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**Beginning School-University Partnerships for Transformative Social Change in Science
Education: Narratives from the Field**

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Abstract

These narratives explore what it might entail to begin school-university partnerships towards the goal of transformative social changes through the voices of two women scholars of color. Using two school-university partnerships as focal cases, we unpack the complexity, tensions, and possibilities that arise through collaborations driven by the objective to promote new and more just forms of science learning within public schools. In this article, we use three key dimensions of participatory design research (namely, critical historicity, power and relationality) as analytical lenses through which to reflect upon school-university partnerships that we are in the beginning stages of forming. Through this methodology, we shed light on: (a) the historical genealogies of equity-oriented work and (b) the tensions that we encountered as we strived for beginning partnerships with K-12 schools. These narratives unveil the dynamic and contentious nature of forming school-university partnerships that always occurs within a sociopolitical landscape impacted by intersecting and powered identity markers, including those around race, gender, language, culture, and status. We provide specific recommendations for supporting education researchers who aspire to transform the learning of sciences at schools through a collaborative and sustainable partnership. These recommendations include ideas around how to collectively generate goals with schools centered on transformative science learning; attention to the role of language and race in shaping partnership role-remediation; and creating infrastructure for developing school-university partnerships toward transformative social changes, including financial, human and relational resources, as well as new forms of recognition systems.

Keywords: school-university partnership, equity, participatory design research

Beginning School-University Partnerships for Transformative Social Change in Science

Education: Narratives from the Field

Introduction

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As female Asian and Latina science education researchers respectively, our work is driven by the underlying goal of creating and expanding equitable forms of science learning and teaching in public education. Specifically, we strive toward a conceptualization of equity in science education that results in sustainable and transformative social changes. By sustainable and transformative social changes, we mean addressing persistent injustice experienced by racially, linguistically, and socioeconomically minoritized students, such as minimal opportunities to engage in deep and powerful science learning that meaningfully centers students' lives, interests, and questions about the world. Furthermore, our approaches to equity-oriented work intentionally question and push back on what has traditionally been deemed "academic" and "scientific" ways of knowing and doing, instead supporting more expansive views of disciplinary engagement (Warren et al., 2020). This commitment draws our attention to a newer, more critical, generation of research epistemologies where various stakeholders (e.g., students, teachers, parents, administrators, community members, scientists) and researchers form long-term, democratic partnerships and work collaboratively toward specific and consequential ends. Bang and Vossoughi (2016) refer to research epistemologies manifested in various forms of "social change-making" projects as *participatory design research* (herein referred to as PDR). In particular, PDR attends to both the process of partnering and the possible forms of learning that emerge in and through partnerships (p. 174). Embracing these types of partnerships and engaging in meaningful PDR requires attention to the complex interplay between an individual's multiple intersecting identities and their goals, with historical, social, political and institutional contexts.

In this piece, we explore what it might entail to begin school-university partnerships through PDR in the service of social transformation. These types of partnerships are central to

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our work because of the need that we - along with other critical science education researchers (e.g., Carlone & Webb, 2006; Bang & Vossoughi, 2016; Vakil et al., 2016; Calabrese-Barton & Tan, 2020) - believe exists to disrupt and reimagine the normative, and powered relations between institutions of education. Two school-university partnerships, one that each co-author is involved in, are used as focal cases to unpack the complexity, tensions, and possibilities that arise through collaborations driven by the objective to promote new and more just forms of science learning within public schools. Recognizing the myriad factors that influence partnerships (such as requirements related to funding, or a school district's changing needs or priorities), in this piece, we specifically focus and dive into the "beginning" processes involved in the onset of this kind of work. By focusing on the beginning stage of school-university partnerships we hope to shed light on important, and often overlooked, aspects of partnerships that are fundamental for fostering relationships that work to "achieve transformative ends" (Bang et al., 2016, p. 173). Issues and tensions will always arise throughout partnerships rooted in PDR; this is inherent to work that is questioning, pushing back on and transforming the status quo. Yet, retroactive work to address issues - instead of being proactive at the beginning stage of the partnership - is often challenging, sometimes insurmountable, and can cause harm to those whose science education experiences the partnerships are striving to improve.

