one of my classroom desks, waiting until I was called on to try to get the right answer. As a teacher, my principals praised me for my behavior management. I would count down from five and warmly commend the middle-schoolers around me who quickly became still and silent. The rules are the same for my children. My four-year-old son proudly shows me how to sit “Criss-Cross Apple Sauce,” placing his folded hands into the small space between his folded legs. My 2nd-grade daughter happily brings home tickets she has earned for her good behavior—I do not have to ask what this entails, my body knows the rules of school. As a mother I also know the rules. I attend school events, listen and nod, and sit quietly while the teacher explains how I can support my child’s learning at home. I have also been the teacher inviting families in to look, listen, and leave. What I did not learn until recently was how to question these norms and find my way to more expansive approaches to being and teaching. Science sensemaking along with Critical Race Theory (CRT; Bell, 1987) and problem-posing pedagogy (Freire, 2000) has helped me disrupt and interrogate these norms to move toward humanizing, asset-aligned practices and perspectives.

Teachers expect students to be a certain way – in elementary classrooms across the country, this way of being is often still and silent, with hands clasped and “a bubble in their mouths” (Gershon, 2019; Juffer, 2019). Silence also aligns with a banking system of education where the teacher is all-knowing, and the students and families are empty vessels (Freire, 2000).
Teachers often praise students for answering questions correctly, rather than inviting students’ insights and wonderings (Mehan, 1979; Gershon, 2019). These practices are particularly prevalent at “no-excuses” schools (Golann, 2015), which fixate on obedience under the guise of urban school reform (Goodman, 2013). Schools similarly expect families to be a certain way, looking, listening, and leaving classrooms during events, and quietly listening to how to best support their child’s learning at home, while rarely being asked for their input (Lareau, 2000).

These norms extend into higher education, where researchers position teachers as deficient, and in need of intervention, particularly within elementary science education (Gray, McDonald, & Stroupe, 2021; Zembal-Saul, Carlone, & Brown, 2020). Underpinning these norms are dehumanizing, deficit perspectives which create Us/Them binaries, flattening and objectifying people as “other,” and ignoring their complexities, knowledge, and assets (Ladson-Billings, 2000; 2003; King, 1995). Overwhelmingly, the “Us” in these spaces are white, English-dominant, upper-class scholars. In this dissertation, I refer to the system that intentionally and systematically privileges dominant groups (white, English-dominant, heterosexual, high social and economic status, male, etc.), divides white people from Black, Indigenous and People of Color (BIPOC), and dehumanizes people outside of the dominant group as “white supremacy” (Jayakumar & Adamian, 2017; Okun, 2021).

When critically examining the epistemological and ontological frameworks that underpin these norms through Critical Race Theory (CRT: Bell, 1987; Delgado, 1995), we can see that they align with white, Cartesian, Euro-centric systems of knowing and ways of being (Gershon, 2017; Ladson-Billings, 2000). Ani (1994) writes: “Rob the universe of its richness, deny the significance of the symbolic, simplify phenomena until it becomes mere object, and you have a knowable quantity. Here begins and ends the European epistemological mode,” (p. 29 in Ladson-Billings, 2000, p. 258). This dominant epistemology forces people into static categories of self
and other and centers an either/or binary without any room for complexity (Ladson-Billings, 2000, 2003; King, 1995). When considering the academic context, it positions the researcher as all knowing, and the teacher as the object to know. Reaching back to the age of enlightenment, epistemologies found in education and schooling are largely Euro-American, centering the mind, the text, and the ocular (Gershon, 2017).

I seek to disrupt these norms through sensorial (Gershon, 2019; Suominen, 2019), reflexive, critically conscious (Freire, 2000), unframing (Greene, 1995; Powell & Serriere, 2013), and humanizing (Bartolomé, 1994; hooks, 1994) approaches. Disruption requires a critique of the Euro-American epistemological frame, and movement toward a polylithic, liminal alterity which challenges relationships between researcher and teacher, and between teacher and students/families (Ladson-Billings 2000). All ways of knowing and being are situated in specific, local, cultural knowledge (Basso, 1996; Ladson-Billings, 2000). However, given how individual and familiar our sensory knowledge is, we often do not question its subjective, highly socialized nature, and instead assume our sensory experiences are True, neutral, and real (Gershon, 2013; 2017). For example, how teachers interpret a student behavior in class largely depends on their local, sociocultural experiences, whether they think the student is being disruptive, engaged, or something more nuanced (Gershon, 2019). People who live only in dominant spaces rarely question how their experiences are embedded within white supremacy, and how the senses and sensory is political and racialized (Gershon, 2019; Suominen, 2019). Meanwhile, people who are intentionally marginalized experience a double consciousness that is rarely considered by those in power (DuBois, 2017). It is hard work to develop a worldview outside of dominant ways of knowing (Ladson-Billings, 2000; Shujaa, 1997). Yet, we can momentarily escape this epistemology and attached practices by critiquing our perspectives and interactions in iterative
cycles of reflection and praxis (Freire, 2000), and leveraging sensorial ways of knowing that move beyond mind, text, and vision.

Using CRT as a tool to constantly critique the permanence of racism and xenophobia in my work, I move away from Euro-centric, Cartesian frames of knowing, and leverage senses and sensorial knowledge (Gershon, 2019; Suominen, 2019) and problem-posing pedagogy (Freire, 2000) to interrogate school norms of staying still and silent. I also employ equitable science sensemaking (Davis, Zembal-Saul, & Kademian, 2020; Haverly et al., 2020) which center phenomenon and inquiry-rich curricula that involve touching, talking, moving, and sensing. This research comes out of my work in the Science 20/20 Project—a Professional Development (PD) project that works with educators to engage students in equitable science sensemaking to help elicit asset-aligned language practices. The Science 20/20 Project positions students and families as knowers, asking them to engage in productive participation that spans discourses. The sensorial nature of science sensemaking embedded in Science 20/20 clashes with typical school norms of stillness and silence, opening up a space for collaborative reflection, dialogue, and changes in practices between teacher and researcher, leading to a different way of being.

Suominen (2019) writes: “It is the articulation of the sensory information and knowledge as not neutral but rather as critically and contextually framed perceptions and conceptualizations of the values that can, in my opinion, disrupt normative thinking and as a result ‘common sense’ education” (p. 179). Creating cycles of disruption through science sensemaking, dialogue, reflection, and changing practices, creates space for teacher and researcher to practice asset-aligned perspectives, along with a new way of being. This dissertation adds to much-needed literature about how teachers and researchers can better interrogate deficit-aligned perspectives of often-“othered” students and families in elementary science sensemaking contexts (National Academies of Science, Engineering, and Medicine, NASEM, 2018).
Sensing our way through whiteness: Interrogating norms with science sensemaking

Research shows that (predominantly white, English-dominant) teachers can better engage with students and families from linguistically and culturally different backgrounds when they hold asset-perspectives (López, 2018), seek two-way communication from families (Epstein, 2010), and engage students in active, learner-centered, phenomenon-based approaches such as science sensemaking (NASEM, 2018; 2021; National Research Council, 2007; 2012; Davis, Zembal-Saul & Kademian, 2020). However, teachers do not often adopt these asset-aligned practices and perspectives (Change the Equation, 2017; Lareau, 2000; NASEM, 2021), and inevitably and often unknowingly take up racist, deficit perspectives and ways of being (Bell, 1987). One undertheorized reason why teachers do not take up humanizing, asset-based practices and perspectives is because these approaches conflict with unexamined school norms. There is incongruity between the norms that position students and families as still and silent, and those that positions them as important contributors who should be heard and who should move, touch, talk, sense and be in ways that are unfettered by white supremacy (Schilling, 2012; Watkins, 2005).

With CRT and CWS, we can see that whiteness operates in classroom spaces, creating implicit habits and rules for being; “whiteness orients bodies in specific directions, affecting how they ‘take up’ space” (Ahmed, 2007, p. 150). Although teachers and researchers may cognitively recognize and interrogate how racism operates in their classroom or attempt to move past it (e.g., colorblind racism), hierarchies persist implicitly through norms and how race is sensed and felt in the body (Powell, 2008; Sekimoto, 2018). Teachers engage in practices and ways of being that are so familiar, routine, and ubiquitous, that they feel neutral and commonsensical, when in fact, they are embedded with oppressive values (Kushamiro, 2004). These practices are difficult to interrupt because they are often unquestioned and feel normal, and because they give us comfort
(Kumashiro, 2004, p. xxiii). When considering how racism and oppression persist through the body, Sara Ahmed (2007) reflects: “bodies remember such [colonizing] histories, even when we forget them” (p. 154). Thus, racialization of ourselves and others moves beyond the cognitive and symbolic, and is taken up, reified, and recognized through our senses (Sekimoto, 2018). Race is often hidden in phenomenology (Merleau-Ponty, 2012), however scholars who have taken up a phenomenology of race (Ahmed, 2007; Alcoff, 19999; Gordon, 1995, 1999; Fanon, 2008; Macey, 1999) elucidate how being in spaces is tied up with whiteness and white rules of being. My work interrupts teachers’ and researchers’ implicit, deficit meaning-making of students and how they learn.

Teachers engaging in noisy, phenomenon-rich science sensemaking break the rules of how students should be in a classroom space. Similarly, researchers engaging with teachers in asset-aligned, polylithic, self-reflective ways disrupt the norms of the objective researcher. By learning from an elementary teacher, and collaborating to engage students in science sensemaking, I resist a norm of positioning elementary teachers as deficient in science pedagogy (Gray et al., 2021; NASEM, 2022; Zembal-Saul, et.al., 2020). Breaking these rules help us recognize the implicit assumptions in these spaces. Within the teacher/students relationship, a hierarchy of (white, English-dominant) teacher as all-knowing persists, and within the researcher/teacher relationship, a hierarchy of researcher (rooted in Eurocentric, white spaces) as all-knowing persists. The discomfort that arises in our bodies as we break hidden norms is an important tool to help us interrogate whiteness, since “we might only notice comfort as an affect when we lose it, when we become uncomfortable” (Ahmed, 2007, p. 158).

Centering and engaging in the sensorial aspects of science sensemaking with students and families creates an opportunity to purposefully disrupt school norms of stillness and silence. This disruption creates opportunities for teachers and researchers to collaboratively and iteratively
reflect, discuss, and interrogate the deficit roots of their discomfort in an effort to move toward humanizing (Bartolomé, 1994) and asset-aligned perspectives and practices. Using CRT as a tool to constantly critique the permanence of racism and xenophobia in my work, I move away from Euro-centric, Cartesian frames of knowing, and leverage senses and sensorial knowledge (Gershon, 2019; Suominen, 2019) and problem-posing pedagogy (Freire, 2000) to interrogate school norms. The three manuscripts in this dissertation all seek to interrogate 2nd grade teacher, Sally Matthew’s, and my deficit-aligned positioning of each other and new immigrant, emergent bilingual (EB) students and families, and the hidden norms of schooling which position students and families and still and silent. In different ways, the manuscripts all ask: **How does leveraging the sensoriality of science sensemaking with critical frames disrupt deficit-aligned school norms and teacher/researcher perspectives and move us toward asset-aligned pedagogies in science and beyond?**

The first manuscript, an ethnographic case study presented in Chapter 2, seeks to disrupt norms of how white, English dominant educators often position new immigrant families as neglectful, uncaring, and in need of support. This chapter describes how 2nd grade teacher, Sally Matthew and I engaged in iterative cycles of dialogue and praxis to interrogate our deficit positionings of families and each other, leading to an Open House event that centered sensorial science making and moved toward asset-aligned practices and perspectives. This approach breaks the norms of typical Open House events where families enter the room, look at classroom artifacts, listen to the teacher, and leave. When Sally and I sit down at a table with families and make sensorial settling jars together, we disrupt a hierarchy that positions teacher as all-knower, and families as in need of fixing. Our disruption of family engagement norms led to a shift in how Sally positioned families, and how Sally and families developed their relationships. Beyond this pivotal event, the manuscript also charts the developing relationship between Sally and me,
recognizing the importance of trust, transparency, and cycles of dialogue and praxis necessary to productively disrupt deficit perspectives. The central questions in this manuscript are: How can educators and researchers productively interrogate deficit-aligned norms of science-centered family engagement with Latine, EB families? How does the sensoriality of science sensemaking create space to de-familiarize and unframe norms of families as looking, listening, and leaving? What are the affordances of an ethnographic and problem-posing approach to teacher/researcher collaboration which centers humility, self-reflexivity, and criticality? In this manuscript, the disruption of school norms of family engagement is felt most strongly by our actions of engaging differently with families through sensorial science making.

The second manuscript, a case study presented in Chapter 3, disrupts how Sally Matthews and I interpret student touch. Similar to Chapter 2, this work seeks to disrupt school norms that position EB students in deficit ways. The manuscript traces how our perceptions of student touch change over time. One important juncture is our interpretations of students’ hands covering a bottle during a science sensemaking investigation. By iteratively reflecting and discussing our interpretations of this moment, Sally and I move from deficit-aligned, monolithic perspectives toward more asset-aligned, polylithic stances. This manuscript illustrates how reflecting on touch in science sensemaking led to recognition, interruption, and expansion of asset perspectives. Similar to Chapter 2, this manuscript also interrogates hierarchies between teacher and researcher, sharing how teacher insights around touch guided a collaborative research inquiry and break the norm of researcher as all-knowing in elementary science education. This manuscript asks: What does de-familiarizing and interrogating deficit-aligned norms of touch in elementary science sensemaking spaces do for teachers and researchers? How does this disruption influence how teachers and researchers perceive and elicit student touch in learning? How does this disruption influence how teachers and researchers think about touch as a way of knowing?
This manuscript centers the productivity of reflecting on disruptions of school norms. Unlike Chapter 2, which centers the act of disruption itself (a sensorial Open House event), this chapter highlights the productivity of reflection, iteratively returning to a disruption (student touch in science sensemaking) to unpack the implicit deficit interpretations.

The third and final manuscript presented in Chapter 4 moves away from an ethnographic exploration of disrupting norms, and instead shares the creation and pilot of a methodological tool that seeks to unframe the deficit norms of sound in science sensemaking. By abstracting the sounds of talk in a science sensemaking space and a grammar lesson, this tool explores how sound can help us interrogate pedagogical spaces. After noting some teachers’ acerbic reaction to hearing students’ (sometimes noisy) productive participation in science sensemaking and recognizing Sally’s and my own inclination to quiet student voices, I explored ways to uplift the affordances of student talk while side-stepping an immediate, negative sensorial reaction. Using sonification (Hermann & Neuhoff, 2011; Ballora, 2000), I abstracted student and teacher talk in an Initiate-Respond-Evaluate (IRE) dominant space and a productive student participation space, transferring student and teacher sounds to instrumental sounds. I could then play two different soundscapes (IRE and productive participation) for teachers to hear and reflect on, while avoiding the possibility for teachers to interpret rich student talk as chaotic, noisy, and off-task. The research questions I pursue in this manuscript are: How does critically listening to the sounds of a classroom space de-familiarize norms of teacher-centered Initiate-Respond-Evaluate instructional patterns? What kind of tool can support teacher listening to center the affordances of productive participation and not get distracted by deficit interpretations of “noise” and “chaos”? Whereas Chapters 2 and 3 surface experiences from my ethnographic research with Sally to disrupt deficit norms through the sensoriality of science sensemaking, this chapter seeks to create a tool to similarly disrupt norms.
Conceptual overview

The conceptual framework in Figure 1-1 is the basis for all three manuscripts and outlines an approach for teacher and researcher to collaboratively interrogate deficit norms through sensorial science sensemaking. The left side of the framework represents how sensorial science sensemaking disrupts school norms of staying still and silent. The picture of “still and silent” shows a student “showing pride” where they sit still, hands clasped, with a “bubble in their mouths.” The black line over the student’s eyes symbolizes how these norms erase students. This representation also applies to families, who are often silenced in family engagement events where they look, listen, and leave. The sensorial science sensemaking box under the still and silent norms box shows students out of their seats, leaning in, talking, and touching science phenomenon. An arrow moving from the bottom box to the top box represents how science sensemaking actively disrupts school norms. This disruption is central to the reflection and interrogation of deficit perspectives and practices for both teacher and researcher. A smaller
arrow moves from the top to the bottom box, since the school norms similarly hinder and disrupt sensorial science sensemaking.

The image on the right side of the framework simultaneously illustrates glasses with eyes looking out and two bodies: a teacher and a researcher. The glasses image represents the perspectives both teacher and researcher hold on the world, including on themselves, each other, and emergent bilingual students and families. The words “asset” and “deficit” are on each lens, representing how we hold both perspectives when reflecting on and perceiving norms and disruptions. This echoes Stuart Hall’s (1996) notion of ideology, which he defines as “fragmentary, disjoined, and episodic” (p. 43) rather than singular and stable. When re-focusing to the image of the two bodies, their side-by-side, overlapping outlines represent collaboration and partnership, where the researcher resists hierarchies and objectifying the teacher. The hearts shown on each body symbolize a humanizing practice of becoming, and signal awareness that stems from body and mind. Reflection on how sensorial science sensemaking disrupts school norms leads teacher and researcher to move toward actions that further expand asset perspectives and practices in an iterative cycle.

The cycle illustrated here mirrors Freire’s (2000) praxis, which is “reflection and action upon the world in order to transform it” (p. 51). Similar to Freire’s (2000) problem-posing pedagogy, this illustration moves between reflection and action to move toward critical consciousness. By interrogating the norms we produce, we make space to not only interpret others’ ways of being in more asset-aligned ways, but also to ourselves engage in more humanizing ways of sensing and interpreting the world around us.
The conceptual framework in Figure 1-1 conceals an essential aspect of my work: the underpinning epistemological and theoretical perspectives. Figure 1-2 reveals the worldview behind my work. In Figure 2 the concept map has been turned around (top right side) to show the theoretical frameworks and perspectives that I view the framework through and includes my own self in the image (bottom left). CRT stands for Critical Race Theory (Bell, 1987), and is shown in large text because it is a foundational framework which I use to continually question the ways in which racism and white supremacy are embedded in school norms as well as my way of thinking, interacting, and being. Given my positionality as a white, English-dominant person, and my work with a white teacher, I also include Critical Whiteness Studies (CWS; Matias et al., 2014b), and its tools to recognize whiteness in my work, shadowed below CRT in Figure 1-2. Within the edges of my field of vision, I also acknowledge that I will never fully escape the white, Western,
Euro-centric perspectives of white supremacy. The wave-like lines that bind my perspective represent back eddies and fluidity that inevitably seeps into my framework. This recognizes the aporia of paradigms that I sit in (Lather, 2006), acknowledging that “reality is not dialectical, colonialism is” (Hardt & Negri, 2001, p. 128). Although Hardt and Negri (2001) discuss the proliferation of reality, identities, and alterities in the context of colonizer and colonized (p. 128), I apply this construct to epistemology and perspectives. Similar to Gloria Ladson-Billing (2003), I recognize that we must reject “false universals” (p. 6), move beyond us/them, either/or, self/other binaries, and seek alterity when considering epistemology.

The act of recognizing the positivistic Euro-centric framework I am unlikely to escape, and placing CRT at the center, helps me become more self-critical and reflexive in my research. Figure 2 also includes my whole self within this framework, as I seek to disrupt the idea of a worldview only centering the eyes and the mind, uplifting the ways in which our whole beings are subsumed by epistemologies. Similar to how Tonda Liggett (2009) examines the social construction of racial discourse, I interrogate the social construction of the sensorial norms of learning, considering how whiteness inherently disembodies the mind from the senses.

In the next section, I will unpack my theoretical and methodological frameworks which underpin all three manuscripts, making connections with the epistemological, methodological, and axiological interconnections. I will then share a review of the literature important to the conceptual framework and summarize the interconnected aspects of all three manuscripts.

**Why this work matters**

My research explores how sensorial, equitable science-sensemaking practices and cycles of dialogue, reflection, and praxis, productively disrupt teachers’ and researchers’ deficit positionings of (new immigrant, EB) students and families as still and silent. This dissertation
matters because when (white, English-dominant) teachers take up asset perspectives of students and families, it leads to more equitable student learning (Bancroft & Nyirenda, 2020; López, 2018), particularly for EB students and families (Bottoms et al., 2015; Carter Andrews et al., 2019; Johnson & Fargo, 2014). However, many teachers are not well-equipped to teach science in ways that are student-centered, reform-based, and equity-aligned (Bancroft & Nyirenda, 2020; Krajcik, 2015; Rodriguez, 2015).

Developing an asset perspective requires a large shift in most teachers’ practices and perspectives of EB students and families (Nieto, 2000). Teachers are not often provided with professional development (PD) opportunities to reform their practices, particularly if teachers are in rural areas (Bancroft & Nyirenda, 2020), nor are teachers often taught how to leverage language practices with science pedagogies (Bancroft & Nyirenda, 2020). Teacher deficit perspectives are also long-lasting, despite PD that seeks to intervene. For example, Bancroft and Nyirenda’s (2020) review of the literature around equity-aligned PD in science education indicated that many teachers still held deficit views about their students after interventions. Seven out of the nine studies that included researcher-based observations to support teachers’ self-reports supported this finding (Adamson, Santau & Lee, 2013; Brenner, Bianchini & Dwyer, 2016; Brown & Crippen, 2017; Buxton et al, 2013; Lee et al, 2004; 2007; Rodriguez, Zozakiewicz & Yerrick, 2005; Yerrick & Beatty-Adler, 2011). These views persisted 6-month to 3-years after the PD and were prevalent in PD that included both critical and non-critical frames (Bancroft & Nyiredna, 2020).

A recent report from the National Academies of Science, Engineering, and Medicine (NASEM, 2018) highlights the need for research, including longitudinal, qualitative approaches, that better understand how to foster the asset-aligned perspectives teachers need to have to create equitable science sensemaking spaces with EB students and families. Specifically, NASEM
(2018) calls for research that: develops “interventions designed to promote asset-based views of ELs and communities in changing ELs’ STEM achievement outcomes,” (p. 311) and questions how to prepare teachers to enhance family/community engagement and build “deep and lasting partnerships with families of communities of ELs that have positive impacts on those students’ STEM learning” (p. 312). My research provides an innovative approach to address this need by unframing norms through the sensoriality of science phenomenon, an aspect that is under-theorized in the science education research community. Specifically, I contribute to this call in several ways: 1) I provide examples of a productive researcher-teacher and researcher-teacher-families partnerships that leverage science sensemaking to build community, foster asset perspectives, and enact equitable practices, 2) my research is done in an important but often under-researched context, providing valuable insights into how to build partnerships in communities situated in a Latino Threat Narrative context (Chavez, 2013), and 3) I move away from dominant, Euro-American epistemologies that privilege words and the mind, and makes space sensory ways of knowing.

The need to foster asset perspectives and practices

Extensive literature highlights the importance of equitable science sensemaking, particularly to encourage language practices with EB students (Buxton et al., 2013; Lee, et al., 2007), but elementary classroom teachers do not often adapt these practices. A recent report by The National Survey of Science and Mathematics Education (NSSME; Banilower et al., 2018) makes clear that reform-based elementary science practices are not being enacted by teachers, particularly when student-centered science sensemaking practices that use phenomenon to build claims and evidence are centered. The 2018 NASEM report calls for research that prepares
teachers who work with EB students to employ culturally sustaining pedagogies, strategies that enhance family and community engagement, and practices that leverage EB students’ assets. However, shifting deficit teacher and researcher perspectives is not easy. Although high-leverage science sensemaking practices are readily accessible for teachers (Davis & Boerst, 2018; Windschitl, Thompson, & Braaten, 2018), deficit and racist perspectives which conflict with implementing these practices are deeply seated and uprooting them is not a quick or easy task (Sengupta-Irving et al., 2021).

Lilia Bartolomé (1994) argues that inequities in education cannot be solved through implementing high-leverage practices alone, but rather we (teachers and researchers in dominant spaces) need to interrogate our own deficit perspectives of students who are intentionally minoritized through de-humanizing pedagogies. Instead of sharing tools that center a one-size-fits all solution with swift and large change in teacher practices, which align with characteristics of whiteness (Jones & Okun, 2021), my work provides three different, yet entangled examples of partnerships with teachers and families, and my journey in attempting to unframe our deficit perspectives through long-term dialogue and consideration of sensoriality. These approaches mirror research in sensory ethnography (Powell & Serriere, 2013; Powell, Altuntas, & Bricker, in press; Truman &. Springgay, 2016) and respond to NASEM’s (2018) call to develop interventions to promote asset-based views of EB students and families, and to engage in culturally sustaining practices with both families and students, while also recognizing the need to resist neatly organized interventions that hide the complexities of these issues (Gutiérrez et al., 2017; Lee, 2019).
An important place

The educational success of intentionally minoritized students, such as the Dominican, new immigrant, EB students in these papers, depends upon a complex intersection of the localized histories, cultures, and social and economic factors (Ogbu, 1992). Although there is ample research centering Hispanic/Latino students and families and education, most of these studies are situated in either the nine traditional Hispanic/Latino states: Arizona, California, Colorado, Florida, Illinois, New Jersey, New Mexico, New York, and Texas (National Taskforce on Early Childhood Education for Hispanics, 2007), or in urban areas (Hamann & Harklau, 2010). There is far less research that considers the different and complex environments of the new Latino diaspora, which is emerging nationally (Hamann & Harklau, 2010; Richardson-Bruna & Vann, 2007). Moreover, the little research that does center the new Latino diaspora often centers communities in the midwest (Hamann & Harklau, 2009; Richardson- Bruna & Vann, 2007; Zuniga, Olson & Winter, 2005). This work adds to the sparse research that considers the unique context of a new Latino diaspora community in a semi-urban community in the northeast, with a history of anti-immigrant political tension and Latino Threat narrative (Rosa, 2019; Chavez, 2013).

Beyond the unique, under-researched context of a new Latino diaspora community, this research also provides an example of a productive partnership between school, university, and families that exists over a hundred miles away from a large university. Thus, not only is the student and family community under-researched, but the teachers and administrators also represent a unique subset of participants that are often under-researched. When considering that most studies do not reflect the context of districts, this work helps provide an example that moves beyond an over-researched participant base (Boser & McDaniels, 2018).
Thinking and knowing beyond the Cartesian lens

Karen Barad (2003) writes: “Language has been granted too much power” and that “every ‘thing’—even materiality—is turned into a matter of language or some other form of cultural representation” (p. 801). Moving beyond words into other ways of knowing through sensory ethnography provides opportunities for new insights that emerge when we move away from a dominant, automatic, visual ways of learning. Western, white ways of knowing both bifurcate the mind and the body (Ohito, 2019), and elevate visual ways of knowing over other senses (Pink, 2015; Feld, 1996, Stoller, 1997). Educational research is dominated by Euro-American epistemologies that value an either/or sensibility (Ladson-Billings, 2000). Academic research, including within the field of education, is rooted in Eurocentric, cartesian epistemology which moves toward simplicity with the author as the “sole expert” (Ladson-Billings, 2000, p. 268). Such an approach resists self-reflexivity and the alterity that exists in complexity, both/and, and in between spaces. I seek to disrupt a Cartesian approach by including sensorial ways of knowing. Research is similarly dominated by the ocular, text, and cognitive (Carspecken, 1996; Gershon, 2019; Suominen, 2019). Exploring beyond the mind into the body, what Stoller (1996) calls “sensuous scholarship” can yield new insights and understandings. My dissertation disrupts societal norms through sensorial affordances (Kumashiro, 2000, 2004; Suominen, 2019), an approach that is novel in the science education community.
Understanding through critical frames and sensoriality

*I am. When I can is, I can be. When I be, I can learn. I am.*

(Walter Gershon, 2019, p. 153)

Our senses are at the heart of our being and our ontologies. Gershon (2019) writes: “ontologies are the contexts in which our knowledges are born and raised, and the sensuous are irrevocably embedded in the epistemological as it is in the ontogenetic” (p. xv). However, most educational research is rooted in theories that mute or temper our whole being and systems of knowing, and instead center the mind, eye, and text (Gershon, 2019; Ladson-Billing, 2000). This research often takes up allochronic language such as “urban” and “inner-city,” and seeks to fix families, and students of color without examining the normative-evaluative ontologies and deficit-aligned perspectives underpinning their work (Duncan, 2005; Fabian, 2002). Sense-less epistemologies trace back to Rene Descartes and the Enlightenment Period which prioritized a Cartesian epistemology that positioned one’s individual self as knower, objectifying and sanitizing the world around them in binary, static ways (Ladson-Billing, 2000). My theoretical and conceptual frameworks seek to create openings that prioritize shared knowing and becoming and recognize the contextual, sensorial, liminal ocean our knowing swims in, rather than a static mantra of “I think, therefore I am.” (Greene, 1995; Ladson-Billings, 2000). My rebellion against a white, Euro-American epistemology informs my goal of unframing (Greene, 1995; Powell & Serriere, 2013) and de-familiarizing (Powell, et. al., in press; Truman & Springgay, 2016) the normative. Included in this disruption is both a criticality that seeks to uncover how hegemony and white supremacy infuse my work through CRT (Ladson-Billings, 2000), and an interrogation of the senses and sensory knowing which are inherently racialized (Sekimoto, 2018), contextualized (Gershon 2019; Greene, 1995), and “simultaneous, rhizomatic, mutually contributing processes of experiencing and understanding” (Suominen, 2019, p. 179). Embedded within these frames are
the ways of being that Sally and I take up in the world (Gershon, 2019), which connect with concepts of problem-posing pedagogy (Freire, 2000), unframing (Greene, 1995; Powell & Serriere, 2013; Powell et al., in press) and asset-based perspectives (López, 2018; Valencia, 1997).

The epistemological and ontological stances I move toward in this work also inform my methodology and methods. By taking up humanizing, sensorial, CRT- and asset-aligned perspectives, I must include myself as central in my research (Ladson-Billings, 2000), and focus on sensuous interactions (Suominen, 2019). Recognizing the pervasiveness of racism requires me to constantly question where race is in my discourse and “in what ways I have reinscribed liberalism in my work” (Ladson-Billings, 2000, p. 272). In this sense, I recognize that I have been learning, thinking, and being in a society rooted in white supremacy and the myth of meritocracy (Bonilla-Silva, 2014) for decades. Despite a recent awareness of how these systems operate, I recognize the likeliness that these tenets will flow into my worldview, thinking, and interpretations.

In using liminality and alterity, I acknowledge the possibility, if not likelihood, of holding competing perspectives and thoughts (Ladson-Billings, 2003), which help me consider how Sally and I hold both asset and deficit perspectives side-by-side, among other complexities. All three manuscripts take up ethnographic approaches that position Sally as a collaborating partner and seek to complicate and understand our interactions over three years. Stemming from my worldview, I move beyond member checking to a vulnerable partnership where Sally and I share our honest perspectives of each other, students, and families in ways that change over time. Through this ongoing discussion, we engage in a process of becoming. In this section I lay out the important theoretical underpinnings of CRT, CWS, and Critical Consciousness.
Critical Race Theory

Critical Race Theory (CRT) is a framework attuned to intersections of patriarchy, heterosexism, and class (Crenshaw, 1990), and is defined as “a collection of activists and scholars interested in studying and transforming the relationship among race, racism, and power” (Delgado & Stefancic, 2001, p. 2). CRT is rooted in Critical Legal Studies (CLS), a movement in the 1970s where legal scholars recognized how civil rights advancements were stalling, while still positioning laws as universal and neutral. Legal scholar Derrick Bell, along with others in the legal field (e.g., Kimberlé Crenshaw, Richard Delgado, Alan Freeman, Mari Matsuda) disagreed with universality in law, branching off from CLS to form a group that theorized CRT. Within the legal arena, CRT interrogated racism within housing, education, banking, employment, and healthcare, in an effort to scrutinize how laws continued to perpetuate racism (Delgado & Stefancic, 2001; Love, 2019). Since its inception, CRT has gained relevance in other fields, including education (Ladson-Billings & Tate, 1995).

Solórzano & Yosso (2002) define CRT in education as: “a framework or set of basic insights, perspectives, methods, and pedagogy that seeks to identify, analyze, and transform those structure and cultural aspects of education that maintain, subordinate, and dominate racial positions in and out of the classroom” (p. 25). This framework is a necessary and powerful tool to center in my research because I am trying to work with teachers to recognize and disrupt the dehumanizing norms within school spaces to move toward more asset-aligned, humanizing practices. CRT “unapologetically challenges the scholarship that would dehumanize and depersonalize us” (Ladson-Billings, 2000, p. 272) and examines “the taken for granted privileges and inequities that are built into our society” (Ladson-Billings, 2003, p. 10-11). It challenges racist norms and the ways in which we essentialize the ‘other’ (Delgado, 1995; Powell, 2008). Recognizing that I have lived most of my life not questioning the ubiquitous, violent, and
dehumanizing norms of whiteness, I find CRT a critical support in interrogating norms. Although different scholars characterize CRT in various ways, central tenets discussed here include: 1) racism as universal and endemic, 2) counter storytelling, 3) whiteness as property, 4) intersectionality, and 5) critique of liberalism (DeCuir & Dixson, 2004; Crenshaw, et al., 1995; Ladson-Billings, 1998; Ladson-Billings & Tate, 1995; Mensah & Jackson, 2018; Parsons 2014; Zamudio, et al., 2010).

A foundational tenet of CRT is that racism is endemic in United States classrooms (Bell, 2018), which maps onto how teachers and schools discipline students’ and families’ bodies to be still and silent, and how researchers discipline teacher participants as objects. Beyond being permanent, racism is hidden and normalized. This aligns with Joyce King’s concept of dysconscious racism, which is:

> an uncritical habit of mind (including perceptions, attitudes, assumptions, and beliefs) that justifies inequity and exploitation by accepting the existing order of things as given […] Dysconsciously racism is a form of racism that tacitly accepts dominant White norms and privileges. It is not the absence of consciousness (that is, not unconsciousness) but an impaired consciousness or distorted way of thinking about race. (King, 1991, p. 135)

This tenet aligns with its Black feminist roots by focusing on the implicit and uninterrogated ways society sustains racism, along with intersections of other oppressive systems (e.g., patriarchy). These hidden, seemingly “normal” ways of knowing and being pervade the legal system, including equality laws, which do not dismantle racism despite their appearance. For example, the finding that affirmative action benefits white women more than people of color (Schmidt, 2005). Recognizing that racism plays out both consciously and unconsciously, and across many systems (e.g., education, healthcare, justice systems, etc.), and is not about to go away quickly or easily, is central to CRT (Bell, 2018; DeCuir & Dixson, 2004; Ladson-Billings & Tate, 1995; Lynn & Parker, 2006; Sung & Coleman, 2019).
A second tenet of CRT is counter storytelling. As two white women, Sally and I do not attempt to create counter-stories for the Dominican students and families in Sally’s classroom. However, we do challenge dominant norms and wisdom (Yosso, 2013), particularly by interrogating how we position Sally’s students and families. Tara Yosso (2005) writes “one of the most prevalent forms of contemporary racism in U.S. schools is deficit thinking” (p. 75). Sally and I engage in iterative reflection, dialogue, and praxis that interrupt the deficit-aligned norms about how we position students and families.

A third tenet of CRT is Whiteness as Property, a concept conceived by Cheryl Harris (1993) that considers the material and psychological affordances which only benefit white people. White claims to property and rights also mean that whites can deny access to others. Whiteness functions through “rights of disposition, rights to use and enjoyment, rights to reputation and status property, and the absolute right to exclude,” (Ladson-Billings & Tate, 1995, pp. 58-59). Whiteness is described as “a category of privilege” (Solórzano & Yosso, 2002, p. 27), and “an embodied sensory subjectivity that assumes itself as the normative, standard, human sensory experience,” (Sekimoto, 2018, p. 94). Whiteness as property provides a tool to question teachers’ claims of how to exist in school. Beyond being a tool to critique the sensorial norms of being, this tenet also allows us to question science sensemaking, and how even in our attempts to disrupt deficit norms, we may still be reifying whiteness (Mensah & Jackson, 2018). For example, when listening to the sounds in Sally’s classroom, we heard how students voices are strictly controlled and relegated to short answers to teacher questions. Questioning who gets to speak and whose voices are excluded through this tenet helped us recognize the need for students, particularly EB students, to have space and time to speak openly.

