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Talking through the "messy middle" of partnerships in science education

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Abstract

This paper's focus is on the "middle" of partnerships for equity in science education. Middle is used in a temporal sense, meaning the time after the general purposes and terms of working together have been set and before outcomes have been achieved. The middle of the partnership also represents people interacting, bounded around the edges, by their institutional roles, norms, resources, and priorities. As co-authors who had not previously collaborated (or even met in person), we approached the construction of this manuscript as a dialogue where we learn by sharing narrations of experiences and values and principles. We were inspired by the conversational book between Horton and Freire (1990) and specifically their discussion of "Is it possible to just teach biology?" (p. 102). In our conversation, we illustrate the ways in which partnerships may make justice-oriented science education possible. Our focus is on complementary and contradictory knowledges, and ways of knowing, institutional resources and constraints, and strategies for making transformative change. We explore the middle of partnerships as a series of opportunities for learning and growing, caring for one another, and building solidarity spaces together.

KEYWORDS

care, equity, humanizing education, science partnership

1 | INTRODUCTION

Equity in science education will not be achieved in isolation. The racialized and gendered inequity that has defined science education for generations is interconnected with inequities throughout society. Therefore, working towards equity within science education must be linked with working towards broader visions of justice. This interconnectedness makes partnerships essential to equity work in our field. Quite simply, there is no way for science educators, especially science education researchers, to work towards equity by ourselves without centering the ideas, knowledges, and voices of students, teachers, parents, and others participating in struggles for equity.

Specifically with respect to science education research, partnerships can take many forms. For our purposes here, we distinguish between collaborations (projects shared between colleagues) and partnerships, which we assume involve some formal linking between the institutions within which these colleagues work. The most typical collaborations in our field are between science education researchers themselves (i.e., science education researchers across more than one institution) and between science education researchers and science education practitioners. The latter include school science teachers and out-of-school educators who explicitly teach sciences. It is also common for science education research collaborations to include university-based colleagues in science disciplines (e.g., chemistry professors, biologists, and so on). Thus, the most typical forms of partnership are between research institutions where science education researchers work and school districts or other nonprofit entities where practitioners of science education work. Partner organizations can include a wide range from small grassroots groups to large institutions like museums with multimillion dollar budgets (for an example of the former, see Vakil & McKinney de Royston, 2022; or Segura et al., 2021). Science education partnerships also include those that are funded by or aligned with large for-profit corporations or military sources.

We consider the interests of these latter two types of partners—that is increasing corporate profits and military prowess—to be antithetical to broader visions of equity and justice. Indeed, despite the popularity of equity and social justice as buzzwords, many partnerships in science education research reinforce existing inequities and take on a superficial or performative view in enacting transformative change. A central reason is that the goals of science education have often been aligned with nationalistic goals of economic competitiveness and military power (Vossoughi & Vakil, 2018). We find these goals for science education problematic in any context, but especially deleterious in the United States whose economic and military interests are characterized by racialized inequality and imperialist projects both within its national borders and around the world.

In contrast, we believe that grassroots social movements lead the way toward a better world. We believe science education research has the potential to contribute to these projects of justice, sustainability, and cultural thriving (Bang, 2020). We also recognize that educational and scientific research has often worked against these goals (Smith, 1999). As such, we consider the primary barriers to these goals to be global hegemonic systems of oppression and exploitation, including racial capitalism, white supremacy, settler colonialism, imperialism, and heteropatriarchy. We see ourselves as part of an emerging collective of thinkers/doers—taking up roles such as researchers, practitioners, and student activists, parents, and partners among others—who have been resisting and challenging these hierarchical power structures. Part of this paper is to reimagine how we create knowledge in partnerships for science education.

Therefore, we consider our task to be finding ways for science education research to follow the lead of grassroots movements and to find ways to center their goals and visions. As such, our essay is a critical dialogue where two co-authors jointly engage in an exploratory talk of how relationality and care play a role in the "messy middle" of partnership work (see Penuel, 2019). It is in this 'messy middle' where the bulk of the work is done, where the relational ties are strengthened, and where boundaries are contested as participants engage in sense making and knowledge construction within the local contexts. Together, we share and examine experiences, self-concepts, texts, pedagogies, and related ideas that have motivated our thinking and practice in building sustaining and generative science education partnerships where we place youth—inclusive of their ideas, expressions, bodies, questions, hopes, and dreams—at the core of our science education knowledge enterprise.

We enter this conversation still early in our academic careers, but with decades of combined experience as science educators. We question and discuss the ways our contributions to science education research have been motivated by our justice goals in the myriad ways we have sought to build knowledge with others (see Cheuk, 2021; Morales-Doyle & Frausto, 2021). Our understanding and lived experiences about social change makes us certain that such contributions cannot be made by researchers or academics working in isolation. In other words, it is through working in partnership with people in different roles and expertise, and in solidarity with those who are marginalized in our society, which drives the "messy middle" of our collaborations.

2 | WHAT DO WE MEAN BY THE "MESSY MIDDLE" OF PARTNERSHIPS?