Conceptual Framework

Engaging in partnership toward transformative social changes

Conducting research in collaboration with teachers and/or members of the community is not a new idea. The types of partnerships embraced and utilized by researchers in the field of education are plentiful. Examples include - but are not limited to - design research (Brown, 1992;

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Edelson, 2002), design-based implementation research (Penuel et al., 2011; Fishman & Penuel, 2018), formative interventions (Engerström, 2011; Sannino et al., 2016), social design experiments (Gutierrez & Jurow, 2016), research-practice partnerships (Coburn & Penuel, 2016), community-based design experiments (Bang et al., 2016), participatory action research (Whyte, 1989), collaborative action research (Erickson, 1994), and youth participatory action research (Cammarota & Fine, 2010). Notably, members in ‘social change making’ partnerships work collaboratively to develop effective interventions in order to transform the experiences of historically marginalized individuals and communities. One unique feature of partnerships formed within PDR projects is researchers’ commitment to address and re-conceptualize normatively powered dynamics reflected in the roles and relations between researchers and “the researched,” the latter of which has tended to include members of K-12 school environments and their communities (e.g., students, parents, teachers, administrators, etc.). These efforts deliberately work to disrupt roles and relations, or to create new ones altogether, so as to achieve transformative ends (Bang & Vossoughi, 2016).

Aligning ourselves with critical researchers (e.g., Bang et al., 2016; Gutierrez & Jurow, 2016; Calabrese-Barton & Tan, 2020), we aspire to build collaborations with school partners that have a specific aim: achieving transformative social change by re-imagining the science teaching and learning that takes place in schools. Bang and Vossoughi (2016) posit that “transformative social change involves the interweaving of structural critiques with the enactment of alternative forms of here-and-now activity that open up qualitatively distinct social relations, forms of learning and knowledge development, and contribute to the intellectual thriving and well-being of students, teachers, families and communities” (p. 175). In the context of school-university partnerships, transformative social change includes attending to and addressing structural

inequities and racism that are deeply ingrained in schooling while simultaneously enacting alternative forms of science learning activity in classrooms. These forms of activity need to: open up qualitatively distinct social relations between educational stakeholders (e.g., teachers and students), bring forth new forms of science learning and knowledge development, and also contribute to the intellectual thriving and well-being of students from minoritized communities. This specific aim of partnerships formed within PDR projects provides guidelines for the members in the partnership when they explore new possibilities for activities and learning.

As a new research epistemology, PDR draws our attention to three key dimensions of partnership that shape design practices and forms of relational activities (Bang & Vossoughi, 2016). In this article, we use these three dimensions as analytical lenses through which to critically reflect upon school-university partnerships that we are in the beginning stages of forming. The first key dimension of PDR is *critical historicity*. Critical historicity attends to the ways that local contexts come to be and inform the need for interventions toward transformative changes. It calls for researchers' sensitivities to the historical genealogies of equity-oriented work, including motivation for forming partnerships, social movements, and the evolution of methods and analytical approaches taken up to capture, examine, illustrate, and shift the science learning that takes place in school spaces (Bang & Vossoughi, 2016). For example, critical science education scholars increasingly note limitations of the dominant paradigm of equity that is often used as impetus for school-university partnerships. In particular, equity has traditionally been framed through the 'access paradigm,' which positions disciplines themselves as settled (Calabrese-Barton & Tan, 2020; Warren et al., 2020) and equates working towards equity as increasing access to established ways of knowing and engaging with the world. Such a view does not consider or make space for "multiple values, purposes, and arc of human learning" (Warren

et al., 2020, p. 278). If the need for intervention in a school-university partnership stems from goals to increase access to, or participation in, settled forms of disciplinary knowledge, then, under the pretense of “inclusion” partnership activities function as forms of assimilation and domestication into settled, White, Western ways of knowing and doing that are (often implicitly) deemed superior. As such, when a school-university partnership is initiated by individuals who subscribe to dominant paradigms of equity, norming the rhetoric of reducing the ‘achievement gap’ as a way to promote equity, the partnership activities less likely result in transformative and consequential social change. Rather than disrupting educational systems that have served particular populations at the expense of others, such activities instead reproduce and reinforce educational inequities. As Bang and Voussoughi noted, “attending to the political and theoretical history of the project *as tied to* the personal histories of participants provides crucial insight into the values, goals, processes and outcomes of learning within the project and partnership itself” (p. 177; italic in original). In short, as a key dimension of PDR, critical historicity enables us to be sensitive about, and respond to, the historical genealogies of equity-oriented work - the ‘why?’ or ‘toward what ends?’ of the partnership in contexts as tied to the personal histories of participants, which includes ourselves as researchers.