A fourth tenet in CRT is intersectionality. Intersectionality conflicts with Euro-centric epistemologies to flatten and neaten the world around us. Kimberlé Crenshaw (1990) highlights
the power of this tenet in recognizing differences within groups, not just between them. When considering how Sally and I position Dominican, EB students and families and each other, intersectionality requires me to consider the differences between people, including both white and Dominican groupings. Intersectionality offers a powerful tool to resist the oppressor/oppressed binary centered in critical consciousness work (Jemal, 2017). Intersectionality helps Sally and I resist positioning all Dominican, Spanish-Dominant families as monolithic, but instead recognizes how some families are more connected to school and can better navigate the hidden curriculum, while others are not. Insider school knowledge is only one of many axes by which to consider power, and therefore “with intersecting identities and variable experiences of oppression and privilege, it becomes nearly impossible to divide most people into categories of oppressed, oppressor, or privileged” (Jemal, 2017, p. 619). Sally and my roles similarly blur power dynamics. Although I enact the role of “researcher,” which affords power, Sally is much more expert in her years as a teacher.

Lastly, a fifth tenet of CRT is the critique of liberalism, which helps uncover the ways well-intentioned, progressive, and liberal ideologies reify racism. For example, the pervasive ideologies of individualism and meritocracy creep into ways of knowing, being, and sensing in Sally’s 2nd grade classroom. This tenet also helps regulate how I can perform anti-racism while ignoring how our ideals are underpinned by racist foundations of capitalism and individualism (Bonilla-Silva, 2017). Important components of this tenet which also exist in legal ideology include colorblindness, neutrality, and incremental change (DeCuir & Dixson, 2004). CRT requires us to look beyond intentions and performances of anti-racism, toward what actions are or are not being taken.
Critical Whiteness Studies

Coupled with CRT, the three manuscripts also use second-wave critical whiteness studies (CWS). CWS provides productive ways to navigate white teachers’ “silence, disinterest, and defensiveness” (Berchini, 2017, p. 467). Second-wave CWS moves beyond its predecessor’s recognition of white privilege, to examine normalized hegemonic whiteness as a discourse and ideology (Leonardo, 2004), and create tools to recognize and disrupt it (Cabrera, Watson & Franklin, 2016; Matias et al., 2014b). By interrogating how whiteness operates, CWS scholars have amassed definitions and strategies to counter the many ways white folx evade whiteness. For example, understandings of colorblind racism and ideology (Bonilla-Silva, 2017), the epistemology of ignorance (Mills, 2017), whiteness at work (Yoon, 2012), white diss-course (Matias et al., 2014b), white fragility (DiAngelo, 2018), white imagination (Matias et al., 2014b), white resistance (Matias et al., 2014a; Ringrose, 2007), white solidarity (DiAngelo, 2018), and white talk (Foste, 2020) provide useful analytic tools when engaging, reflecting, analyzing and writing about my research.

As a white researcher working with a white teacher, this framework is a helpful companion to CRT since it provides tools to negotiate white deflection both in myself and Sally (Matias et al., 2014b). However, CWS is also problematic. The paradox in being white and doing anti-racist work means navigating a fine line between producing anti-racist scholarship and colonization. CWS scholars are never in a safe space doing this work (Berchini, 2017; Levine-Rasky, 2000; Matias et al., 2014b). Whiteness scholarship creates a “double bind” where the act of centering and naming race and whiteness perpetuates it, yet the absence of doing so hides it (Levine-Rasky, 2000; Matias et al., 2014a). Much of this work burdens BIPOC: “[CWS] relies on contrast of blackness/otherness, and often burdens others to share stories so that white folx can learn,” (Berchini, 2017, p. 469). CWS also often highlights the ways in which white supremacy
has harmed BIPOC, which although important, overshadows stories of black resilience, creativity, and joy, leading to a deficit perspective of BIPOC as victim. This tension reminds me to stay focused on how Sally and I can interrogate our own deficit positions of others and try to move toward productive strategies rather than navel gazing.

**Critical consciousness**

Freire’s (2000) work on critical consciousness and problem-posing pedagogy inspires both my theoretical framework and my methodology. Critical scholars provide different definitions of critical consciousness, although all highlight two main dimensions: a continuous movement between awareness and action, and a method that leads to becoming (Jemal, 2017; Cervantes-Soon, et al., 2017). Critical consciousness entails recognizing the oppressive ocean you are swimming in, and then moving toward action to liberate yourself from that oppression, or “learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality” (Freire, 2000, p. 35). This process of liberation creates space for a new reality. Freire’s (2000) problem-posing pedagogy translates critical consciousness into an approach to being, or a “complex process of awakening, reflecting, learning from each other, and learning how to learn for oneself about issues of oppression” (Sleeter, et al., 2004, p. 82).

Praxis and dialogue are critical components of this work. Praxis consists of an action and a reflection of that action, in a constant cycle. Freire (2000) defines praxis as “reflection and action upon the world in order to transform it” (p. 51). This process leads to an awakening of how we are steeped in systems of oppression, which then lead to further reflections and actions, thus deepening critical consciousness. This process is iterative and never-ending: “critical consciousness is not a destination but an ever-evolving, ongoing process influenced by social
context” (McDonough, 2009, p. 531). The term “dialogue” can be a problematic empty signifier in this work. Dialogue as used in critical consciousness has important nuances. Freire’s dialogue (which he refers to as “the word”) is an act of praxis. Freire (2000) writes: “within the word we find two dimensions, reflection and action, in such radical interaction that if one is sacrificed—even in part—the other immediately suffers. There is no true word that is not at the same time a praxis. Thus, to speak a true word is to transform the world” (p. 87). Shor and Freire (1987) similarly emphasize the praxis of dialogue: “Dialogue is a way to recreate knowledge as well as a way we learn,” (p. 11). This dialogue is not a diatribe or lecture, it is not apolitical, it is not a tool to move toward friendship, it is not a debate, nor is it a conversation (Darder, 2003; Freire, 2000; Shor & Freire, 1987). Dialogue requires trust between the oppressed and oppressor, and an ability to accept and seek to understand the other’s input, rather than to judge or evaluate it as fallible.

Critical consciousness is a method, however the aspects of praxis and dialogue are also epistemological—a way of knowing (Freire & Macedo, 1995). A major critique of critical consciousness is that it centers class, and does not center race and whiteness, nor race’s intersections with other dimensions such as gender, sexuality, ability, or class (Allen, 2004; Ellsworth, 1989, Ladson-Billings, 1997). Critical consciousness and associated critical pedagogies are rooted in Marxism, which has historically minimized race (Allen, 2004). When we apply the lenses of CRT (Ladson-Billings, 1998) and CWS (Matias et al., 2014b) to critical consciousness, we can move past oppression that centers class and consider the often-evaded oppression of racism along with intersections of other groups. These lenses interrogate how even critical pedagogies such as critical consciousness reproduce whiteness, even as they align with liberal and activist stances. However, critical consciousness should not be completely left behind; valuable aspects of the framework complement a focus on racism (hooks, 1994; Freire & Macedo, 1995).
Becoming

An important aspect of engaging in cycles of reflection and action with Sally is that it leads to us becoming – to transforming who we are, how we perceive the world, and how we act in it. This idea of becoming comes from Freire’s (2000) discussions about problem-posing pedagogy, whereby “people develop their power to perceive critically in the way they exist in the world with which and in which they find themselves; they come to see the world not as a static reality, but as a reality in process, in transformation” (p. 83; original italics). This notion of becoming is tightly intertwined with praxis. Key characteristics of the process of becoming are that they are: active, not static, open ended, not linear or closed, require engagement with the world and dialogue with people, not an individual process, and tied to ideology and identity. The process of becoming is ever changing (Freire, 2000)—there is no arrival, since the cycle of reflection and action is similarly perpetual.

Although becoming is rooted in Freire (2000), it is kin to other scholars’ notions of becoming. Freire (2000) cites philosopher Henri Bergson as an influence on his ideas. Bergson’s work (1907): *Creative Evolution*, considered the ontological act of becoming, recognizing the duality of virtual and actual, of creative and intuitive (Khandker, 2016). Deleuze and Guattari similarly built from Bergson’s work when considering becoming, positioning becoming as active, not static (Bennett, 2010). This becoming differs from Kant’s Bildurigstrieb, which positions becoming as “equilibrium maintaining,” and stays within boundaries rather than transforms them (Bennett, 2010, p. 60). Deleuze and Guattari (2004) consider becoming as an act of deterritorialization and reterritorialization (p. 83), and something that “continue[s] to evolve beyond the boundaries of the sets they have been distributed into” (Williams, 2002, in Sherbine, 2018, p. 4). Their becoming leans into transformation and creating something new (Biehl & Locke, 2010). Maxine Greene (1995) discusses how imagination allows us to “break with what is
supposedly fixed and finished, objectively and independently. Real” (p. 19). Her work ties to Dewey’s (1934) idea of using imagination to move into new consciousness. These conceptions of becoming aligns with Freire’s limit situations, where one can transform past boundaries if they engage in praxis.

Another important aspect of becoming is that it entails interconnection, clashes, and conflicts (Braidotti, in Bennett, 2010, p. 235). These ideas align with Spinoza’s conception of becoming which recognizes it as a necessarily discordant process. In this sense, “be(com)ing is a process of difference and transformation” (Sherbine, 2018, p.4). Freire (2000) similarly embraces contradictions to fuel the process of becoming. The need for interconnection to drive transformation and becoming also recognizes the need for dialogue and community. Freire’s (2000) framework requires interaction with others and the world, as does Ted Aoki’s (2005) move toward becoming and humanization.

In summary, becoming is a fundamental component of my framework and an outcome of Sally and I engaging in cycles of reflection and action. As we continue to reflect on how sensorial science sensemaking disrupts and unframes school norms, we interrogate our deficit perspectives and move toward more humanizing, asset-aligned practices. Through this process, we change who we are, how we critically reflect and perceive the world around us, and how we engage with each other and others. This conceptualization of becoming stands firmly within Friere’s (2000) camp, but it is important to recognize how other scholars, such as Deleuze & Guattari (2004), Ted Aoki (2005), and Spinoza (2016), position becoming in similar ways.
Being

I want to distinguish how I use “becoming” in this dissertation, from “being.” When I refer to teachers and students as having to be a certain way, I am referring to the expectations of how people are expected to act and perform their roles as teachers, students, or family members. Unlike becoming, this notion of being is a norm that is limiting. The act of becoming is the act of overcoming the static “be.” Once an individual becomes critically aware of how norms can limit how they act in the world, they can theoretically break down these barriers as they engage in cycles of praxis (Freire, 2000). Although I usually invoke the disciplinary nature of norms when discussing being, I recognize how being operates within a larger field of becoming. Scholars who conceptualize becoming similarly to Freire (2000) have used the phrase: be(com)ing to demark the interconnectedness between being and becoming (Sheribine, 2018). Although I use “being” often to highlight how school and society positions teachers, students, families, and researchers in static roles that limit their humanization, this use of being is situated within the framework of becoming that recognizes the possibility of escaping these limits through praxis and critical consciousness.

Key differences between frameworks and my research

CRT and critical consciousness are fundamental theories that underpin my work. However, the specific context I am applying these frameworks to inevitably change how the theories were intended to operate. Rather than overlook these powerful frames, I adapt them. For example, CRT’s goal is to uncover and upend racism and how it operates in implicit and explicit ways. Counter-storytelling makes space for non-dominant narratives to expose the myths of normative narratives. However, Sally and I are both white educators. To create counter-narratives
from the perspective of her Dominican students and families would be a problematic practice of the white imagination (Matías et al., 2014b). Thus, my work does not create counter-narratives. In addition, Friere’s (2000) critical consciousness centered a relationship between the oppressor and oppressed. Although there are power relations between Sally and me, we do not have an oppressor/oppressed relationship, nor are we engaging in problem-posing pedagogy with the aim of liberation in the same way Freire worked with peasant laborers. However, the framework of disrupting norms through iterative cycles of dialogue and praxis is adapted to our context.

**Critical ethnography as epistemology and methodology**

Epistemology, theory, and methodology are inherently linked (Madison, 2005). As noted earlier, my research is rooted in efforts to disrupt normative, Euro-American systems of knowing and ways of being in the world and interrogates how sensory knowledge is implicitly perceived as objective fact. This position aligns with an activist stance, which works to “unearth, disrupt and transform existing ideological and/or institutional arrangements” (Fine, 1994, p. 17). Critical epistemology rebels against taken for granted certainties that position visual interpretations as objective Truth, to recognize that our perspectives are limited by our consciousness, which in turn is largely influenced by power dynamics (Carspecken, 1996).

Critical ethnography, a methodology that addresses social injustice and inequality through research, tightly aligns with critical epistemology, CRT, and critical consciousness. Although it overlaps with conventional ethnography in many ways, including its qualitative approach that centers field work and thick descriptions, critical ethnography’s focus is not to describe a context or culture, but to address social injustice and inequality and refine social theory (Carspecken, 1996; Norander, 2017). Critical ethnography understands that “all thought is
fundamentally mediated by power relations which are socially and historically constituted” (Kincheloe & McLaren, 1994, p. 140). Unlike more traditional ethnographies, critical ethnography recognizes that research is “not innocent or neutral” (Murillo, 1999, p. 7) and requires involvement with subjects (Thomas, 2011, p. 11). This reflexivity and critique require researchers to carefully consider their methodological approaches, including: “active reflections on their choice of theories and methods, accountability for any potential consequences of their research, researcher positionality, deconstructing taken-for-granted assumptions to uncover the workings of power and control, and advocating for social change” (Norander, 2017, p. 297).

Other methods inherent in critical ethnography include direct observation, open-ended interviews, and textual analysis, as well as constantly interrogating the predilection to “representationally essentialize” (Clifford, 1992) cultural “others” in a way that leads to “metonymic freezing” (Appadurai, 1988).

Metonymic freezing is an example of the hidden ways white supremacy and Eurocentric epistemologies persist even in contemporary ethnographic practices. The term, coined by Arjun Appadurai (1988), refers to the anthropological habit to categorize, classify, and label subjects or cultural “others” in ways that do not capture the full nature of a person or group, resulting in a scholarly practice that limits and subjugates people. Appadurai (1988) uses the term “natives” to exemplify metonymic freezing, since “natives are not only persons who are from certain places, and belong to those places, but they are also those who are somehow incarcerated, or confined, in those places” (p. 37). The use of “native” has the power to connote deficit stereotypes, while “serving as a respectable substitute for terms like primitive” (Appadurai, 1988, p. 36). By acknowledging the inevitability that I will categorize, freeze, and flatten people, particularly through covert labeling, I hope to better interrogate this Eurocentric practice. For example, I try to use terms like “students,” “teachers,” and “families” more frequently than “Dominican,”
“emergent bilingual,’ and “new immigrant” since the latter terms have more limiting boundaries in their interpretations.

Similar to other ethnographic endeavors, I began working with Sally at Douglas Elementary School before having exacting research questions. Instead, as I reflected on my work with Sally and my own positioning over time, my research unfolded as my fieldwork unfolded (Norander, 2017; Patton, 1990). As I moved toward a critical epistemology and ethnography, I recognized that the focus of my work should not be working with Sally to “help” the students and families from new immigrant, EB backgrounds thrive, but instead for Sally and me to work together to reflect on how our own lenses can expand to be asset-aligned and self-critical. Families and students in Sally’s community are not broken or in need of fixing. I wanted to move away from the dehumanizing research that centered conversations by white men, for white men about the “other”: “A conversation of ‘us’ with ‘us’ about ‘them’ is a conversation in which ‘them’ is silenced.” (Minh-ha, 1989, p. 67). This dissertation does not center an “other,” but instead focuses on how the dominant deficit lens can be better interrogated. I and other white, English-dominant educators have a lot to (un)learn about white supremacy and racism, and the deficit lenses we have implicitly used.

I also did not want to position Sally as someone who was in need of fixing. This is a familiar trope in elementary science education research (Gray, McDonald & Stroupe, 2021; NASEM, 2022; Zembal-Saul, Carlone, & Brown, 2020). Instead, I wanted to move toward a joint partnership that centered self-reflexivity and collaborative learning and recognized the many strengths Sally brings to my work. For example, in my manuscript around touch in Chapter 3, I illustrate how Sally’s insights greatly influenced my research and understandings. Unlike other forms of ethnography, I centered “critical reflection and raising awareness throughout the
process” (Norander, 2017, p. 297) by engaging collaboratively in iterative cycles of critical reflection and praxis with Sally.

Recognizing one’s own complicity in research is central. However, simply including oneself is not enough. Considering Fine’s (1994) scrutiny of self and other, I seek to “unpack[...] notions of scientific neutrality, universal truths, and researcher dispassion” (p. 71) and examine how I position myself, Sally, students, and families in my work, specifically with respect to intersections such as race, class, ethnicity, language dominance and gender. While conducting research, the critical ethnographer works to examine their own bias and discover value orientations implicit in their work (Kincheloe and McLaren, 2000). In critical ethnography, researchers recognize that truth claims are normative, and “recognize where they are ideologically located in the normative and identity claims of others and at the same time be honest about their own subjective referenced claims and not let normative evaluative claims interfere with what they observe” (Kincheloe and McLaren, 2000, p. 300). This framing was important in my work with Sally, moving me away from evaluative, distant observations of Sally’s words and teaching, and toward more collaborative engagement and discourse.

Although my methodology differs in several ways from collaborative ethnography (Lassiter, 2005), this branch of ethnography informed many of my approaches in working with Sally. For example, I was careful to move toward joint participation (Penuel et al., 2015) and side-by-side work, rather than keeping a distance from Sally. As I moved away from an initial evaluative stance, I also made sure to explicitly share my research interests and perspectives and ask Sally for her perspective and feedback as we held on-going discussions. We co-conceived conference proposals, presentations, and journal articles, and I shared drafts of my writing with Sally for comment and feedback as my work iterated over the three years. Over time, Sally’s insights led me to change my research focus. For example, my second manuscript’s focus on
sensorial touch, although beginning with my own observations, evolved as Sally shared her insights on touch in learning. These approaches were inspired by collaborative ethnography, which: “deliberately and explicitly emphasizes collaboration at every point in the ethnography process, without veiling it—from project conceptualization to field work, and, especially, through the writing process. Collaborative ethnography invites commentary from our consultants and seeks to make that commentary overtly part of the ethnographic text as it develops” (Lassiter, 2005, p. 16). However, unlike much of collaborative ethnography, my research does not originate in the interests of Sally, and Sally is not from a significantly different cultural background than me. For these reasons, as well as the close connection to critical ethnography, I do not call my work collaborative ethnography, despite its influential role in my methodological approach.

Another affordance of critical epistemology and ethnography is that it critiques the taken-for-granted certainty of sense perception, recognizing that an object’s existence doesn’t mean definitive truth, but rather we only see through our consciousness (Carspecken, 1996). Recognizing the Euro-American roots which position our senses as tools to collect facts and moving toward a more phenomenologist positioning of senses that align with Derrida and Husserl (Carspecken, 1996), helped me re-center sensory understandings as inherently biased, subjective, and racialized (Gershon, 2019; Powell, 2008; Sekimoto, 2018). A critical ethnography provides space to consider how sensory knowledge is tied to values and norms, and I asked whose values and norms were being centered (Gershon, 2019). This aligns with sensory ethnography, which I also adopted in my work (Pink, 2015). Although sensory ethnography is most explicit in my third manuscript, which uses acoustemology (Feld, 2005) and sonification (Ballora, 2014; Hermann, Hunt & Neuhoff, 2011) to critique the sounds in the classroom, approaching my research with an attunement beyond the ocular, the mind, and the text, into senses and embodiment underpins all three manuscripts. My aim to de-familiarize the senses (Powell et. al., in press; Truman &
Springgay, 2016) and unframe habitual postures (Greene, 1995; Powell & Serriere, 2013) aligns with research in art education (Greene, 1995; Powell, 2015) and walking methodologies (Powell et al., in press; Powell & Serriere, 2016; Truman & Springgay, 2016). To put it another way, I position the senses as value-laden and contextualized (Gershon, 2019; Suomninen, 2019), and as a way of knowing that circumvents a Cartesian epistemology which separates mind from body and only prioritizes vision and words. This sensorial approach disrupts normative thinking and interrupts how sensory information is often accepted without question or acknowledgement of its subjective nature. The smells, sounds, tastes, and other intermingled perceptions of a space affects how one knows, yet researchers and educators often overlook this aspect of the senses.

In conclusion, critical ethnography, along with influences from collaborative and sensory ethnography, is a well-aligned methodological match to the central goals of my work, which aim to recognize and interrogate norms which position students and families as silent and still. A sensorial approach allows me to move away from Euro-American predilection to sight and text and aligns well with the phenomenon-rich disruptions that Science 20/20 affords. A collaborative approach mirrors the Frerian cycle of disruption, dialogue, reflection, and changing practices and positions, which Sally and I necessarily engaged in together. A critical approach underpins the whole premise of the research, which seeks to disrupt racist and deficit-aligned norms.

A review of the literature

When considering the concept map in Figure 1 (p. 8), there are two bodies of literature that underpin this dissertation: the practices of sensorial, equitable science sensemaking that disrupt norms of staying silent and still, and a cycle reflection, dialogue and praxis which interrogate these norms and move Sally and me toward more asset-aligned perspectives and practices. In this
section, I will unpack the literature on science sensemaking and the affordances of sensoriality in science learning, along with how cycles of reflection and praxis interrogate school norms, and shift educators toward asset-aligned perspectives and practices.

**Equitable science sensemaking produces students differently**

The Science 20/20 Project centers phenomenon-rich, sensorial learning that positions students and families as knowers, and invites them to productively participate to create knowledge. This is very different from more traditional pedagogies that positions students and families as blank slates, and position teacher as all-knowing sage. This section discusses scholarship around equitable science sensemaking practices that underpin the Science 20/20 Project and create productive disruptions to the norms of staying still and silent.

**Science sensemaking: History and definitions**

Science sensemaking traces back to John Dewey (1910) who considered how “reflective experiences” move between observation and theory to understand nature. This process involves noticing an inconsistency in the world, and iteratively forming hypotheses, collecting observations, building explanations, and eliminating ideas which do not align with the evidence (Odden & Russ, 2018). Dewey (1902/1990) also applied this process to learning, where he “sees the building of curriculum as inherently constructive and interactive,” (Warren & Rosebery, 2008, p. 49). Since Dewey’s “sensemaking,” the term has had a revival, appearing again in the 1980s as it applied to organizational research, artificial intelligence, and decision-making scholarship, and more recently in science education (Odden & Russ, 2018). This most recent use of science sensemaking is a reform on didactic, teacher-centered science education pedagogies,
and positions science as a practice, similar to scientists, including inquiry and argumentation of evidence (National Research Council, NRC, 1996, 2007; Vellom & Anderson, 1999). Reform-based science sensemaking pedagogy emphasizes students as knowers, where students lead explorations to build evidence and make claims (Stroupe, 2014). In addition, a reform-based science sensemaking centers argumentation and discourse (Berland & McNeil, 2010; Colley & Windschitl, 2016; Driver, et al., 2000; Haverly, et al., 2020), insisting that students productively participate in their learning. In such a space, teachers move to a co-learning role, and meaning-making is co-constructed between students (Vellom & Anderson, 1999).

Odden & Russ (2018) define sensemaking as “a dynamic process of building an explanation in order to resolve a gap or inconsistency in knowledge. These explanations are built in one’s own words through an iterative process of construction and critique;” (p. 199). They add that sensemaking means figuring something out, as opposed to finding a right answer or re-stating known facts. Haverly, et al., (2020) define sensemaking as “a proactive engagement in understanding the world by generating, using, and extending scientific knowledge within communities of practice—for all students” (p. 63) and “a process in which students co-construct their understanding of the world as they generate, use, and extend their ideas in the classroom, (p. 64). Rosebery and Puttick (1998) describe science sensemaking as “a human, meaning-making activity, a particular way of inquiring into, conceptualizing, evaluating, and representing the world,” (p. 651).

Despite different nuances in the definitions of science sensemaking, they all include five general characteristics. First, science sensemaking is a nonlinear process where students engage with an open-ended, perhaps unexpected phenomenon which they observe and test to better understand. Using this process, students gather increasingly stable evidence to build claims and find logical explanations (Buxton, 2006; Odden & Russ, 2018; Zembal-Saul, et al., 2013).
Second, science sensemaking requires a stance where students seek to understand a phenomenon rather than a “getting it right” stance (Odden & Russ, 2018). Third, engaging in science sensemaking follows a cognitive process where prior knowledge is leveraged in discourse with others to make new understandings (diSessa, 2014; Odden & Ross, 2018). Fourth, science sensemaking has a distinct discourse that centers argumentation (Lemke, 1990; Odden & Ross, 2018). This discourse can include gestures, writing, and home languages (Ash, 2004), and “science talk,” which requires students to “use their own words to express and think through their ideas about the world” (Rosebery & Ballenger, 2008, p. 4). Lastly, a science sensemaking space is different from a traditional learning space where teachers are more didactic and students work on getting the “correct” answers, (Brickhouse, 2001). Instead of engaging in science learning where the teacher is the authoritarian who validates student knowledge through initiate-response-evaluate (IRE) or “triadic dialogue” patterns (Cazden, 2001; Lemke, 1991) science sensemaking uplifts students’ voices and makes space for students to engage in science thinking with each other.

Equitable practices in science sensemaking

The science sensemaking I center in this dissertation takes up a specific strand of science sensemaking that is focused on equitable practices, such as fostering students’ epistemic agency, leveraging students’ funds of knowledge, and engaging in discourse that includes students’ home languages and multiple repertoires. This form of sensemaking recognizes the value of all students’ thinking, speaking, and knowledge, and acknowledges that teachers often value middle class, white, English-monolingual students’ ways of knowing more than students outside of this
dominant space, particularly when considering science (Lemke, 1990; Roth & Lawless, 2001; Tobin, 2006).

An equitable science sensemaking space positions students as knowers and provides students with epistemic authority, which leads to epistemic agency (Haverly, et al., 2020). This positioning allows teachers to see students as intellectual and capable in ways that traditional science education does not allow (Rosebery & Ballenger, 2008). This shift not only changes how students interact with learning science, but also what the teachers focus on, moving away from students’ behaviors toward their thinking (Haverly et al., 2020). Haverly et al (2020) observes: “as teachers made space for student noticing and discourse, they noticed shifts in epistemic authority in the classroom; ideas became public resources for collective sense making,” (p. 68). Elementary classrooms are well accommodated for this shift, since many teachers do not have expertise in science and may not feel comfortable as science authorities (Siry, 2014).

Recognizing that the classroom often centers the white norms which align to most teachers’ life experiences and understandings makes space for pedagogies that can include the often-excluded perspectives, resources, and ways of knowing of intentionally marginalized students (Hudicourt-Barnes & Ballenger, 2008). Engaging students’ lived experiences and home lives into the classroom aligns with funds of knowledge (Moll, et al., 1992). Funds of knowledge refers to “historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being,” (Moll et al., 1992, p. 133). Scholars recognize that middle class, white students’ cultures are more closely aligned with the norms of Western science (Rosebery & Ballenger, 2008, p. 4). However, when teachers leverage often excluded (i.e., non-white, emergent bilingual, low socio-economic status) students’ funds of knowledge and home languages, and use them to think about scientific matters, it provides a
powerful resource for all children (Hudicourt-Barnes & Ballenger, 2008; Lee, 1993; Roychoudhury, 2014; Warren & Rosebery, 2008).

A central component of science sensemaking is the exchange of ideas through discourse and argumentation. However, argumentation in science sensemaking, which aligns to scientific norms, does not always align with the norms and values of students’ lived experiences. Researchers note how science talks are typically “impersonal, objective, and without emotion” (Rosebery & Ballenger, 2008, p. 3), which align to “Western science and middle-class norms,” (Hudicort-Barnes & Ballenger, 2008, p. 21). The NRC (2007) recognizes that “the norms of scientific argument, explanation, and the evaluation of evidence differ from those in everyday life,” and that “children’s experiences vary with their cultural, linguistic, and economic background” (p. 186). Productive participation considers the lacuna between students’ cultural backgrounds, norms, and practices and those expected in science sensemaking spaces, and recognizes the need to include students’ ways of knowing and talking (NRC, 2007). Hudicourt-Barnes & Ballenger (2008) note: “an important aspect of science talk is allowing students’ language styles and out of school knowledge to permeate discussions” (p. 28). Lee & Fradd (2001) focus their work on the differences between students’ home languages and cultures and those of the classroom, seeking to find productive intersections and bridging gaps through science sensemaking. Productive participation considers the balance between students’ funds of knowledge and repertoires, and the norms of scientific argumentation, including “habits of mind, such as adopting a critical stance, a willingness to ask questions and seek help, and developing a sense of appropriate trust and skepticism” (NRC, 2007, p. 40). The science sensemaking approach I take up in this dissertation welcomes all forms of discourse, encouraging students to use any and all of their repertoires, both verbal and non-verbal (e.g., gestures, embodiment, drawings, objects) in a translanguating space (García & Kleyn, 2016; Gómez-Fernandez, 2019).
Sensoriality in science sensemaking

Science education research often overlooks sensoriality (Ash et al., 2009; Roehl, 2012). The little research I could find within science education about the senses focuses on the use of objects, realia, and tools, particularly within the context of language learning (Eisenkraft, 2013; Lee et al., 2016; Ünsal, 2017; Williams & Tang, 2020; Winter, 2004) and literacy (Clark, 1973; Grifenhagen et al., 2021; Luke, 1992), and within a museum learning context (Ash, et al., 2007; Ash, Tellez & Crain, 2009; Kopeczak et al., 2015; Lindemann-Mathies, 2001). However, science is often intrinsically connected to phenomenon (Pickering, 1995), and science knowledge develops through material and sensorial explorations of the natural world, often through objects and instruments (Cowie et al., 2015). Although research has shown the power of realia, artifacts, and objects in hands-on science approaches, there is little research that considers the sensory aspects of these objects (Hetherington & Wegerif, 2018; Klemm & Plourde, 2003). Here I will review the scarce research that does exist around the productivity of sensoriality in science sensemaking. Specifically, I will highlight the affordances of objects and touch for EB students, how the sensoriality of objects create different assemblages and position students differently, and lastly how objects and the senses are entangled in ways that position students as knowers and afford epistemic authority to students, shifting the roles of teacher and student.

Before diving into this research, I first want to explain my choice of words. Although the little research I have found around the senses and science phenomenon uses various terms, I use the word “sensorial” to navigate the terrain of senses and materials in science learning. ‘Sense’ terms (e.g., ‘sense’, ‘sensoriality’, ‘sensuous’) are centered in sensory ethnography (Pink, 2015; Powell, 2017; Stoller, 1997), used to critique value-neutral positions of the senses (Baker, 2019; Gershon, 2019; Howes, 2006), and are interconnected with race, racism, and whiteness (Hazel, 2014; Sekimoto, 2018). Walter Gershon (2021) uses the word ‘sensorium,’ to describe “the way a
group socioculturally conceptualizes anything that may be considered ‘the senses,’ understandings always in relation to nested and layered ecologies that strongly inform those ways of beingknowingdoing” (p. 5). My choice in using “sensorial” and other “sense” terms is intentional, to align myself with scholars who recognize the social construction of the senses (Howes, 2006; Gershon, 2019). I move away from the term “materiality” to not confuse readers with a New Materialist frame, although there are interconnections between these frameworks, and much of my work centers on the materiality of science phenomenon.

**Sensoriality and language learning**

Objects and touch help students “talk science.” The literature around the senses and objects in science highlight the affordances of objects and touch for supporting language learning. Research shows that objects, realia, and artefacts support students in their communication, both as props for their communication (Cowie et al., 2015), as well as creating an additional mode of communication (Roehl, 2012), which is tightly aligned to gestures and indexical expressions (Roth, 1999). For example, Rye et al (2012) highlights the affordances of a garden-based learning lesson where students were able to show and point to plants while discussing their learning. In this study, students were able to expand their vocabulary beyond expectations, inspired by the rich objects found in the garden. When considering the terrain EB students must navigate in school, particularly when encountering abstract concepts that are represented through signs and symbols, realia in science provides students with “a shared physical world, [which] is a fundamental and necessary condition for intelligent language production and use” (Roth, 1999, p. 55). Research in neuroscience also highlights that language students are better able to understand new knowledge if teachers include objects and multi-sensory dimensions (Taljaard, 2016). This
research substantiates the idea that objects, sensoriality, and touch are beneficial supports to learning how to “talk science” (Lemke, 1990), particularly for EB learners.

**Sensoriality, the assemblage, and re-positioning students**

Similar to the findings in my dissertation manuscripts, other studies illustrate how teachers notice something different happening when students engage in sensory, hands-on learning and can use materials to build their knowledge (Cowie et al., 2015). Although my work does not center new materialism, actor network theory, intra-actions, or assemblages (Bennett, 2010), research around phenomenon and material objects in science education often are tied to these foundational theories. For example, Roehl’s (2012) ethnographies around materials in science education consider Actor Network Theory and post phenomenology, which help move toward the embodied dimensions of material objects. Roehl (2012) describes how “experiments create a fascinating presence and configure students as witnesses of co-present phenomena” (p. 66). By shifting the lens from humans to the intra-actions between objects and humans in a more than human frame, research in this space highlights the power of objects in science education to shift the learning environment.

**Sensoriality and pedagogical approaches**

Although I do not take up Vygotsky and the power of tools, New Materialism, or other more than human frames in the manuscripts, I recognize the power of sensoriality within objects and how they re-shape the classroom environment. Centering realia, artefacts, and phenomenon often occurs in tandem with a student-centered science sensemaking approach (Klemm & Plourde, 2003). Student-centered, inquiry- and reform-based pedagogies position both the student
as knower, and the object or phenomenon as complicit in this knowing. Whereas a more didactic classroom positions the teacher as knower, with the blackboard positioning the student as a recorder (Roehl, 2012), a science sensemaking classroom positions the phenomenon as something to be understood, sensed, and examined by the students. In an equitable science sensemaking classroom, objects and phenomenon open up space for open-ended student wondering that is tied to their lived experiences and interests. This conflicts with didactic norms of schooling, where students are positioned as blank slates or empty vessels that teachers can deposit knowledge into, similar to Freire’s (2000) banking pedagogy. Blades (2001) describes the outcome of such an approach to science learning:

*The child does not touch, for example, a willow tree and the healing power of its bark. No one marvels at the struggle of dandelions pushing through concrete or studies the ancient use of herbs: That's not science. After more than a decade of education students can faithfully recite the mechanisms of gymnosperm (evergreen) reproduction and taxonomy but have no clue which parts of which evergreen can be used to make a healing tea or even how to tell the difference between a Douglas fir or a white pine - or why this might be important to know in everyday life.* (p. 72)

When teachers center the sensoriality of science phenomenon, along with an equitable science sensemaking approach, students are encouraged to touch, notice, and wonder in ways that connect to students’ prior knowledge, lived experiences, and own values. Often times this approach to science sensemaking affords greater insights from students, including those who have special education needs (Essex, 2020). The main difficulty in this approach is to resist the school norms of teacher-led order and control, where students are still and quiet (Blades, 2001; Essex, 2020). Research confirms that an equitable, phenomenon-centered approach to science sensemaking expands students’ discourses, as they can leverage materials to communicate (Ash et al, 2009; Essex, 2020).

Science sensemaking is a fundamentally different approach to teaching than is traditionally upheld in elementary classrooms because the former positions students as knowers,
and the latter does not. Objects used in science sensemaking intertwine students’ sensoriums, lived experiences, and discourses with the Western science curriculum. The critical frame that underpins my work goes beyond the phenomenon-rich science sensemaking approach, which still positions the senses as neutral purveyors of Truth, to recognize that the sensorial sensemaking that occurs in a progressive science classroom is racialized, contextualized, and depends on individual sensoriums (Carspecken, 1996; Gershon, 2019; Suominen, 2019).

Moving toward asset perspectives: Cycles of dialogue, reflection, and praxis

My research assumes that a Freirian-like cycle of dialogue, reflection, and praxis can productively move Sally and I toward asset-aligned pedagogies and practices. This section shares a review of the literature on professional development (PD) that moves educators toward asset-aligned practices. Specifically, I define asset and deficit perspectives, critical reflection, critical consciousness, and how an asset perspective aligns with inquiry, humanizing pedagogy, funds of knowledge, and other critical pedagogies. Lastly, I discuss the role of teacher and researcher collaboration in shifting asset perspectives.