Even as we define partnerships as implying the formal collaboration of institutions, we recognize that the actual work is done by people within those institutions as they build relationships with each other. Our focus in this study is on the "middle" of partnerships in a temporal sense, when the general purposes and terms of working together have likely been set at the beginning and people are working together within the structures of their institutions. In this sense, the "middle" of the partnership also represents people interacting with each other bounded by their institutional roles, norms, resources, and priorities. Thus, our conversation focuses on the ways in which people navigate their work and relationships with each other as informed by their principles, ethics, and commitments and mediated by their institutional contexts. This is complex because people work for and within institutions with ties that range from loosely to strongly coupled (Coburn, 2004). At the same time, individuals within partnerships also belong to broader community and familial networks that inform their values, action, and relationships to the work. No institutions in our society exist without contradictions, tensions, and problematics. This includes universities, schools, and community organizations. When we, individuals within and across institutions, are engaged in partnerships, we need to be honest and direct our work into these contradictions (Ayers et al., 2014). Even as we acknowledge that all institutions and organizations have their own problematics, by no means are we equating or flattening these issues. The contradictions of large powerful institutions with histories rooted in colonialism (such as universities) should not be conflated with those of small, grassroots, community-based organizations.

In focusing on "the messy middle" of partnerships, we do not consider the initial process of coming together nor the ultimate outcomes of shared work. The beginnings of partnerships are taken up by our colleagues (Kang & González-Howard, 2022). Instead, we try to illustrate the ways in which partnerships make justice-oriented science education possible in the context of doing the work. The middle is where the bulk of the work happens, where plans change, where unexpected negotiations and comprises crop up. This is true temporally and in terms of participation and collaboration. Our focus is on complementary and contradictory knowledges and ways of knowing, institutional resources and constraints, and strategies for making transformative change. We explore the temporal middle of partnerships as a series of opportunities for learning and growing, caring for one another, and building solidarity spaces together.

As co-authors who had not previously collaborated (or even met in person, for that matter), we approached the construction of this manuscript as a dialogue where we learn by sharing narrations of experiences and articulation of values and principles. We were inspired by the conversational book between Horton and Freire (1990) and specifically their discussion of "Is it possible to *just* teach biology?" (p. 102). In that spirit, we share our thoughts as a conversation organized around the following questions:

1. What is the "work" that happens in science education partnerships oriented towards justice if and when we agree that it is not possible to "just teach biology," and that grassroots social movements lead progressive change?

2. How do we humanize our work together and center the generative and reciprocal values of care and healing toward a sustainable partnership, while understanding that institutions often value partnerships in science education for purposes of funding and publicity?
3. How do we stay attuned to disrupting hierarchies and building scientific and educational knowledge in democratic and heterogeneous ways in the midst of working together across formal institutional roles (e.g., organizer, professor, scientist, student, teacher, etc.), informal relational roles (e.g., parent, neighbor, friend, comrade, etc.), and social identities (e.g., race/ethnicity, gender, sexuality, class, etc.)?

We take up these questions in this dialogue, which took place via videoconference in the spring of 2021 and then revisited in 2022. Our 2.5 hour videoconference dialogue was transcribed and edited for clarity, keeping intact as much of the dialogue as possible. We further reviewed and reflected on our dialogue transcripts and written text with feedback from mentors and reviewers, kept the key ideas that captured the essence of our conversation, and added citations where needed. This dialogical exploration allowed us to be critically aware of how we used language grounded in professional, personal, and sociohistorical discourses in representing our practices (i.e., actions, behaviors, and intentions). The bulk of the manuscript is a lightly edited transcription of our dialogue, organized around the three questions above. After the dialogue, we offer a synthesis of the ideas we discussed in a brief conclusion that encourages readers to take up our third question reflexively in their partnerships.

Question 1: What is the "work" that happens in science education partnerships oriented towards justice if and when we agree that it is not possible to "just teach biology," and that grassroots social movements lead progressive change?

Daniel: For me, the "work" is about figuring out where teaching and learning science fit into or connect with the work that other people are doing to build just and sustainable futures and communities. This involves bringing together science teachers or out-of-school science educators with others. In my experience, those others have included community organizers, scientists, and young people from our classrooms. And the reason why we're bringing people together is to reconfigure agendas for the teaching and learning of science in ways that make sense for people in their contexts.

Looking at the biggest funders and drivers of science and science education in the US, we see a rationale that is also frequently heard from politicians of both major political parties: that is science education serves the purposes of economic development and national defense (National Science Foundation, n.d). On a national level, there's lots of dissent and different points of view from state to state, and school district to school district. But there is a broad consensus at the highest levels of power, in the US and in other countries too, that the driving force of science education is economic development and national defense.

That's not why I'm a science educator. I reject nationalistic, imperialistic and exploitative goals for teaching and learning science. But I also don't think it's appropriate for us, as so-called experts in science education, to set an alternative agenda alone. And so, that's the work that we need to do together through partnerships. And that implies a lot of work, because constructing a different bottom-up agenda involves reworking all the machinations of science education: what we learn, how we learn it, how we teach it, and what teachers need to know as part of their preparation and professional development. For me that's what partnership work is about. It's about setting an alternative agenda that's focused on constructing "just, sustainable, and culturally thriving futures" for ourselves and our communities (Bang, 2020). This alternate agenda contrasts with the current goals that are nationalistic, imperialistic, and exploitive. So, it requires rebuilding all of what we're doing in science education and doing it together with teachers, communities, and students—especially those who have been alienated and marginalized by the top-down agenda.

Tina: I love Bang's description of "culturally thriving" and "pluriversal" futures. In much of my work, I see myself as a facilitator as I think about expertise in less hierarchical ways and recognize the different ways that students experience the world around them, and express themselves and their ideas through language. At the same time, I consider all the ways people in the room co-construct and negotiate shared goals. We have to start with where

students are and create spaces where they can not only express how they are experiencing and interacting with the world around them, but also create spaces and opportunities where young people can flourish and thrive.