The other two key dimensions of PDR that guide the critical reflection of our own partnership activities are highly interrelated: *power* and *relationality*. These dimensions intrinsically depart us from commonly adopted research epistemologies in which the analytical focus tends to be on ‘subject-object’ relations. Within prevalent research epistemologies, attention is typically given to investigating the ways in which actors, such as participating teachers and students (i.e., the ‘subject’), interact with or relate to disciplinary knowledge and practices (i.e., ‘the object’) in order to achieve desired goals; goals that are often defined as

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students' mastery of standardized objectives of disciplinary learning. Thus, in these traditional "subject-object" relationships, power is unequally distributed, and the relationality is one-directional – from the teachers and/or researchers toward the students.

By comparison, PDR attends to the 'subject-subject relations' that are constantly under development and actively re-developing throughout the partnering project. In the context of school-university partnerships, PDR calls for attending deeply to the ways that designs for learning and processes of partnering are organized for particular kinds of interactions and relationships among 'the subjects' – researchers, teachers, district partners, students, and parents. Deliberate attention to subject-subject relations enables us to recognize, challenge, and re-constitute forms of epistemological hierarchy and unequal power distributions. This process of role re-mediation also creates opportunities to expand both the 'content' and 'forms' of disciplinary learning that can be re-imagined, such as forming new social relationships, learning to be in relation and becoming.

Scholars who partake in, and study, partnerships increasingly address the power-laden social relations between the researcher and "the researched," relations that are shaped through partner members' identities and positionalities, all of which occur in specific contexts. While noting that constructs such as race and power are often absent from design research, Vakil and colleagues (2016) draw our attention to 'politicized trust' in partnerships. They remind us that human relationships are inevitably shaped by histories of race and differential power that set the stage for partnership formation (p. 199). From this perspective, it is crucial to consider the various identity markers (such as race, ethnicity, gender, language, etc.), as well as the status and positionality of the researcher and "the researched" who become involved in a school-university partnership. This consideration ought to include an examination of how the process of role re-

mediation between the researcher and “the researched” maintains or disrupts, either explicitly or implicitly, normative hierarchically powered decision-making structures in local contexts (Bang & Vossoughi, 2016). For instance, these powered relations might be exhibited within a school-university partnership through approaches taken around decision-making (e.g., Whose ideas are asked for and heard? Whose ideas are neglected or silenced? Whose ideas are ultimately taken up to advance the partnership work?).

In short, as two key dimensions of PDR work, power and relationality lead us to attend to the roles and relations between researchers and “the researched” who are in the process of forming school-university partnerships. Remaining sensitive to the nuanced complexities of partnership work that occurs within historied local contexts, in this piece, we elevate moments when tensions arose in our own partnerships as sites for inquiry and critical reflection. Doing so enabled us to unveil and shed light on the dynamic and contentious nature of forming school-university partnerships toward transformative social changes.

Promoting equity in science education through partnerships

As a discipline, science poses unique challenges, and opportunities, for promoting transformative social change. At its core, science is an ever-evolving field that encompasses people working individually and collaboratively, coordinating their multiple meaning-making resources, tools, and approaches to better understand, respond to, and care for our natural world. Ideally, science education would mirror these activities and goals, with classroom spaces being ones in which students “pursue the questions that capture their imagination, pursue questions that relate to who they are and who they want to become, and see science as a tool for addressing the needs and aspirations of their communities” (González-Howard & Suárez, 2021, p. 751).

Historically, however, science teaching and learning within schools have not played out in these ways, especially for students from minoritized communities (e.g., students of color, multilingual students, etc.) (Bang et al., 2012; Nasir et al., 2014; Bang et al., 2017). Science has been portrayed as a bias-free and objective discipline, with the science taking place in public schools being similarly represented. Yet, traditional science education has privileged certain ways of engaging in science and communicating scientific ideas (Bang et al., 2012; Brown, 2019). Long-standing inequities in science education have been maintained by encouraging and rewarding learning that looks and sounds a certain way (Bang et al., 2017). These injustices have been further perpetuated by the dominant conceptualization of equity that drives much science education research and practice: the “access paradigm” (Calabrese-Barton & Tan, 2020). To facilitate transformative changes through science education, it is important that school-university partnerships move away from notions of equity centered on increasing access and participation, while being critical of, and problematizing the types of science teaching and learning that are valued in our schools.