Asset and deficit perspectives: Definitions and histories

The term “asset” originates from the Old French, asseter, that roughly translates into equity—property and other valuables that are transferred after marriage (Hall, 1947). In fields such as business and economics, the term retains this meaning. In education, an asset perspective moves away from tangible wealth toward resources found within the character, knowledge, and lived experiences of students and families. Rosebery and Ballenger (2008) write: “All children, regardless of their first language or educational background, come to school with rich experiences
of the world and ways of accounting for them that can be used as resources in teaching and in learning science” (p. 10). Francesca López (2018) similarly aligns an asset frame with viewing students’ lived experiences and cultures as strengths, defining the practice of teaching with an asset-based pedagogy as “a bridge that connects the dominant school culture to students’ home and heritage culture, thus promoting academic achievement for historically marginalized students” (p. 9).

Research shows that teachers do not often position students and families with an asset perspective, particularly if they are not white, English-dominant, and/or middle-class (Bancroft & Nyirenda, 2020). Instead, educators often perceive students and families with deficit frames (Valencia, 1997). A deficit perspective positions students as failing because of internal deficiencies within themselves or their culture, race, ethnicity, social class, or other group identity, rather than considering institutional factors (López, 2018; Valencia, 1997). Valencia (1997) names six characteristics of deficit thinking: blaming the victim, oppression, pseudo-science, temporal changes, educability, and heterodoxy (p 7-9). Educational theories are rife with deficit perspectives, most notably the culture of poverty theories that position students’ deficits as tied to their social class and race (López, 2018; Valencia, 1997). Norma González (2008) aligns teachers’ deficit perspectives to a conflation of cultural difference with cultural deficiency.

Deficit positionings are ubiquitous in education, where teachers and researchers implicitly position students as less than and in need of being fixed. Eve Tuck’s (2009) critique of “damage-centered” research asks communities, educators, and researchers to critically examine the way Native communities are frequently researched in ways that only document their pain, hurt, and brokenness. Carter-Andrews and colleagues (2019) apply this idea to pedagogy, interrogating the way teacher educators perpetuate a deficit, damaged-centered approach in their efforts to prepare pre-service teachers to teach in ways that are equitable and socially just. I
include these examples of damage-centered work to highlight how we as teachers and researchers are deeply steeped in deficit perspectives, despite attempts to escape this frame. Tuck (2009) and Carter-Andrews et al.’s (2019) work highlights the ways in which asset and deficit perspectives and pedagogies are not binaries but entangled.

**Critical reflection and critical consciousness**

Critical reflection and critical consciousness are fundamental to having asset-aligned practices and perspectives (Aronson & Laughter, 2016; Carter-Andrews et al., 2019; Carter-Andrews & Richmond, 2019; Chen & Mensah, 2018; Gay & Kirkland, 2003; López, 2018). Critical reflection is often defined as the act of questioning one’s own perspective of others and the larger institutional systems in which we operate. This includes reflections about one’s lived experiences, identities, privilege, cultural norms, and implicit biases in conversation with larger systems of racism, xenophobia, patriarchy, heteronormativity, and other oppressive systems (Carter-Andrews et al., 2019; Civitillo et al., 2019; Gay & Kirkland, 2003; Howard, 2003; Nieto, 2000).

**Critical reflection.** To enact asset-aligned practices, educators must understand their own lenses on the world (Expósito & Favela, 2003). Howard (2003) states that critical reflection “requires one to seek deeper levels of self-knowledge, and to acknowledge how one’s own worldview can shape students’ conceptions of self,” and that it “forces the individual to ask challenging questions that pertain to one’s construction of individuals from diverse racial, ethnic, and cultural backgrounds” (p. 198). Kressler (2020) similarly positions critical reflection as an act of disruption, and as a fundamental component of culturally relevant education. Self-reflection creates an opportunity to interrogate our implicit norms and biases (Carter-Andrews & Castillo,
Many authors include critical reflection or awareness as a key component to culturally responsive, sustaining, and/or relevant pedagogies (Aronson & Laughter, 2016; Chen & Mensah, 2018; Gay & Kirkland, 2003; Howard, 2003; Johnson & Fargo, 2014; Kressler, 2020; Ladson-Billings, 1994). Parker Palmer (2007) connects reflection to identity, stating “we teach who we are” (p.2) and continues:

Teaching, like any truly human activity, emerges from one’s inwardness, for better or worse. As I teach, I project the condition of my soul onto my students, my subject, and our way of being together. The entanglements I experience in the classroom are often no more or less than the convolutions of my inner life. Viewed from this angle, teaching holds a mirror to the soul. If I am willing to look in that mirror and not run from what I see, I have a chance to gain self knowledge—and knowing my students and my subject. In fact, knowing my students and my subject depends heavily on self-knowledge. When I do not know myself, I cannot know who my students are. I will see them through a glass darkly, in the shadows of my own unexamined life – and when I cannot see them clearly, I cannot teach them well. (p. 2-3)

Identity and asset perspectives help us interrogate deficit perspectives, yet teachers are not often reflective about these entanglements (Carter-Andrews et al., 2019). When educators reflect on their experiences, instead of responding in self-defense (Palmer, 2007), they are more likely to productively interrogate deficit perspectives and teach in ways that are asset-aligned (Gay & Kirkland, 2003; López, 2018).

Beyond reflections about privilege, experiences, and identity, critical reflection also questions institutional, systemic, and societal norms which reinforce white supremacy (Bartolomé, 2004; López, 2018; Sleeter, 2017; Watts, Diemer, & Voight., 2011). Lilia Bartolomé (2004) writes that teachers are “uncritically accepting the status quo as natural” (p. 100). Teachers and educational institutions are predominantly white, and new teachers joining these spaces are rarely taught to question the implicit norms in their schools (Chen & Mensah, 2018; Expósito & Favela, 2003; Sleeter, 2017). Annamma and Morrison (2018) write: “For educators to engage in a
radical critique, they must understand how societal inequities are (re)produced in dysfunctional learning ecologies and how shifts in their own consciousness and understanding of learning can disrupt intersectional injustices” (p. 10).

**Critical consciousness.** Most definitions of critical consciousness highlight two dimensions: a continuous movement between awareness and action, and a method that leads to becoming (Cervantes-Soon, et al., 2017; Jemal, 2017). Essentially, critical consciousness seeks to recognize the oppressive ocean one is surrounded by, and then moves toward actions to liberate oneself from that oppression (Freire, 2000). This process of liberation creates space for a new reality. Alvaro Vieira Pinto’s definition, as cited in Freire (2000) states: “Consciousness is in essence a ‘way towards’ something apart from itself, outside itself, which surrounds it and which it apprehends by means of its ideational capacity. Consciousness is thus by definition a method, in the most general sense of the word” (p. 69). These definitions align with the idea of constantly becoming “…to begin always anew, to make, to reconstruct, and to not spoil, to refuse to bureaucratize the mind, to understand and to live life as a process—live to become… (Friere, 1993, p. 98).

Becoming through critical consciousness is challenging, given how oppressive systems are normalized and often invisible. Power-knowledge relationships are often hidden in the myths of neoliberal ideologies of meritocracy, which provide reasons for inequities at the systemic level. (Freire, 2000; Giroux & Giroux, 2006; Giroux, 2010; Shor & Freire, 1987). However, before disrupting these systems, first we must see them. Although there is no easy strategy to move towards awareness, becoming conscious of hidden oppressive systems is a first step to critical consciousness. Shor & Freire (1987) write: “the moment you begin to seek a scientific understanding of your naivete, you are no longer naïve […] you’ve made the first transition to critical consciousness, seeking a systematic understanding of your impressions” (p. 20). This
awareness begins a cycle of praxis and dialogue to continually expand examination and critique of the ways oppression hides in the world around us (Freire, 2000; Macrine, 2020; Sleeter et al., 2004).

**Asset-aligned pedagogies.** Critical consciousness allows educators and researchers to recognize and interrogate deficit lenses and move toward more asset-aligned perspectives and teaching (López, 2018). An asset-aligned stance, in turn, creates space for more equitable, asset-aligned teaching practices, which is an umbrella term I use to define equitable teaching practices that include culturally responsive teaching (Gay, 2000), culturally relevant pedagogy (Ladson-Billings, 1995), culturally sustaining pedagogy (Paris, 2012), and humanizing pedagogies (Bartolomé, 1994). Although I will not go into depth in these various pedagogies, I will highlight some aspects of asset-aligned pedagogies that are of particular importance to the dissertation, including: 1) welcoming students’ and families’ culture, language, and knowledge; 2) interrogating culture as unique and not monolithic; and 3) constantly becoming through humanizing pedagogy.

**Welcoming culture, language, and knowledge.** The notion that students’ and families’ cultures, identities, languages, and knowledges are welcomed resources to be leveraged in school learning is central to an asset perspective (López, 2018; Rosebery & Warren, 2008). Darder (2002) refers to this as critical bicultural pedagogy, and it is a central tenet behind other critical pedagogies (Gay, 2000; Ladson-Billings, 1995). Underlying this approach is the assumption that students and families, regardless of race, ethnicity, socioeconomic status, language, or any other aspect, are not broken. López (2018) notes that schooling has a history of erasure and othering, “yet it is the students who are described as deficient rather than the schooling practices they endure” (p. 25). Educators often blame the student when they fail, and take credit when the student succeeds ( Valencia, 1997). When educators have critical consciousness and an asset
perspective, they move away from positioning the student as deficit, failing, and in need of saving, which stems from a culture of poverty frame (Valencia, 1997), toward seeing students as holding valuable resources and recognizing the systematic way education can limit this success.

**Resisting flattening culture.** Another important aspect of asset-aligned pedagogies is to resist the temptation to position students as part of a monolithic culture (Gutiérrez & Rogoff, 2003; López, 2018). Gutiérrez & Rogoff (2003) warn against positioning cultural regularities as static traits, and instead recommend highlighting the ways people vary in traits and over time. Mary Catherine Bateson (2000) reminds us “[t]he encounter with persons, one by one, rather than categories and generalities, is still the best way to cross lines of strangeness” (p. 81). Essentializing others aligns with an either/or binary that seeks to simplify the world around us (Ladson-Billings, 2000; 2003). Gloria Ladson-Billings discusses this in her work around epistemology and CRT, considering how “all culture is local (2003, p. 6), and that “the dominant imagination constructs a mythical solidarity (2000, p. 262). Although it is possible to perceive others in essentializing ways through an asset-aligned perspective, when educators seek to understand rather than evaluate students and families, it makes more space to complexify categories and resist predefinitions (Suominen, 2019).

**Becoming through humanizing pedagogy.** “Schools are a dehumanizing space” (González, 2018, p. 122). As we become aware of our deficit perspectives and individualized, systemic dehumanizing practices, we can more easily interrupt them and move toward humanizing practices (Bartolomé, 1994; 2004). Thus, centering asset perspectives entails centering humanizing pedagogies, and vice versa (Carter Andrews et al., 2019; Johnson & Fargo, 2014; López, 2018; Rosebery & Warren, 2008). Critical consciousness and a humanizing pedagogy require people to see themselves and others as subjects and not objects, and for people
to be humble, loving, and critically aware that they are not better, nor know more than someone else—particularly when considering the lived experiences of those whose realities are often marginalized and ignored (Freire, 2000; hooks 2001). “No one can be authentically human while he prevents others from being so. Attempting to be more human, individualistically, leads to having more, egotistically, a form of dehumanization” (Freire, 2000, p. 85-86).

Asset perspectives and teacher-researcher relationships

Given that much educational research still resides in Euro-American epistemologies that resist complexity and force people into static categories (Ladson-Billings, 2000; 2003), it is unsurprising that the literature on asset and deficit perspectives positions these constructs as binary. My research with Sally highlights how we both held and still hold asset and deficit perspectives which constantly vacillate (Brown, 2019). Recognizing that we never “arrive” at an asset perspective but must always interrogate our positionings has implications for the teacher and researcher roles themselves.

Most studies about interrogating deficit perspectives center pre-service teachers, and do not often position the researcher as a co-collaborator in this process (Bancroft & Nyirenda, 2020; Penuel, 2017). Although there are examples of teacher educators including their own position in this process (e.g., Ohito, 2019), most work on PD at the in-service level largely ignores the role of researcher, despite knowledge that collaborative PD is effective (Bancroft & Nyirenda, 2020). This is contrary to critical consciousness, where teacher and learner are positioned as equals, not subject and object (Freire, 2000; hooks, 1994). To model an asset perspective and humanizing approach, researchers should position teachers as competent and knowledgeable, and engage in a
process that helps both researcher and teacher learn, reflect, and change their practices (Bottoms et al., 2015; Gray et al., 2021; NASEM, 2022; Zembal-Saul et al., 2020).

A recent review of the literature in science education indicates that most research positions the subject (often pre-service or in-service science teachers) in ways that are deficit-aligned (Gray et al., 2021). A few researchers have called for a new approach to PD which moves beyond a post-positive, interventionist approach that positions the researcher as all-knowing, to an asset-aligned, humanizing, collaborative approach that focuses on partnerships for both researcher and teacher to learn together (Johnson & Fargo, 2014; Penuel et al., 2015). Bill Penuel and colleagues’ (2015) work on joint partnership and Luke Lassiter’s (2005) work on collaborative ethnography provide alternative approaches to equity research. In their work, interrogating perspectives and practices are done in collaboration where both researcher and participant are placed on equal footing in mutual ongoing reflection and dialogue. Sustained partnership between researcher and educator is an important component to create long-lasting changes in practices, particularly when focused on asset-aligned pedagogies and stances (Penuel, 2017).

Conclusion

When I was a child, I had poor eyesight, but didn’t realize it. My drawings and vision of trees mirrored most illustrations, with large fluffy green blobs surrounding tree trunks. In first grade I got glasses. I remember driving home with my new vision, yelling in excitement: “I can see the leaves on the trees!” The whole world appeared different—crisp, with lines I didn’t know existed until that moment. After my new vision, my drawings of trees included each individual leaf.
There are moments when we can see the world through a new lens due to new understandings of reality.

The three manuscripts presented in this dissertation explore ways to sense with new, asset-aligned lenses, shaking both myself and Sally into awareness through the sensoriality of science sensemaking. My work adapts practices in the arts which unframe and de-familiarize how we sense and exist in the world (Greene, 1995; Powell et al., in press; Powell & Serriere, 2013; Truman & Springgay, 2016), and applies these practices to science sensemaking to uplift the dangers of subjective meaning-making and move toward critical consciousness. The first manuscript interrogates how families are positioned as still and silent, often engaging with teachers coming to the classroom, looking, listening to the teacher, and leaving. This manuscript summarizes a three-year critical ethnography, where Sally and I interrogate our deficit perspectives of families and each other and reflect on the productivity of being with families while engaging in sensorial sense-making. The second manuscript shares a case study around touch in science sensemaking, where Sally and I interrogate our deficit perspectives and positioning of student touch, leading to more expansive practices and engagement. The third manuscript considers the sounds of a science sensemaking classroom, sharing a tool that abstracts classroom sound to better disrupt its subjective, deficit nature. Each manuscript explores different approaches, but all three disrupt school norms that position students and families as still and silent by engaging in sensorial, equitable, science sensemaking and reflection and action, leading to expanding, asset-aligned perspectives and practices.
Coda

Since this dissertation chapter has been written, my thinking and discussion about aspects of this work have continued to evolve. One notable shift not addressed in this work is a reconsideration of the ways in which my work encompasses both ethnography and participatory action research. This distinction is made more thoroughly in Chapter 2, but is summarize here briefly. Although what counts as ethnography is blurred, especially across disciplines (Hammersley, 2006), it is possible that scholars may not consider my work a “true” ethnography or critical ethnography.

Critical ethnography centers a critique of a larger system (Kincheloe & McLaren, 1994). Although my research is driven by critique of racist and deficit norms within larger systems of education, both at the elementary and academic realms, my research focuses on Sally and my individual transformations. Thus, although critical ethnography informed my work, I also recognize how my work does not fully encapsulate it. In terms of the larger field of ethnography, one possible critique of how my work does not align with ethnography is that it does not center culture. As my research moves toward reflexivity, and Sally and I engage in cycles of reflection and action, we move toward transforming our perspectives and practices. This transformation refocuses my research away from an observation of Sally’s culture. Thus, I moved toward Participatory Action Research (PAR; Jordan, 2008) practices over time. As I argue in Chapter 2, I acknowledge this shift away from ethnography, while also recognizing the ways in which ethnography continued to inform my practices.
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Chapter 2: Manuscript One

From Look, Listen, and Leave, to Sense, Share, and Stay: Interrogating Deficit Perspectives of Families with Critical Frames and Science (Sense)making

Introduction

“This is amazing! I’ve never seen anything like this!” Aidan’s older sister exclaims as she enters Sally Matthew’s classroom. Families sit around a big table creating Settling Jars – mesmerizing jars filled with glue, water, and glitter. Brothers, sisters, mothers, fathers, aunts, uncles, grandparents, and other family members pour glue and water into jars, then shake, stir, and carefully drop glitter inside with the help of the 2nd grade children who had spent weeks investigating liquids and their properties. Families speak in Spanish, English, body language, and gesture. The evening lingers on until there are a handful of families sitting around the large table with Sally and me. One older brother jokes with Sally, then checks in on his younger brother’s behavior in class. A mother eventually asks about her son’s reading, and Sally shares resources she sends home with the mom. We laugh and relax. After everyone has left, Sally and I reflect on the night, agreeing that it felt more like the end of a dinner party than an open house—that feeling when acquaintances have left, and only close friends and family remain.

The family engagement event described above marks a significant shift in how Sally and I had previously engaged with families. In Sally’s Open House events in the past, as well as my own events as a former teacher, families entered the room, looked around, listened to us as we informed them of our classroom practices and what they could do to support learning at home, and left. On this night, something different happened. By sitting and making together, touching bottles, and pouring glitter and liquids, a new space emerged that made room for families and Sally to share, laugh, and talk in a way that disrupted typical norms between families and schools. How did we get here? This paper describes how Sally and I disrupted norms of family engagement to expand towards more asset-aligned perspectives and practices through
phenomenon-rich engagement and the sensoriality of science sensemaking. Central to our work is a tangled cycle of dialogue, reflection, and changing practices, which changed how we were/are and our perceptions of families, each other, and ourselves.

This paper begins with a rationale around why we should engage differently with families, sharing the thesis and research questions of my study. I then briefly review the literature on school-family partnerships within science education and across linguistic and cultural landscapes. I introduce my conceptual and theoretical frameworks, providing a visual representation of my work, and introducing conscientização, praxis, and becoming (Freire, 2000), Critical Race Theory (Bell, 1987), and sensoriality (Gershon, 2019; Sekimoto, 2018). I then share my methodology, explaining how this critical ethnography developed over time. I devote ample space to my findings, where I unpack how 2nd grade teacher, Sally Matthews, and I engaged in cycles of reflection and action to reconsider each other and family engagement. I outline four large movements of Sally and my relationship over time: 1) evaluating, 2) seeking to understand, 3) collaborating, and 4) becoming. In the discussion that follows, I answer my research questions, highlighting how affordances of sensoriality and praxis shifted our perspectives and practices as we engaged with families. I conclude with limitations and implications.

Why this work matters

Strong partnerships between families and teachers lead to higher student academic success, particularly when families and teachers span cultures and languages (Bajaras-López & Ishimuru, 2020; Epstein, 1995; Henderson & Mapp, 2002; Jeynes, 2005). Epstein’s (2010) Family-School-Community Partnership framework acknowledges the need for teachers to move beyond one-
directional communication and make space to learn from and build relationships with families. However, even this model leans on “best practices” and does not significantly change the underlying assumptions that position nondominant families, such as those who are EB and Latine, as deficit (Ishimaru & Bang, 2016). Most family engagement research implicitly prioritizes school norms, implying that families need to learn how to adapt to schools (Baquedano-López, 2021; Barton, Drake, Perez, et al., 2004).

Although less prevalent, some literature exists around family engagement that interrogates “normative parent involvement literature” and how power, race, language, ethnicity, and gender are central to whose definition of family engagement are enacted in schools (Bang, Montaño Nolan & McDaid Morgan, 2018; Baquenado-López, 2021; Fine, 1993; Ishimaru & Bang, 2016). Researchers recognize the need to position families through asset-based lenses (Auerbach, 2007; Bajaras- López & Bang, 2018; Blair & Haneda, 2021; Jiménez-Castellanos, Ochoa & Olivos, 2016; López & Ishimaru, 2020), and reassess the values implicit in the status quo version of family engagement (Fine, 1993; Kulago, 2016). There is a need for research that shrewdly questions how seemingly equitable family engagement practices still reify hierarchical norms, and that considers what happens when “we move from individualistic, deficit-based approaches toward families to tapping nondominant parent, family, and community knowledge and collective capacities in theory, policy, and practices of learning and systems of change for educational equity” (Bajaras-López & Ishimaru, 2020, p. 40). However, it is challenging for teachers to interrogate their deficit perspectives of families and normative, narrow, one-directional practices within family engagement (Baquedano-López, Alexander & Hernandez, 2013; Lareau, 2000; Sengupta-Irving et al., 2021; Valencia & Black, 2019). This study adds to the research by explicitly interrogating white, English-dominant teacher’s and researcher’s deficit perspectives around families and family engagement. Centering our own deficit perspectives and
assuming successful partnerships are stymied by our own positions imply that families are not broken, but instead that school norms and deficit perspectives play roles in separating school and home.

At the heart of this work is an attempt to become a researcher and educator that looks outward with a humanizing, asset-aligned gaze, and inward with humility and self-reflexive criticality to disrupt dehumanizing ways of being. The 2nd grade teacher I work with, Sally Matthews, and I seek to do this despite our immersion in systems that do the opposite, both in higher education and k-12 schooling. A recent report from the National Academies of Science, Engineering, and Medicine (NASEM, 2018) highlights the need for research, including longitudinal, qualitative approaches, that better understand how to foster the asset-aligned perspectives teachers need to have to create equitable science sensemaking spaces with EB students and families. Specifically, NASEM (2018) calls for research that prepares teachers to enhance family/community engagement and build “deep and lasting partnerships with families of communities of ELs that have positive impacts on those students’ STEM learning” (p. 312).

This paper shares findings from an ethnographic case study between Sally and me in our efforts to disrupt and change our practices engaging with families through iterative cycles of dialogue, reflection, and action. By centering hands-on, phenomenon-rich science inquiry and making, I explore the over-looked affordances of science inquiry in disrupting norms of family engagement. This work contributes to the field in several ways: 1) it provides an example of productive researcher-teacher and researcher-teacher-families partnerships that leverage the sensoriality of science sensemaking to build community, foster asset perspectives, and enact equitable practices, 2) it is done in an important but often under-researched context, providing valuable insights into how to build partnerships in communities situated in a Latino Threat Narrative context (Chavez, 2013), and 3) it moves away from dominant Eurocentric, Cartesian
ways of knowing which privilege words and the mind, and makes space to consider embodied
cognition and sensory ways of knowing within STEM-centered family engagement.

The research questions which guide this work are: How can educators and researchers
productively interrogate deficit-aligned norms of science-centered family engagement with
Latine, EB families? How does the sensoriality of science sensemaking create space to de-
familiarize norms of families as looking, listening, and leaving? What are the affordances of an
ethnographic and problem-posing approach to teacher/researcher collaboration which centers
humility, self-reflexivity, and criticality?

Family engagement across the literature

What do we know about family engagement practices across language and culture, and within the
case of science sensemaking? This section briefly reviews the literature, highlighting the need
for new approaches to interrogate deficit positioning of students and families, particularly within
an EB, Latine context.

School – family partnerships across language and culture

When considering the extensive body of literature around family engagement with
families who are Latine and EB, researchers recognize the need to move away from traditional,
one-directional engagement that implies families lack resources and care (Baquedano-López,
Alexander & Hernandez, 2013; Baquedano-López, 2021; Jiminéz et al., 2016; Valencia. & Black,
2019). Critical researchers examine the underlying assumptions behind how families are engaging
in schools (Barton et al., 2014; Fine, 1993), recognizing that “non-dominant families have been
regulated to participation in school-centric ‘parent involvement’ activities” and thus teachers have
overlooked their “untapped expertise” (Barajas-López & Ishimaru, 2020, p. 38). Much of the literature around family engagement with Latine communities encourages asset-aligned or strengths-based approaches to engagement (Auerbach, 2007; Barajas-López & Ishimaru, 2020; Blair & Haneda, 2021; Hong, 2011; Ippolito, 2010a; 2010b; 2015; López, 2001; Olivos, 2006; Pushor & Murphy, 2004; Warren et al., 2009). These approaches leverage families’ cultural funds of knowledge in student learning (Moll et al., 1992), and position families as resources.

Epstein’s (2010) Family-School-Community Partnerships framework is a largely cited resource, highlighting how home, school, and community influences overlap, and sharing various ways educators can engage with families, moving toward two-directional engagement. However, Epstein’s (2010) and Henderson & Mapp’s (2002) work uncritically center school-centric family engagement practices, rather than beginning with family and community ecologies (Bang et al., 2019; Barton et al., 2004). Bang et al (2019) state: “Family engagement paradigms largely remain a one-size-fits all assimilative demand modeled after White, middle class forms of engagement and practices” (p. 3). Work such as the Family Leadership Design Collaborative (Ishimaru & Bang, 2016), the Empowerment Model (Delgado-Gaitan, 1994), and the Ecologies of Parental Engagement Network (Barton et al., 2004) more carefully consider power, dominance, and whiteness in their work. Kulago’s (2016) work similarly interrogates the Eurocentric value system implicit in family engagement frameworks, considering how indigenous value systems value relationships in more extensive and productive ways.

Understanding that family engagement is socially constructed and often privileges white, middle-class norms is important to move toward asset-aligned perspectives and practices (Auerbach, 2007). Typical family engagement practices position teacher as all-knowing expert, and family as in need of intervention and learning (Barajas-López & Ishimaru, 2020). Beyond positioning, there are complex motivations, identities, and tactics that families use to negotiate
relationships. For example, Fabienne Doucet’s (2011) work examines how Haitian families resist bridging school and home. Underneath engagement that entails families looking, listening, and leaving during family engagement events are passive deficit notions that maintain the status quo (Bajaras-López & Ishimaru, 2020, p. 39). An important foundation to strengths-based engagement approaches is holding an asset perspective of families.

Lilia Bartolomé (1994) argues that inequities in education cannot be solved through implementing high-leverage practices alone, but rather we (teachers and researchers in dominant spaces) need to interrogate our own deficit perspectives of students and families who are intentionally minoritized through de-humanizing pedagogies. This perspective is taken up in science education spaces as well (Madkins & McKinney de Royston, 2019), where there is less robust critical research on dehumanizing and racist perspectives and practices (Parsons, 2014). Teachers struggle to position families with an asset perspective, particularly if they are not white, English-dominant, and/or middle-class (Bancroft & Nyirenda, 2020). Instead, educators often perceive students and families with deficit frames, positioning families as deficient, unsupportive, uncaring and inadequate (Lareau, 1987; López, 2018; Valencia, 1997). Educational research within academia has similarly positioned families in deficit ways. For example, culture of poverty theories attribute poor student success to social class and race, instead of systemic inequities (López, 2018; Valencia, 1997). Norma González (2008) aligns teachers’ deficit perspectives to a conflation of cultural difference with cultural deficiency.

**Science education and family engagement with Latine families**

When considering family engagement across language and culture within science education, most research either focuses on how experiences at home influence students’ success
in science (e.g., Baker & Stevenson, 1986; Davis & Maximillian, 2017; Peng & Hill, 1994; Schibeci & Riley, 1986), or how to leverage students’ funds of knowledge to bridge to science learning in the classroom or informal settings (Basu & Barton, 2007; Barton et al., 2004; Lee & Buxton, 2010).

Within the field of science education, scholars have studied what it means to “do science” in schools and with families in ways that unsettle white, Eurocentric, Cartesian epistemologies (Basu et al., 2007; Bang & Medin, 2010; Bang et al., 2017; 2019; Barton et al., 2004; Goldman, Luce, & Vea, 2018; Haverly et al., 2020; Ishimaru & Bang, 2016; Marin & Bang, 2018; Marin, 2019; 2013; Medin & Bang, 2014; Nasir et al., 2006; Warren et al., 2001). This scholarship is driven by the fundamental question of whose culture dominates science education and builds from scholars in human development such as Michael Cole, Barbara Rogoff, and Fred Erickson. Within science education, this requires a critique of the norms for what counts as engagement and learning in science (Nasir et al., 2006). This critique has enabled scholars to desettle norms of family engagement, particularly with and within science. There are ample examples of how such a critique informs practices. For example, Megan Luce and colleagues (2017) work explored resources that leveraged family practices. Ananda Marin’s work on family forest walks (Marin & Bang, 2018; Marin, 2019; 2013) departs from typical science education and family research and moves toward building knowledge with families. Other scholars (Goldman, Luce, & Vea, 2018; Ishimaru & Bang, 2016), similarly start from a family perspective, questioning what counts as science knowledge and learning. This research has not only helped me critique norms in family engagement, but also highlights gaps in my own research which starts with Sally and I, rather than families. Barton et al., (2004) conceptualize “ecologies of parental involvement” to capture the nuanced and interconnected nature of family engagement, presenting it as a “dynamic,
interactive process in which parents draw on multiple experiences and resources to define their interactions with schools and among school actors” (p. 3).

An area of science education family engagement relevant to my work considers how sensorially-rich science inquiry and making opens up space for new teacher-family collaboration. In Buxton, Allexsaht-Snider & Rivera’s (2013) work, investigations around Alka Seltzer rockets with EB students, families, and teachers built trust and opened up discussions in ways that repositioned power dynamics between teacher and family. Buxton et al., (2013) found this new space led “to shifts in how the parents and teachers relate to each other in the school context” (p. 257). Siegel et al., (2007) similarly found that family interactions changed and discussions expanded when families in a science inquiry project around buoyancy moved from prediction to testing. The authors reflected that “open ended activities […] encourage more collaborative discussions about science between adults and children” (p. 1464). Rautio & Winston (2013) describe how playing affords an opportunity for experiencing improvisation and being human.

Although there are few studies that consider the affordances of science sensemaking in family engagement, the few studies highlighted here suggest that sensorial rich inquiry creates a productive space to interrogate teacher/family hierarchies—“spaces that foster dialogues, integrating families’ and community’s funds of knowledges, including dark knowledge” (Kayumova et al., 2015, p. 273). Within a phenomenon-rich inquiry space, families have space to speak, play, and be in ways that resist deficit norms and positionings.
Frameworks: Combining criticality and sensoriality

Who one is determines how and what one knows ways of being so ordinary that they feel natural in spite of multiple layers of mediation. Yet how one is affects not only learning but also movement in relation to others, ecologies, ideas, ideals, and other processes. (Gershon, 2019, p. 150).

Fundamental to the ontologies, epistemologies, and axiologies underpinning my work is an intent to interrupt the insidious nature of white supremacy to position white, Eurocentric, and other dominant positions as good and normal, and all other ways of being as bad and abnormal (Kress, Mallot & Porfilio, 2012; Duncan, 2005). I define “white supremacy” as the system that intentionally and systematically privileges dominant groups (white, English-dominant, heterosexual, high social and economic status, male, etc.), divides white people from Black, Indigenous and People of Color (BIPOC), and dehumanizes people outside of the dominant group (Jayakumar & Adamian, 2017; Okun, 2021). I recognize this system even within the medium and context I write, and seek to name, recognize, and interrogate these ways of being, systems of knowing, and value-laden norms, while acknowledging the likelihood of slipping back into whiteness and settlerism (Bang et al., 2019).

Ontologies are intermingled with epistemology and the senses; “the contexts in which our knowledges are born and raised, and the sensuous are irrevocably embedded in the epistemological as it is in the ontogenic” (Gershon, 2019, p. xv). When considering the contexts in which my own knowledge has been born and raised, along with Sally Matthew’s contexts, they are largely white, Western, and replete with dominant positionalities. This ties to our epistemology, or “system of knowing” (Ladson-Billings, 2000, p. 257), which is similarly embedded in Cartesian roots of enlightenment, a separation of mind and body, and a severing of self from other (Ani, 1994; Ladson-Billings, 2000, 2003). There is a need to unsettle such onto-epistemologies in larger fields of science education (Bang et al., 2012) and early childhood
education (Salazar Pérez & Saavedra, 2017). My work centers on becoming something else—moving toward asset-aligned perspectives and practices, and positioning the “other” not as object, but as subject, and a collaborating, partnered subject at that. Given this focus, I require theoretical underpinnings that seek to critique dehumanizing, othering norms and deficit perspectives, and move toward unending, humble, and self-reflexive practices that lead toward critical consciousness and becoming in ways that are humanizing and asset-aligned. Building from scholars who have similarly centered sensoriality as a way to disrupt Eurocentric thinking (Gershon, 2019; Sekimoto, 2018; Suominen, 2019), as well as those who critique dominant Euro-American epistemologies (Ladson-Billings, 2000), I center conscientização (Friere, 2000) and Critical Race Theory (Bell, 1987; Delgado, 1995).

In this section I will share a conceptual framework for the study. I will discuss Freire’s (2000) conscientização, including discussion of problem-posing pedagogy and becoming. I will then unpack how CRT (Bell, 1987) underpins the study, with a disruption of whiteness and deficit norms being center in this work. Lastly, I will connect sensoriality with critical frames, highlighting how rethinking with the senses and criticality creates space for productive interrogation of deficit engagements with families.

**Conceptual framework**

Central to my work is disrupting deficit norms that position families as deficient, neglectful, and in need of tutelage. Figure 2-1 represents a conceptual framework of this study. The box on the left of the map represents the disruptions that provoke productive interrogation of deficit perspectives and practices through cycles of reflection and action (praxis). The black box in the top left represents typical school norms of family engagement, where families look at
student work in the classroom, listen to the teacher as they describe ways to support students at home, and soon after leave the space. Implicit assumptions behind these norms are that the family needs to align their values to the school in a unidirectional, unexamined way, and that families are in need of the teacher’s help for how to best support their children.

The gray box underneath the black box represents a disruption to school norms, where instead of looking, listening, and leaving, families are invited to engage with the teacher in sensorial sensemaking. Here families sit down alongside the teacher and engage in making and sensing. This makes space for families to share more about themselves and to stay and be with the teacher. Shifting from talking at families to being with families also changes the hierarchies, and to some extent, the power dynamics in the space. When the teacher moves toward a stance of listening and learning from families, the underlying assumptions about whose voice matters also changes. These changes significantly change how the space is felt and sensed, which may also

Figure 2-1: Conceptual Framework for Manuscript 1
change how comfortable teachers and families feel in the (Ahmed, 2007). While this approach disrupts a deficit-aligned norm of family engagement, the school norms of look, listen, and leave, similarly influence sensorial family engagement. These disruptions provide rich opportunities for teacher and researcher to reflect on their perspectives of families and family engagement, represented by the top arrow. The image to the right which is both a pair of glasses and two bodies represents how teacher and researcher view families, family engagement, and each other with both asset and deficit perspectives. When engaging in dialogue with each other, these reflections can lead to new ways to engage with families and each other (actions) that are increasingly asset-aligned, represented by the bottom arrow.

As Sally and I engaged in dialogue and reflection around how we interact with families, our perspectives expanded to include more asset-aligned positions. Over time, we also changed our practices, engaging differently with families in ways that moved toward two-way communication, positioning families as knowers, and leveraging science sensemaking to change family engagement spaces. Alongside reflecting and changing practices in how we engaged with families, we also reflected and changed how we positioned and engaged with each other, moving toward more collaborative stances over time. Thus, the conceptual framework has both teacher and researcher standing side-by-side. Iterative cycles of reflection, dialogue, and action led to our disruption of school norms that position families as still and silent, along with research norms that created binaries between researcher and informant.

**Theoretical frameworks: Criticality, conscientização, and sensoriality**

The conceptual framework in Figure 2-1 illustrates this study’s process, whereby a 2nd grade teacher, Sally, and I moved toward expansive asset-aligned perspectives and practices when
engaging with families and each other. The theories underpinning this process are Freire’s (2000) conscientização and Critical Race Theory (Bell, 1987). This section summarizes important aspects of the theories as they apply to the study, and then connects these critical frames with sensoriality.

**Conscientização**

Conscientização, or critical consciousness, has various definitions, although all highlight two main dimensions: a continuous movement between awareness and action, and a method that leads to becoming (Jemal, 2017; Cervantes-Soon, Dorner, Palmer, Heiman, Schwerdtfeger, & Choi, 2017; Freire, 2000). Conscientização is both method and epistemology (Freire & Macedo, 1995). When coupled with critical frameworks, conscientização provides an approach to nudge researchers and educators toward asset-aligned views and actions. Disrupting the deficit norms of family engagement and research, where teacher and researcher, respectively, believe they need to “fix” deficits in the other (families and teacher participants) (NASEM, 2022), requires an ongoing process of dialogue, reflection, and changes in practices. This cycle aligns closely with Paulo Freire’s (2000) problem-posing pedagogy.