What I've noticed is sometimes, there's a mismatch with what "we" (as nationalistic priorities) have prescribed for our young people especially in our era of standards and assessment-based accountability systems. What is it that students care about and is at the top of mind for them? How do we elicit their ideas and what tools do we have on hand to do that better?

What is it we can achieve together? For me, who is in the room matters—this may include community members, administrators, teachers, and students—and their thinking around science ideas, their students' work. Especially when there are such diverse roles in the room, I think about how we can create spaces of belonging, so that the interest is not solely driven by raising test scores. This work is politically challenging, especially when researchers often hold the purse strings and respond to funding calls with specified goals in mind. Not only that, our educational system confers to us—those holding the PhD as "experts." That's a lot of power. Yet, at the same time, I don't have expertise of what's going on in a classroom because I'm not there, I can only infer. All I know is through what the teacher tells me or what students have shared. The data that I have is very limited in that sense.

I also want to return to your point around grassroots social movement. How do we empower learners, and shake up the status quo power structure? In what ways can I amplify student voices and their ideas, especially communities who have been historically excluded from the science knowledge building enterprise? How can I take these diverse perspectives and 'connect the dots'? This work is messy as the goals for the various stakeholders aren't always aligned with one another. At the end of the day, it's easy to forget that our students are our key stakeholders.

Daniel: There's a lot of alignment between what you and I are saying. When you talk about starting from where our students are and adding what they're pondering and what they're thinking, it makes me think about how our field has begun to move away from old models of conceptual change. For so long, the presumed goal of science learning was to move students to a simplified scientific consensus explanation for each phenomenon. Now even mainstream voices in our field are lifting up the idea that it is valuable for students to make meaning on their own terms—with scaffolding and prompts from teachers, of course. It's extending beyond the deficit-framing of eliciting misconceptions or the euphemistic way of saying that—eliciting preconceptions. Students are sophisticated thinkers—whether or not we intervene. That's an important principle that we share.

Another important thing that happens when you value student meaning-making ahead of students arriving at the canonical explanation is that you quickly get pushed in interdisciplinary directions because student thinking isn't usually organized within disciplinary boundaries. That brings us back to this question from Freire and Horton: "is it possible to just teach biology?" in light of what you said about thinking about the broader political context. I've never been a biology teacher. I was always a chemistry teacher. But I've been thinking a lot about how impossible it is to isolate biological understandings from sociopolitical understandings in this last year during the pandemic, especially as it relates to the ways people understand the disparate impact of the pandemic on people in racialized and classed ways. A system of science education that has tried to "just teach biology" hasn't cultivated widespread engagement with the complexities that exist between biological and social worlds or, more accurately, biological and sociological ways of looking at the world. This is the reason why partnerships are so important to our work as science educators who care about racial justice. We can't do it alone and we can't sit idly by while regressive and white supremacist forces try to push education backwards. It implies that one type of partnership that we need is between science educators and social science educators or between science educators, biologists, and critical theorists of race.

Tina: To our question: it's not possible to just teach biology, especially with our current context with the pandemic. It's been eye-opening. The facade and the cracks show 'the way we've always done things' are simply upholding hierarchical power structures—and with deadly outcomes. How do we move forward when we have to unlearn much of how we organize schooling, ways we prioritize science education, and acknowledge how racism, sexism, classism, and ableism touches upon so much of our existence? Your example of the pandemic is timely. We

simply can't teach biology without understanding the ramifications for those who have been historically left out of the conversation and for society as a whole.

Daniel: This idea that it's not possible to teach just teach biology leads me to another thing that we've seen during the pandemic and the movement against anti-Black racism, the movement for racial justice that's coincided with the pandemic. One of the things you mentioned is the importance of setting priorities. It's been clear in the various kinds of political battles over guidelines for reducing the impact or slowing the spread of COVID that there are good reasons to teach biology. There are concepts that people should understand about viruses and how different fields of science gather and make sense of data. It's been even more clear that maybe we need to teach public health along with biology in high school. If that's clear, but then, if it's not possible to just teach biology, where does it fit with all of our other priorities? And how are they woven together? I think that's part of what these partnerships are about. There is a lot of work we need to do with people beyond the science education research community if we are to truly reconfigure the aims and purposes of science education.

Proclamations from elites don't convince people. And so connecting the two, I hope that science educators don't sit on the sidelines as critical race theory is under attack in schools, as there are all these states trying to pass laws against teaching about racism. I hope that science educators see that we too have a place in that conversation that we need to be part of pushing back. It is not just our colleagues who teach history who are under attack with those efforts. And so the partnerships to me, then, can move in that direction.

Tina: There is something about presenting and teaching science with an objective stance that serves to protect the status quo. This issue of public health has differential impacts depending on your race, your gender, your income, where you live, and so forth. It's a privilege to "just to teach biology". But for those who have been most marginalized—and who are most adversely impacted, they don't have that privilege. The urgency is there. It's about survival.

So what is "the work" we keep on talking about? Maybe it is my cultural upbringing that contributes to more community and collective values. Especially now, there is greater urgency. If we revert to the ways we've always done science education—and this includes ways we work together—in solidarity, nothing will change. Both of us are parents, and what motivates me the most is not just about teaching the content, but it's about improving lives. I accept as a fact that there is systemic and structural racism in the US and beyond. Our education systems aren't immune. They are designed to uphold these power structures. The more opportunities we can empower our students and teachers at the grassroots level so that they can convene and lead, the more we can learn from them.

Question 2: How do we humanize our work together and center the generative and reciprocal values of care and healing toward a sustainable partnership while understanding that institutions often value partnerships in science education for purposes of funding and publicity?

Tina: Most recently, I've been thinking about care work and disability justice frameworks and ways this country views care work as something that is individualized, and of course, heavily gendered. Care work here in the US is simply not considered as a community or collective good. What happens is that care work becomes this invisible labor that is not necessarily counted or valued in academic spaces.

In terms of partnership work, there's this third space we get to create that excites me (Bhabha, 1994; Gutiérrez, 2008). It brings me joy to create new spaces where we can come together and learn from one another. For example, for so long, I hadn't reflected on how my racialized experiences as a graduate student during my training would impact me today a researcher. It wasn't until more recently that I realized so much of my own work had been centered around whiteness. It was through talking with other science educators of color that I realized that my experiences weren't isolated. So now, with the privileges I have as a faculty member, I seed spaces that bring aspiring teachers of color together. In order for us to heal from the racial trauma that persists, we need to know that we belong in community with others who are also on the continuum of healing.

Building these third spaces is beyond providing access or simply bringing "a seat at the table." Access is continuous, not a timestamp. It's this perennial practice of working in communities that have easier access, mostly because they are the dominant population, and then add accommodations and modifications for our emergent

multilingual learners and students with disabilities as an afterthought. How do we flip that narrative so that we care about all students and value their bodies, minds, and existence?

(It is right at this moment that Daniel's 16-month-old is heard in the background. We took a pause so that he could comfort his child during our zoom call.)

If there's anything I've learned from the pandemic are ways home and work life becomes blurred. For those who have care-taking responsibilities, care work becomes ever more salient with the school closures for many of us. We had to be our full selves during this time. The people we interacted with had to provide grace as our full selves are complex and at times, feels at odds with our work life. Yet, we know that it can be possible. There are lots of examples in disability communities around care collectives. It's a way of how they look out for each other, because if they don't, they can't survive.

In our roles, how do we bring our full selves into the work, and then also ensure that those who are in this partnership space can also do that. At the core, that's what humanizing partnerships allows. If we deconstruct the term "humanizing," the word human is central. It's about recognizing the full humanity of everyone who is at the table. It's about moving beyond these individualistic notions which are capitalistic driven and move toward a collective notion of caring.

Daniel: Yes, then I think about the concept of care in education, I always go back to Angela Valenzuela's (1999) *Subtractive Schooling*, which was a really important text, for me, when I was an undergrad. She built on Nell Nodding's ideas (1984) about care to distinguish between aesthetic and authentic care. As science educators, I think, an important part of that distinction is whether we're viewing students only in relation to their schoolwork and in respect to their science learning or whether we view them as full and complete humans. Aesthetic care is just valuing students for their schoolwork or for their science learning. Authentic care is about caring for students as humans—valuing their full humanity. This is true for partnership work too. We have to practice authentic caring in partnerships. We can't just value partners for their measurable contributions to the work, but we have to care for each other as humans. In science education, I love the way that Alexis Patterson and Salina Gray (2018) have articulated this (w)holistic science pedagogy. They do an excellent job in that framework connecting the dots between the affective and the critical thinking components of science education in the direction of justice and equity.

Tina: The current default is around funding and status, which is intimately tied to power. It's not a surprise to me that our higher education institutions hold neoliberal values. That's one of the biggest tensions. Here we are, laborers in these value-driven spaces that may be at odds with care for *all*. So much of my energy, and I'm sure yours too, is to secure funding so that we can create spaces where we and our partners can be our full and complex selves. It's a constant argument we have to make to funders and institutional leaders who hold purse strings to convince them that it's good for society when learning opportunities aren't stratified, and that resources are limited. Do we care enough for others to put resources toward their survival, well-being and thriving?

Daniel: I think your take on institutions and publicity and funding is right on. Partnerships make for good grant proposals. They make for good press releases. And too often, universities, in particular, prioritize securing grants and a good public relations narrative over humanizing work that is genuinely grounded in communities and beneficial for students and participants.

Very early in my career in the academy, I was put into a position by university administrators, where I felt like they were trying to exploit my relationships with communities. A group of senior administrators were writing a grant about science education and they invited me to contribute. In the draft proposal, the biography that they wrote for me didn't highlight that I was a science educator—even though I actually had more expertise in science education than the PI of the grant and the main idea closely mirrored projects I had facilitated. Instead, I was positioned as a community liaison.

The ways I heard them talking in the meetings, it was clear that my involvement was a way for them to access community partners with whom I had formed relationships over many years of activism and collaboration outside of the academy. I pulled out of the project before it was submitted, because that's the opposite of the type of partnership we're talking about here.

Right after that experience, I almost gave up hope that universities could partner in equitable ways with grassroots community organizations. But I think that larger institutions can play a role, we just have to co-opt and challenge their existing structures to be more just and equitable. I really like the idea that there is a different decolonial possibility for universities (Paperson, 2017; Patel, 2021).

There are tensions in terms of thinking about partnerships as existing between institutions, but also between people. So it's important to emphasize that partnerships are in the relations between people. That's the humanizing view of partnerships. But it's actually also important not to diminish the role of organizations and institutions, which we're doing when we distinguish between collaborations and partnerships.

Growing up as the son of a community organizer, my dad taught me that it's important to build up organizations, because organizations are a way to access resources and build power that is beyond what we can do as individuals. Through organizations, people and communities can more readily respond to bad situations and can sustain their work over longer time periods. It's important that partnerships are between people, but it's also important that partnerships involve organizations because of the fact that organizations can wield more power than individuals. Also, organizations offer opportunities to build structures for democratic decision making and for reflecting the collective will or direction of a community.