**Problem-posing pedagogy.** Freire’s (2000) problem-posing pedagogy translates critical consciousness into an approach to being. Central to this approach is praxis, which is a “reflection and action upon the world in order to transform it” (Freire, 2000, p. 51). This process leads to an awakening of how we are steeped in systems of oppression, which then lead to further reflections and actions, thus deepening a cycle toward critical consciousness. The conceptual framework mirrors this cycle by iteratively engaging teacher and researcher in dialogue and reflection about how they are engaging with families and each other, and subsequent actions that expand toward
asset-aligned approaches. Dialogue is a space to try to understand another’s position, rather than to evaluate it as fallible. Sally and I move toward more and more authentic dialogue over the course of the ethnography. With greater understanding comes new insights and reflections, which leads to changes in practices and perspectives in a never-ending cycle: “critical consciousness is not a destination but an ever-evolving, ongoing process influenced by social context” (McDonough, 2009, p. 531). Key aspects of conscientização are: resisting objectification of others and moving toward humanizing practices, and moving toward becoming through transformation.

**Humanizing practices.** Critical consciousness requires people to see themselves and others as subjects and not objects (Freire, 2000; hooks, 1994). A humanizing pedagogy requires humility, love, and critical awareness that one is not better, nor do they know more than someone else—particularly when considering the lived experiences of those whose realities are often marginalized and ignored (Freire, 2000; hooks 2001). “No one can be authentically human while he prevents others from being so. Attempting to be *more* human, individualistically, leads to *having more*, egotistically, a form of dehumanization” (Freire, 2000, p. 85-86). Dehumanization occurs in education easily whenever teachers or researchers consider themselves as the all-knowing authority, and position students, families, or teachers as blank slates. This traditional classroom and research environment aligns with Freire’s (2000) notion of the banking method of education, which positions students as objects. Additionally, a humanizing pedagogy requires us to see people as whole beings, not stereotypes or monoliths. This changes the way we interact, needing to listen and learn from others, rather than teach and tell. These practices contradict a Western, white way of knowing: “The Western arrogance of feeling that it has everything to teach others and nothing to learn from them” (King, 1967, p. 13). Over the course of the ethnography,
Sally and I move toward more humanizing practices with each other and the families we engage with, as is uplifted in the findings below.

**Be(com)ing.** Moving through cycles of praxis leads to a constant transformation where one’s perspectives change how one is in the world; “people develop their power to perceive critically in the way they exist in the world with which and in which they find themselves; they come to see the world not as a static reality, but as a reality in process, in transformation” (Freire, 2000, p. 83; original italics). This study highlights the transformations in both Sally and me as we move through cycles of reflection and action. Freire’s (2000) becoming is similar to Deleuze and Guattari’s (2004) descriptions of becoming, which they position as acts of de- and re-territorialization. This notion of becoming as creating something new is tied to grappling with conflicts and an active, open-ended process that necessitates engagement with the world and people (Bennett, 2010).

Although being is intertwined with becoming (be(com)ing) in this study being has a second meaning. Families, teachers, and researchers are expected to be a certain way and to conform to norms. However, as Sally and I move toward a transformational becoming through praxis, we also can perceive and resist norms of how we should be. Thus, being is also an important aspect of this work, both in naming the expected, disciplined ways of being and the escape from these confining and deficit-aligned norms.

**Important differences.** Although conscientização is an important theoretical frame and method that informs this study, Freire’s (2000) conscientização is different from my own work. Freire’s (2000) work seeks to liberate the oppressed from the oppressor. In my research, I (the white, middle-class, cis-gendered, English dominant researcher) am in dialogue and praxis with Sally, a fellow white, middle-class, cis-gendered, English dominant person. Although power dynamics are still at play, this is a significant turn from Freire’s (2000) work. Secondly, Freire
(2000) is rooted in critical pedagogies that do not prioritize race over other areas such as class differences (Macedo, 2000). However, that does not mean conscientização cannot complement critical frames that center race (hooks, 1994; Freire & Macedo, 1995). By applying CRT to critical consciousness, I can ensure that my work centers the often-evaded oppression of racism. A critical lens interrogates how even critical pedagogies such as critical consciousness reproduce whiteness, even as they align with liberal and activist stances.

**Critical Race Theory (CRT)**

The aim of my research is to disrupt deficit norms. This includes both the class, school, and societal norms that position families as negligent and unknowledgeable, as well as those that position elementary school teachers in this community as in need of fixing. The norms I am trying to disrupt are racialized, and intersect with gender, ethnicity, class, and other -isms. CRT aims to uncover or “illuminate racial power and subsequent racial hierarchies, analyze their effects, understand why and how they persist, and advance social action to disrupt and alter them” (Parsons, Rhodes & Brown, 2011, p. 953). Thus, it moves beyond our vision of the world, and into how we must act in that world. As can be seen in the conceptual framework (Figure 2-1), beyond disrupting norms, I seek to interrogate the perspectives behind the actions, so that our practices, actions, and whole selves also move toward socially just, asset-aligned perspectives and actions. CRT posits that racism is endemic and ubiquitous in the United States, evident by the ways families are disciplined to engage with the teacher and school, and researchers are disciplined to engage with teachers. Beyond the central tenet of racism as endemic (Bell, 1987), this research is guided by CRT’s call to interrogate the implicit norms aligned with racism and white supremacy, the tenet of whiteness as property, and intersectionality.
Another important tenet of CRT is to challenge claims of neutrality, objectivity, colorblindness, and meritocracy (Ladson-Billings & Tate, 1995). I recognize that family engagement is subjective and socially constructed, privileging white, middle-class norms and is viewed through lenses of race, class, culture and gender (Auerbach, 2007). I similarly recognize the senses as socially constructed and racialized (Gershon, 2019), and my focus on the sensorial productivity of making seeks to disrupt the Cartesian mind/body disconnect prioritized in dominant epistemologies, which privileges vision, text, and the mind, and silos senses rather than recognize their interconnectedness (Kumashiro, 2000; Ladson-Billings, 2000). I am not focusing my study on the Latine, EB families that engage with Sally and I in our work—centering families as the subject (object) of my research would pathologize families (Ishimaru & Bang, 2016). Also, I do not present an interventionist study where I work with the teacher to identify best practices in family engagement. This would infer that a static, “technical” problem exists to be solved, whereas CRT points me toward a larger systemic, implicit perspective instead of those more aligned with “gap-gazing” (Gutiérrez, 2008). My work places a critical lens on the teacher I work with, as well as myself – considering the ways in which I am othering and flattening both teacher and families and inviting Sally to do the same.

CRT’s tenet of whiteness as property operates within the norms of academic research and family engagement in schools. Whiteness as property recognizes how whiteness affords the rights of disposition, use and enjoyment, representation and status property, and the absolute right to exclude (Harris, 1993). When considering foundational literature around family engagement (Epstein, 2010; Henderson & Mapp, 2002), there is an uninterrogated correlation between family engagement and student achievement (Bang et al., 2019). However, with CRT and whiteness as property, I can question whose family engagement is centered, and what kinds of engagement are excluded. Using this tenet helps refocus an interrogation on family engagement to the way
families and schools are expected to engage with each other, and how this is rooted in whiteness and ways of being that are discordant with families from nondominant races, ethnicities, cultures, languages, and backgrounds. A focus on the implicit norms helps resist an inclination widespread in the literature to focus on what educators and families should do to better connect families to schools. By recognizing the larger system in which family engagement takes place, and the ways in which this system prioritizes white ways of being and knowing, I can move into more productive, and less obvious spaces.

Another useful tenet of CRT is intersectionality (Crenshaw, 1991). Intersectionality recognizes differences between groups, and how nondominant identities multiply, not add, burden, violence, and hypervisibility/invisibility to individuals. I use intersectionality as a tool to move beyond either/or binaries of white/non-white to consider how gender, ethnicity, and language create exponentially advantageous or disadvantageous positions in complex and context-dependent ways. For example, as Sally and I interrogate school norms, I recognize how an intersection of whiteness with gender (femininity) aligns with compliance, making it harder to disrupt norms when engaging with families. I also recognize how this intersection makes it harder to interrogate each other’s deficit perspectives and be transparent about how we are positioning each other, since a “nice white lady” does not put others at unease.

Why CRT? Aligned with an epistemology that critiques the binary, CRT is not in conflict with other frames, such as sociocultural theory (SCT; Vossoughi & Gutiérrez, 2016; Vygotsky, 1978), particularly the version of SCT that carefully considers context and history within cultural norms (Rogoff, 2003). For example, I consider the relationship between individuals (e.g., teacher, researcher, and families) within a larger society, and the cultural and contextual nature of these interactions. However, my efforts are in disruption of power and the racialized but often unnoticed norms of how both researchers interact with teachers in educational
research, as well as how teachers engage with families. With power, race, and racism at the center of my work, CRT is able to productively examine this sphere in a way that sociocultural theory does not afford (Parsons, 2016).

**CRT with CWS.** With CRT at the center of my frame, I also employ Critical Whiteness Studies (Matias et al., 2014) as a sister framework to support my analyses. Critical Whiteness Studies (CWS) problematize and examine the normality of hegemonic whiteness. CWS seek to “unmask the seemingly invisible privileges of Whites and demonstrate that the privileges are real” and defines whiteness as an approach that “interrogate[s] the means by which Whiteness is hegemonically constructed, reified as normal, while remaining socially dominant” (Cabrera, Watson & Franklin, 2016, p. 120). Similar to race, whiteness is defined as socially constructed, yet “unlike Blackness, whiteness is normalized because white supremacy elevates white and whiteness to the apex of racial hierarchy” (Matias et al., 2014, p. 291). In CWS, white supremacy is “a sociohistorical process that works to ensure white racial domination through various social institutions and through the maintenance of a white racial common sense” (Leonardo & Manning, 2017, p. 16). As a white woman working in partnership with another white woman, CWS is a useful frame to better understand how whiteness functions, and productive ways to respond to deflections both within myself and others.

**Critical frames and sensoriality**

Gloria Ladson-Billings (2000) begins her chapter in the *Handbook of Qualitative Research: Racialized discourses and ethnic epistemologies* with two quotes: Descartes’ “I think, therefore I am,” and an African saying: Ubuntu, which means “I am because we are.” The academy, an institution largely built on philosophies from the Age of Reason and Enlightenment,
operates through a system of the knower and the known (Ladson-Billings, 2000). Without these binaries, research would be in “epistemic panic” (Ladson-Billings, 2003). With conscientização and CRT, I move away from Eurocentric epistemologies toward complexities and juxtapositions of us and them—of ubuntu. Moving away from Cartesian sensibilities also means moving toward a different understanding of the senses – not as solid facts that support reason, but as socially constructed ways of being and knowing that are bound to the body and mind together. Building from scholars such as Kim Powell (Powell, 2008; 2015; Powell, Altuntas & Bricker, in press; Powell & Serriere, 2013), Walter Gershon (2019), Maxine Greene (1995), and Sarah Truman and Stephanie Springgay (2016), I leverage the sensorial to unframe deficit habits and defamiliarize school norms that position families as still and silent. In this study, the act of making sensorial settling jars with families and educators created an opening to be in ways that defied hierarchical, deficit norms of families during school engagement events. With this affordance, the sensorial aspects of science sensemaking can be attended to more carefully, which I take up in the discussion.

Methodology

My research methodology expanded from ethnography toward participatory action research (PAR; Jordan, 2008) as my work with Sally moved toward praxis (Freire, 2000). My work was initially firmly entrenched in an ethnographic approach, aligning with social sciences and educational research, and less aligned with a classical anthropological approach (Hammersley, 2006). However, as my work with Sally evolved, my reflexivity grew to where Sally and I moved into cycles of praxis to better interrogate our own deficit perspectives. This movement into praxis expanded my research to encompass a collaborative partnership with Sally.
that moved us toward critical consciousness. Although I did not recognize this shift at the time, it most closely aligns with PAR in that it unsettles researcher/researched hierarchies and moves toward action and transformation instead of a more ethnographic stance of understanding cultural differences. I argue here that this work holds both ethnographic and PAR characteristics. I also share how this work is not aligned with more traditional anthropologic ethnography, in that the focus on the culture of white, female, English-dominant teachers becomes fuzzy as Sally and I move into praxis and transformation over time.

**Ethnography**

My research in ethnographic in the sense that I studied “at first hand what people do and say in particular contexts” (Hammersley, 2006, p. 4). The people and culture central to my work is that of white, English-dominant, female educators, and the context is a place that has experienced recent shifts in demographics amidst a Latino Threat Narrative (Chavez, 2013). My research emerged as I collaboratively co-planned and co-taught science lessons with Sally through weekly iterations that spanned four years. This long-term engagement afforded me a deeper understanding of the context, lived experiences, and perspectives of Sally and her school, and aligns with a key characteristic of ethnography (Hammersley, 2006). In addition, I engaged in participant observation, open-ended interviews that sought to understand Sally and her approach to engagement and teaching, and I wrote field notes following each field visit (Emerson, Fretz, & Shaw, 2011; Hammersley, 2006). Interviews sought to understand Sally’s perspective, while also recognizing how understandings are “socio-discursively constructed in a context-sensitive fashion” (Hammersley, 2006, p. 9). Although my research is more ethnographic in data collection and fieldwork than analysis, there are some overlaps with my analytical approach over time. Similar to ethnography, I took an inductive approach to understanding Sally’s perspectives and
practices as they changed over time. My analysis began alongside my research, and was formed and clarified iteratively as I fieldnoted, memoed, and analyzed findings repeatedly (Hammersley & Atkinson, 2007). I also was reflexive in my approach (Marcus, 1998), and engaged in grounded theorizing (Hammersley & Atkinson, 2009), engaging in analytical practices taken up in ethnography (Emerson, Fretz, & Shaw, 2011).

My use of CRT and a critical lens aligns somewhat with critical ethnography, in that it addresses social injustice and inequality through research, tightly aligns with critical epistemology, CRT, and critical consciousness (Carspecken, 1996; Norander, 2017). This methodology understands that “all thought is fundamentally mediated by power relations which are socially and historically constituted” (Kincheloe & McLaren, 1994, p. 140) and acknowledges that research is “not innocent or neutral” (Murillo, 1999, p. 7). Reflexivity and critique require researchers to carefully consider their methodological approaches. Other methods inherent in critical ethnography include direct observation, open ended interviews, and textual analysis, as well as constantly interrogating the predilection to “representationally essentialize” (Clifford, 1992) cultural “others.” For example, consideration of how words are used to describe and represent actions and groups of people can lead to more careful representations, rather than “metonymic freezing” (Appadurai, 1988), where a term is used to substitute the full meaning of a person or group, thus making it static and sanitary. This is often done in ways that conjure deficiency without explicitly taking a deficit stance. Although I do not escape this practice, I limit terms which conjure a stereotype or monolith despite politically correct terminology (e.g., Latine, new immigrant, EB, Dominican, etc.,) and try to employ more general terms (e.g., families, students, etc.,) to characterize people and groups.

Similar to other ethnographers, I did not have a pre-conceived research agenda upon first working with Sally, nor did I have pre-conceived research questions. Instead, my research
unfolded as my fieldwork unfolded (Norander, 2017; Patton, 1990). I recognized that the participants I wanted to focus on in my research were not the Dominican, EB students and families, but instead the white, English-monolingual teachers. Taking a critical stance, who I focused my vision on mattered – there is nothing broken about the Dominican students and families. However, I do feel that I have a lot to (un)learn about white supremacy and racism, and the deficit lenses I implicitly use. Unlike other forms of ethnography, I centered “critical reflection and raising awareness throughout the process” (Norander, 2017, p. 297) by engaging collaboratively in iterative cycles of critical reflection and action with Sally. I also interrogated the normative nature of truth claims (Kincheloe and McLaren, 2000), and tried to move away from evaluative, distant observations of Sally’s words and teaching, and toward more collaborative engagement and discourse.

Although my methodology differs in several ways from collaborative ethnography (Lassiter, 2005), it informed my approach as my relationship with Sally evolved. Initially I held a more distant, evaluative stance of Sally and the field site. However, as I moved toward joint participation (Penuel et al., 2015) and side-by-side work, I began explicitly sharing my research interests and perspectives with Sally and asking her for her thoughts and feedback. We co-conceived conference proposals, presentations, and journal articles, and I shared drafts of my writing with Sally for comment and feedback as my work iterated over the three years. These approaches mirror key principles of collaborative ethnography, which: “deliberately and explicitly emphasizes collaboration at every point in the ethnography process, without veiling it—from project conceptualization, to field work, and, especially, through the writing process. Collaborative ethnography invites commentary from our consultants and seeks to make that commentary overtly part of the ethnographic text as it develops” (Lassiter, 2005, p. 16).

However, unlike much of collaborative ethnography, my research does not originate in the
interests of Sally, and Sally is not from a significantly different cultural background than me. For these reasons, as well as the close connection to critical ethnography, I do not call my work collaborative ethnography, despite its influential role in my methodological approach.

Although my work aligns in many ways with ethnography, I also recognize the significant ways in which this is not a true ethnography. Most notably is that I did not live in the community with Sally and her students (Hammersley, 2006). Also, a central component of ethnography is its focus on culture. Although I am focused on studying white, English-dominant, women, which aligns to my own culture, I also recognize ways in which Sally’s lived experiences and context is significantly different from my own, and an attention to praxis expands during the ethnography, unsettling a centrality to culture. I do tie this localized culture to national ideologies of racism, patriarchy, and a Latino Threat Narrative (Chavez, 2013), representative of ethnography (see Buraway et al., 2000 in Hammersley, 2006), however the lack of clear boundaries between culture and local to holistic representations make it difficult to consider this an ethnography in the traditional anthropological sense. Thus, I use “ethnography” more liberally, akin to scholars in educational research, rather than how it is taken up in anthropology (Hammersley, 2006).

**Participatory Action Research (PAR)**

When considering the trajectory my research took over time, I began to encompass Participatory Action Research (PAR; Jordan, 2008) practices. Although rooted in social psychology, PAR has been taken up by more critical scholars, including a strong tie to Paulo Friere’s (2000) work. In many ways, my research mirrors a fundamental component of PAR, in that it “continually sought to critique and challenge the researcher-researched relation through participation in the research practice” (Jordan, 2008, p. 601). Similar to how Sally and I engaged
in iterations of reflection and action, PAR centers a dialogical relationship between theory and practice, uplifting understandings that emerge from the “everyday world” (Jordan, 2008). PAR also rejects positivist, Western, conventional social scientific research, and moves toward qualitative, reflexive understandings that seek to disturb a researcher/researched hierarchy (Jordan, 2008). Much of PAR’s work aligns with Freire’s (2000) conscientization, which is a fundamental component of my framework. However, my work does not fully encompass PAR in that the research questions and direction initially was spurred from myself, not in partnership with Sally. Although we moved toward collaboration, transparency, and co-authorship, we did not begin our research endeavors tightly aligned with PAR.

**Context**

This work is situated in Douglas Elementary School, a K-2 school with about 400 students, in a semi-urban city in the northeastern United States that has a majority Latine, largely Dominican new immigrant population. My research is part of a larger national professional development project that brings together school, university, and community partners in support of EB students’ learning. The project’s vision is for researchers and eventually family and community members to work alongside teachers as they co-design, enact, and assess the ways in which science sensemaking can amplify equitable language practices and students’ lived experiences. The demographics of the community have changed significantly in the last two decades. In 2000, the community was 93% white, while recent data suggests that the population is now approximately 56% Latine, primarily from the Dominican Republic and Puerto Rico. I perceive a dominant Latino Threat Narrative (Chavez, 2013) in the community, where white, Irish and Italian community members position Latine, new-immigrant community members as
dangerous and hoarding resources such as medical services and welfare. Although this narrative aligns with a national, xenophobic ideology, it is taken up within school spaces in implicit ways, positioning students and families as deficient and neglectful. This perspective sits alongside Sally’s lived experiences of family neglect and abuse across races and ethnicities.

Sally Matthews, the 2nd grade teacher with whom I collaborate, reports of having over 90% Latine, EB students in her classroom. Sally is a white, English-dominant, woman with a background in Special Education. She is the mother of a bi-racial son and has taught in the community for over 20 years. Sally considers her students like a family, prioritizing kindness and community. I am also a white, English-dominant woman, mother, and novice researcher. I am the mother of two white children, and before becoming a graduate student, I taught middle-school and 9th grade science for eight years, working in education for over 12 years. Similar to the norms at Douglas Elementary and schools in general, I engaged in teacher-centered practices and hosted family engagement events that aligned with a “look, listen, and leave” approach. I found myself reverting to teacher-dominated, authoritarian positions when co-teaching with Sally.

Methods

This manuscript is a case of Sally and my perceptions of families who are largely new immigrant, Dominican, and emergent bilingual, and how we engage with families as we engage in cycles of praxis. This is an instrumental case (Stake, 1995), in that it seeks to better understand how cycles of praxis around family engagement transformed two white, dominant-English speaking educators’ perspectives and practices. During our three years of collaboration and research, I moved toward inductive understandings of how Sally’s and my perspectives and practices with families changed over time. Through open coding, my understandings of these
patterns developed, similar to practices found in case study (Dyson & Genishi, 2005, p. 85). This process created a bounded case, where I sought to understand how Sally considered and engaged with families over time.

I created fieldnotes, conducted interviews, and collected other data over three years, from August of 2018 to November of 2021. Until the pandemic, I visited Sally’s classroom weekly for 2-3 hours a day to co-plan and co-teach science lessons, debrief our work, and reflect on family engagement, totaling 53 visits. When the Covid pandemic paused our co-teaching in the spring of 2020, we continued to collaborate on research over the summer. In the fall of 2020 we began co-planning and co-teaching science lessons remotely, which led to new ways to engage with students and families. IRB permissions allowed for audio/video recording of our planning meetings, classroom teaching, and interviews, as well as collection of student artifacts, and recordings of family engagement events with teacher, student, and family consent. Each week I made jottings and wrote field notes (Emerson, Fretz, & Shaw, 2011). I also collected and transcribed analytic memos, weekly interviews, and an oral history. Following the 2018-2019 academic year, I analytically coded fieldnotes through an open coding process (Emerson, Fretz & Shaw, 2011). I wrote memos from the initial codes, organized them into themes, and re-coded data as theories developed, aligning to a “retroductive” approach (Bulmer, 1979). As member-checking turned into collaborative reflections of our work, I reanalyzed data, adding the themes of how our own positionings of each other changed, along with our shifting family engagement practices. By the end of data collection, I had amassed 393 pages of field notes, memos, and excerpted interview transcripts. I have re-coded this data three times, with themes expanding as our work changes.
Findings Through Time

It is impossible to fully represent my experiences from over three years working with Sally and various families in one manuscript. Although I necessarily need to organize my findings, I present them here in four “movements” or sections that expand over time to move toward a more tangled, ecological representation that “account[s] for the interconnectedness of space and time” (Gutiérrez et al., 2017, p. 41). These four movements show how Sally’s and my relationships, positionings, engagements, and theories about families and each other eddy over time. Similar to musical movements, the movements below are separated by distinct qualities while still connecting across each space. Each movement begins with a non-fictional vignette that summarizes a pivotal moment or is representative of the period of time. Quotes represent verbatim dialogue. The vignettes are then followed by a discussion that narrates our perspectives and practices during that movement. I resist analyzing interactions to better illustrate how they evolved and regressed over time.

Movement one: Evaluating (Fall, 2018)

August 17, 2018: It is the first day of school at Douglas Elementary. As many young students navigate the terrain of a new school, I join them as a novice researcher in the building. Mary, my research colleague, and I walk into the large, brick building, up two flights of stairs, and meet Sally Matthews. Sally is in her late 40s, with shoulder-length brownish-blond hair and blueish-gray eyes. She is standing at her desk, preparing laminated name cards for her new 2nd grade students who will soon enter her class. She smiles and welcomes us into her room. We offer to help and she hands us name tags to start taping to desks. Sally tells us how students arrive to school with nothing in their backpacks—no names, no way to identify them, and that they don’t even “know their own name.” She questions: “how do you send kids to school [without any identification]?”
I began my work with Sally from an evaluative stance. I interpreted Sally’s stories and statements during this time as representing families as greedy and uncaring. Sally shared stories of family abuse and neglect and was highly concerned for the safety of her students, sometimes resulting in mistrust of families. While hearing these stories, I was afraid to question Sally or seek to better understand her experiences, instead positioning her as xenophobic, judgmental, and deficit minded from a distance. In mid-October I conducted an oral history interview with Sally. I was surprised to learn during this interview that Sally has a bi-racial son and repeatedly took anti-racist stances by naming and challenging racism as a mother and a teacher. By seeking to understand Sally better in the interview, I began challenging the assumptions I had made about her that positioned her as deficit-minded and monolithic. This early shift towards listening rather than evaluating surfaced my former simplistic, deficit positionings which I had made based on Sally’s race and ethnicity.

Sally and I also theorized about and engaged with families in ways that were deficit-aligned and evaluative. Early on in our collaboration, Sally and her colleague were reluctant to send students home with science materials, believing families did not carefully watch children at home, and materials would be damaged and not returned. Although I tried to counter this view by

Figure 2-2 Science boards during a family engagement event.
suggesting different ways to send home materials, I did not openly interrogate this notion. In November, Sally and I hosted a Family Night. Sally created science stations along the classroom perimeter with science experiment materials and tri-fold boards explaining each activity (see Figure 2-2). Sally reflected that this family engagement event was different than events in the past, resulting in families staying longer. During the event, I noted that Sally seemed to engage more with the students than the families. However, I did not share my assessment with Sally, keeping an evaluative stance.

By the end of the fall semester, Sally and I began planning new ways to engage with families. We discussed sending materials home and inviting families in to engage with their children and other students. At the same time, Sally shared stories about families that positioned them as greedy and neglectful. For example, Sally questioned families’ motives for attending family engagement events: “If you say there’s going to be free food, they come,” and shared stories about students staying with their landlords instead of families, who they do not see for years.

**Movement two: Seeking to understand (Spring, 2019)**

*March 26, 2019: Sally, a colleague, and I are sitting around a small table, finalizing our upcoming conference presentation. Sally and her colleague share multiple stories about how families have abused students. I sit with them, trying to understand these stories, while also finding ways to interrogate deficit perspectives implicit in them. I scrawl the word “stories” in my notebook and ask why families do not want to come to our class. Sally shares, “I just want them to be more comfortable. Like I don’t want this to always be such a (. ) pulling teeth. I don’t understand why. We think most- like, we have some [families] that work, but we have a lot that don’t work (. ) I don’t know. I'm like: ‘Am I that scary?’ (laughter) like, I don't know what the thing is, unless, but then again, I don't know what kind of teachers they've had in the past (. ) They could be basing it on their own experience.”*
As Sally and I continued to collaborate with science lessons, family engagement, and preparing for a conference presentation about our work, we moved toward a collaborative relationship. Rather than quietly interpreting Sally’s stories and statements about families as deficit aligned, I sought to understand her thoughts, and occasionally challenged her theories in circuitous ways. We started sharing more of our own lived experiences with each other, building trust. Sally’s stories about families in late 2018 and early 2019 signaled students as living far from their “real” families, and Sally seemed concerned with her students’ safety. However, she was also interested in better understanding families. With the help of fellow research colleagues, we designed a survey for families and distributed it at a PTA event. Sally was surprised by the family turnout and their interest in supporting their children with literacy. As Sally and I reviewed the survey results, we moved into a collaborative space, and my perceptions of Sally expanded and complexified. Sally and I started inviting individual families into the classroom, while Sally’s fears of students getting harmed or neglected by families persisted.

In February and March we continued reflecting about families and family engagement. Sally reflected on how families appreciate the school and their community events, noting how much food families bring to these events. This starkly contrasted with an earlier position that families came to events for the free food. I more frequently noticed Sally’s positioning of families as caring, and she began questioning her own role in the limited engagement between school and home (see vignette on p. 99). This reflexive turn persisted as she considered how she and the school could be factors in the limited family engagement. Sally considered how xenophobia and Trump’s presidency may have made new immigrant families feel afraid of engaging with (white, monolingual) teachers, sharing a story of how students were upset and afraid when Trump was elected as president. She then returned to describing how families do not show up to PTA
meetings, and only engage in school when students’ grades are poor. These juxtapositions mirrored my own positions, where I vacillated between deficit and asset stances of Sally.

By the end of spring, Sally and I moved more fully into collaborative research. In late March I shared my research questions with Sally, and she agreed to join me in an inquiry around family engagement. Our collaboration for a conference presentation made me feel comfortable to discuss asset and deficit perspectives, interrogating deficit-aligned language. For example, I introduced the term “emergent bilingual” to replace the dominant school-wide label for EB students at Douglas Elementary: “non-speaker.” Although I had wanted to interrogate this term in the past, I was afraid it would upset Sally, ending our collaborations. Sally responded to this correction openly, having not thought about the harm that underpinned a ubiquitous label in the school. I also spent an evening calling families with Sally, hoping they would be interested in visiting her classroom, but no families seem interested. In late May I explicitly shared my dissertation interests with Sally. I began feeling comfortable countering deficit narratives of “illegitimate” families, offering more expansive definitions of “family.”

Movement three: Collaborating (Fall, 2019 – Spring, 2020)

September 6, 2019: I am in a college classroom at my university, standing next to a poster that shares my work with Sally from the prior academic year, practicing for my first academic conference. I have mapped out Sally’s perspectives of families with quotes that show changes from deficit to asset perspectives. My friend sits in front of me, listening to me explain my work. When I finish, she asks me: “Have you shown Sally this work?” A cannonball plummets to the bottom of my stomach. Although I have positioned myself as doing collaborative work with Sally, although she knows my research interests, although we have co-presented at a conference, I would not want her to see this work. I worry that if Sally knew how I positioned her in deficit ways, she would not want to collaborate anymore. I recognize that true collaboration means complete transparency and that I cannot talk about Sally without talking about myself. In my next meeting, I nervously read Sally my research, making clear my early positions of her. She responds openly and with ease, confirming their accuracy. For the first time, there is space to reflect with Sally about our changing theories, which she attributes to our ongoing
conversations. We share our initial perspectives of each other, which have also changed over time.

Unlike the previous year, I began this academic year more familiar and comfortable with Sally and the school, and Sally’s stories were not dominated by deficit perspectives of families. Our meetings now included informal lunches, where we shared personal stories, rather than stiff interviews and co-planning meetings. I often felt self-conscious sharing personal stories and my thoughts, worrying it was crossing a researcher/participant divide and influencing the “data”. We continued inviting families to join the classroom. For this year’s Open House, we created space for families to engage with science together. Students created home-made invitations for the Open House, making it clear that all family members are welcome. On the night of the Open House event, families trickled in (see vignette on page 72), eventually settling down at a long table covered with green plastic tablecloths. Once seated, families made a “Settling jar” with their children—a science activity we had done in class as part of a longer exploration of properties of solids and liquids. Although Sally initially seemed to engage more with students than families, eventually she was speaking comfortably with many families. By the end of the night, only a few families remained (Figure 2-3). We all sat around the table, making jars, talking, and laughing. Sally conversed with an older brother and a student’s mother, sharing resources for how families could support literacy at home. Following the event, Sally and I debriefed. This engagement event felt different—more connected, more casual. I felt closer to the families we had met, and two mothers were interested in joining our class throughout the year.
Sally and I started moving into a more transparent, authentic, collaborative relationship. We began to co-write a paper together about our family engagement reflections. Sally chose her own pseudonym, fully aware that she was central in my research. Our reflections and discussions about family engagement became routine and continued to expand, intermingling with new theories and ways to reach out to families. Sally considered reflexive barriers to family engagement more frequently. I became more comfortable sharing my perspectives and experiences with Sally, being less self-critical about what this meant for our research. Sally also helped me navigate the complex social systems within the school, giving advice so I did not overwhelm other teachers participating on the project. We became stronger friends, now knowing each other’s families by name. Sally invited me and my daughter to the Halloween Dance, where I was able to be more fully human as a mother, friend, and researcher, and feel like part of the community, recognizing teachers, staff, and families at the dance. As my daughter and I left the

Figure 2-3 Families making settling jars at Open House
dance, we heard another family reflecting on how much fun they had. I recognized my egocentric, interventionist, deficit assumption that my project was pioneering successful family engagement in this space.

Throughout the fall, into early winter, Sally and I continued to surface our deficit perspectives of each other, students, and families. A Video-Cued Ethnography project (Brown, Zembal-Saul & Nebuse Bose, 2021) helped us interrogate our deficit positionings of students. We began explicitly naming our perceptions and practices as “deficit,” speaking frankly about our own deficit views of students, families, and each other. Sally shared her initial perception of me as being out of touch with the reality of the school, and I shared with Sally how I had initially perceived her having a deficit perspective of families. It became easier to have conversations about our perspectives, particularly those that aligned with problematic viewpoints. Sally continued to share concerns for students’ safety, which I began hearing more carefully, recognizing they were rooted in her real lived experiences.

In the spring of 2020, Sally’s stories began to shift toward asset-aligned accounts. I began reflecting on school practices with Sally instead of privately, as she helped me unpack dichotomies of asset and deficit practices and the intricacies of the school culture. We started sending home science experiments for students to do with families and decided to have another science-centered inquiry for the spring Parent Night, where families could stay and share. We also hosted a focus group during the Parent Night to better understand families and their concerns. Sally engaged more with families, and we learned about differences in schooling between the Dominican Republic and the United States from a grandparent with the help of a school liaison. I felt more connected with families, having been in contact with two mothers over the year, one of whom had joined us during the school day. Our focus group ran late, with school staff giving subtle and not-subtle hints for families to leave over the PA. Sally’s theories about
families continued to expand, noting that many families moved to the community to be safe, leaving a city that felt unsafe. We ended the Parent Night, not realizing we would not see each other in person again for months—before my planned return the next week, Covid closed down the school.

Movement four: Becoming (Fall 2020 – Spring 2021)

October 21, 2020: I hear families talking. A man’s voice says: “You got to keep trying.” A woman hugs her child and straightens their hair. “I can’t hear nobody. Is anybody awake?” “Bye buddy, have a good one!” A child is screaming, adults are yelling. Sally laughs: “Okay, I’m going to mute everybody.” “Who’s that?” “My nephew.” “You’re an uncle? Wow, that’s awesome!” (Fieldnotes)

Although Covid brought devastation, tragedy, and the stark reality between social class, ethnicity, and race in the United States, it also created new ways for Sally and her students’ families to connect. My first experience with remote learning shared in the vignette here, represented families in a completely new light. Sally taught virtually from her home, her cat occasionally interrupting class. Students, families, and I, shared our whole selves as privacy and distance between home and school disappeared. In December, Sally and I began sending science materials to students’ homes and students engaged in phenomenon-rich virtual science sensemaking storylines. Sally started using an app to communicate daily with families, sometimes being able to alert families when their children were struggling in real time. Many families were engaged in our science sensemaking lessons, and we began inviting them to join their children as we explored. By mid-January, some students’ families began engaging in lessons. One student’s older brother joined our lesson, asking questions; a mother scaffolded her child’s learning about the properties of soap, asking: “How does it feel? Is it heavy or light?” When I asked a student to describe how Ivory Soap felt, I heard a family member speaking to them in Spanish off screen.
When the student responded “soft,” I asked them how to say “soft” in Spanish. They looked to their left, to the Spanish-speaking voice off camera. Then I heard a voice softly tell them “suave,” which they repeated to the class (fieldnotes, 1/13/21, p. 351). Over the semester, families became part of our lessons. One day in late March we had asked how many ways students could say “clear.” An adult’s hand flew up in front of their child’s camera. When invited to share, they said “transparente,” which we then repeated to teach the cognate transparent (fieldnotes, 3/24/21, p. 369). Sally and I reflected on the new way we were engaging with families:

Michelle:  
It feels like a little family engagement event every Wednesday – I don’t know, maybe not, but-

Sally:  
No, it does! And I like that because they are doing something with their kid that doesn’t involve them having to pay or give them a toy, or buy them something, but it’s something they do at home. I think it’s kinda neat. (3/3/21, 6:53 - 7:33)

As Sally and I navigated remote science teaching, our relationship with each other also grew. Our planning meetings moved fluidly between friendly conversation to a co-planning meeting. I reflect in my fieldnotes: “We are becoming friends. I find myself enjoying her stories, while also becoming uncomfortable with the level of our comfort. This is not a researcher/teacher relationship. However, this is a real relationship” (fieldnotes, 1/12/2021, p. 350). As our collaboration continued, so did my research. I explained three central research topics for my dissertation, leading us to more frequently center topics relevant to my work. For example, Sally shared that her perspective had changed—she was much less tough on students and families now. I shared with Sally the fieldnote I had written after our first meeting in 2018 (see vignette on p. 97), and how I now understood how much more complex she and her lived experiences were. Sally shared how she was scared for students. She then shared a story of a student in danger which helped highlight the complexity between herself, her students, and their families, all trying to navigate threats to safety. When hearing this story, I no longer heard a flattened, deficit
stereotype of families, but Sally’s concern for the child (fieldnotes, 1/26/2021). As we continued to collaborate, Sally often shared reflections or stories that made me reconsider my research or collaboration with science sensemaking. For example, in late February I wrote: “[Sally] is smart and I learn a lot from her, and often times I feel like it’s me apprenticing with her.” (fieldnotes, 2/23/2021, p. 360).