Partnerships with grassroots organizations are difficult to navigate because of the unequal power relations between small organizations and large institutions like universities, but they're important. And in between grassroots organizations and universities, in terms of money, status, and power, sit K12 schools. So we have to enter these partnerships with humility, honesty, and integrity—conscious of our positionality as academics (Tolbert et al., 2018). We have to find creative ways to flatten those uneven power relations and secure resources for smaller organizations and schools. I'm still figuring out how to do this well. I've been inspired by the way Megan Bang and her colleagues (2010, 2016) have done this in their work.

There are ways that we can push, co-opt, or create third spaces, as you said, so that partnerships between institutions or as people can sustain good, justice-centered work in science education. As people, we go through seasons in our life and in our work and so we need organizations and institutions to support that work as we may need to step back for personal and family reasons or as leadership evolves among the different collaborators. A person who is a leader right now may need to step back to allow for other organic leadership to grow and build. Part of that process happens between people in the form of mentorship (Haverly & Brown, 2022). Partnerships can also offer opportunities for young people and community members to get experience or credentials that position them to take on ever-increasing leadership (Bang, et al., 2010).

Tina: You brought up a lot of good points about organizations especially around sustainability. There is and has been ebbs and flows and what happens in people's lives. Earlier in my career, I had a "director" title, but my daily work was maintaining a partnership between researchers and school districts, and their respective schools and classroom communities. At that time, I called myself a boundary spanner, but I did more than that. It was about moving the partnership work so that together, we could coalesce our energies around science learning, especially the brilliance of those whose learning is too often ignored. There was a novelty about my role in that it was created specifically to build and nurture this third space of partnership work.

One of the core values that emerged was about working and learning in place. It's a powerful notion to work in the communities where you also call home. You care differently about how the work impacts your "nonwork" life. We weren't working as transplants, peering into other people's spaces and domains, and then leaving. Because our research and partnership work was in place, the work was less transactional. We had this sense that we could build a community and were invested in the livelihoods of our students and their families that were outside of the boundaries of science education.

Don't get me wrong, the bulk of our work was around research, but in working with others, the work was just as much about the people with whom we worked with as much as the "work."

Daniel: In academia, we're often coached to think and talk about what we do as "my work." We're taught to build a "signature" so that we're known in the field. That is a really problematic, individualistic way to conceive of

the work because, as you're saying, the work always happens collectively, always happens in teams. It always has a range of different participants who are all equally important. If our goal is social transformation, that kind of "my work, my signature" type of thinking is antithetical. That kind of positioning can harm the relationships that constitute true partnerships. Relationships are built on trust over time with integrity and humility. The individualism of an academic career doesn't mesh well with building those kinds of relationships.

Tina: The academy prescribes much of our roles for us, like you said—in how we are trained, the whole hierarchical nature of it all, even in our titling system! Again, what we do is beyond our titles. Our lives are much more complex than our contributions, just as the data we collect is only a sliver of what our students and teachers are capable of.

Like you, I struggle in this field when there is a lot of pressure to be a researcher of something very specialized. I don't like being contained, or restricted. What I mean is that I've been doing work in education for about two decades in various roles as a teacher, administrator, partnership director, and more recently, a researcher and teacher educator. Those lived experiences are just as valuable as my academic training to be a researcher.

I value the training that I've received, much of it was focused on ideas, in the abstract. Yet, my biggest lessons to date have been from my students. I learned from them because of the relationships I had developed with them over the years and what they share with me from their vantage point. The ideas or the content was almost secondary. The students had to know that I saw their full humanity first before any learning would even take place. You can't have one without the other.

When we write proposals around research partnerships, the calls often ask us to talk about each of our roles and anticipated contributions in a sanitized and coherent way. We like to put people in buckets and label them because it's easier for us to build assumptions of what these groups can do and contribute. Yet, we know that the human experience is so complex. There are roles that we haven't even imagined or dream of yet! So in this middle part of the partnership, I try to help people shed those prescriptive labels and open up spaces for our community members to contribute in their own way.

Sometimes I question how much we can generalize the work we do around science teaching and learning because we know so much of the work is context-dependent. When I say context, that's inclusive of the place, the time, and the histories that contribute to how these learning spaces came to be. And of course, there are the people. So to what extent do our generalizations we make apply, especially if we end up studying a "part" of something? It feels so piecemeal, the way we've designed the infrastructure of higher educational institutions and the way funding mechanisms further reinforce these incremental piecemeal solutions. It's a mismatch to the expansive, complex, interdisciplinary problems we face in science education.

Because I know our time on this earth is limited, our time together is important, I want to make sure I make decisions that have the most radical impact—radical in the sense that the work we do gets at the root of the problem.

Daniel: I think what you said about people's roles being prescribed and limiting is on point. Yet on the other hand, if we don't make sure to include people who have different formal roles, then that can also be a problem because that's one way that certain perspectives get left out. For example, if we don't include K12 teachers in any kind of initiative or policy decision about schools, that's shortsighted. You and I both have a long history working as K12 teachers. I like to think that I can continue to understand that perspective from having spent more than a decade teaching high school. But the reality is that since I'm not currently in that role, I need to work with individuals who are. Like you said, I don't want to prescribe for them what their role is or what their perspective is, but I know it's important to have that type of perspective in any project that involves schools.

Partnerships should position people from various formal roles to claim their rightful role as knowledge producers, with the recognition that producing knowledge can take many forms. Not everybody values the limited scope of disseminating knowledge in academic realms. A related tension is that partnerships should take care not to push people to take on responsibilities that they don't have the space for and that aren't part of their so-called job description. At the same time, partnerships should push us to transcend our job descriptions and knock down the

institutional barriers that make knowledge production an elitist enterprise. All the while we need to respect people's time and work and whether they're being compensated fairly.

Tina: One of the issues I've been thinking about is sort of transformational versus incremental change especially around improvement sciences. It is an incrementalist view of change. The idea that by making a series of small changes, we can get closer to solving the problem at hand. We already know that our educational system is full of these loosely coupled parts. It's dynamic, and as mentioned earlier, and context dependent. In our partnership work, we have to consider how our work that we do together is situated within these complex, dynamic, and loosely-coupled systems. We can't develop curriculum and ignore the local school cultures that have deprioritized science instruction at the elementary level. What I love about partnership work is to bring people together so that we can identify the boundaries of our work and move together.

There's this analogy I was told in my graduate studies that our work as researchers is to build bricks. I've certainly been afforded all the tools to build plenty of bricks. I question, to what ends? As Audre Lorde describes, "For the master's tools will never dismantle the master's house. They may allow us temporarily to beat him at his own game, but they will never enable us to bring about genuine change." Along with the people we bring into the partnership, what is the movement we are working towards? How can we be in solidarity with one another so that we can all flourish?

What I've most enjoyed about this conversation with you is our dialogue around issues we care about. This conversational genre removes us from the constraints of the academic genre of writing that we've been trained to do with other academics, which has not always been accessible to non-academics. This all started with your recommendation of Myles and Horton book, *We make the road by walking*.

Daniel: Asking the questions, 'what do students want? what do community members want?' is super important at the beginning of a partnership. But one of the things about the messy middle is that those decisions about whose interests are guiding us are constant in partnership work. It's not that we begin from the will of the students or the community and then that's it, we're set on our path. Questions or issues come up throughout partnership work that get taken up, ignored, modified. There are decisions all along the way that are also about whose vision are we following and what are we co-constructing. It's not just at the beginning and towards the end that we have the opportunity to focus on collective construction.

What you said about improvement science really hit me, because there's a number of issues I have with it. One is the point that you're raising, which is that it aims for incremental change, at best. But it also assumes that we're starting from the right place and that we agree on where we're going. The word improvement assumes that we've got the right structure or skeleton or that we're pointed in the right direction and that we just need to tinker around the edges. But that's a dishonest assessment of the causes and consequences of inequity in science education. The structures and starting points were never designed to be equitable and we certainly do not have consensus on where we're headed or what constitutes improvement. Inequity in schools didn't happen by accident. It wasn't unintentional and it's not due to incompetence or inadequacy. In other words, it's not because science education is not good enough. It's because it was always aimed at the wrong goals. You can't improve your way out of that problem.

Inequity that was always intentional and structural means that improvement will never get us to equity. It gets back to the start of our conversation about why we teach science and who is deciding on our priorities. If the aim is economic competitiveness or national security, then I want no part of their improvement or reform. I don't want the US to get better at dominating the world via military power and economic exploitation. I don't want our schools to get better at sorting students into various pipelines, not towards STEM or prison or anywhere else. So then partnership work begins from the idea that we have to rebuild our goals and with rebuilt goals we need different ways of engaging with science teaching and learning.

Tina: I think you're speaking to the current paradigms of the status quo systems that we work in right now. We are building upon knowledge of others, however, that knowledge base is incomplete. So if we continue to build on the knowledge of others when we know that knowledge is incomplete, then we need to acknowledge ways our own contributions may be flawed and problematic.

So what we need more of is a pluralistic approach. It's nonlinear. The work is messy as you move a step forward, and then two steps to the left. And then you recalibrate and decide as a group whether the movement is still the best path forward. This includes what to leave behind.

Question 3: How then do we stay attuned to disrupting hierarchies and building scientific and educational knowledge in democratic and heterogeneous ways in the midst of working together across formal institutional roles (e.g., organizer, professor, student, scientist, teacher, etc.), informal relational roles (e.g., parent, neighbor, friend, comrade, etc.), and social identities (e.g., race/ethnicity, gender, sexuality, class, etc.)?

Daniel: Let's begin from the belief that every partner's knowledge is equally valuable and complex. Unfortunately, I think some academics enter partnerships, assuming that knowledge production is their role or their domain in the relationship. There's sometimes this really crude 'brains and brawn' idea about working with others. There is an assumption that academics are the knowledge producers and community partners or teachers have some sort of more practical role. This has been especially true for scientists and science educators. It's the wrong way to approach partnerships if we care about sustainability, equity, and justice or even rich adaptable and meaningful knowledge production, for that matter.

As a side note, as early career academics, sometimes we get the advice about focusing on our intellectual work and delegating some of the more tedious or rote parts of our work to others, whether those others be graduate students or staff or somebody else. But it's been really important for me to resist that even if sometimes it means being less productive in an academic sense. Then, on the other hand, sometimes I've gotten caught up so much in focusing on the research and writing that haven't been fully present or engaged in other aspects of partnerships, to the extent that I think I should be. Don't get me wrong, I think that academic forms of knowledge production and dissemination are important and valuable. But they're not the be-all and end-all. Different ways of knowing offer insights and produce oversights. They have flaws and limitations and of course they're always changing. As a subset of academic ways of knowing, this is true for disciplinary ways of knowing in the sciences. One of the big problems I have with science education is that our science classes give students the false impression that there's one scientific method or even a set of methods that is the universal path to truth and understanding. Some people in our field position science as *the* way of understanding the universe. There's not some kind of universal knowledge hierarchy like that—or at least there shouldn't be. In our social world, such a hierarchy exists but, if we just take a step back, we realize that it's a false hierarchy. Scientific ways of knowing are really powerful and really insightful in particular ways, but they're also really limited and even dangerous in other ways.