In May I returned to Douglas Elementary to co-teach with Sally in a hybrid setup. When co-planning for our lesson, Sally shared reflections about a movie she had watched:

As I’m watching it, the guy says: “An octopus—two-thirds of their cognition is in their arms outside their brain. Their 2,000 suckers explore independently and they learn as they explore their world.” And it just made me think of kids, because they’re touching things and doing things, they learn more when they’re doing things. (5/4/2021).

Sally shared her reflections on touch with me because she knew this was a central aspect of one of my dissertation manuscripts. I reflected in my fieldnotes:

This was an amazing moment for me, where [Sally] is helping me think further about my own research because we are openly sharing and aware of what I am doing with the research. [...] Sally is providing critically tuned reflections that tie to my interests because she is fully aware of the research I’m interested in, and because we have developed a transparent relationship (5/04/2021, p. 372).

By late May, Sally and I were interrogating European epistemologies in science education after taking students on a nature walk (fieldnotes, 5/19/21). In early June, Sally suggested we should invite families from this class back next year (fieldnotes, 6/2/21).

**How sensoriality and praxis interrogates deficit perspectives**

The central research question around this work is: *How can educators and researchers productively interrogate deficit-aligned norms of science-centered family engagement with Latine, EB families?* My answer, in short, is that teachers and researchers should 1) create spaces
where families and teachers make, explore, seek to understand each other, and be together with their whole, sensorial selves, and 2) engage in cycles of discussion, reflection, and action moving toward critically evaluating and disrupting deficit norms of family engagement. In this section, I unpack how the sensorial nature of making settling jars opened up space for humanizing practices between families and Sally. I then will examine how cycles of reflection and action expanded and humanized how Sally and I engaged with each other and families. Within these discussions, I will connect themes back to CRT, CWS, conscientização, and sensorial epistemologies.

**Sensoriality and family engagement**

The sensoriality of science sensemaking creates space to disrupt deficit norms of family engagement. A science (sense)making space (i.e., a space that centers making with the senses) can position families and teachers differently, with the potential of escaping hegemonic, authoritarian schooling norms. When families, students, Sally, and I sat down together to make settling jars, something different happened. Sally and I felt more connected to families following this event than in the past. This same feeling returned when student sensemaking moved to virtual learning, and families once again engaged with us in sensorial-rich science learning. Barajas-López & Ishimaru’s (2020) eponymous phrase: “darles el lugar,” which refers to “a mother’s desire for place (e.g., physical and emotional) for her son as a human being in the classroom and in school” (p. 40), makes me wonder if re-focusing attention to our bodies as we collectively make re-attunes us to feeling and being in ways that attend to our whole selves. This interrogates a Cartesian epistemology that disembodies the mind from the senses (Gershon, 2019; Ladson-Billings, 2000). Suominen (2019) writes “it is the articulation of the sensory information and knowledge as not neutral but rather as critically and contextually framed perceptions and
conceptualizations of the values that can, in my opinion, disrupt normative thinking and as a result ‘common sense’ in education” (p. 179). The nascent resonance that something productive happens in this space—that families and teachers are repositioned in ways that are humanizing when engaged in sensorial (sense)making—is affirmed by the few studies that discuss the productivity of students, families, and teachers engaging in science together (Buxton et al., 2013; Siegel et al., 2007).

Science (sense)making repositions roles in family engagement spaces. When considering the status quo of school family engagement events, a sensorial space of making repositions the teacher’s role from authority figure to co-learner (Buxton et al., 2013). This disrupts the asymmetry of teacher as knower and family as in need of knowledge. Rather than focusing on engaging at families, telling families about class rules, showing families student work, etc., making settling jars together required families, Sally, and me to sit and be together. This created a space that centered inclusion and community. Freire’s (2000) conscientização similarly moves away from a subject/object positioning and a banking pedagogical method, toward a humanizing approach. When considering indigenous scholars’ work around place and family engagement (Kulago, 2016; Medin & Bang, 2014), being, relationality, and relationships are important values in Indigenous epistemologies that are absent from Western ways of knowing and being. The play and exploration that emerges from science (sense)making makes space for participants to be human and improvise, bringing families and teachers’ whole selves closer to the space (Rautio & Winston, 2013; Wohlwende, Keune & Thomson., 2017). Unsettling the hierarchies in the family engagement space through making similarly pushes against an either/or binary implicit in whiteness that positions teacher as dominant and family, particularly families that are EB and Latine, as subordinate. CRT acknowledges that the teacher/family hierarchy is pervasive and
forces people into static categories of us/them, widening distance between families and schools (Ladson-Billings, 2000).

In the settling jar Open House and the virtual science (sense)making spaces, Sally and I disrupted the implicit school norms that positioned families as still and silent. Sitting down at a table together with families to share stories, explore senses, and stay together goes against an expectation of families looking, listening, and leaving. Inviting nearby family members to join our virtual science (sense)making lessons during the school day—inviting brothers, grandparents, and other family members to share their noticings and wonderings about phenomena in English or Spanish—broke the implicit rule that a classroom space is between a teacher and students in English only. Sally and I were able to break these rules because we started recognizing them as socially constructed and aligned to norms of whiteness through our praxis. CRT impels us to question norms, and who has the right to decide what we know and how we know.

When considering the conceptual framework (Figure 2-1, p. 82), our novel engagement with families disrupted deficit-aligned school norms. However, the school norms also disrupted how we engaged with families. Unsurprisingly, Sally and I still maintained authority in these spaces. Family members still asked Sally for resources, rather than discussing how we could better leverage family assets. Families still waited for Sally and I to call on them, as they shared and we still maintained control over the direction of the sensemaking lessons. Although we were in both family and school spaces during virtual learning, we were firmly entrenched in a dominant school space. CRT and CWS expect this. When considering CRT’s whiteness as property tenet (Harris, 1993), despite our efforts to disrupt hierarchies, the white, English-dominant, Eurocentric teacher has the authority to decide how family engagement operates.

Whiteness is the deferred setting that we automatically reset to—like the grooves on a record and
a needle, our interactions will fall into the comfortable grooves of white, English-dominant educator/researcher as authority.

CRT helps us recognize that norms are never neutral, and racism is endemic. Critical consciousness provides a process to become more aware of these systems and to disrupt them through praxis. In this paper, I argue that sensoriality in science sensemaking offers a productive space to momentarily break from deficit norms of family engagement—the moment when the record skips as it is jerked out of the record’s grooves. By moving into a novel space with science (sense)making, Sally and I could disrupt epistemic authority and norms, if even for brief moments.

**How cycles of dialogue and praxis expand asset perspectives**

If Sally and I had remained in our traditional and distant researcher/teacher roles, we would not have engaged with families through sensorial science making. Our ethnographic problem-posing research approach moved us toward humility, self-reflexivity, and criticality. In this space, we were able to expand how we engaged with each other and families, moving toward honest, asset-aligned practices. In this section, I unpack how praxis (cycles reflection and action) expanded and humanized how Sally and I engaged with each other and families.

*Engaging with each other: Moving from evaluative to becoming*

Most science education research, particularly in elementary school, positions researcher as expert or interventionist, and elementary teacher as in need of remediation or support (Gray, McDonald, & Stroupe, 2021; Zembal-Saul et al., 2020). Over our three-year collaboration, Sally and I moved from a more traditional relationship, where I held a distanced, evaluative stance,
toward a collaborative relationships that led to a process of transformation and becoming. After my first honest member check with Sally in the fall of 2019, I began to break the rules of a distant observer. Moving away from an evaluative stance and seeking to understand Sally’s perspective allowed me to recognize the complexity in our work. This, however, causes epistemic panic (Ladson-Billings, 2003)—for the authority of knowledge is no longer in the hands of the academic.

When thinking with CRT, I recognize how dismantling the researcher/teacher and subject/object relationships threatens whiteness. An authoritarian researcher perspective aligns with a Eurocentric epistemology that protects and advantages white privilege and a dominant worldview (Ladson-Billings, 2000). This perspective insists that one authority (i.e., the researcher) is positioned as the knower. Using the tenet of whiteness as property (Harris, 1993), the researcher decides what knowledge is valuable and who has the right to decide what counts as knowledge. A black and white, evaluative stance on the world holds no room for complexity, and makes it easier to degrade groups of people, forcing them into static categories (Ladson-Billings, 2003). By the fourth movement of this study, Sally’s awareness of my research interests made space for her insights to re-shift how I considered touch in science sensemaking. Although I had set the research boundaries, the transparency around my research made space for Sally to bring insights into my work which I would have otherwise overlooked. Although looking at the researcher/teacher participant dichotomy through CRT is problematic when applying it to Sally and I, who are both white, English-dominant women, I take up this analysis to illustrate how praxis can unsettle epistemic authority.

Beyond re-positioning each other, Sally and I moved from deficit to asset-aligned perspectives of families by engaging in praxis. Figure 2-4 shows a timeline of how Sally’s and my relationship, theories, and positionings changed in our first year working together (Brown, et
al., 2019). The purple bars at the top of the figure represent my ethnographic approach, which changed from evaluating to seeking to understand, and eventually collaboration (collaborating and co-researching). The middle area of the figure in gray, tracks Sally’s theories about families, beginning with more deficit-aligned and one-directional paths, and expanding toward self-reflexivity and more asset-aligned theories as we move toward collaboration. The bottom section of Figure 2-4 in blue and green tracks how I perceive Sally. Initially I position her as having a static deficit perspective of families. However, as I move toward seeking to understand and collaborating, I recognize how Sally’s positions are both asset and deficit aligned. In doing so, I also recognize my own deficit positioning of Sally.

Mapping Sally’s theories of families and family engagement over time shows how they moved from deficit-aligned toward asset-aligned while we engaged in our praxis. Unsurprisingly, these shifts were not neat or complete. Deficit-aligned stories of families persisted throughout our engagement. As discussed above, an important shift toward asset-aligned stances occurred when I...
moved away from an evaluative position. Alongside expansions of asset-aligned perspectives came practices that positioned families as equals with assets. Moving away from the subject/object binary aligns with Freire’s (2000) conscientização and a humanizing pedagogy (Bartolomé, 1994; hooks, 1994). This changed how I interacted with Sally, needing to listen and learn from her, rather than teach, evaluate, and tell. An important aspect of my expanding positioning of Sally as collaborator, and our move toward critical consciousness was that it helped me overcome my hesitancy to disrupt Sally’s perspectives of families, which I heard as deficit. In analyzing my data, I recognized multiple instances where I did not outwardly interrogate Sally’s perspectives of families. Rather than questioning her beliefs, I remained silent, for fear of making Sally uncomfortable.

My instinct to not disrupt or displease others is part of my identity as a white woman, understood through the theory of white femininity (Delvosky, 2010). My fear of discomfort also intertwines with white solidarity: “the unspoken agreement among whites to protect white advantage and not cause another white person to feel racial discomfort by confronting them when they say or do something racially problematic” (DiAngelo, 2018, p. 57). Moving toward critical consciousness required that I engage with Sally in authentic and transparent ways (Freire, 2000). When I finally did share my evaluative stances with Sally in the fall of 2019, I began to unlearn white solidarity and move toward becoming. Seeking to better understand Sally’s perspectives made space for us to earnestly interrogate them. Sally was able to reflect and expand on her positions of families, and I was able to recognize how Sally’s lived experiences included stories of families as uncaring and neglectful. This helped me recognize the complicated nature of how we position families. Our constant cycles of praxis also helped me see how deficit and asset perspectives are not binary but are constantly intermingled. Our cycles of praxis helped me move
from a Cartesian “I think therefore I am” toward Ubuntu: “I am because we are” (Ladson-Billings, 2000).

**Engaging with families: Expanding asset-aligned perspectives and practices**

My purpose for this work is to neither navel-gaze nor gap-gaze (Gutiérrez, 2008), but to move toward asset-aligned practices through interrogating my and white educators’ deficit norms and perspectives. Thus, more important than shifts in Sally and my interactions with each other, is shifts in how we engaged with and perceived families. The four movements described in this paper illustrate shifts in how Sally perceived and engaged with families. Over three years, Sally’s stories of families changed. Although Sally’s lived experiences with abusive and negligent families continually surfaced over the three years, counter examples that positioned students and families as caring, intentionally marginalized, and valuable emerged over time. Although I do not attribute Sally’s changing practices to our collaboration alone, our repeating interrogation of how we engage with families made space for families to be invited in more frequently and in more expansive ways over time. Covid opened up an opportunity to engage differently with families, creating space for Sally to move toward daily interactions with families. Science sensemaking gave space for families to share noticing and wonderings alongside Sally and the students.

These expansions exist alongside deficit perspectives and within an entrenched school space that positions Sally as the authority. With CRT, we can understand that power asymmetries are well established, despite moments of atypical family engagement. However, this study illustrates the opportunity that science (sense)making affords to reposition families. With an increasing movement toward becoming and humanizing pedagogies, Sally and I can envision relationships with families that extend beyond the school year, and perhaps beyond a dichotomy of us/them.
Conclusion

Within the system of education in the United States, schools often position families as still and silent, disciplined to only engage with teachers to understand what they need to do to help their child or the school (Barajas-López & Ishimaru, 2020; Fine, 1993). Deficit perspectives are implicit in these norms, which assume families are obstacles, not resources, to their children’s learning. By engaging in cycles of reflection and action that interrogate deficit perspectives of each other and families, and moving toward family engagement practices that are sensorial, focusing on being with each other communally, Sally and I were able to expand toward asset-aligned practices and perspectives with families. This study shares our three-year journey, highlighting important movements that brought us toward humanizing stances. Here I share limitations of the study, along with implications for future research and practice.

An important limitation of this work is that I do not make space for the voices of Latine families. Centering my research on interrogating white, English-dominant, Cartesian ways of seeing, knowing, and being necessarily shines a spotlight on Sally and I, and interrogates our own deficit perspectives. Although our praxis moves us toward more humanizing engagements with families, a continued effort on this front would move us away from school-dominated norms of family engagement into spaces that muddle a teacher>family hierarchy. A limitation of this work is that our practices do not escape the boundaries of school. In future work, I hope Sally and I can build relationships with families that create opportunities for families to be positioned as decision makers, designers, and leaders within family-school partnerships. I recognize research that begins with the community (CBDR, Marin & Bang, 2018) as a more socially just and productive research frame than my endeavor which began and ended with Sally and me.

I also recognize the limitations of representing the complexities of a three-year ethnographic study in limited amount of space. Although I attempt to illustrate our journey over
four movements, this approach came at the cost of clarity and understandings of themes and findings. Lastly, much more research is needed to support a burgeoning hypothesis that sensorially rich making with families leads to more humanizing relationships. In the fall of 2021, colleagues and I piloted a family engagement professional development (PD) module with seven teachers in the community. This job-embedded PD module revolved around an interrogation of deficit perspectives of Latine families, alongside the planning, implementation, and reflection of a family engagement event that centered sensorial making, and being with families, rather than talking at them. Nascent reflections from teachers who participated in the PD suggest the productivity of a sensorial making space with families, however more research is needed in this space.

This paper speaks to the affordances of collaboration and transparency between researcher and teacher, particularly in long-term ethnographic work. Sally’s and my theories of engaging with families expanded once I moved into a more transparent and authentic collaborative role (see Figure 2-4). When researchers are positioned as authoritative and hold distant, evaluative stances of teachers, particularly when engaging in work that disrupts norms and perspectives, it limits the opportunity for knowledge production both for the researcher and the teacher. Moving beyond member checking to more collaborative approaches to ethnography (Lassiter, 2005) affords more rigorous research. Many of my theories about the senses and norms were seeded from Sally sharing her reflections with me. Had she not understood my research interests clearly, these could have been missed opportunities in theory building. Although other researchers have encouraged a move to engage with teachers as equals (e.g., Penuel, et al., 2015), science education literature, particularly at the elementary level, has room to improve (Gray et al., 2021; Zembal Saul et al., 2020).
Literature on the affordances of science sensemaking, making, and sensorial engagement with families, and how it repositions family/teacher dynamics is scarce (Buxton et al., 2013; Kayumova et al., 2015; Siegel, 2007). There is also a need for research that disrupts school-centric norms of family engagement that reifies whiteness (Auerbach, 2007; Bang et al., 2019; Fine, 1993). Initial findings from this study support the idea that making with students and families are productive. Although limited in scope, my study also shares productivity of making with students and families through virtual engagement. Thus, there is a need for future research that takes up sensoriality with the aim to disrupt deficit school norms of family engagement. One last implication from this work is the need to reconsider how the literature speaks about asset and deficit perspectives, and to reposition asset and deficit as both/and instead of either/or (López, 2018; Valencia, 1999). Although not explicitly presented as binaries, little if any literature positions asset and deficit perspectives as concurrent. However, both I and Sally juxtaposed deficit and asset perspectives. Recognizing the complexities in these frames can help better leverage them as tools.
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Chapter 3: Manuscript Two

Hands Off: Disrupting School Norms and Interrogating Whiteness Through Touch in Science (Sense)making

Introduction

“A world of meaning can live within the simplest gesture, a kiss, or the touch of a hand” (Classen, 2012, p. 10).

Soon after the start of the school year, my four-year old son came home from his daycare excited to show me how he must sit in his class. He crossed his legs carefully, explaining how he was doing “criss-cross applesauce.” He then clasped his hands together and put them in the small space in between his folded legs in front of him. “This is the spoon!” he said excitedly. Systems to manage and discipline students’ bodies, including their hands, and phrases like: “hands off” and “hands to yourselves” are ubiquitous in education, particularly in the early years (Juffer, 2019). There is a reason for these tools—teachers feel a need to control the potential chaos that ensues when bodies are not disciplined. However, disciplining students’ bodies to be still impedes their ability to engage fully with science phenomenon and sensemaking. This case study examines how a 2nd grade teacher and researcher navigate touch in a science sensemaking space and seeks to understand and interrogate underlying deficit perceptions of student touch. Using Critical Race Theory (CRT), critical consciousness (Freire, 2000), unframing (Greene, 1995; Powell & Serriere, 2013) and sensoriality (Gershon, 2019) as frames to interrogate our deficit positionings of emergent bilingual (EB), Latine student touch, I investigate the following questions: What does de-familiarizing and interrogating deficit-aligned norms of touch in elementary science sensemaking spaces do for teachers and researchers? How does this
**disruption influence how teachers and researchers perceive and elicit student touch in learning?**

*How does this disruption influence how teachers and researchers think about touch as a way of knowing?*

I begin with a rationale, illustrating why touch matters in science sensemaking, and briefly review the literature in this area. I then share my theoretical frameworks and methodology. Findings and analyses from the study are shared by highlighting three pivotal moments in time: an initial phase of disruptions and vacillations about touch in the fall of 2018, explicit interrogation of deficit perspectives through video-cued ethnography in the fall of 2019, and a reconsideration of touch in knowing during spring 2020 to 2021. I then discuss the affordances of disrupting and interrogating norms of touch in a science sensemaking space, particularly for EB students, as well as how this disruption leads to expansive ways of thinking about touch and student touch for both teacher and researcher. I conclude with limitations and implications from this work.

**The importance of touch in science sensemaking**

Despite the reluctance to encourage touch in classroom learning, research shows that touch has complex connections with the brain, and connects to exploration, manipulation, communication, and social interaction (Napier & Tuttle, 1993; Wilson, 1998). Touch is implied within reform-based science sensemaking curricula which centers an exploration of phenomenon (National Research Council, NRC, 2007; 2012). Research indicates that when elementary students, particularly emergent bilingual (EB) students, learn science through active, student-centered, phenomenon-based learning that models science practices, they are more likely to participate productively in science and language learning (National Academies of Science, Engineering, and
Medicine, NASEM, 2018; 2021; NRC, 2007; 2012). Students’ direct exploration of realia and phenomenon are productive language (Eisenkraft, 2013; Lee et al., 2016; Ünsal, 2017; Williams & Tang, 2020; Winter, 2004) and literacy (Clark, 1973; Grifenhagen et al., 2021; Luke, 1992) support strategies in science sensemaking. Museum science literature also supports the productivity of touch in science sensemaking (Ash, et al., 2007; Ash, Tellez & Crain, 2009; Kopeczak et al., 2015; Lindemann-Mathies, 2001). However, teachers, particularly those in low socio-economic communities, do not often engage students in student-centered, phenomenon-based science sensemaking (Change the Equation, 2017; NASEM, 2021). Many schools, particularly elementary classrooms, institute norms that position students’ bodies as still, keeping hands off of materials (Juffer, 2019). It is common for schools to have phrases to remind students how to sit, often including a prompt for students to clasp their hands, sit on their hands, or fold them neatly into their lap (Watkins, 2005).

The academy, including science education, has historically overlooked touch as a way of knowing, instead prioritizing vision, the mind, and language (Classen, 2012; Smith, 2007). This aligns with a Cartesian disembodiment of touch, smell, and taste, and a positivist inclination that one can know by their sight and thought alone—an idea built from the Enlightenment and Age of Reason (Smith, 2007). However, when critically examining our systems of knowing through Critical Race Theory (CRT; Ladson-Billings, 2000) and unframing (Greene, 1995; Powell & Serriere, 2013; Truman & Springgay, 2016), we can disrupt this tendency and consider the affordances of touch. Aligned with a critique of the Cartesian certainty of one’s sensorial knowledge, I position touch as both sensorial and socially constructed (Gershon, 2019). Similar to Ahmed & Stacey’s (2001) feminist construction of touch and the body, which can be seen “as both the subject and object of thinking” (p. 3), I recognize touch as “both an act and an enactment of meaning” (Schiller, 2015, p. 22). In this perspective, touch is racialized, along with other
intersections such as sexualized, gendered, etc. The racialization of touch is often hidden and
normalized (Claussen, 2012). CRT helps interrogate how whiteness positions non-white (e.g.,
Latine students of color) students’ touch in deficit ways.

Teachers and researchers also perceive EB, Latine students’ touch in ways that align with
a deficit perspective and a Latino Threat Narrative (Chavez, 2013; Rosa, 2019). A Latino Threat
Narrative characterizes Latine, new immigrant people as invading the U.S. and taking up welfare
and medical services, jobs, and housing (Chavez, 2013, p. 30). When applying this narrative to a
touch-centered science sensemaking space, teachers and researchers may position students’ touch
as greedy, off-task, and unruly, rather than as supporting cognition and connection. Given the
importance of touch in learning, particularly for EB students in a science sensemaking space, it is
necessary to disrupt norms of “hands off” and staying still, and to interrogate their underpinning
deficit perspectives. Teachers and researchers should uplift touch as a valuable way of knowing.
Literature supports the fruitfulness of disrupting sensorially-limiting norms in the classroom, and
engaging teachers and researchers in asset-aligned practices through critical consciousness
practices (López, 2018; Valencia, 1997).

Moving toward sensorially-rich ways of knowing and being in education has led to
productive outcomes in various education fields. For example, Suominen (2019) position the
senses and sensory as political, racialized, and deeply immersed in sociocultural context within
education: “It is the articulation of the sensory information and knowledge as not neutral but
rather as critically and contextually framed perceptions and conceptualizations of the values that
can, in my opinion, disrupt normative thinking and as a result ‘common sense’ education” (p.
179). Researchers within art education have used aesthetics to de-familiarize (Powell, et al., in
press; Truman & Springgay, 2016) everyday experiences and to unframe (Greene, 1995; Powell
& Serriere, 2013). Habitual norms to move toward “wide awakeness” (Greene, 1995) and critical
Researchers have recently put out a call for an epistemological shift in how we position the mind and body in education, moving toward more interconnected positionings (El Halwany, et al., 2020; Gershon, 2019; Kayumara, et al., 2015), however these stances largely sit in post-structuralist spaces.

Despite the literature that supports the value of touch, particularly in science sensemaking and with EB students, and the call for more literature that moves toward sensorial understandings and affordances, there is little literature on this topic in science education. This study takes up this space by examining how disrupting norms of “hands off” and stillness in a 2nd grade elementary classroom through science sensemaking and cycles of dialogue, reflection, and praxis, led a teacher and researcher to expand their understandings and practices of touch.

Critically examining deficit perspectives and reconsidering sensoriality of touch

My focus on touch is strategic. By centering a sensorial aspect of science sensemaking which teachers often tacitly discipline, I can surface a tension between the implicit norms of schooling and sensemaking. This tension provides rich fodder for Sally Matthews, the 2nd grade teacher I work with, and me to reflect on together, leading to changes in how we perceive and discipline student touch. A cycle of reflection and action affords us a path to critique and reconsider touch in learning spaces. Figure 3-1 (p. 133). illustrates this cycle. The box on the left shows a student “showing pride”, where they sit still with their hands clasped together. This is a norm at my field site, as it is in schools across the country, and symbolizes how teachers discipline student touch. The gray box below represents the opposite: hands on. The image shows students holding a bottle, their hands overlapping as they engage in touch. The blue arrows that encircle the boxes
represent how science sensemaking disrupts norms of hands off, but at the same time, school norms restrict touch in science sensemaking.

The disruption of norms creates a valuable space to reflect on the hidden and deficit ways we perceive touch and discipline how students engage in learning through touch. The image on the right of the diagram represents both a pair of glasses and a teacher and researcher. The teacher and researcher engage in collaborative reflection and dialogue, interrogating their own and each other’s deficit perspectives. Mirroring Freire’s (2000) praxis, this reflection leads to shifts in teacher and researcher perspectives, and in turn, how they engage students in touch. The cycle is iterative, with interrogation of school norms and deficit perspectives leading to expanding asset-aligned stances and practices. Central to this framework is the implicit deficit norms that exist in the classroom space around touch. I use Critical Race Theory (CRT, Bell, 1987), Critical
Consciousness (Freire, 2000) and a critique of Eurocentric positions of sensoriality (Gershon, 2019; Suominen, 2019) to better scrutinize the hidden deficit norms of student touch.

**Critical Race Theory**

CRT examines the uninterrogated norms within a classroom space, such as how students’ touch is disciplined and interpreted (Bell, 1987). This theoretical framework considered the local and national xenophobic ideologies, and helped maintain a focus on how norms are racialized and aligned with deficit perspectives and positionings. Tenets of CRT that are central to this work include: 1) how racism is endemic, normalized, and implicit; 2) whiteness as property; and 3) counternarratives. Intersectionality and either/or binaries are considered to a lesser degree.

**Racism as endemic**

A central tenet of CRT is that racism is “a permanent component of American life” (Bell, 1992, p. 13). Beyond being permanent, racism is also hidden and perceived as normal. This aligns with Joyce King’s concept of dysconscious racism, which is

> an uncritical habit of mind (including perceptions, attitudes, assumptions, and beliefs) that justifies inequity and exploitation by accepting the existing order of things as given [...] Dysconscious racism is a form of racism that tacitly accepts dominant White norms and privileges. It is not the absence of consciousness (that is, not unconsciousness) but an impaired consciousness or distorted way of thinking about race. (King, 1991, p. 135)

This tenet aligns with its Black feminist roots by focusing on the implicit and uninterrogated ways society sustains racism, along with intersections of other oppressive systems (e.g., patriarchy). These hidden, seemingly “normal” ways of knowing and being pervade the legal system, including equality laws, which do not dismantle racism despite their appearance.
Recognizing that racism plays out both consciously and unconsciously, and across many systems (e.g., education, healthcare, justice systems, etc.), and is not about to go away quickly or easily, is a critical component of CRT (Bell, 1992; DeCuir & Dixson, 2004; Ladson-Billings & Tate, 1995; Lynn & Parker, 2006; Sung & Coleman, 2019).

Whiteness as property

Whiteness as property recognizes how racial identity and property are and historically have been intertwined, with white people being afforded privileges that Black and Indigenous people do not have (Bell, 1987; Harris, 1993). Cheryl Harris’ (1993) work unpacks how whiteness affords rights of disposition, use and enjoyment, representation and status property, and the absolute right to exclude, and recognizes how property is both real and symbolic. Central to Harris’ (1993) work is the recognition that the right to possession of property has been legally constructed alongside whiteness, with only whites being afforded this privilege. Applying this tenet to the system of education highlights how schooling is complicit in whiteness as property (Annamma, 2015; Ladson-Billings, 1998). Mensah and Jackson (2018) apply this tenet to pre-service teachers in science education, recognizing how science is positioned as white property.

Counter narratives

Counter narratives help challenge dominant norms (Yosso, 2013) and challenge claims of “neutrality, objectivity, color-blindness, and meritocracy” (Ladson-Billings & Tate, 1995, p. 56). Uplifting voices that are silenced allows people to engage with hidden racism and white supremacist ideology (Ledesma & Calderón, 2015). These counter-stories can destroy deficit mindsets, “shatter complacency and challenge the status quo” (Delgado, 1989, p. 2414). Through
counter-stories, critical race scholars are able to “cast doubt on the validity of accepted premises or myths, especially ones held by the majority” (Delgado & Stefancic, 2001, p. 144).

CRT is a useful tool to interrogate touch, particularly in a context with a large community of students who are Latine and emergent bilingual (EB). For example, CRT recognizes how the body and touch is racialized (Sekimoto, 2018). Disciplining touch so that students keep their hands off of materials and phenomenon, and instead sit still and silent reveals a hierarchy in the senses and the mind. Students as still and silent positions vision, text, and the mind as superior to touch and other senses. This aligns to a white, western, Cartesian way of knowing. Centering critical lenses in this work re-aligns my researcher perspective to resist binaries and hierarchies of mind/text. This framework interconnects with both an epistemology that moves toward becoming, and a methodology that includes sensorial ways of knowing and movement toward critical consciousness through reflection, dialogue, and action.

**Critical consciousness**

Paulo Friere’s (2000) critical consciousness is both a theoretical framework and a methodology. It informs the way I position myself as a researcher and the way I perceive and consider Sally Matthews, the 2nd grade teacher I work with. Freire’s (2000) problem-posing pedagogy positions the object as subject. Freire (2000) writes: “No one can be authentically human while he prevents others from being so. Attempting to be more human, individualistically, leads to having more, egotistically, a form of dehumanization” (p. 85-86). Although my relationship with the teacher I work with does not align with Freire’s oppressor/oppressed hierarchy, I have taken up this positioning of self and other in partnership.
Freire’s (2000) problem-posing pedagogy describes iterative cycles of dialogue and praxis to lead toward expanding critical consciousness. My relationship and experience with Sally in interrogating our own and each other’s deficit positioning of students and the norms of touch in the classroom echo this structure. Praxis consists of an action and a reflection of that action, in a constant cycle. Freire (2000) defines praxis as “reflection and action upon the world in order to transform it” (p. 51). This process leads to an awakening of how we are steeped in systems of oppression, which then lead to further reflections and actions, thus deepening critical consciousness. Praxis and dialogue are two sides of the same coin, representing ways to move toward critical consciousness: “In dialectical thought, word and action are intimately interdependent. But action is human only when it is not merely an occupation but also a preoccupation, that is, when it is not dichotomized from reflection […] not in terms of explaining to, but rather dialoguing with the people about their action” (Freire, 2000, p 53).

An important concept taken up in Freire’s (2000) Pedagogy of the Oppressed is the act of becoming. In my work, I conceptualize becoming as transforming who we are, how we perceive the world, and how we act in it. This definition comes from Freire’s (2000) discussions of problem-posing pedagogy, whereby “people develop their power to perceive critically in the way they exist in the world with which and in which they find themselves; they come to see the world not as a static reality, but as a reality in process, in transformation” (p. 83; original italics). As this paper will exemplify, over iterative cycles of praxis, Sally and I moved toward a space of transformation and becoming when considering how we engage students in science sensemaking and touch. By critically reflecting on our actions and interpretations of student touch, we were able to transform our perception of ourselves and others. This aligns with becoming, where centering tensions and contradictions alongside critical reflection and action, makes space for us
to expand our boundaries of how we are, how we think, and how we engage with the world around us (Aoki, 2005; Freire, 2000).

An ethnographic case study

Ethnography is the study of culture—a way to understand a place or people in ways that make the familiar strange and the strange familiar. I am seeking to understand and interrogate the deficit perspectives of white, English-dominant teachers and researchers. Although I consider how a collaborating teacher and myself position and engage with Latine, EB students, the culture I am studying is that of white, English-dominant, female educators. When I consider the key tenets of critical consciousness, it is imperative I am not a distant observer in this work, but rather that I work alongside the teacher, examining and interrogating my own interactions with the teacher and the students. My ethnographic approach takes up some of the same characteristics of collaborative ethnography (Lassiter, 2005), in that it positions participants as consultants rather than informants and is completely transparent with research throughout the ethnographic process, including in subsequent written work, which is often co-written.

I distinguish this work from collaborative ethnography in that my work did not begin with a question or research interest from the community, but instead I began with my own questions which were taken up and built on by the teacher I work with, Sally Matthews. Also, many collaborative ethnography projects are partnerships across cultural boundaries, whereas Sally and I, although from different cultures in many ways, share many dominant backgrounds and spaces. Beyond conducting ethnography in a collaborative fashion, I also center sensorial ethnography (Gershon, 2019; Suominen, 2019). CRT has helped me examine my researcher lens, recognizing how Western, white ways of knowing and being are implicit in my research methods.
and perspectives (Fine, 1994; Ladson-Billings, 2000). To better recognize and move away from Eurocentric, Cartesian research approaches and epistemologies, I take up sensorial ethnographic approaches, moving toward the sense of touch in this work (Ladson-Billings, 2000). By centering touch, I seek to complexify how we know and are in the world, rather than draw clear lines between the mind and body (Ladson-Billings, 2000).

**Context**

This research is part of a national professional development (PD) project that brings together school, university, and community partners in support of EB students’ learning both in and out of the classroom. Researchers work alongside teachers as they design, enact, and assess how science sensemaking can amplify English language development and equitable access to meaningful learning experiences for all children (Hopkins, Zembal-Saul, Lee, and Cody, 2019). This work is situated in Douglas Elementary School, a K-2 school with about 400 students, in a semi-urban city in the northeastern United States that has a majority Latine, largely Dominican new immigrant population. The demographics of the community have dramatically changed in the last two decades. In 2000, the community was 93% white, while recent data suggests that the population is now approximately 56% Latine, primarily from the Dominican Republic and Puerto Rico. Sally’s 2nd grade classroom similarly has a majority Latine, Dominican new immigrant population that has grown dramatically in the last two decades. The behavior expectations in her classroom align with those in the school, where students are expected to “show pride,” which entails sitting upright, folding their hands together, and “putting a bubble in their mouths.” These expectations mirror many elementary school norms across the country (Watkins, 2005). Sally and I are both white, English-dominant, women. Sally has a background in Special Education and is
the mother of a bi-racial son. She has taught in the community for over 20 years. I am the mother of two white children, and am a former science teacher, who was praised for my ability to manage behavior in middle-school and 9th grade science classrooms.

**Positionality**

My experiences, perspectives, and being are inextricably linked to this work. I am a white, heterosexual woman who comes from a middle-class family, raised with ideologies rife with the myth of meritocracy. I taught in an urban public middle school for six years and worked in an urban charter high school for three years, learning and reifying norms of whiteness that positioned students and families as still and silent. When collaborating with Sally during the past four years, I often returned to my teacher-self, praising students who were still and silent. When analyzing my research and writing, I often overlook the ways whiteness operates, including in the language I use that hides whiteness through passive tenses and metonyms. The theoretical frameworks I use helps interrogate how I engage, perceive, and exist in this work. CRT helps me pay attention to whiteness, and how white ways of knowing and being are implicit in my research methods and my perspective. Inevitably, I also center words and sight, and a sensorial approach helps me move toward the body and touch.