Tina: Why is it that we privilege one type of knowledge over another? The more I look around the room to see who is in the room, who is doing the decision making, and who is part of the knowledge generation process, I feel disheartened. There are so many gatekeepers in place.

The system didn't come by accident like you mentioned earlier. It was and continues to be designed to protect certain groups of people to maintain the power and status hierarchy. It wasn't until more recently that I've seen how high the walls are in academia.

The power of partnerships is that you can redesign and reimagine what that space looks like and feels like. It's defined by those who are there. In some respects, partnerships provide this freedom from the prescribed roles inscribed upon us by our institutions. That's where our creativity can come in. How do we allow all of us in this partnership space to flourish and contribute in ways that are generative? This goes to your notion of epistemic humility of where we situate ourselves within the partnership space.

Daniel: Yeah, that's a really good point. On one hand, this idea that as academics, we study this tiny little sliver of something really specific. The brick analogy that you mentioned is an honest and humble way to view what we do. On the other hand, it exemplifies the limitations of the scientific and academic ways of producing knowledge. They represent a reductionist approach to problem solving where we can easily lose sight of the larger context and the whole picture like where problems come from, their history, their politics (Levins, 2007). That's what I'm talking about when I talk about viewing our ways of producing knowledge as having insights and oversights. It's not to minimize our particular contributions or role—or even our power and responsibility to use what we learn for equity

and justice. But it is to acknowledge that the role of academics, the role of researchers is not to be more knowledgeable than teachers or students or community organizers or the other individuals with whom we might partner. You're right that I've used the term epistemic humility, as have others in different contexts. But you've been encouraging me to avoid those super academic terms, so the everyday, schoolyard way of keeping that mindset is to remind myself not to be a "know-it-all"—or as Bravo Zamora (2019) writes in his description of epistemic humility, "Don't be an arrogant mosquito!" (p. 27).

For example, in a project that we're doing right now, we have really clear evidence that the actual process of teaching and, in turn, the direct involvement of teachers in our research process as full contributors was essential. Their full involvement was indispensable to our knowledge production process—and the same has been true for the community organizers and the young people, and the scientists who were working with. This gets back to what you said earlier about the ways that people can get boxed in by their roles.

This morning my role in a community-based participatory science project was to carry this 24-foot ladder around my neighborhood. My shoulder was hurting, and I was sweaty, and my partner and I brought our kids along for the work. I was reminded that this is the work in the messy middle of partnerships. As much as it was a little uncomfortable physically, it felt good to be doing a community science project in the neighborhood where I live. It's a working-class community where most of the residents are Latinx. My contribution this morning wasn't intellectual, so to speak, it was practical. But honestly, it was the most important thing I could have done to help that project happen today. It was the most important role I could have played in the process. And others, including students, were doing some of the more "scientific work," and that was important too. I aspire to structure community science projects in ways that flatten hierarchies and everybody pitches in for all aspects of the work, like the way Bang and colleagues (2016) describe the distribution of work in their projects located in a community center. But I have to admit that I haven't fully realized that goal yet.

Whenever I'm in my community, I think about my positionality there too, because in some ways, my name and family characteristics help me fit in and feel at home. But, I experience white privilege that most of my neighbors don't and I have class privilege that most of my neighbors don't have. That's something I'm also aware of as I do the participatory science work in my neighborhood. More than once, while doing community science projects with Black and Latinx youth, we've been interrupted and questioned by the police. I got some funny looks carrying a big ladder around, but that didn't happen this morning—as suspicious as I might have looked. I'm conscious of the privileges I have, which includes the ability to write and speak in venues that most of the people in my neighborhood don't have access to. At the same time, it's been an intentional choice that our kids go to our neighborhood school. My work projects are located in contexts that are similar to the one where I live, or even right where I live. My research and my life are intertwined. But that's not common in our field and that's a problem with lots of partnerships and science education research. Researchers will do research on one type of community and then retreat home to a different type of community and that can be extractive and exploitative. And even as I try not to do that, the contradictions of the university always implicate us in that kind of relationship and that kind of approach.

Tina: I want to revisit our earlier question about care and relationality with others. How do we acknowledge our histories, our lived experiences and use it to inform our present and future decision making? This 'middle' work is filled with choices we make, much of it in the company of others.

We have this pervasive normative culture that science (and scientists) are objective, sanitized, and devoid of politics and values. I would argue differently, so much of the decision making that creates the "how" we will interact with one another to the outcome of knowledge generation is steeped in values. What is it that "we" within the partnership care about? How do we interact with one another that allows all of us to flourish and thrive?

This pandemic has brought to light ways people have opportunities to care for each other *beyond* the work. We all got to peer into each other's home life, which I think before the pandemic, most workers kept it separate. Gloria Ladson-Billings (2021) talks about ways we can use this pandemic to "re-set" how we interact with one another and what work is important. Do we go back to the pre-COVID times when we know many of those learning spaces didn't do justice for our historically marginalized learners?

One way that we can disrupt hierarchy is to allow for those ebbs and flows of our role identities and continue to protect and create spaces in these partnerships where we can have different forms of ourselves show up and contribute.