**Methods**

This study comes from a larger four-year (2018-2022) ethnographic study (Emerson, Fretz, & Shaw, 2011) that considers how Sally Matthews and I move toward asset-aligned perspectives and practices with Latine, EB students and families through disrupting school norms of staying still and quiet, and engaging in praxis. I use case study design to draw a boundary
around how Sally and I (de)center and reflect upon touch, its affordances for language practice, and how it conflicts with school and classroom norms. This case study is an ethnographic (Merriam, 2001), instrumental case (Stake, 1995) in that it seeks to better understand how touch is centered, and how tensions between tactile learning in science sensemaking and elementary school norms of staying still are navigated. It is a descriptive case study (Yin, 2003) in that its aim is to explain and describe the expanding understandings of the role of touch in science sensemaking and language practices, alongside norms that limit tactility in learning.

This case study uses field notes, video observations, interviews, and data from a video-cued ethnography (VCE) project (Brown, 2020; Tobin et al., 2009). To gather data for the case study, I created an observation guide which looked for moments of or reflections about touch in science sensemaking and considered how Sally and I disciplined touch (Hamilton & Corbott-Whittier, 2013). I reviewed data from 73 different co-teaching and co-planning visits (totaling 393 pages of fieldnotes and over a hundred video clips). See Appendix A for a description of the observation guide and raw data. I then employed a grounded theory approach (Glaser & Strauss, 2017) to openly code nuances within the larger case to arrive at the themes discussed below. I triangulated data through field notes, video, and interview data. The findings were also member checked with Sally.

**Expanding perspectives and approaches to touch over time**

After collecting data that centered touch in science sensemaking and openly coding the bounded data, I noticed tensions and expansions of how Sally and I positioned touch. Sally positioned touch within a science sensemaking space as both disruptive and a valuable learning tool, and my own engagement in her classroom mirrored these dichotomies. At the same time, throughout our
practices, reflections, and dialogue, we gradually moved toward more expansive, asset-aligned touch-centered explorations and reflections. My case study analysis highlights three major shifts over time: 1) an initial phase where we vacillate between reifying and subverting school norms of staying still and deficit perspectives of student touch, 2) a phase where we actively interrogate our own deficit perspectives of students’ engagement and touch, and 3) a phase where we expand our thinking about touch and its affordances for learning. Although our perspectives and practices around touch did not expand linearly, and asset and deficit positionings and conflicting norms co-existed across our four years, there was a general movement toward a more expansive, asset-aligned stance on touch over time. I outline the three phases in the section below, beginning with vignettes that epitomize each phase along with supporting data and analysis.

**Disruptions and vacillations: Fall, 2018.**

*Sally, co-teacher Iris, and I meet to discuss recent lessons around science sensemaking and to plan our future lesson. In last week’s lesson, students explored models of clouds involving shaving cream. Sally and Iris report success, noticing students were talking more. Iris also recalls: “[Students] wanted to touch [the shaving cream] so badly!” Sally shares how she had to have students watch her demonstrate the cloud model with shaving cream because it was too chaotic when students were doing the lesson themselves. When discussing an upcoming evaporation lesson, Sally decides she will call groups of students up to a table to observe and discuss the phenomenon, while other students wait. I suggest that we give each student their own materials. After a short silence, Sally and Iris decide this will be too noisy and disruptive, and students would not stay on task with materials at their desk. Although I disagree, it is early in our relationship, and I go along with their decision, fieldnoting my concerns rather than sharing them.*

Since our early collaborations, Sally and I engaged students in science sensemaking lessons that involved touching various phenomenon (e.g., water, glowsticks, ice, shaving cream). In reviewing audio and video recordings, interview transcripts, and fieldnotes, Sally and I both
disrupted school norms of hands off, while at other times reinforcing these norms. Our deficit perspectives arose alongside asset positionings of student touch. These side-by-side vacillations started in September of 2018, as excerpted in the vignette above. Sally was hesitant to have students engage with materials at their desk, while recognizing the affordances of science sensemaking and touch. Sally’s inclination to not provide students with materials, but to instead expect them to sit and wait quietly reifies the school norm of “showing pride,” where students sit with hands folded and mouths closed. Although I disagreed with this positioning, I did not openly inquire Sally and Iris’ position, and during our co-teaching, I reified norms of hands off and staying quiet by similarly disciplining students who were out of their seats, touching phenomenon, or talking. This vignette and other examples from the fall of 2018 shared below highlight how science sensemaking disrupted a norm of “hands off,” while this same norm disrupted science sensemaking, surfacing deficit positions of touch.

**Disrupting norms and norming disruptions**

The presence of tactile-rich phenomenon in Sally and Iris’ science sensemaking lessons made it even harder for students to enact the norms of hands-off. Iris notes this herself when reflecting on how the students responded to the shaving cream, stating “they wanted to touch it so badly!” When we planned for the next lesson, my suggestion of placing materials within students’ unsupervised touch again disrupted a norm of hands-off. In mid-October, I proposed sending rain gauges home with students, and later that month we gave students glowsticks and cups of water, disrupting a hands-off school norm. However, the norm of being still and not touching, in turn, disrupted our science sensemaking lessons. In September, Sally decided to have students observe a demonstration instead of providing students with materials they could touch and dismissed the
idea of sending home materials to students and families. However, even early in our collaboration, there were many instances where Sally allowed and even promoted touch, movement, and sensorial learning. In late October, students cracked glow sticks, shook them, and felt the warm and cold water they were placed in, alongside us setting norms about when, what, and how to touch. Students’ bodies increasingly stood, moved, and leaned as hands reached to feel the wetness of condensation, the warmth of hot water, and explore the glow sticks. These interactions occurred alongside my own and Sally’s redirections, for example I told students: “Don’t touch, just look” and Sally asked students to listen and stop “playing.”

Deficit and asset positionings

A critical analysis of video, audio, interview transcripts, and fieldnotes highlights how Sally and I positioned students’ and families’ touch in deficit ways. For example, in the vignette on page 140, touch is precluded for fear of students being too noisy and chaotic. Rather than positioning touch as a way to learn and explore, and assuming students are seeking to understand phenomenon, Sally assumed touch would result in students actively not learning. Sally’s supposition was based on a prior science sensemaking lesson where students explored a cloud model that included shaving cream. Sally reflected that this exploration became chaotic, resulting in a teacher demonstration of the model with students observing from a distance. Positioning touch as chaos and play assumes students are arriving to the exploration without an interest to learn and understand – that their touch is off-task rather than on-task. Another deficit positioning of touch and phenomenon occurred in mid-October, when Sally dismissed the idea of sending students home with rain gauges. Both Sally and her co-teacher believed the objects would not return, since there was no care of objects, with Sally stating: “they [students] destroy everything.”
You should see the playground. The plastic cup will never make it home.” This notion of carelessness aligns with a Latino Threat Narrative that positions the Latine community as destructive and dangerous, and is predominant in the school, community, and nation (Chavez, 2013). These deficit stances co-existed with Sally’s strong asset perspectives of students and their families. Sally cared deeply for her students and was excited to see how students took up ideas and thinking. She positioned students as knowers, regardless of their ability to speak English. Sally also trusted her students to be able to handle phenomenon such as hot water and glow sticks—a positioning that directly contradicted a viewpoint that students destroy materials.

A lack of dialogue and reflection

My early interactions with Sally were evaluative and centered my own deficit positionings of her. When Sally declined my suggestions for students to take home materials or have materials at their desks, I never tried to understand her reasonings or share my own, yet I privately questioned her intentions. Considering Freire’s (2000) theory of conscientização, this was a missed opportunity to fully understand Sally’s thinking and engage in a cycle of reflection and action. When I showed this vignette to Sally in the spring of 2021, she shared how she usually does not put students into groups until October, after she knows her students better. Although she acknowledged the tension between school norms and touch, this highlights the importance of open dialogue between researcher and teacher to fully understand how and why decisions are made around touch.
Interrogating deficit perspectives of touch: Fall, 2019.

In October I show Sally a video of her students creating a bottle filled with glue, glitter, and hot water. In one video clip, students’ hands overlap each other, one tries to peel other fingers away, and then hands rest on top of each other. I point out the scene to Sally, asking her what she thinks about it. She responds: “They all want to be involved. [...] They all want to help. They all want to be the person, like they all want to be the line leader, they all want to be, that’s typical. [...] Like it’s like: mine, mine, mine, mine – like I’m the helper, I’m the one ...” A month later, I return to the video, sharing my perspective of how these hands represent the physicality of a Latine culture. Sally confirms her earlier position, stating: “They’re very greedy.” In early December, we return to the video clip again, laying Sally’s, a student’s, a community member’s, and my own perspectives side by side. I interrogate my own response that positioned students in a monolithic way. Sally similarly re-considers her perspective, saying: “Well, look it, I was like ‘they’re being greedy’ and later I was thinking, that’s not what they were doing, they were trying to be helpful.”

The vignette above highlights the expanding perspectives on touch that Sally and I developed since our initial collaborations a year earlier. After a year of co-planning and co-teaching lessons that center tactile phenomenon, the school norm of “hands off” is regularly disrupted by our science sensemaking. Also, as Sally and I work together, I move from an evaluative stance toward an interest in better understanding Sally, her perspectives, and her practices. During our time together I recognize my own deficit positioning of Sally and move towards a more transparent and trusting relationship with her. This vignette and examples shared below illustrate how our hands-on science sensemaking approach becomes normalized and less disciplined over time, and our collaborative relationship affords us to interrogate our own and each other’s deficit perspectives of student touch.

Disrupting norms and creating new ones

Although Sally’s initial engagement with science sensemaking resulted in disciplining and limiting touch, as we moved into the spring of 2019, seemingly chaotic, noisy, and messy
tactile exploration of phenomenon became a weekly occurrence. Students dove their hands into Oobleck—a non-Newtonian fluid consisting of corn starch and water. In a sustained investigation around properties of matter, students tested out various materials, such as oil, soap, water, glue, clay, pasta, salt, and sand to help define and understand liquids and solids. As students engaged in these explorations, their language expanded, often alongside touch. Sally and I disciplined students’ touch less frequently over time, although we would occasionally redirect students when their excitement felt overwhelming. In one especially noisy classroom in October of 2019, Sally called out: “Hands off! Hands off!” after students had started loudly shaking and almost mixing various bottles with solids and liquids in them, with me yelling: “Do not open! Let’s stop shaking!”

A notable indication that norms were changing was when Sally and I began rewarding students for their rich discussions, noticings, and wonderings that stemmed from their tactile explorations. Similar to other schools, teachers at Douglas Elementary give students “Pride Paw” tickets to reward them for “showing pride” which often means sitting still and being quiet. In May of 2019, Sally began encouraging me to reward students for doing the opposite—for sharing thoughtful insights after exploring phenomenon. The vignette that begins this section refers to a science sensemaking lesson where students try to recreate settling jars—bottles filled with glue, water, and glitter that have different viscosities. In this series of lessons, students were routinely pouring, touching, and making, resulting in a video clip that showed students’ hands touching each other. Beyond classroom norms of touch and engagement with phenomenon, Sally also began sending home materials in February of 2020. Sally was happily surprised to receive back materials and reflections from every student following this endeavor, spurring touch and material-rich learning to move beyond the classroom.
Interrogating our deficit perspectives of touch

Over the course of our first year together, I moved from an evaluative stance of Sally toward a position of seeking to understand. With this change in stance came a movement toward dialogue, reflection, and increasing trust. In our second year together, from late September to early December of 2019, Sally and I engaged in an iterative reflection and analysis of a short (7 minute) video that highlighted students’ science sensemaking. This work was part of a course project on video-cued ethnography (Tobin, 1989; Tobin & Hsueh, 2007), an approach that seeks to surface tensions between various perspectives. A key scene in the video shows students’ hands holding the bottle (Figure 3-2). Then two more students’ hands join in, and one appears to try to peel another off from the bottle (see Figure 3-3). One student’s hands then move over to another student’s hands, resting there for a moment (see Figure 3-4). Lastly, a student’s hands leave the bottle as one student’s hands remain (see Figure 3-5).

Figure 3-2: Jonathan’s hands on the bottle
Figure 3-3: Jonathan peeling off Calvin’s hands.
Figure 3-4: Lydia’s hands rest on Jonathan’s hands.
Figure 3-5: Jonathan’s hands remain on the bottle.
After Sally’s initial viewing of the video in late September, she did not point out the hands on the bottle scene. When I showed her the video again in mid-October, and specifically asked for her reflections about the hands on the bottle scene, she responded: “They all want to be involved. […] They all want to help. They all want to be the person, like they all want to be the line leader, they all want to be, that’s typical. […] Like it’s like: mine, mine, mine, mine – like I’m the helper, I’m the one …” (Interview 10/15/19). During this time, I began formulating my own interpretation of the scene, believing it showed a physicality and closeness between students which I was not used to seeing in school. After speaking with a Dominican friend in the community who held my hand in hers while we spoke, I attributed this physicality to students’ Latine, and specifically Dominican culture. In November, I shared my interpretation with Sally, and asked for her interpretation again. When I discussed how students were grabbing the settling jar, almost hugging it, Sally confirmed her earlier position, stating: “They’re very greedy” (Interview, 11/19/19). I then asked two other people for their interpretations of the hands on the bottle scene: Sally’s 2nd grade student, Calvin, and a community educator, Natalia. When I asked Calvin why everyone’s hands are on the bottle, he responded: “Cause you’re pouring water inside it” (Interview 11/19/19). After more discussion, he explained “so the water doesn’t get out […] we don’t want the water to spill.” When I heard Calvin’s interpretation, I began to question my own interpretation: had I read too much into what I saw? I began considering how I was mapping a cultural stereotype of being physical, warm, and close, onto the Latine students in the video.

In early December, I asked Natalia for her interpretation of the hands on the bottle scene. She responded: “It’s like, everybody wants to hold the bottle. They- they- like want to hold the bottle. Like move your hand, I’m holding it” (Interview, 12/03/2019). After hearing this perspective, my hesitancy again shifted, and Natalie confirmed my culture-centric interpretation, stating: “We [Hispanic people] touch. Touch hair, touch—we are very touchy” (Interview,
12/03/2019). I also shared Calvin’s and Natalia’s perspectives of the hands on the bottle scene with Sally, and we discussed our interpretations a fourth time. I had come to our conversation recognizing how my initial interpretation positioned Sally’s students in monolithic, static ways—attributing their touch as connected to a single stereotype. I also came to our discussion prepared to challenge Sally’s “students as greedy” interpretation, interrogating it as a deficit perspective that aligned with a Latino Threat Narrative (Chavez, 2013). I was surprised to learn that Sally’s perspective had also shifted—that children (regardless of their ethnicity) want to help: “Well, look it, I was like ‘they’re being greedy’ and later I was thinking, that’s not what they were doing, they were trying to be helpful” (Interview, 12/03/2019). The shift in perspective allowed Sally and I to discuss our deficit-aligned interpretations openly, leading to an agreement to work together to challenge ourselves and each other on the deficit perspectives we bring to working with EB students.

**Dialogue, reflection, and changing practices and perspectives**

The Video-Cued Ethnography project expanded a practice where Sally and I openly interrogated our own and each other’s deficit-aligned perspectives of each other and the EB students and families in her class. When comparing our interactions to those from the previous year, our trust and ability to try to understand and critically recognize deficit norms and practices had expanded significantly. Also, centering the hands on the bottle scene, and repeatedly reflecting on it with Sally, helped me better recognize the importance of touch in student learning, paying more careful attention to touch in ways that would continue to grow in the next years.
Reconsidering touch as knowing as we move into becoming: Spring 2020 - 2021

Sally and I are on a zoom call, planning our co-teaching lesson for the next day. Amidst discussions about what students will notice and wonder as they explore different reactions of acids and bases, Sally recounts how she was watching the movie My Octopus Teacher because one of her students likes squids. “As I’m watching it, the guy says: ‘An octopus—two-thirds of their cognition is in their arms outside their brain. Their 2,000 suckers explore independently and they learn as they explore their world.’ And it just made me think of kids, because they’re touching things and doing things, they learn more when they’re doing things.” (5/4/2021).

In early 2020, with the reverberations of interrogating touch through the hands on a bottle video clip lingering in my head, I began considering touch in Sally’s classroom differently. I started talking about touch differently with students, which is evident from fieldnotes and video recordings. For example, I asked students to share what they notice and wonder about how objects feel, centering texture and touch more than I had in the past.

As Sally and I continued to engage students in tactile-rich phenomenon through sustained science investigations, class norms continued to be hands-on, rather than reinforcing the school norm of hands-off. My fieldnotes centered touch more frequently, with words like “touch,” “feel,” and “hands,” showing up more. Sally and my roles also shifted, as I begin to supporting Sally as she took the lead in engaging students in science sensemaking more often. Although we still disciplined students to stay still and not touch, touch moved towards an accepted way to explore science. In early March of 2020, our collaboration paused as Covid hit, and did not resume until mid-Fall. However, when we resumed our science endeavors, we did not hesitate to send home weekly packets of tactile-rich materials, and engage students in weekly, albeit remote, hands-on science sensemaking lessons. With the “chaos” now virtual, my ability to reflect on students’ sensorial learning was muted. Being in a room of student touch felt and sounded differently than engaging with student touch over a computer screen. Still, I centered touch in my
practices. Sally and I often began our explorations with students holding each material, taking in how they felt before observing phenomenon. We asked students what they noticed and wondered about textures, often inviting nearby family members to join in. By early spring of 2021, I began to recognize moments of touch that felt different in Sally’s classroom, similar to my reaction to the hands on a bottle video clip. For example, one fieldnote states: “There is this beautiful moment of all the screens I see filled with students handling materials. There is something so comforting in knowing they [students] are still able to hold, touch, and test things even though it is during a remote learning session in the pandemic” (2/17/21). Figure 5 shows such a moment during this lesson.

![Figure 3-6 Students hold materials while learning remotely](image)
Repositioning touch as a way of knowing and as a teacher

Although I had begun noticing and thinking about touch more since our VCE hands on a bottle interviews, I did not consider how Sally had thought about touch differently following that event. Amidst the chaos of Covid, virtual teaching, and navigating a completely new reality, I did not spend much time reflecting on how my own perceptions of touch had changed. In early May, Sally and I met virtually to plan our science lessons, and her comment about *My Octopus Teacher* and touch, as summarized in the vignette starting this section, jolted me. I had never considered the cognitive nature of touch—the way touch leads to a direct knowing that moves beyond conscious thought. Sally’s reflections on touch as a way of knowing marked a significant shift in my research focus, along with how I positioned touch. Prior to this interaction, I had positioned touch as an important additional sensorial component that helps EB students put words to objects. I recognized the importance of touch in engaging students in science sensemaking, but I had not considered how touch itself was a way of knowing, how touch communicated understandings in ways beyond and intermingled with dominant senses. From this point forward, I not only saw touch as an important scaffold for student learning and understanding, but as a teacher itself. This movement toward learning from phenomenon impelled Sally and I to write a storyline over the summer of 2021 that centered natural phenomenon and Indigenous perspectives of learning, where nature itself was positioned as teacher, and touch as an important way to learn and understand about the world around us.

**Becoming**

Sally’s insights about touch not only helped me re-think my understandings of touch, but also my understandings of our relationship. My fieldnotes from that day note:
This was an amazing moment for me [when Sally shared about touch as cognition] [...] Sally’s thinking that she’s sharing with me is directly influencing how I think about co-teaching and my larger research interest [...] Sally is providing critically tuned reflections that tie to my interests because she is fully aware of the research I’m interested in, and because we have developed a transparent relationship (5/4/2021).

Although I had sought to position Sally as a collaborator and partner, recognizing the ways in which she was also a mentor and teacher opened up space for us to strengthen our practices of interrogating norms (in this case, of touch), engaging in dialogue and reflection, and moving toward changing practices, perspectives, and asset-aligned ways of being.

Changes in how I perceived and interacted with Sally and her classroom moved beyond our positionings of each other. When analyzing my fieldnotes, along with seeing increased use of touch-centered words, I also noticed an increase in words about love, joy, and the energetic response students had when engaging with touch. For example: “There was a lot of love in that room [Sally’s classroom], and it felt really good—my heart was joyful” (5/12/2021). While re-analyzing data and arriving at this pattern, I recognized a recent interaction that aligned with a more humanizing lens on Sally and her students. After passing a Jericho plant around the room and asking students to feel, hold, and touch it while they shared initial noticings and wonderings, a student raised his hand and shared that a classmate in his group had been overlooked, and hadn’t been able to hold the plant. Handing the plant to the overlooked neighbor, I praised the student for his kindness. Sally handed me a “Pride Paw” ticket to give to him—a similar ticket which I handed out two years prior for good discussions, and which is typically given to students for “showing pride.”
Touch in science sensemaking: A productive space for interrogating norms

Phenomenon-rich, tactile science sensemaking elicited tensions and changes in Sally’s 2nd grade classroom. When analyzing four years of ethnographic fieldnotes, interviews, and video recordings through a case study bounded in touch, I recognized how Sally and my negotiations of touch with each other and her students changed over time. Initially Sally limited students’ touch by conducting demonstrations and resisting sending materials home. However, as Sally and I continued to collaborate around science lessons, materials more often reached the hands of students both at school and at home.

Engaging in sensorial science sensemaking created space to break norms of students “showing pride,” instead making room for students to touch, talk, and be in ways that were noisy and messy. This new space was ephemeral, with Sally and I often disciplining students toward stillness and silence. Looking at how Sally and I engaged and restrained students’ touch over four years highlighted both expansions and backslides. For example, when tracing how we gave students praise and “pride tickets” over time, students were initially praised for staying still and silent, but this moved into praise for their science discussions, and eventually for recognizing the importance that all students get to touch and experience science phenomenon. The brief moment of a video clip, where students’ hands covered a bottle, led to a pivotal period of interrogating how we perceived student touch, and the deficit, monolithic perspectives that underpinned our thoughts. At the time, I did not recognize the value and subjective quality of touch, but it led me to hone into the sensorial and how senses were interpreted in deficit ways by Sally and me.

Following this period, Sally and I became more attuned to touch in her classroom, with Sally’s reflections on knowing through touch shifting my own perspectives and research. In this discussion, I unpack the productivity of touch in science sensemaking to disrupt deficit norms and perspectives, specifically through CRT and critical consciousness. I will critique the norms of
touch, tying these norms to whiteness through CRT, and unpacking how these norms align with a Latino Threat Narrative and deficit positionings. I also will uplift the power of praxis to recognize and disrupt how touch is disciplined and debased.

**Critiquing norms of touch**

White ways of knowing implicit in education position the visual, verbal, and textual as superior to touch and other senses (Clausson, 2012; Gershon, 2019; Smith, 2007). Marimba Ani (1994) states: “Rob the universe of its richness, deny the significance of the symbolic, simplify phenomena until it becomes mere object, and you have a knowable quantity. Here begins and ends the European epistemological mode” (p. 29). In classrooms across the United States, students sit with their hands clasped and mouths shut, stuck in didactic teaching that aligns with this Cartesian sensibility, as well as a banking model of education (Freire, 2000). These epistemologies also align with whiteness and white supremacy, which separate mind from body and recognize white, Eurocentric, English-dominant knowledge as superior (Bell, 1982; Ladson-Billings, 2000). However, it is difficult to recognize, let alone challenge how teachers discipline students to be still and silent, when these norms are pervasive in schooling.

With CRT, I recognized how positioning touch as a valid way of knowing actively disrupts Eurocentric norms (Ladson-Billings, 2000; Gershon 2019). Centering touch through science sensemaking contrasts with school norms that position students as still, silent, and with their hands off. These norms are not unique to Sally’s classroom or school. Elementary schools across the United States often train students to sit “criss-cross applesauce” or position their bodies in other ways that control and limit hands (Juffer, 2019). These practices are particularly prevalent in “no excuses” schools which strictly discipline bodies, popular with “urban” school-
reform models (Golann, 2015). However, these norms, which conflict with a tactile-rich, “hands-on” science sensemaking approach to learning, are rarely discussed in elementary science education literature. Those that acknowledge the need to change school norms do not pay attention to touch, but instead uplift aspects that are tied to post-structuralism and social negotiations (Gershon, 2019).

Touch is socially constructed (Ahmed & Stacey, 2001) and racialized (Classen, 2012; Schiller, 2015; Smith, 2007). When we look at how touch is disciplined and perceived in elementary classrooms, particularly in classrooms with EB, Latine students, deficit-aligned assumptions about touch as off-task, chaotic, and aligned with play not learning, surface. Bringing in a Latino Threat Narrative, which recognizes national ideologies that position Latine people as dangerous, dirty, and hoarding resources (Chavez, 2013), helps connect student touch with a notion of greed. For example, Sally’s initial interpretation of the hands on a bottle video clip was that it represented students as greedy. CRT also helps us interrogate Eurocentric epistemologies that position reality in a binary, either/or frame (King, 1995; Ladson-Billings, 2000). This either/or frame positions groups as us versus them (Ladson-Billigns, 2000), and makes no room for holding the complexity of two competing thoughts (Ladson-Billings, 2003). With a CRT lens, we can see that a monolithic, us/them mentality benefits white supremacy, as often white, English-dominant, high SES groups are positioned as superior to Spanish-dominant, Latine, lower SES families. I viewed the hands on a bottle video clip as representing a physicality of Latine people, which upon reflection, flattens Latine students into a stereotype. Only after interrogating my perception of touch, alongside dialogue and reflection with Sally and a CRT lens, was I able to recognize how this aligned with Eurocentric positionings of others.

Upholding a critical lens to touch also impels me to consider who benefits and who is harmed when touch is disciplined and positioned as inferior to sight. Research shows that touch
provides cognitive understandings of phenomenon (Ginsburg & Golbeck, 2004; Napier & Tuttle, 1993; Triona & Klahr, 2003; Wilson, 1998; Zacharia, 2015), and benefits EB students by supporting language learning, particularly in science sensemaking (Ash et al., 2009; Lee et al., 2016; Williams & Tang, 2020). Physically touching and manipulating phenomenon help new language learners understand words and build bridges from objects to meanings and language (Ash et al., 2009; Rivers, 1990). However, elementary school norms align with students staying still and silent, prioritizing vision as a way to learn (Juffer, 2019). We see this in Sally and my early collaboration around phenomenon-rich science sensemaking, where Sally turns down suggestions to provide materials to individual students and send home materials. Similarly, Sally and I continue to discipline touch during our collaborations, particularly when the space becomes noisy and we perceive students as playing. When considering which senses students are allowed to use to explore science, touch is largely excluded. Given the Eurocentric priority on the visual, whiteness operates in ways that limit other senses—excluding touch. This aligns with the CRT tenet of whiteness as property (Harris, 1993), where our (white) system of education excludes touch. When considering the benefits of touch for learning, particularly for EB students, this exclusion privileges English-dominant learners.

The vide-cued ethnography project Sally and I engaged in in the fall of 2019 was a pivotal moment in disrupting a dominant white perspective of touch. Although VCE aligns with a Bakhtinian (1981) heteroglossia that does not question power dynamics between insiders, and CRT recognizes and challenges racial hegemony, the multivocal approach makes space for counternarratives to interrogate a dominant perspective (Adair, 2014). Placing student and community perspectives of touch alongside Sally and my dominant, deficit perspectives made space for us to reconsider how we were positioning students in deficit and monolithic ways.
Although tenuous, I recognize the power of counternarrative (Bell, 1987) to help disrupt whiteness in our perspectives of touch.

**The power of dialogue and praxis**

A productive disruption of class norms and repositioning of touch would not have been possible without the iterative cycle of dialogue, reflection, and action that I engaged in with Sally. Although our cycle of reflection and action differs significantly from Freire’s (2000) problem-posing pedagogy, his framework informed how we operated with each other as we moved toward asset-aligned perspectives and practices. In our beginning engagement with science sensemaking, Sally was reluctant to engage students in touching, which was interpreted as chaotic, noisy, or play. I similarly reified hands-off, silence, and stillness as I returned to my former teacher identity with its familiar disciplinarity that restricted students’ bodies. Had I maintained an evaluative stance in my ethnography, and taken up less critical theoretical lenses, I may have not recognized how science sensemaking and touch were disrupting school norms of whiteness in productive ways. More importantly, I would have not interrogated my own role as researcher, recognizing the ways Sally was knowledgeable beyond elementary pedagogical content knowledge (NASEM, 2022). Freire’s (2000) recognition that people must position each other as subjects, not objects, and seek to understand each other and oneself in a constant critique and movement toward awareness was foundational to understanding touch in this space. Had I not moved toward this way of being, Sally’s recognition of touch as a direct mode of cognition may not have surfaced. This engagement helped me reposition touch to interrogate how it was socially constructed as inferior and racialized (Ahmed & Stacey, 2001).
Touch and other senses are normalized, and their social construction and racialization often persist without awareness (Clausson, 2012; Smith, 2007). However, as Sally and I engaged in iterative, expanding, tactile-rich science sensemaking and open dialogue and reflection, we were able to recognize our deficit positionings of students’ touch, particularly EB students’ touch. Considering the Latino Threat Narrative (Chavez, 2013) pervasive in the school community and the nation at large, it was important to use theories that recognized how ideologies spread and move into unnoticed ways of being, knowing, and teaching. The hands on a bottle video-cued ethnography project created a space to explicitly dissect our deficit positionings of touch. Given our transparent, collaborative relationship, I also was able to share my perspectives of our interactions. Sally’s awareness of my burgeoning research interests around touch and criticality afforded us to discuss norms of touch frequently, spurring her recognition of touch as a way of knowing, as shared in the third vignette. Through this realization, we could re-consider touch not as chaotic or off-task play, but as a way of knowing. In this sense touch became a teacher—educating us in ways that moved beyond words. Positioning touch as a teacher not only helps interrogate the Eurocentric epistemology that debases touch, but is also powerful for EB students who are harmed by prioritizing (English-only) language and words. A cyclical reflection of our deficit positionings and damaging norms led to our movement to humanizing pedagogies, eventually rewarding productive participation and kindness over staying still and silent.

**Conclusion**

Over four years together, Sally and I move from having a distanced relationship and deficit-aligned perspectives of students and touch, to collaboration and normalizing hands-on science sensemaking, to becoming and expanding how we perceive and enact touch. CRT’s nature to
unpack how all systems is rife with white supremacy afforded insights into touch’s positioning that I could not sense without this lens. Although this case study is the culmination of four years of critical ethnography, I also recognize the limitations of this study, given the small sample size and my nascent explorations into touch. I did not fully leverage the tenets of CRT in this work. For example, in considering how Sally and I perceived student touch, I did not consider how the intersections of race, ethnicity, and gender influenced our perspectives across students. As Sally and I continue to collaborate, I hope our theories and understandings of how touch is racialized, disciplined, and interpreted through a deficit lens due to Eurocentric ideologies hidden in education, can provide fruitful insights and interrogations. Moreover, I hope these initial findings provide a small step forward in an undertheorized obstacle for successfully implementing equitable science sensemaking practices at the elementary level.

An important implication from this study is that touch, along with other non-visual senses, is a powerful way of knowing, particularly for EB students. Centering touch in science sensemaking is a productive way to disrupt norms that reify whiteness and debase the body and the senses. Recognizing that education operates within a Eurocentric, Cartesian space further interrogates sensory knowledge in science sensemaking. When engaging teachers in professional development around science sensemaking, including reflections on how touch is disciplined through a deficit lens can surface the very real tensions between typical school norms and equitable science sensemaking lessons. Although centering touch and other senses has gained increasing attention in art education (e.g., Suominen, 2019), it is less visible in science education. Within science education, touch stays isolated in silos of technology and haptic touch (Zacharia, et al., 2012), museum education (Ash, et al., 2007; 2009), and language learning connections (Lee, et al., 2016).
Another implication from this study is the value of conducting research in ways that position both educator and researcher as knowledgeable learners. This implication is not new (Penuel, et al., 2016.), however this study adds to the literature that recognizes the tendency to position teachers, particularly elementary teachers in science education, as in need of intervention (Gray et al., 2021; NASEM, 2022; Zemba-Saul et al., 2020). Beyond positioning educators as subjects instead of objects, it is important to collaborate with educators when it comes to writing, presenting, and discussing the theoretical aspects of research. Had I not shared drafts of my work with Sally or collaboratively engaged in writing with her, she would not have known my research well enough to share valuable insights about touch that significantly changed my perspectives and the outcome of my work. Although earnest member checking is intimidating, moving to open, collaborative discussions about the researcher’s real-time perspectives is necessary to enact humanizing, asset-aligned practices, particularly when taking up equitable practices in science education.

Lastly, this study highlights the importance of centering CRT in science education. (Parsons, 2014). Without CRT, the ability to carefully unpack how whiteness operates within science education is (intentionally) difficult. Using CRT as a tool to disrupt how I look at my data helped me recognize aspects of whiteness I would not have otherwise seen. Using CRT to critique our epistemologies themselves is also a productive, but often overlooked practice in science education (Ladson-Billings, 2000). The three vignettes highlighted in this paper illustrate a growing expansion of how Sally and I considered touch in a science sensemaking space. As we move toward collaboration and a Freireian (2000) practice of reflection, dialogue, and action, our ability to interrogate our interpretations of touch and how students are disciplined expanded over time. This expansion led to us centering touch in our reflections and lessons, and to increasingly touch-centered science sensemaking experiences for students.
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Chapter 4: Manuscript Three

The Sounds of Science Sensemaking: An Exploratory Sonic Tool to Interrogate Deficit Classroom Practices

Close your eyes and imagine the sounds of an elementary classroom. What you hear is dependent on a myriad of factors—for example: your own experiences as a teacher and learner, whose classroom you are in, what school you are in, what district and region, what time of day, and what activity you imagine. Beyond the sounds, what you hear and how you interpret those sounds fundamentally shape how you make meaning behind them (Gershon, 2019). Do loud, overlapping student voices with Spanish, English, and non-linguistic sounds represent active engagement or off-task chaos? Hearing sounds is a subjective practice (Gershon, 2011). What sounds like learning and joy to one set of ears, sounds like disorderly conduct to another. When seeking to move away from didactic teacher practices and toward student-centered engagement that is discursively rich, one undertheorized obstacle is how these classrooms sound and how they are interpreted.

This paper describes a tool to interrogate deficit perspectives of student talk. By moving away from vision into sound, I leverage sensory facets of classroom talk to question who benefits and who is harmed from teacher-centered classroom practices. I begin with a rationale and brief review of the literature, highlighting the predominance of deficit-oriented, Initiate-Respond-Evaluate (IRE) practices in classroom spaces, and sharing an undertheorized approach that leverages the senses as a novice way of knowing and unframing deficit perspectives. I then introduce my theoretical framework which uses Critical Race Theory (CRT; Bell, 1987), unframing (Greene, 1995; Powell & Serriere, 2013), de-familiarization (Powell, Altuntas, & Bricker, in press; Truman & Springgay, 2016) and acoustemology (Feld, 1982) to interrogate
whiteness in classroom spaces. Next, I share my methodology, beginning with a pivotal moment that spurred the development of the sonic tool, and then unpacking sonification, and delineating the steps I took to transform classroom audio recordings to abstracted sounds. I share a description of the soundscapes, as well as clickable links to directly hear each audio recording. I also discuss nascent results after piloting the tool in teacher workshops. I conclude this work by considering the productivity of unframing and disrupting sound in science sensemaking spaces, and how CRT aids in this examination. The research questions that center this project are: How does critically listening to the sounds of a classroom space de-familiarize norms of teacher-centered Initiate-Respond-Evaluate instructional patterns? What kind of tool can support teacher listening to center the affordances of productive participation and not get distracted by deficit interpretations of “noise” and “chaos”?

**Classroom talk: IRE, tensions, and new directions**

“But what of the ethnographic ear?” (Clifford, 1986, p. 12)

Research shows that (predominantly white, English-dominant) teachers productively engage with students from linguistically and culturally different backgrounds when they use active, learner-centered, phenomenon-based approaches to science sensemaking (National Association of Sciences, Engineering, and Medicine, NASEM, 2018; 2021; National Research Council, NRC, 2007; 2012). This teaching approach positions students as competent knowers, whose voices and thoughts are heard through productive participation (Bang et al., 2017; Bartolomé, 1994; Lemke, 1990; Stroupe, 2014; Thompson et al., 2016; Warren et al., 2001; Zembal-Saul, 2009). Haverly et al., (2020) defines equitable science sensemaking as: “a co-construction of knowledge incorporating students’ epistemic resources—including language practices, discursive forms, and
cultural practices (Nasir, Rosebery, Warren, & Lee, 2006)—not always traditionally legitimized in classroom spaces” (p. 74). This productive participation spans discourses, including diverse linguistic repertoires (Espinosa & Herrera, 2016; García & Klein, 2016).

Despite efforts to move science sensemaking toward a discourse-rich space, teachers across the globe are reluctant to enact these practices (Braaten & Sheth, 2017; Change the Equation, 2017; Goodlad, 1984; Moje et al., 2001; Mortimer & Scott, 2003; NASEM, 2021; Stroupe, 2014; Oakes et al., 2000; Tolbert, Spurgin, & Ash, 2021; Windschitl, 2002). Mortimer & Scott (2003) remember:

[A] time when science lessons saw the teacher standing at the front of the room, and the students sitting firmly in their places. A time when the science teacher presented scientific facts to the class, and the students listened. A time when student participation in science lessons was restricted to copying notes from the board. (p. 1)

Mortimer and Scott (2003) recognize that this memory is alive and well in schools today. Contrary to an equitable science sensemaking space, most classrooms position teachers as the sole authority, and discourse that centers Initiate-Respond-Evaluate (IRE) patterns lead students to a singular “right” answer. This more traditional approach to science education, particularly predominant in elementary school science (Braaten & Sheth, 2017), aligns with Freire’s (2000) banking model of education, where the teacher deposits knowledge into students’ minds and positions students as blank slates.

Researchers have theorized tensions and dilemmas that explain a reluctance to engage in equitable pedagogies (Braaten & Sheth, 2017; Radloff & Capobianco, 2021; Richards & Robertson, 2016; Scott, Mortimer & Aguilar, 2006; Windschitl 2002). Windschitl (2002) identifies three ways tensions are positioned in the literature: as roadblocks (Hammerness, 2004), manageable contradictions (Herbst, 2003), and necessary (Scott, Mortimer & Aguilar, 2006) or productive (Stillman, 2011). Most researchers theorize that teachers do not adopt equitable,
discourse-rich, science sensemaking practices because school and classroom norms contradict them on epistemic, conceptual, cultural, political and/or pedagogical levels (Braaten & Sheth, 2017; Mortimor & Scott, 2003; Windschitl, 2002).

One undertheorized facet of this conflict is that discourse-rich science sensemaking classrooms sound different from traditional, IRE-centric spaces, and sound is an often un-interrogated aspect of transforming teacher practices (Greene, 1994; Powell & Serriere, 2013). Although sounds are critical to how people make sense of their world (Ellsworth, 1989; Powell & Gershon, 2020; Powell, 2015; Wozolek, 2018), they are hidden, undertheorized, undervalued, and underused (Gershon, 2011). The sounds of a classroom are embedded in “nested layers of local and less local norms and values, combinations of particularized experiences, understandings and tastes” (Gershon, 2011, p. 66). These sounds “reverberate across histories, contemporary contexts, and through bodies and beings” (Wozolek, 2018, p. 4). For example, Kim Powell’s (2008) work centering taiko drumming considered how “taiko performance can be used to rupture and recreate raced and gendered categories” (p. 901). Powell found this sounding and embodied art form to be “a site of intervention, an attempt to challenge hegemonic descriptors of race as a discrete category by providing space for hybridity” (p. 922). Building off of Maxine Greene’s (1995) concept of wide awakeness, Powell &. Seriere (2013) seek to unframe hidden norms and habits through sensoriality, unframing meaning-making implicit in the senses, and “highlighting the potentiality of an experience and the ways in which the arts might frame experiences for future possibilities of awakeness, participation, and agency” (p. 3). Similar to unframing, scholars have sought to de-familiarize norms through embodied methodologies such as walking ethnographies (Powell et al., in press; Truman & Springgay, 2016). For example, Powell et al’s (in press) work on defamiliarizing walking explores how to escape implicit habits of movement and awareness: "sensations are not felt in a determinant way; such a becoming is indeterminant.
Art, then, might open new ways of engaging with the world, but not in that we might be able to name, identify, or predict; art is felt as differential flows” (p. 11).

I build off of Powell and colleagues’ work, applying the concepts of unframing and defamiliarization in art education and walking methodologies to science education. The “different” sound of a science sensemaking space is heard as off-task noise, particularly when it is not aligned to a teacher’s agenda (Gershon, 2011). When considering sounds from Latine, emergent bilingual (EB) students, this “noise” aligns with deficit narratives of students as disruptive (Chavez, 2013). Positioning sound as socially constructed, intersectional, and racialized repositions how we consider student talk, or the lack thereof, in elementary classrooms, and offers new possibilities to disrupt this space in science education.

Given the call in the science education literature to better understand how to foster discourse-rich science sensemaking spaces (Braaton & Sheth, 2017; Thompson et al., 2015; Windschitl, 2002; Windschitl, Thompson, & Braaten, 2011; Zembal-Saul, 2009), and the lack of studies that position sound as a way of knowing in education (Gershon, 2011), this paper shares an exploratory tool to disrupt classroom sound. I describe how I compare two 2nd grade classroom environment sounds, one aligned with normative IRE patterns, and another representing a discourse-rich science sensemaking space. Using sonification (Ballora, 2014), I abstract classroom sound to make the familiar strange, in an effort to productively disrupt implicit deficit-positionings of science sensemaking and highlight the affordances of this approach. I also share the early outcomes of piloting this tool with a collaborating 2nd grade teacher, and teachers in a Professional Development (PD) workshop.
Using critical frames to interrogate soundscapes

At the center of this paper is an attempt to disrupt, unframe, and de-familiarize teachers’ deficit-aligned norms of sound in a science sensemaking classroom. Underpinning this exploration are theories that unearth and critique classroom norms and the senses. Thus, I leverage Critical Race Theory (CRT; Bell, 1987), unframing (Greene, 1995; Powell & Serriere, 2013), de-familiarization (Powell et al., in press; Truman & Springgay, 2016) and Acoustemology (Feld, 1982) as a theoretical sounding boards.

Critical Race Theory

Wherever there are norms, there is race, and norms are everywhere. Both are socially constructed, and both perpetuate whiteness. I approach my exploration of sound with the perspective that racism is endemic and ubiquitous in institutions, including education and the 2nd grade classroom where this work was born. Critical Race Theory (CRT) is a framework attuned to intersections of patriarchy, heterosexism, and class (Crenshaw, 1990), and seeks to “illuminate racial power and subsequent racial hierarchies, analyze their effects, understand why and how they persist, and advance social action to disrupt and alter them,” (Parsons, Rhodes & Brown, 2011, p. 953). Solórzano & Yosso (2002) define CRT in education as: “a framework or set of basic insights, perspectives, methods, and pedagogy that seeks to identify, analyze, and transform those structure and cultural aspects of education that maintain, subordinate, and dominate racial positions in and out of the classroom,” (p. 25). This framework is a necessary and powerful tool to center in my research because I am working with teachers to recognize and disrupt the

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1 To further disrupt ocularcentric language, I attempt to replace more familiar visual metaphors such as “frame” and “lens” with auditory equivalents.
dehumanizing norms within school spaces to move toward more asset-aligned, humanizing practices. CRT’s tenets of: 1) permanence of racism, 2) either/or binaries, 3) intersectionality, and 4) whiteness as property inform this paper.

The permanence of racism, described above, is a fundamental tenet of CRT which is relevant to this work. This tenet helps me continually interrogate how racism is implicit in the classroom and senses. Either/or binaries force people into static categories of us and them, or self and other (King, 1995; Ladson-Billings, 2000). These binaries position whiteness as superior to all other races and ethnicities, protecting the white advantage (Ladson-Billings, 2000).

Intersectionality recognizes that the various facets of one’s identity, including race, ethnicity, gender, sexuality, class, ability, age, and language-dominance, cannot be considered in isolation. Although this concept stems back to scholars and activists from the mid-19th Century, such as Sojourner Truth, the tenet is theorized by Kimberlé Crenshaw (1988; 1991) within Critical Legal Studies. When considering teacher and researcher inclination to control and quiet sonic spaces, intersectionality affords examination of not only whiteness, but also how the patriarchy impels women to quell disturbances, such as noise (Miller, 2017). Lastly, whiteness as property (Harris, 1993) recognizes how whiteness is privileged to own property, both real and imagined, and to determine what is and is not allowed in institutions such as law (Harris, 1993) and education (Annamma, 2015; Ladson-Billings, 1998; Mensah & Jackson, 2018). Whiteness as property affords insights into which sounds are permitted and which are disciplined and excluded in classroom spaces.

I also consider CRT’s sister framework of Latino Critical Race Theory, or LatCrit. Solórzano & Yosso (2002) define LatCrit as “a framework that can be used to theorize and examine the ways in which race and racism explicitly and implicitly impact on the educational structures, processes, and discourses that effect People of Color generally and Latinas/os
specifically,” (p. 479). LatCrit moves away from the black/white binary to consider aspects such as culture, language, and immigration within white supremacy and racism. Central to LatCrit theory is a critique of how Latine children often receive microaggressions due to their immigration status, and are positioned in deficit ways, such as being culturally deprived and in need of fixing, (García & Guerra, 2004; Ledesma & Calderón, 2015). Latino threat narratives position Latine people as dangerous, criminal, and dependent on government resources, (Chavez, 2013; Ledesma & Calderón, 2015; Longazel, 2016; Rosa, 2019). Additionally, Latine students are problematized for their native Spanish abilities, and are often “in need” of services to unlearn Spanish and replace it with English (Ledesma & Calderón, 2015). When considering sound in an EB classroom, LatCrit affords important insights into how Spanish language is heard.

**CRT and the senses**

Critical Race Theory provides “a useful rubric for understanding the taken-for-granted privileges and inequities that are built into our society” (Ladson-Billings, 2003, p. 10-11). This theory affords critical examination of how education prioritizes a Eurocentric epistemology that positions text and sight as superior to other senses, including sound, touch, and taste (Ladson-Billings, 2000). Scholars in education, such as Ted Aoki (1991) similarly recognize “the primacy of the eye in curriculum studies” (Gershon, 2011, p. 67). Visual metaphors, particularly in ontology, theory, and philosophy, echo these sentiments: “visual information occupies a privileged epistemic role and our language frequently reflects a tight coupling of seeing and knowing” (Nudds & O’Callaghan, 2009, p.1). Prioritizing sound oversight in this work makes space to interrogate Eurocentric norms and the Cartesian priority of sight. Kim Powell’s (2008) work on CRT, sound, and identity provide an example of the power of using CRT with sensorial
unframing. When analyzing how the aesthetic forms in taiko drumming create and disrupt race, Powell notes the affordances of CRT: “when undergirded with aesthetic forms of inquiry, CRT offers an interpretive epistemology based on multiple modes of aesthetic representations” (p. 904). Although sound is prioritized here, I recognize that senses do not operate in silos or isolation, but rather are in concert with each other (Gershon, 2011).

Schafer (1977) states: “sound reflects sociocultural norms and values” (p. 7). The Eurocentric priority of text over speech, when applied to a Latine, new immigrant classroom, privileges English-dominant students over Spanish-dominant, EB students. Most EB, Spanish-dominant students have English-monolingual teachers (Hansen-Thomas, et al., 2020; Liggett, 2009; Menkin, 2013). When considering LatCrit (Solórzano & Yosso, 2002) and the Latino Threat Narrative (Chavez, 2013; Rosa, 2019), Spanish discourse in schools is positioned as loud, chaotic, disruptive, and off-task. Beyond teachers’ proclivity to discipline any speech that does not adhere to an IRE approach, speech that is in dialects and languages outside of a Eurocentric, white vernacular is devalued and disciplined (Menkin, 2013).

**Acoustemology**

Acoustemology (Feld, 1982) is both methodology and epistemology, and is a system of knowing that subverts Cartesian ocular centrism and a separation of the body and mind. Sounds studies allows me to pay attention to “the ways in which sounds, any and all sounds, are meaningful to the hearer or listener” (Gershon, 2011, p. 71). In considering sound, I seek to disrupt the dominance of visual ways of knowing, and “to understand the body not simply as a source of experience and activity that would be rationalized and/or controlled by the mind, but itself as a source of knowledge and subsequently of agency” (Pink, 2015, p. 26). While
recognizing that senses are interconnected, I focus on Stephen Feld’s (2005) theory of acoustemology: “an exploration of sonic sensibilities, specifically of ways in which sound is central to making sense, to knowing, to experiential truth” (p. 185). Through this medium, I move beyond defining sound as vibrations in matter, to defining sound as a socially constructed, racialized way to understand place, steeped in norms (Gershon, 2019; Powell, 2015; Powell & Gershon, 2020). Similar to Powell’s (2015) interrogation of sound in taiko drumming, I seek to interrogate the subjective nature of sound in a science classroom. Powell’s (2015) work conceptualizes sounds as a way of knowing that “configures the social construction of identity” (p. 114), “reberberates beyond a physical location” (p. 115), and is subjective, having both “physical and psychological dimensions” (p. 114). Gershon (2019) similarly positions sound as subjective: “Where a sharp loud popping sound is informational, its immediate interpretation as a car backfiring, a boat starting, a tree branch falling, or a gun firing is sociocultural and experiential” (pp. xiv – xv). How people hear a classroom space is equally socially constructed and subjective, and science sensemaking can be heard as a disruption to learning or engagement with it.

Methodology: From ethnography to sonification

My disruption of how sounds are heard in classroom spaces arose from a larger critical ethnography (Kinchole & McLaren, 2000) with 2nd grade teacher, Sally Matthews. From the beginning of my research, I sought to understand the culture of Sally and I, who are both white, English-dominant women, not the cultures of her EB, Latine, new immigrant students and families. From 2018 to 2021, we co-planned and co-taught science sensemaking lessons in her classroom. In the fall of 2019 and spring of 2020, we began to recognize and disrupt school
norms that discipline students as staying silent and still. In late February, Sally and I reflected on how students who typically do not talk in class were starting to speak more during our science investigations. Sally compared science with math and reading and discussed how, unlike other subjects, science allowed students to “come up with their own ideas and to look at things in different ways.” Our conversation continued:

Sally: When we’re doing science they can’t wait to do it because they can’t wait to come up with their own ideas and to look at things in different ways. When do they get to have a voice and be heard? I think that’s what it is. They have a voice and they’re heard. Honestly, I think that’s what it is. And they’re not wrong.

Michelle: I’m like [I gesture to tears welling up in my eyes]

Sally: I know, I almost want to cry too, because you think about it. It’s not like be quiet. We’re not telling them to be quiet, number 1, because most of the time it’s be quiet, be quiet, be quiet. We’re not telling them be quiet, and when they say something it’s heard. I honestly think that’s what it is. (2/26/20)

In our collaboration following this discussion, I began exploring and comparing the soundscapes of Sally’s classroom, commencing my foray into acoustemology. Sally’s reflection of students as wanting to be heard shifted my attention from seeing students to hearing them. My field of study moved from the visual to the sonic—from the landscape to the soundscape (Schafer, 1977).

**Context**

This exploration is part of a larger national professional development project that brings together school, university, and community partners to support emergent bilingual (EB) students’ learning. The project’s vision is for researchers and eventually family and community members to work alongside teachers as they co-design, enact, and assess the ways in which science
sensemaking can amplify equitable language practices and students’ lived experiences. Our project is situated in a semi-urban city in the northeastern United States that has a majority Latine, largely Dominican new immigrant population which has dramatically increased in the last two decades. In 2000, the community was 93% white, while recent data suggests that the population is now approximately 56% Latine, primarily from the Dominican Republic and Puerto Rico.

Sally and I have been working together since the fall of 2018. Sally identifies as a white, monolingual English-speaking 2nd grade teacher at Douglas Elementary School. I identify as a white, English-dominant novice researcher. Sally identified the students in her class as over 90% Latine, largely coming from the Dominican Republic. When her classroom was audio recorded for the creation of the tool, more students were identified as boys (15) than girls (9). The behavior expectations in Sally’s classroom align with those in the school, where students are expected to “show pride,” which entails sitting upright, folding their hands together, and “putting a bubble in their mouths.” These expectations mirror many elementary school norms across the country (Watkins, 2005).

**Positionality**

My experiences, perspectives, and being is inextricably tied to this work. I am a white, heterosexual woman who comes from a middle-class family, raised with ideologies rife with the myth of meritocracy (Bonilla-Silva, 2017). I taught in an urban public middle school for six years and worked in an urban charter high school for three years, learning and reifying norms of whiteness that positioned students as still and silent. When collaborating with Sally, I often returned back to my teacher-self, quieting students, and praising students who were still and
silent. When analyzing my research and writing, I often overlook the ways whiteness operates, including in the language I use that hides whiteness through passive tenses and vocabulary. The theoretical frameworks I use help interrogate how I engage, perceive, and exist in this work. CRT helps me pay attention to whiteness, and how white ways of knowing and being are implicit in my research methods and my perspective. Inevitably, I also center words and sight, and a sensorial approach helps me move toward the body and sound.

Methods

In this section, I describe the exploratory steps I took to create a tool that interrogates the norms of sound in Sally’s class. In my last visit to Sally’s classroom, before the Covid pandemic interrupted our in-person collaboration, I captured 30 minutes of a grammar lesson on video for us to compare to a science sensemaking space. This recording, along with a 30-minute science sensemaking video recording were used to begin a critical, sonic exploration of these spaces. I extracted the audio from the two recordings. The grammar lesson focused on Sally teaching about plural nouns, which I refer to as a “traditional” soundscape. The second recording captured an investigation Sally and I co-led where we discussed what students had observed about evaporation and condensation, and came up with new questions and tests, which I refer to as a “science sensemaking” soundscape. My first exploration was to simply listen to each soundscape in their entirety. While listening, I jotted down my thoughts with more attention to the sounds of the space, rather than the words and their meanings. Beyond listening to the musicality in each soundscape, I noted when I heard students using repertoires other than standard English, such as Spanish, and emotive sounds, as well as when Sally or I directed students to be still or quiet.
After listening to each soundscape, and noting my interpretations and responses, I edited each recording down to a four-minute clip which was representative of the entire recording. I then openly coded these shorter clips, again focusing on sounds rather than words (Emerson, Fretz & Shaw, 2011). I identified four key themes: discipline (moments where the teacher spoke, and then students were silent often aligned to the teacher quieting the class down), student talk, teacher talk (patterns of didactic or sensemaking sounds), and other repertoires of discourse (e.g., oohs and ahhs, chairs scraping, tapping). I populated sub-codes within each category while listening to the clips, and then used these categories to code the full 30-minute audio recordings of each soundscape using VNote software. This created a visual representation of various aspects of the soundscapes. See Appendix B for a description of themes and subcodes, along with the visual representation of each coded soundscape.

**Sonification**

The patterns that I created from coding each soundscape in VNote reminded me of piano scrolls. To explore and contrast these soundscapes in different ways, I decided to try to “play” each soundscape by assigning different notes to each code, beginning my exploration of sonification. Sonification is a process where data is transposed into sound to allow for novel ways to understand a phenomenon or space (Scaletti, 2018). Researchers define sonification as “the technique of rendering sound in response to data and interactions” (Hermann, Hunt, & Neuhoff, 2011, p. 1). Scaletti (2018) describes three components of sonification: a process where data are mapped to sound, a goal to “better understand, communicate, or reason about the original model, experience, or system” (p. 365), and a loop back path, where the process of sonification changes as new understandings are made. Most of the literature in sonification focuses on attributing
quantitative data to audio signals, where multiple parameters of a phenomena (e.g., various aspects of earthquakes, hurricanes, or planets) are mapped onto different parameters of sound: pitch, loudness, timbre, and localization (Rimland et al., 2013). I explore using sound to understand aspects of teacher-student interactions through mappings of parameters (codes of discipline, teacher talk, student talk, and discourses other than English) to sound (focusing on pitch and timbre). An undertheorized affordance of transcribing recorded classroom sound to sonified sound is that it abstracts the classroom space to make the familiar strange. I approach this work humbly, with nascent understandings of these concepts, and am aware that I may possibly misinterpret the theories and terms of this field (Ballora, 2000).

In alignment with sonification, I transposed the codes I created through VNote to hear the data differently. In reviewing the literature on sonification, I recognized the problematic and highly subjective nature of assigning data to various notes and pitches and realized the need to be careful about choices of notes, instruments, and attack (how sharply or softly the note is played) when transposing data to sound (Ballora, 2000). Although the issue of aesthetics and musicality is a subject of debate in sonification, I considered how harmonious or discordant sounds would affect the transposition (Walker & Nees, 2011). I decided to test my perception that there were notable differences both in code pattern and sounds between a traditional and science sensemaking soundscape by randomly assigning notes to each code through a MIDI keyboard in the GarageBand software in a control transposition. I varied pitch, and controlled for loudness and attack, and assigned random notes within a major C chord to each code, so as to not be distracted by discordances.

The control experiment helped me hear key differences between categories in each space, but I also wanted to better understand how these combinations of differences overlapped to produce different soundscapes. To do this, I intentionally mapped different, distinct timbres (tone
qualities) to each larger theme (discipline, teacher talk, and student talk) so that I could better hear how these themes were interplaying with each other. Similar to Prokofiev’s *Peter and the Wolf March*, mapping different sounds to different themes allowed me to hear how they interacted with each other in a novel way. This next sonification I named as an “Orchestral Soundscape” since I centered three different orchestral instruments: an Oboe in mostly lower octave range for disciplinary codes, French Horns in middle-octave range for Teacher Talk, and String Ensemble in higher octave range for Student Talk. Similar to the control experiment, I kept notes aligned with a Major C chord to ensure discordance did not influence how I heard the sounds. The Orchestral sonification afforded a new way to hear interactions between themes, but it was at times challenging to distinguish between the student and teacher talk. To explore and try to better hear student vs. teacher talk, I again re-mapped codes to sounds a third time to create a “Percussive Soundscape.” This time, I assigned instruments to each code that had crisper start and end points. Keeping the octaves the same, I transposed the discipline category to a drum sound (Blocks and Bells), teacher talk to an electric bass that was plucked, and student talk to a vibraphone. See Appendix C for the assigned octaves and notes of each code and transposition.

**The soundscapes**

Listening to the traditional and science sensemaking soundscapes led to productive reflections about how students and teachers are produced differently in each space. A challenge with sensory ethnography is that it does not always easily translate to the written word. In this space, I offer written descriptions of the soundscapes I attended to, as well as url links (represented by sound icons) to hear the sonified data. Listening to the data creates new ways of hearing and understanding the spaces, particularly with an ear towards oppressive norms. This section shares
descriptions and recordings of the different ways I sought to understand each space: 1) listening to the original audio recordings of each soundscape, 2) listening to the sonification of each soundscape, through control, orchestral, and percussive transpositions, and 3) considering the critical analysis of who speaks and what they say in each space.

**Original audio recordings**

**Listen to recordings.** I edited each soundscape down to shorter audio clips that were representative of the longer audio recording. Click on each link to hear the audio file.

- Edited audio clip of a traditional soundscape.
- Edited audio clip of a science sensemaking soundscape.

*Figure 4-1: Original audio recordings*

The original audio recordings of the traditional and science sensemaking soundscapes sounded different from each other. See Figure 4-1 to access clickable links to each recording. When I listened to the audio recording of the traditional soundscape, I heard a pattern of sound between teacher and student that aligned with IRE (Initiate-Response-Evaluate), where Sally asked a question, paused, called on a student, the student responded, and Sally affirmed or corrected the response. These interactions had their own distinct staccato rhythm which was visible in the coding (see Appendix B). I also heard sounds of frustration, joy, and restlessness—tapping on desks and the repeated moving of chairs. In my second listening of the soundscape, I focused on what Sally and students were saying, and their patterns of behavior. I noticed Sally sometimes pre-emptively warned students to not call out. After Sally shared examples of irregular plural nouns, she directed students to complete independent work. Students were initially
relatively quiet, but noise levels grew until Sally told students to be quiet, stop sharpening pencils unnecessarily, and directed a few students to “take off,” whereby they lost points in a reward system. During IRE, when students did not answer correctly, other students called out or responded in a chorus without being disciplined. However, when students called out at other times, they were often redirected. Sally praised students when they answer a question correctly.

The audio recordings of the science sensemaking space immediately sounded differently to me; a cacophony of sounds struck my ears and the cadence was more syncopated than the IRE beats in the traditional instruction. Pitches and tones expanded as I heard singing, excited oohs and aahs, urgency, and surprise in voices. Voices moved back and forth between teacher and students and among students in more prolonged periods than I heard in the traditional soundscape. There were similarities to the traditional soundscape as well: moments of silence after an intermittent disciplinary sound, the restlessness of chairs moving and pencils tapping, however repeated interruptions for silence seemed less frequent. The visualization of these codes (see Appendix B) showed different patterns than the traditional soundscape, with longer stretches of student talk, particularly of students talking to each other. In my critical listening of this soundscape, I heard different patterns between Sally, the students, and me. In this space, Sally and I spent most of our time summarizing students’ observations and asking students questions. Unlike the traditional soundscape, students talked over each other, Sally, and me, and Sally and I only redirected such behavior when Sally imparted directions or certain pieces of information. Voices still rose to a level where Sally would discipline them to create silence, but the tolerance for noise seemed higher. In this soundscape, Sally and I praised students for asking “good” questions and making “good” observations.
Sonified soundscapes

Exploration into assigning notes to the coded data of each soundscape afforded new insights into how these spaces produced students differently. In the control transposition of each soundscape where data was assigned random notes, the recordings had noticeably different rhythms, however it was unclear whether this difference was due to differences in all parameters (discipline, teacher talk, student talk, and other), or differences between specific sub-categories.

To better understand this, I listened to each category separately and compared sounds.

Listen to recordings from the Control Transposition. Click on sound icons to hear audio files.

<table>
<thead>
<tr>
<th>Sonification:</th>
<th>Traditional</th>
<th>Science-Sensemaking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>![icon]</td>
<td>![icon]</td>
</tr>
<tr>
<td>Control: Discipline Only</td>
<td>![icon]</td>
<td>![icon]</td>
</tr>
<tr>
<td>Control: Teacher Talk Only</td>
<td>![icon]</td>
<td>![icon]</td>
</tr>
<tr>
<td>Control: Student Talk Only</td>
<td>![icon]</td>
<td>![icon]</td>
</tr>
<tr>
<td>Control: Other Discourses Only</td>
<td>![icon]</td>
<td>![icon]</td>
</tr>
</tbody>
</table>

Figure 4-2: Control transpositions of sonified data.

I noticed a significant difference between the discipline soundscapes in the control sonification. The traditional (IRE pattern) soundscape had more frequent, although punctuated sounds, while sounds were less frequent and more dispersed in the sensemaking soundscape. Often, two different discipline notes would be played close together in both spaces, illustrating how discipline often grouped the voice and the body together.
When comparing the teacher talk tracks for each space, I was surprised to hear many similarities between the two. Both sonifications produced persistent sounds, varying between several pitches, but focusing on one or two pitches most predominantly. Notable differences between the two recordings (i.e., between IRE and science sensemaking coded soundscapes) were that the science sensemaking production had different repeating pitches than the traditional one, which indicated that different aspects of teacher talk were being used, and the traditional recording had a longer period of relative silence in the middle.

I heard the most differences between the student talk tracks. In the traditional recording, sounds were continual but with a pause after each one. The science sensemaking recording, however, had more persistent, repeated hammering of sound, with a dominant note being reproduced frequently. More sounds overlapped, and there were occasional pauses of silence that ended by a return of sounds with a different dominantly played note.

When I analyzed how sounds that were not verbal (e.g., “oohs” and “aahs”, laughter, tapping, chairs scraping) compared between traditional and science sensemaking soundscapes, I was surprised to hear recurring, and varied sounds in the science sensemaking space, while far less frequent sounds in the traditional space. I had assumed there would be more restlessness in the traditional space.
Embracing the iterative and exploratory nature of sonification, my transpositions of the data to orchestral and percussive sounds helped amplify different aspects of the data. See Figure 4-3 to access clickable links to each recording. The orchestral transposition helped me better hear patterns between teacher and student were audible. In the traditional transposition, I could hear different patterns between the discipline (low Oboes) and student talk (high strings) tracks, and between the teacher talk (middle horns) and student talk tracks. By separating these groups out by different instruments, I could pay closer attention to the rhythm between each. In the science sensemaking soundscape, the teacher and student sounds overlapped, and the discipline sounds were far more infrequent.

**Listen to Orchestral and Percussive Transpositions.** Click on sound icons to hear audio files.

<table>
<thead>
<tr>
<th>Sonification:</th>
<th>Traditional</th>
<th>Science-Sensemaking</th>
</tr>
</thead>
<tbody>
<tr>
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<td><img src="sound_icon_orchestral.png" alt="Sound Icon" /></td>
<td><img src="sound_icon_science.png" alt="Sound Icon" /></td>
</tr>
<tr>
<td>Percussive</td>
<td><img src="sound_icon_percussive.png" alt="Sound Icon" /></td>
<td><img src="sound_icon_science.png" alt="Sound Icon" /></td>
</tr>
</tbody>
</table>

*Figure 4-3: Orchestral and percussive recordings.*

The percussive transposition (see Figure 4-3) helped sharpen the relationship between discipline and student talk in each soundscape. I clearly identified a drum sound as the last sound before a pause of silence. I could more clearly hear how student talk grew again after this silence, only to quiet from another disciplinary sound, or from teacher talk. In the traditional soundscape, I could more clearly hear the vacillation between two bass notes, which aligns with the initiate and evaluate portions of the IRE pattern. In the science sensemaking soundscape, the speed of interactions was more audible—there was a faster rhythm which was not as easily heard through the orchestral sound transposition. I noticed the persistence of one bass note (representing
researcher talk) during this space, highlighting a weakness in my coding, since I didn’t expand types of researcher talk in the same way I had for teacher talk. Thus, I re-coded and re-soundified the researcher data. I also noticed the lack of discipline in the percussive science sensemaking soundscape in a way that was more distinct than from listening to any other version of the soundscape. This helped me understand just how powerful sound choice is when mapping to a code.

**Hearing and here-ing differently**

The reason I developed a sonic tool was to explore how to interrogate the norms of sound, in hopes of expanding spaces where students could engage in productive participation. While and after developing this sonic tool, I began testing out my hypothesis that interrogating a deficit hearing of productive participation could lead to more expansive, asset-aligned reflections and practices (i.e., here-ing) with teachers. In this section I share nascent reflections and outcomes from a collaborative examination of the norms of sound and from piloting the sonic tool.

**Praxis and re-sounding with Sally**

I developed the sonic tool presented in this paper because of a discussion Sally and I had in early 2020 (see the vignette on pages 177-178). Sally recognized how science sensemaking was creating space for students to be able to speak more and be heard—something that was not happening in more didactic, IRE-aligned classroom spaces. As Sally and I continued thinking about this, we engaged in cycles of reflection and action, similar to Freire’s (2000) praxis. Over time, Sally changed how she both perceived and disciplined student talk in her classroom. As she became more aware of the norms of sound in her classroom, she re-considered student talk,
resulting in more expansive spaces where students could engage in productive participation. By the beginning of the 2021 school year, Sally and I openly questioned the school norm of “showing pride,” where students sat at their desks with hands clasped, and a bubble in their mouths. Our discussion below illustrates how we reflected on how science sensemaking disrupted norms of who speaks.

Sally: I think she's [a student] one of those kids where it's sit down, be quiet, behave. And she was more concerned about behaving and being good, then, you know; showing off and always raising her hand and you know, answering questions. And I think once she realized that, especially during science and in class, there's a lot more talking than most classes. And I think she realized she could- she had a little bit more input.

Michelle: That's in my proposal. I think what- I feel like science sensemaking... the norms of what it means to be a good student in that science we're creating is to talk a lot, to touch a lot, to hear a lot. Whereas the norm – it's not just at Douglas Street Elementary School [...] I think there's a pretty common norm in elementary school to sit-

Sally: And listen! [...]

Michelle: So what we're doing is kind of pushing against that norm. But it was cool because I even have in my notes that I gave pride tickets [school reward tickets for good behavior] for students who were engaging a lot in science. You told me to do that – you told me to reward the kids who were talking, and so it's almost like we're shifting what it means to be a good student.

(Interview, 09/14/21)

As Sally and I interrogated the norms of staying silent in class, and engage in equitable science sensemaking practices, we began to re-consider what “good” behavior looks like in school and rewarded student discussion over silence.

Our conversation continued with Sally reflecting on how student talk had expanded beyond the realm of science sensemaking spaces into IRE-dominant spaces after beginning our interrogation of sound:

Sally: I think they [students] opened up a lot more. Like I can think of; when I would be introducing vocabulary words and they would raise their hand and just say: “Well, that word sounds like this word,” or “This word sounds like that word.”
Most, prior [to our collaboration] anyway, most kids wouldn't- they would only answer a question-- not be so forward to give information. Especially with the past two classes [cohorts of students] that I’ve had, there’s been a lot of that.

Michelle: So you’re seeing the shift- the changing norms in your whole classroom, not just science?

Sally: Yes, yeah, absolutely. (Interview, 09/14/21)

Sally’s reflections indicate that student talk that aligns more with productive participation rather than IRE is expanding beyond the boundaries of science sensemaking. Although we cannot attribute this solely to our interrogation of the sounds of classroom spaces and have not yet triangulated data to rigorously consider how Sally’s classroom sounds are changing, this reflection impels future research around the interrogation of sounding norms in elementary classrooms.

**Piloting the sonic tool**

From my work with Sally around the sounds of science sensemaking, I developed the hypothesis that discussing and interrogating classroom norms of sound change how teachers perceive and discipline student talk in their classrooms. With this nascent hypothesis, and a sonic tool aimed at disrupting the norms of classroom sounds, I piloted the sonic tool with teachers in a virtual webinar.

In the spring and fall of 2021, I played the orchestral sonification of Sally’s grammar lesson and science sensemaking lesson and shared images of the coded data, during a virtual webinar. 32 teachers from three elementary schools in the district attended the virtual webinar in the spring, and 12 additional teachers attended in the fall. The webinar was part of a larger PD project aimed at supporting teachers as they engaged with EB students through science
sensemaking. This webinar was the introduction to a five-week module centering sustained investigations and talk moves and was part of a series of three stand-alone professional learning opportunities. Teachers who participated in the PD were interviewed following the module.

An initial review of interview transcripts suggests the sonic tool influenced how teachers thought about their classroom soundscapes. Andra Mueller, a 4th grade teacher who attended the webinar, reflected: “It made me self-conscious because I imagined my classroom and what it would look like and sound like [...] and it would definitely be a little too much of me [talking]. So, there was a self-realization of ‘Oh, my goodness, there’s something I should be doing differently’” (Interview, 12/14/21). Although Andra reported being comfortable with a loud classroom, she had been uneasy as a new teacher when administrators walked by. The sonification tool both helped her recognize how she reifies norms of teacher-centered talk, while also providing justification for a loud classroom to potentially reproachful administrators.

Other teachers also recognized how school norms prioritize teachers voice and “control” over student voices. When asked for her biggest takeaway from the PD, kindergarten teacher Kelley Barrett reflected:

I need to let go. I need to not be as needing to be in control of everything. And I’ve said this in one of my reflections. You know, we’ve been taught over the years to just teach as much as you can, in the time you have. And there’s days I—every day I’m just about—like I didn’t have enough time— I didn’t have enough time, so to get the mindset to switch back to wait—let the kids explore, let’s give them that time, it was hard, but it also helps me reflect because that’s exactly how I should be going. Like, that’s the direction I should go more with students. (Interview, 12/9/2021)

After trying out science sensemaking in her classroom, special education teacher, Wendi Hanley, tried to extend student-centered discourse beyond science:

With the hands-on in science, I did try to incorporate that into my math lessons, in my reading lessons a little bit more. And I tried to like really let my students be the leaders, because seeing the [project and module PD], them [students] being the leaders and saying words and things that I never thought my students could say or think or do, I’m trying to carry that through to the other lessons. Of course, it’s always hard to give like
Similar to Kelley, she struggled with “giving your classroom away,” which implies a school norm where the teacher is in full control. However, moving into this space allowed students to demonstrate their assets and knowledge. Moving into a student-centered productive participation space is not easy, since it conflicts with teacher-led classroom norms. Wendi went on to reflect:

*A lot of my stuff is really teacher-led. [...] My reading lesson is very, very strict. It's very scripted. [...] So every day it tells me what to do. It says a, apple, ah; b, back, bah. So it is scripted. We normally cannot go off of it. And then our math program is also scripted for the lower, lower kiddos. (Interview, 6/08/2021)*

Similar to Kelley, engaging students in productive participation clashed with teacher-led talk that centered IRE.