Daniel: It may be a positive shift that the pandemic has expanded the number of people who find breaking down barriers with respect to children, family, school, and work acceptable. Bang (2020) writes about how age-segregated spaces have been used as a tool of colonialism, to separate youth from their elders. There's tension too, because there are important distinctions between home life and professional life and people with privilege sometimes blur those boundaries in ways that aren't appropriate (Ridgeway & Yerrick, 2018). Also blurring those boundaries is less accessible to those whose family lives are othered, because they operate outside of the dominant cultural or gendered norms. In partnership work, it's important to be transparent and considerate about the range of ways that family, community, and work may be intertwined and how our expectations are shaped by colonial and heteropatriarchal norms.

Tina: This comes back to our notion of individual care work versus collective care work.

What are some models we can draw from? In what ways can we move closer to those spaces of collective care in how and what we do in our partnership work, especially when we are attuned to the institutional logics that constrain and in effect normalize certain values that are at odds with what we value?

Daniel: Absolutely, and I think that what you just said is a good example of how there are two sides to the coin. Being fully human and being our full selves means acknowledging that people have different caring responsibilities that change over time and as you mentioned caring work is gendered and there are also important considerations around class and ability. When a partnership is between individuals and, in the middle of the work, an individual has to step away or do less, you know other people can step up. But that's often not sustainable. When there's a certain organization and structure to it, there may be other ways that allow that person to step away and allow the work to keep going. Humility is a part of that too because no one person is so central in terms of the knowledge they bring that it causes the work to stop when they need to step away. On the other hand, everybody in the partnership is valued and has important knowledge and perspectives to contribute. There are ways in which institutions can provide structures that democratize and flatten hierarchies and allow the work to be distributed in ways that are good for everybody's health and workload and also better for the processes of making meaning. Unfortunately, those aren't the ways our institutions tend to be structured, but it doesn't mean we can't co-opt or change some of those structures as a way to make them work the way we think they should.

Tina: Partnerships are where we can create and be inventive. How we create the in-between space can be fluid and we get to build it. We take what's good and useful, and leave behind practices and ideas that are harmful.

Daniel: Yes! This is one facet of the tension that all education undertakings should grapple with: we have to educate in the world that exists right now even as we educate towards the world that we want.

3 | CONCLUSION

Our dialogic narrative is a departure from what is typically considered as contributions to scholarly conversations. This decision was deliberate as the co-authors were tasked to build upon and share their knowledge around partnerships in science education. The format allowed us to draw on experience, and together, to co-construct what it means to us, as early career researchers where we have been, where we are now, and where what we are hopeful for in the future of this collective work in science education partnership.

In response to the first question about the work that happens in science education partnerships, we agreed that it is collectively reimagining science education with a different set of goals and aims so that our priorities are to work towards “diverse dreams of justice” instead of promoting the enterprise of science in service of military and economic prowess (Tuck & Yang, 2018). In the middle of science education partnerships, this means negotiating to

what extent we're positioning our work to respond to the pressures of the dominant goals and aims versus making and creating space for different goals and aims.

In response to the second question about humanizing the work, we also emphasized pushing beyond "meeting the standards" and gaining proficiencies on tests scores or securing grants. Rather, the partnership work we do centers on creating spaces of belonging and care so that participants can be their true selves, ask questions about what and how they are learning and steer the resources (i.e., time and effort) to address issues that are important to their collective goals and learning. Although the starting point might include the discipline of science, the boundaries of the work are fluid. That is, complex societal problems demand solutions that are multidisciplinary, addressing past histories while leveraging the resources in the current localized contexts. At the core are the reciprocal relationships that get built in the moments of togetherness partners have with one another. Clustered within these reciprocal relationships are two parts. One is building relationships with people over time so that we can trust each other and understand each other's priorities, principles, and commitments. The second is to be understanding and adaptable to each other's institutional constraints, pressures, and opportunities.

In response to the third question about staying attuned to disrupting hierarchies, we emphasized that science education and the research we do is entangled in broader social projects (Martin, 2013). Inequity in science education mirrors and at times amplifies the inequities in all facets of our society (Rodriguez et al., 2022). In the middle of partnerships, there will be unexpected turns that remind us of that. Contemporary examples might include local politics that limit how and what can be taught in classrooms and unraveling from the disparate impacts of COVID-19 on our most marginalized students, their families, and communities. As a result, we respond or make decisions with broader understandings of these interdependences in mind—as we also prioritize our relationships with one another.

This dialogue serves as an example of the "messy" exchanges and negotiations of ideas that takes place with our own partnership experiences when individuals who come from diverse stakeholder groups gather and share ideas through storytelling, moments of connections, and the banter that centers the humanity of our interactions and exchanges. What has been revelatory to us is that even though neither one of us had worked with one another, our journeys to where we are today echoed similar moments of frustration, clarity, and hope for our students, families, and communities—and the field at large. We spoke openly and were able to identify the structural and implicit norms that reinforced oppressive hierarchies of power that persists in our field and ways our work has managed to chip away these structures and rewrite new futures. Although not all attempts proved to be lasting or "successful," the we hold what Jeff Duncan-Andrade (2009) calls "audacious hope" that together, we can create these transformational partnership spaces oriented towards justice. We believe that within this "messy middle" of partnerships, we need to better center our efforts toward generative and reciprocal values of care and healing as these values are just as important to the knowledge that is emerges from the voices of students, teachers, families, and community members that we serve as researchers. We ask our colleagues—you, our readers, to consider that same proposition—most salient in our closing question: How do we stay attuned to disrupting hierarchies and building scientific and educational knowledge in democratic and heterogeneous ways in the midst of working together across formal institutional roles, informal relational roles, and social identities?

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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A data availability statement is not applicable to this manuscript.

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