The tensions which teachers shared following the PD reverberates with those discussed in the literature around why teachers do not readily take up equitable practices such as productive participation (Braaten & Sheth, 2017; Radloff & Capobianco, 2021; Richards & Robertson, 2016; Scott, Mortimer & Aguar, 2006; Windschitl 2002). Having time and space to interrogate those norms through the sonification tool helps examine talk practices and explore other modes of student participation. These excerpts are not meant to validate the power of the sonification tool, however they do confirm the tension between teacher and student voice in the classroom, and the necessity to provide tools to interrogate whose voices are heard in the classroom.

**Unpacking the sounds of science sensemaking**

My work is predicated upon the idea that school norms position students as still and silent in schools, which is detrimental to student learning, particularly for students who are EB (Windschitl, 2002). In Sally’s classroom and school, “showing pride” is an explicit call for
students to clasp their hands and close their mouths. This silence is not unique to Sally’s school, but is the status quo in schooling (Goodlad, 1984; Oakes et al., 2000). Administrators encourage and praise educators to go “with the grain” (Cochran-Smith, 2001), and follow norms such as IRE (Cazden & Beck, 2003; Lemke, 1990; Nystrand & Gamoran, 1991) which positions teachers, not students, as knowers. The sonification tool I introduce in this paper surfaces the tensions of productive participation as disruptive to those school norms. This section discusses the productivity of unframing the norms of how science sensemaking sounds, how these tensions align with a hidden reification of whiteness, and early evidence of the power in disrupting norms through acoustemology.

**Productively surfacing tensions**

Science sensemaking that encourages productive, “noisy,” student talk disrupts school norms that position students as silent. Sally, other teachers, and I consciously choose to move toward student-centered discourse that is translingual and which positions students as knowers through our collaborative PD. However, by enacting these practices, we also subconsciously resist them, since they disrupt the “proper” way students should be in a classroom (i.e., silent). It is in the resistance to enacting these practices, and the explicit acknowledgement, reflection, and dialogue around this resistance that we can recognize and interrogate the norms. When examining how Sally and I resist productive participation in a science sensemaking space and reflecting on teacher interviews as they attempt to enact these practices in a virtual PD, it is clear the tensions abound.

As Sally and I collaborated on science sensemaking lessons, she began to notice students talking more, recognizing her tendency to quiet them down. Despite this realization, when I
analyzed how Sally and I responded to students in a science sensemaking space, we both repeatedly disciplined students’ voices. In videos throughout our collaboration, both Sally and I return to norms that position students as silent. However, as we increasingly acknowledged how student sensemaking conflicts with positioning students as silent, it became easier to recognize and resist moments of silencing students. Teachers who participated in a five-week long module to enact science sensemaking practices and talk moves similarly recognized their inclination to return to teacher-centered norms. Kindergarten teacher, Kelley, recognized this by listening to audio recordings of her lessons. By acknowledging that a science sensemaking approach to teaching actively disrupts norms and by paying attention to the sounds and sonic patterns in the classroom, teachers can better recognize and disrupt the status quo in teaching. Sound is a useful medium. It impels us to consider who is speaking and who is not, and to hear how classroom sounds differ between IRE and productive participation. Moving away from language into sound also helps focus on who is speaking, rather than what people are saying or what language they are speaking in, which may lead to teacher deficit perspectives of students.

**Sounding CRT to hear whiteness**

When hearing how educators and researchers reify traditional norms of schooling despite engaging in equitable science sensemaking and critical reflection, we can better understand why there is a resistance to position students as knowers and engage in productive student participation. My own and other teachers’ proclivities to silent students when discourse became too loud aligns with a need to keep the room orderly and tidy, and to not make disturbances in a space. When considering theories of white femininity (Delivosky, 2010), white, female, elementary teachers have been stereotyped as begin caring, while also controllable by the white,
male administrators (Miller, 2017). Using CRT’s tenet of intersectionality, the intersections of race, gender, and sexuality position white, female, heteronormative elementary teachers as resisting disruption and complying with school norms that resist student talk.

The intersectionalities of ethnicity, race, and gender also overlap in meaningful ways when considering how Latine, EB students’ sounds are perceived. Using CRT and LatCrit (Solórzano & Yosso, 2001) impels me to consider the local and national context in which students are heard. Recognizing that sounds are socially constructed and subjective to the context of a place (Gershon, 2019; Powell, 2008), the national and local ideologies that position Latine people as criminal, dangerous, and threatening outsiders (Chavez, 2013) influence how white teachers hear Latine, EB students. Although I could not unearth literature about how white, monolingual English-speaking teachers hear EB students in the classroom, particularly at the elementary level, I posit that it aligns with how the media portrays Latine people as chaotic, noisy, and disruptive. Yosso and García’s (2010) work considers how the media positions Latine students as lower class, troubled, and loud. Giroux (1997) critiques Dangerous Minds, which “attempts to represent whiteness as “the archetype of rationality, authority, and cultural standards” (p. 46) and which locates whiteness “in the authority of the teacher” and “privileges itself against the racially coded images of disorder, chaos, and fear” (p. 46). The positioning of Latine students as loud also is substantiated by Latine students’ self-reports of how they suspect white students and teacher perceive them. Gil’s (2016) dissertation interviews various Latine students who imagine how white teachers and students perceive them as disruptive, loud, and discipline problems, among other deficit positions. Combining acoustemology with LatCrit and Latino Threat Narrative affords novel ways to uncover whiteness in classroom spaces.

CRT also disrupts the Either/Or binary. Teachers who explored student talk in our PD expressed a resistance to positioning students as knowers and not controlling the lessons.
Productive participation and the implicit student agency underpinning this approach moves away from a teacher/student binary where the teacher is all-knowing, and the student is a blank slate. A science sensemaking space where teachers hear students as knowers and students engage in more open discourse blurs the boundary of who is teacher and knower. CRT’s questioning of Us/Them and simplistic binaries moves us to question our interpretations of sound, recognizing that sounds are subjective and can have more than one meaning. This builds on Powell’s (2008) work which leverages CRT and its rejection of “single, objective truth-claims to knowledge” (p. 904), and recognizes the ways in which taiko drumming both maintain and disrupt racial identities. My work similarly moves to both/and spaces through unframing norms of sound.

Whiteness as property also helps us re-hear normative classroom soundscapes and a resistance to other ways of engaging. This tenet compels us to examine classroom sound, asking questions such as: “What sounds are allowed in class?” and “Who is allowed to make sound?” Considering the resistance to student-led, overlapping, translingual discourse, teachers often speak and make sound more than students, and when students are allowed to sound, it is in English through short responses to teacher questions. Implicit behind the norms of who speaks is the deeper question of who is positioned as being knowledgeable. Whiteness as property recognizes that whites own knowledge (Ladson-Billings, 1998). Unsurprisingly, teachers do not give students, particularly those who are EB, ample space to speak and share knowledge.

**Productive interrogations of norms through sonification and critique**

Although the exploratory sonification tool presented in this paper is new, and ample evidence has not yet been collected, initial reflections recognize the importance of disrupting school norms of sound. Sally Matthews reflected that her students are productively participating
more frequently since our recognition that science sensemaking pushes against norms of “be quiet,” with this talk branching into disciplinary spaces beyond science. Teachers in the PD acknowledged how hearing classrooms with the sonification tool helped bring awareness to normed differences in each space. Coupled with supports of talk move strategies (Michaels et al., 2007) and co-planned science sensemaking storylines (Penuel & Reiser, 2018), teachers reported shifting their practices. For example, 6th Grade teacher Lela Dawson reported that the PD webinar and module gave her “permission” to engage students in discourse-rich practices, and 4th grade teacher, Andra Mueller, could justify similar practices after participating in our PD. This suggests that some tensions between constructivist science sensemaking practices and authoritative, traditional approaches are tied not only to the teacher’s implicit perspective of the sounds of science sensemaking, but also school norms of classroom sounds.

**Limitations and implications**

This paper presents a nascent exploration of a sonification tool that can help interrogate how teachers hear classroom sounds, particularly seeking to disrupt an inclination to hear students’ (noisy) productive participation as off-task and disruptive. Given the hidden norms of what a classroom should sound like, this contribution is a valuable contribution to the fields of acoustemology and science education. I conclude with a reflection on limitations and implications to this work.

This exploration has limitations. I built the sonification tool from a small sample of audio clips. Moreover, the “traditional” audio clip and the science sensemaking audio clip covered different disciplines. A more rigorous method would be to compare more traditional IRE recordings of multiple science lessons to more constructionist recordings of similar science
lessons. The coding process of the soundscapes also needs scrutiny. By sonifying the codes of who is talking and how they are talking, my work moves away from a Cartesian realm of text and linguistic interpretation. Although sonification offers a way to move Cartesian coding toward a different way to hear and analyze meaning, a future direction could more carefully stay within an acoustemological boundary of sound during coding. In other words, I could code the soundscapes in ways that resisted listening to the words teachers and students were speaking.

There were missed opportunities to better understand the productivity of the tool when initially piloting and exploring classroom sounds with Sally. For example, comparing the sonification of the classroom with actual audio of each soundscape may have expanded insights into the productivity of sonification as a tool. In future pilots of this tool, I hope to include both the actual sounds of the classroom along with the sonification of data to better understand how teachers respond to each soundscape. This would help me understand whether the abstraction of the classroom sounds was an important component of interrogating deficit norms or not. In addition, besides my work with Sally, I did not collect extensive data before or after teachers engaged in disruptions of their classroom sound. Research that more carefully considers the sonification tool as an intervention and collects data accordingly could speak to its effectiveness or lack thereof on interrogating sound and changing practices around students’ productive participation. Lastly, I did not carefully unpack or consider how teachers’ participation in other aspects of our PD work influenced new awareness or changes in practices with regards to classroom sounds.

Implications from early applications of the sonification tool and engaging Sally in disrupting class norms of sound indicate the importance for iterative cycles of dialogue, reflection, and changing practices to increase awareness and ability to interrogate norms of sound
in the classroom. This practice mirrors Freire’s (2000) problem-posing pedagogy and aligns with CRT’s call for cycles of reflection and action (Miller et al., 2020).

Early piloting of the sonification tool suggests that it is more productive when teachers reflect on their own audio recordings of their classroom teaching. Given the priority of teachers reflecting on their practice through video reflections (e.g., Moje et al., 2001; Noonan, 2019; Roth & Lawless, 2002; Taylor, 2019), which align with Eurocentric ocular priority, research that considers how less dominant sensory reflections help interrogate perspectives and practices may be fruitful. A review of the literature on how white teachers interpret Latine students in deficit ways, with attention to sound, revealed few studies on the topic, unlike research centering white teachers’ deficit perspectives of Black students. Lastly, it may be productive to give more attention to the hidden ways racism and other oppressive ideologies are implicit in the sensorial facets of space and teaching. I leave this work particularly interested in how abstracting classrooms in ways that make the familiar strange can help educators interrogate norms that may be easily overlooked.


Chapter 5

Science (sense)making in summary

As I write this chapter, 36 states have passed or proposed legislation to limit discussions about race, racism, and white supremacy in the United States (Schwartz, Harris & Pendharkar, 2022). Toni Morrison’s (1988) *Beloved* was almost banned (Grablick, 2021), and a little over a year ago, Trump supporters stormed the capitol (Leatherby et al., 2021). Although these are facts, they are driven by dehumanizing ideologies, binaries, and polarities which proliferate how people “other” each other. In this moment, we are in grave need of novel tools to help interrogate deficit perspectives of others, and to make space to question how racism, xenophobia, sexism, and other “uncomfortable” systematic realities exist within education. Humanizing tools, which are inherently collaborative and self-reflexive, must be used with, rather than at educators, as teacher and researcher collectively recognize how we are implicit in stereotyping, othering, and categorizing each other. This dissertation shares my journey toward practices that bring teacher and researcher together to surface and examine the hidden deficit-aligned norms of schooling, and how we perceive each other.

The central question underpinning my work is: How does leveraging the sensoriality of science sensemaking with critical frames disrupt and de-familiarize deficit-aligned school norms and teacher/researcher perspectives and move us toward asset-aligned pedagogies in science and beyond? The three manuscripts in this dissertation address this question by examining how sensorial-rich science (sense)making and cycles of praxis led a teacher (Sally Matthews) and a researcher (me) to recognize whiteness and interrogate our own and each other’s deficit stances of families, students, and each other. In our journeys, we move toward asset-aligned perspectives
and practices through the process of becoming. To recognize the oppressive and deficit school norms concealed by familiar and everyday practices, I lean on Critical Race Theory (Bell, 1987), and Critical Consciousness (Freire, 2000). These critical frames ensure that I move toward critically recognizing and disrupting norms of whiteness. To more productively shake us to awaken to hidden norms, I leverage concepts of unframing (Greene, 1995; Powell & Serriere, 2013) and de-familiarization (Powell, Altuntas, & Bricker, in press; Truman & Springgay, 2016) to consider the sensoriality of science sensemaking and its disruption of deficit school norms. In this conclusion, I unpack the central thesis of my dissertation, highlighting its internal coherence, return to larger themes, and share implications, highlighting productive tools and approaches that emerged from this work.

Science (sense)making across the manuscripts

My research illustrates how sensoriality is an important facet of science sensemaking and can be leveraged to productively interrogate deficit norms of students and families. All three manuscripts highlight how attending to a sensorial aspect of science sensemaking changed dynamics, spaces, and interactions, interrupting norms that often discipline families and students as still and silent. In most schools, students are disciplined to sit still in their seats, hands clasped, with mouths closed, participating in normative schooling where students spend time responding to teacher-initiated questions (Braaten & Sheth, 2017; Wozalek, 2002). Families similarly take on “passive, accommodationist roles in maintaining the status quo” (Barajas-López & Ishimaru, 2020, p. 39), attending school-centered family engagement events where they look, listen, and leave. An equitable science sensemaking approach (Davis, Zembal-Saul, & Kademian, 2020; Haverly et al., 2020) disrupts these school norms by providing sensorial, phenomenon-rich
practices that position students and families as knowers who engage with teachers in productive, two-way communication (Warren & Rosebery, 2008). In the three papers presented here, 2nd grade teacher Sally Matthews and I engage in cycles of reflection and action (Friere, 2000) around science sensemaking, which expand how we recognize and disturb school norms. Below I summarize each study to make clear the coherence between manuscripts.

The first paper, *From look, listen, and leave, to sense, share, and stay: Interrogating deficit perspectives of families with critical frames and science (sense)making*, shares a critical ethnography of Sally and me, where we move from deficit-aligned, normative practices in how we engage with families and each other, toward asset-aligned, sensorial, and disruptive ways of engaging and being with families and each other. This manuscript considers how cycles of praxis helped move us toward new positionings of families and each other, as well as the productivity of engaging with families through sensorial-rich science and sense making.

The second paper, *Hands off: Disrupting school norms and interrogating whiteness through touch in science (sense)making*, is a case study that considers how Sally and I disrupt and reposition touch in a science sensemaking space. This manuscript similarly shares how we positioned and re-positioned touch over three years of collaboration, moving from disciplining touch to recognizing the power of touch in learning through cycles of dialogue and praxis.

The third manuscript, *The sounds of science sensemaking: An exploratory sonic tool to interrogate deficit classroom practices*, is a methodological paper which shares the development of a tool to help teachers and researchers recognize the productivity of discourse-rich student sensemaking. This tool abstracts the sounds of two classroom spaces: a normative Initiate-Respond-Evaluate (IRE) space where students are largely silent, and a discourse-rich space of productive participation. I share nascent reflections from piloting the tool, considering the
productivity of sensoriality. Although each manuscript disrupts the norms of schooling in different ways, all three leverage the sensoriality of science sensemaking and praxis.

**Reverberating themes between manuscripts**

Despite each manuscript’s differences, such as research method and sensory focus (e.g., being, touch, sound), all three works illustrate how the sensoriality of science sensemaking alongside critical consciousness, unframing, de-familiarization, and CRT disrupts teachers’ and researchers’ deficit positioning of students and families. These papers narrated changes over time, which resisted either/or binaries. They all employed Freire’s (2000) problem-posing pedagogy, where Sally and I engaged in cycles of praxis to move toward a productive sensorial disruption. They used a CRT frame to help Sally and me understand how norms are subjective, racialized, and steeped in whiteness. They apply concepts of unframing and de-familiarization within the senses, as taken up in art education (Greene, 1995; Powell, 2008; 2015; Powell & Serriere, 2013) and walking methodologies (Powell et al., in press; Truman & Springgay, 2016), to a science sensemaking space. Lastly, they resisted hierarchical roles between researcher and teacher, impelling me to include my own positionality and expanding positions and perspectives alongside Sally’s.

Movement underpinned each manuscript. In the first (family engagement) and second (touch) manuscripts, I illustrate how Sally and I moved from deficit frames and evaluative stances toward asset-aligned positions with criticality and self-reflexivity. In other words, we moved toward becoming (Freire, 2000). Manuscript three (sonic tool) took up the sensoriality of science (sense)making to explore its productivity. Although all three papers move toward an expansive position, they also are complex, with back eddies and juxtapositions that recognize both/and. An
important motif across papers is that asset and deficit perspectives are not binary but intertwined. Sally and I return to deficit and/or evaluative positionings of each other, students, and families throughout our years together. We continue to discipline touch and sound despite our nascent awareness.

Sally and I move toward awareness and asset-aligned stances largely because we mirrored Freire’s (2000) problem-posing pedagogy. The movement entails engaging in praxis—cycles of reflection and action. Each manuscript enters this cycle along different points. The family engagement manuscript begins at the reflective stage, where we participate in long-term dialogue and reflection about our positions of families before changing our practice with a (sense)making family engagement event. In the touch manuscript, our active engagement in tactile science sensemaking allowed the hands on a bottle video clip to be a starting point for productive dialogue and reflection. This manuscript documents how our reflections on touch fuel expansive ways to take up touch in practice. The sonic tool in the third manuscript stems from dialogue with Sally, and a reflection that students want to be heard. Capturing soundscapes of two spaces provided an anchor for future dialogue, reflection, and changes in practices. In all three manuscripts, events, tools, and/or experiences that disrupt school norms of staying still and quiet provided a rich experience to further disrupt deficit perspectives and practices.

Similar to how my research unfolded as I engaged in collaboration with Sally, my understandings of criticality and CRT also expanded as I began analyzing and writing. The act of thinking with (Jackson & Mazzei, 2012) CRT helped me understand its power, and the reason for its recent censure. For example, Whiteness as Property (Harris, 1993) forced me to question who owns school spaces and who is allowed to discipline the senses. As someone who has taken up dominant positions in society as a white, heterosexual, middle-class, cis-gender human, I am not used to asking critical questions of who benefits, who has access, and who has power to deny
access. CRT helped me ask these critical questions, whereby I recognized how sensory understandings are disciplined and controlled by those in power (e.g., the white, English-dominant researcher and teacher). Applying whiteness as property to family engagement made clear that despite our movement toward asset-aligned practices, Sally and I still controlled the boundaries around where and how families engaged with us. When applying this tenet to touch and sound, I perceived that Sally and I still decided when and how students touched and talked in science sensemaking. This tenet helped push our reflections of hidden norms to the surface, beginning a never-ending journey of recognizing them in our practices.

Another affordance of CRT and CWS was that it made me more carefully consider how my identity as a white woman reified norms of deficit perspectives, stillness, and silence, and how student and family identities as Latine and EB interacted with deficit perspectives and the Latino Threat Narrative (Chavez, 2013). The CWS tenet of white solidarity (DiAngelo, 2018) similarly was productive in considering how Sally and I unconsciously protect whiteness while trying to explicitly disrupt it. The themes that reverberate between the manuscripts strengthen the argument that sensoriality is important to attend to within science sensemaking spaces and is a productive place to begin disrupting the deficit norms of schooling. When theories like CRT are used alongside critical consciousness, teachers and researchers can begin recognizing deficit perspectives and practices in themselves and others.

**Productive tools and approaches**

In this section, I share what was created from interrogating science (sense)making. From reflecting on each manuscript, I can identify tools or approaches which teachers and researchers can consider to initiate meaningful interrogation of deficit norms in other spaces. As with any
tool, it matters what context the tool is used in, who uses it, and how they use it. The ontological roots of my work clash with a positivist frame that consider “best practices” (Edge & Richards, 1998) or “turnkey strategies,” and I do not imply that the outcomes shared below should be scaled up or duplicated. However, I do share them as potential paths for educators and researchers in science education to consider as they move toward asset-aligned practices and perspectives.

Manuscript 1: A new approach to family engagement

This study engages families and teachers in sensory-rich making together. A fundamental component of this approach is to position teachers and families as equal partners, and to be with each other through sensorial making. Teachers can start to unlearn normative deficit ways of being in family engagement events by moving away from didactic lectures about rules of the classroom and how to support students at home, and instead focus on being in community with families. Sensorial making creates space for families and teachers to sit down together at a table and listen and share with each other, building trust and relationships instead of delivering one-way knowledge. Exploring a sharing, sensing, and staying approach with families and teachers led to expanding ways of being both with Sally and teachers in a job-embedded PD pilot.

Manuscript 2: Video elicitation that centers touch and multivocality

Critiquing touch in science sensemaking was catalyzed when Sally and I iteratively reflected on videos of touch-centered lessons. Laying various perspectives of the hands on a bottle video clip side-by-side through video-cued ethnography (Tobin & Hsueh, 2007; Valente, 2019) made space to interrogate tensions and deficit-aligned interpretations of student touch.
Beyond the productivity of praxis, this manuscript uplifted the power in paying more attention to how teachers use and perceive touch makes space for a critique of wider school norms. Teachers and researchers engaging in this disruption can uplift video-cued ethnography or multivocal ethnography to interrogate interpretations by including different perspectives. Cycles of dialogue and praxis, along with a critical lens can help further disrupt deficit norms of touch.

Manuscript 3: Sonification tools that abstract and critique sound

This manuscript described a sonification tool that compares an IRE dominant space with a space that centered productive participation. Although the sonification tool itself can spark important reflection and changes in practice, the larger approach of listening critically to classroom spaces is productive to questioning hidden norms of how sounds are disciplined. I suggest that listening to a classroom space with a critical attention to who gets to talk, how they talk, and who benefits from this talk can yield valuable reflections that move beyond teacher reflections of classroom video. Asking teachers to record audio of their classrooms and listen to them, reflecting with CRT or prompts such as the ones above, can help educators and researchers alike recognize ways they are limiting meaning making. If teachers are reluctant to move towards more “disruptive” spaces of student talk, using a sonification tool that abstracts noise to help see affordances may be productive as well.

Coda: Reflections on what this work means to me

When reflecting on my four years at Douglas Elementary School, I often return to a memory of being with 1st grade students one spring afternoon in my first year at the school, a moment which I had captured on video and later studied. Their teacher, Stephanie, and I were co-
teaching a lesson on the seasons. After predicting what trees might look like in spring, we prepared to go outside and see a tree we had been studying since the fall, mostly from a window that students pass by on their way to lunch. Before transitioning outside, Stephanie reminded students of behavior expectations, saying: “When I call you to line up, we’re going to get in line, and we’re going to go outside and look at the tree. Now boys and girls, please remember, this is not recess time. We’re not going to run off. You’re not going to be yelling, jumping around, you need to stay in line. This is science class, okay?” Stephanie then directed the line leader to the door. After doing this, a girl sitting at the front table immediately clasped her hands and put “a bubble” in her mouth to show pride (Figure 5-1). She waited, sitting on the edge of her seat, moving her legs outwards until her name was called. Stephanie then remarked: “Let’s see which group is ready to go.” A boy in an orange shirt, who was just organizing his notebook, immediately clasped his hands and also “showed pride” (Figure 5-1).

Figure 5-1: Students showing pride.
Once outside, students instinctively lined up along the sidewalk facing their teacher and me, waiting for instruction (Figure 5-2). Students stood still, listening to me talk about how they could observe the tree. As I spoke, students slowly edged closer to the tree (Figure 5-3). Their desire to run and play was palpable. After 40 seconds, the restraint to stay still and silent naturally abated. Students jumped in place, took steps forward and backwards, and slowly edged closer to the tree. They started walking, then running toward the tree, breaking free of the expectations to stand still and silent. The line of bodies dispersed (Figure 5-3). Stephanie and I attempted to give
directions, to restrict where students could go to, but they had escaped, hands touching, voices speaking (Figure 5-4). I wonder how classroom norms with Stephanie might have changed if we had interrogated tensions between the traditional norms staying still and silent and the norms of touch, movement and talk in science sensemaking.

![Figure 5-4: Students touch, move, and talk.](image)

When I started my journey in graduate school, I was afraid I would lose myself and waste energy on navel gazing or esoteric research that didn’t matter. I asked a friend for advice, and he told me: “Make sure the work you do has a positive impact for students tomorrow.” As I explored acoustemology and sensoriality, I often questioned my path. However, I leave this dissertation confident that interrupting deficit norms that position student as still and silent through the sensoriality of science sensemaking alongside CRT and praxis can lead to real changes in how students are humanized in classrooms.
References


Appendix A

Case Study Observation Guide and Raw Data

Before reviewing data, I identified key components of touch in science sensemaking that would help me draw a boundary around the case (Hamilton & Corbott-Whittier, 2013). Specifically, I reviewed fieldnotes, video data, and interview data, looking for moments where 1) touch in science sensemaking was discussed (fieldnotes, audio transcripts of co-planning sessions, interview data), 2) where students engaged with phenomenon in ways that were tactile and hands-on (video recordings, fieldnotes), and 3) where Sally and/or I disciplined student touch (video recordings, fieldnotes, interview data). After identifying these three areas to look into, I then reviewed all relevant data, making open-ended notes where this is present (see table below). Whenever relevant, I transcribed specific quotes. File numbers and video file location is emitted for space here. I then returned to these moments iteratively to code and generate themes around touch in this space.

<table>
<thead>
<tr>
<th>Date:</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>190226</td>
<td>Oobleck, loud, messy - students touching oobleck, very tactile - newspapers on tables, students talking while touching - lots of touch!! Frankie talking</td>
</tr>
<tr>
<td>190319</td>
<td>students are tapping, shaking, grabbing, and turning property bottles. The room is loud and chaotic. We talk about what the bottles are while touching and shaking them. I say &quot;there's no right or wrong answer&quot;… spanish with Frankie. Sally: sounds like maracas</td>
</tr>
<tr>
<td>190319</td>
<td>loud, Sally comes over asking questions - student shaking bottle loudly, she doesn't stop him.</td>
</tr>
<tr>
<td>190521</td>
<td>still hands on</td>
</tr>
<tr>
<td>190604</td>
<td>still hands on</td>
</tr>
<tr>
<td>190917</td>
<td>hands on bottle episode… we're not shouting out, our hands are down. We will make 1 together in your group. Working with me or with Ms. Brown. Later you'll be able to make your very own, but first we'll make the correct way. We're going to experience first, and see what.. Items (takes out items, students smile, get excited, sit up, shout). &quot;Umm, you're shouting out. Student's hand goes up, Arella claps. &quot;Uh, stop - Chanelyis you're talking, you're shouting out. hands are down, because right now we're listening. We're not talking, we're listening.&quot; We are going to make our - we're not talking. (1:52). Sally shows materials. Glitter (Arella's mouth opens) - glitter glue, clear glue, Are we listening or are we talking? Then I'll stop. Shaving cream. Shampoo (wow - Arella's mouth) water. Corn syrup. What? Arella's hand goes up. &quot;Ohh the magic&quot; (student). And we have oil. (Arella - hand to mouth - acetate).</td>
</tr>
</tbody>
</table>
And this is glitter glue. This is the funnel we will use. Excuse me. You need to be listening. First thing we're going to do... "Rapido - lento - sparkley - etc.

| 190917 | "Careful! We're not fighting over cameras." "Careful"
| 190917 | hands on bottle episode...
| 191001 | discipline noise at 5:46, 6:10 - bottles down, "We will not do science if that is the noise. You are yelling, screaming at each other, shaking bottles in faces. This is not what we're going to be doing." If I have to say it one more time, you're done for the day. ~10:00 "he wants an ipod". "Go sit down." - "Guys, we are not squishing bottles" (10:38) [very chaotic] "Ok, but we're not mixing bottles." 11:21. "Ugh - " (11:34) -- getting confused with mixing bottles. Lights off - bottles - put the bottles in the middle of your table - hands off. Hands off. Bottles in middle of table. Show pride. Showing pride. No one's hands are on a bottle. Showing pride. We are not touching a bottle. We are done. (2) our voices are off. We are going to take a minute and you are going to think to yourselves quietly. Too much craziness. We were not talking about mixing bottles. We were not mixing bottles today. (2) we were talking about sorting bottles. Sorting means which bottles will go with which group. Noemi, sit down. What group would you put what categories in? Sorting means this group ...

| 191001 | Michelle: "do not open" Do not open!
| 191001 | video showing me leading group hands on bottles - making own bottles.
| 191029 | Glow sticks - Sally - demoing glowsticks in water... -DEMO.
| 191029 | Darla holds glowsticks and discusses them
| 191029 | :49, Michelle: "listening!" -- Edwin explaining while holding - Sally puts glowstick how Edwin is touching.
| 191029 | Edwin & Noemi touching, talking
| 191103 | VCE Interview – first time thinking about touch
| 191112 | Property bottles - students not touching as much?
| 191112 | Sally: "We're talking, we're listening" -- bottles at desks.. -- later on Sally comes over and lifts bottles to help define liquid
| 191112 | Videos of Arella and Kaylee touching and talking in spanish with bottles.
| 191119 | Video - group discussion, only some students have bottle sto use to talk - using bottles to speak. Michelle: "Everyone's listening to Erik. I love how Gabby's sitting quietly..."
| 191203 | OOBLECK (compare with last year?) Arella speaking with touching -- seca, -- similar interaction with other students -- oobleck...
| 191203 | groups hands shoved in box together...
| 191203 | Arella, Michelle: "Take a deep breath and calm down" to Edwin -- Edwin - vomit... Arella - I'm going to throw up. Arella - speaking in Spanish...
| 191203 | Sally: "Is it a liquid or a solid?" - in your hand it melts - an dit melts on your hand..."
| 191203 | Leony and others - stay on your hand
| 191203 | family member there too - Noemi , Emmanuel - talking about picking up
| 191203 | Modeling liquid vs. solid with Noemi at front of room
| 191210 | Instant snow (kids have at desks) - Sally: Touching not tasting. Michelle: "Don't put it in your mouth!" "Feels like crumbs like sugar" -- you know bottles - thing that shake (gestures) -- Brian: feels like salt - Erik: it feels like salt. 1:27: Arella - speaking in Spanish with feeling.
| 191210 | Arella speaks in Spanish - Sally at front of room -- "we need someone to translate" -- 0:45 "We're all listening right now" Michelle " Stay at your station right now" translation in groups
| 191210 | Students feeling instant snow
| 191210 | Sally says: "So we have to test it" -- takes up students' noticings
| 191210 | 1 student explains theory with testing touch as demo in group
| 200120 | Instant snow - demonstration, dried out - passed around, not everyone gets one
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>200204</td>
<td>discussions, passing around Ivory Soap around, asking what it is like with N/w: “go ahead, say it in Spanish” -- we can’t hear it because everyone is talking, Sally models breaking soap, then microwaving soap</td>
</tr>
<tr>
<td>200212</td>
<td>instant snow evaporation, students watch in group, we build CER</td>
</tr>
<tr>
<td>200219</td>
<td>evaporation (demo? Need to double check)</td>
</tr>
<tr>
<td>210217</td>
<td>“While we take these things out, fell them, put them in your hand, do not eat them, we’re not squirrels today. But make sure you get a sense of what they are like so that your prediction can be really good”</td>
</tr>
<tr>
<td>210504</td>
<td>Sally and I talk about octopus teacher—Sally shares how.</td>
</tr>
</tbody>
</table>
Appendix B

Codes for Sonification

Coding schemes populated in VNote represent different categories, which were later assigned to sounds. Below are the complete codes. Reds represent discipline. Blues and purples represent teacher talk. In the science sensemaking space, browns are included to represent researcher talk. Greens represent student talk. Yellows represent other discourses (e.g., oohs, aahs).

Traditional Space:
Science Sensemaking Space:
Appendix C

Category, Sub-Category, and Assigned Instruments, Octaves, and Notes for Control Data

<table>
<thead>
<tr>
<th>Category:</th>
<th>Sub-Category:</th>
<th>Instrument:</th>
<th>Octave:</th>
<th>Note:</th>
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<tbody>
<tr>
<td>Discipline</td>
<td>Behavior</td>
<td>Grand Piano</td>
<td>C2</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Student Name</td>
<td>Grand Piano</td>
<td>C3</td>
<td>Eb</td>
</tr>
<tr>
<td></td>
<td>Controls Voice</td>
<td>Grand Piano</td>
<td>C4</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Controls Body</td>
<td>Grand Piano</td>
<td>C2</td>
<td>Dd</td>
</tr>
<tr>
<td></td>
<td>Students discipline each other</td>
<td>Grand Piano</td>
<td>C3</td>
<td>Dd</td>
</tr>
<tr>
<td></td>
<td>Researcher controls voice</td>
<td>Grand Piano</td>
<td>C4</td>
<td>Bb</td>
</tr>
<tr>
<td></td>
<td>Researcher controls body</td>
<td>Grand Piano</td>
<td>C2</td>
<td>D</td>
</tr>
<tr>
<td>Teacher talk</td>
<td>Off topic</td>
<td>Grand Piano</td>
<td>C3</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td>Researcher talks</td>
<td>Grand Piano</td>
<td>C4</td>
<td>Bb</td>
</tr>
<tr>
<td></td>
<td>Teacher gives directions</td>
<td>Grand Piano</td>
<td>C2</td>
<td>Eb</td>
</tr>
<tr>
<td></td>
<td>Teacher talks</td>
<td>Grand Piano</td>
<td>C3</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Teacher asks questions</td>
<td>Grand Piano</td>
<td>C4</td>
<td>Ab</td>
</tr>
<tr>
<td></td>
<td>Teacher responds to students</td>
<td>Grand Piano</td>
<td>C2</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>teacher confirms answer</td>
<td>Grand Piano</td>
<td>C3</td>
<td>Gb</td>
</tr>
<tr>
<td></td>
<td>Teacher restates to get correct answer</td>
<td>Grand Piano</td>
<td>C4</td>
<td>Ab</td>
</tr>
<tr>
<td></td>
<td>Teacher summarizes</td>
<td>Grand Piano</td>
<td>C2</td>
<td>F</td>
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<tr>
<td>Student talk</td>
<td>Asks question to teacher/class</td>
<td>Grand Piano</td>
<td>C3</td>
<td>C</td>
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<tr>
<td>Activity</td>
<td>Instrument</td>
<td>Pitch</td>
<td>Note</td>
<td></td>
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<tr>
<td>--------------------------------------------</td>
<td>-----------------</td>
<td>-------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Called on and responds</td>
<td>Grand Piano</td>
<td>C4</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Calls out (1)</td>
<td>Grand Piano</td>
<td>C2</td>
<td>Gb</td>
<td></td>
</tr>
<tr>
<td>Calls out (more than 1)</td>
<td>Grand Piano</td>
<td>C3</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>Choral response</td>
<td>Grand Piano</td>
<td>C4</td>
<td>Gb</td>
<td></td>
</tr>
<tr>
<td>Talks to teacher/class</td>
<td>Grand Piano</td>
<td>C2</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>Talks to each other</td>
<td>Grand Piano</td>
<td>C3</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Spanish</td>
<td>C4</td>
<td>G</td>
<td></td>
</tr>
<tr>
<td>Hand clap/banging</td>
<td>Grand Piano</td>
<td>C2</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>Ooohs/aahs</td>
<td>Grand Piano</td>
<td>C3</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>laughter/excitement</td>
<td>Grand Piano</td>
<td>C4</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>Grand Piano</td>
<td>C2</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>
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**EDUCATION**

**Doctor of Philosophy in Curriculum and Instruction (Science Education)**  
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- Equity Fund- The Pennsylvania State University, College of Education  
  Teacher educators' Community of Practice: Disrupting troubling hierarchies through critical coaching. $4550 (Cunningham, C., Jackson, C., Brown, M.N., & Henward, A.S.)

**SELECT PUBLICATIONS AND PRESENTATIONS**

**Brown, M. N.** (2022, March). *Reconsidering touch in an elementary science sensemaking space.* Paper accepted at the National Association of Research in Science Teaching (NARST), Vancouver, BC.