School-university partnerships grounded in PDR approaches provide opportunities to disrupt, re-imagine, and transform the current science education system towards one that values and promotes epistemic heterogeneity (Bang & Vossoughi, 2016). To move toward providing more equitable and just science learning experiences for minoritized students, it is necessary to foster and support new forms of learning activity; forms that authentically connect students’ identities and lives with what they are learning; forms that transcend across students’ past, present and future experiences (Bang et al., 2017; Brown, 2019; Warren et al., 2020). This will include educational stakeholders, especially teachers, developing and taking on expansive views of what learning science looks like, particularly learning that is grounded in students’ own ways

of thinking and doing as informed by their identities and contexts. Central to this goal will be creating new and substantively different science learning environments that foster this perspective. School-university partnerships grounded in PDR can do transformative work and tackle issues at various levels of the educational system (e.g., teacher education, curriculum and instruction, assessment, etc.) in order to truly unearth and disrupt inequities.

Purpose and Research Questions

Our intention for writing this piece was to deeply examine the process of beginning school-university partnerships through PDR methodologies, specifically, partnerships that work toward critically improving science teaching and learning in public schools. Employing a qualitative case study approach (Yin, 2013), we unpack the complexity of this process, and shed light on potential tensions one might face while forming partnerships for transformative social change in science education. In the context of our own newly formed partnerships with high schools and elementary schools (respectively), we considered the following two questions.

1. Who initiated the partnership? How and why was the school-university partnership initiated?
2. What tensions have we encountered? How do these tensions interplay with our own identities, positionality, and social relations with schools?

These questions were grounded in the three key dimensions of PDR: critical historicity, power, and relationality. Specifically, the first question attends to critical historicity as we reflect upon the historical genealogy of each partnership. The second question guides us to identify places and moments when tensions arose in the process of forming school-university partnerships, and

interrogates these moments through the analytical lens of power and relationality. In the section that follows, we use personal narratives to respond to these questions.

Narratives of Partnership Beginnings

Before delving into our narratives, we would like to begin by articulating our deepest gratitude and respect for those who engaged in this work with us. Despite various challenges and tensions that we encountered in the process of forming partnerships, our partners engaged in the work *with* us, opening the possibilities for forming school-university partnerships toward transformative social change. We are well aware of the subjective nature of our stories as they reflect our own histories, identities, and perspectives on these experiences. The accounts that follow touch upon a moment in time within the emergence of our partnerships. As noted earlier, partnerships include ongoing work, constantly evolving in response to each local context. Thus, these narratives are snapshots of our partnerships and are not necessarily representative of the relationship nor our work as a whole. Moreover, the intention for sharing these personal stories is to illustrate the politicized nature of developing relationships, not to describe the struggles of two women of color in academia. We hope these narratives unveil and make tangible the ways that this work occurs within a sociopolitical landscape impacted by intersecting and powered identity markers, including those around race, gender, language, culture, and status.

Each narrative consists of two parts. Part 1 focuses on the dimension of critical historicity, specifically shedding light on how local contexts informed the “why?” and “toward what end” of the partnership work. Part 2 centers on the ways in which power and relationality played out in each local context during the process of forming a school-university partnership.

Narrative #1: *Hosun’s Story*

Part 1 - From studying individuals' learning to improving the system: Beginning a partnership fueled by an increasing awareness of structural inequities. After seven years of teaching within public schools, I decided to pursue my PhD in the areas of teacher education and science education. I thought of doing research as processes of learning and growing, therefore becoming a better educator. I aspired to become an educational researcher who would make a difference in students' learning experiences in science classrooms, in particular those from under-resourced families who mostly rely on public education, just like I had growing up. Since beginning my PhD work in 2006, I have studied the learning of individuals in various settings: African American girls' science learning in classrooms and after school science clubs (Calabrese-Barton et al., 2013; Kang et al., 2019; Tan et al., 2013), preservice secondary science teachers' learning to teach (Kang, 2017; Kang & Anderson, 2015), beginning science teachers' development of teaching practices (Kang & Windschitl, 2018; Kang & Zinger, 2019). Employing qualitative and quantitative methodology, I documented these individuals' lived experiences and stories over an extensive time (one to three years). In retrospect, I naively believed that by better understanding how individuals learn and change, I could change and improve science education within public schools for students from historically underserved communities (i.e., students of color, multilingual, special education, and students from low-income families).

A critical shift of my research trajectories from studying individuals' learning to designing and studying improvements in the *system* took place around 2016, about three years after I started my position as assistant professor at a research-oriented institution. While teaching secondary science methods courses in a university-housed teacher education program, I followed six novice secondary science teachers for three years from their teacher education courses to

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their second year of teaching. I visited various schools where my students (teacher candidates) were hired, observed their instruction, talked to them, their students, and administrators. I still remember the day I visited two seventh grade classrooms at two different schools--one was located in a community that constitutes mostly families of upper-middle class, White, and Asian backgrounds, and the other was located in a predominantly low-income, Latinx community. The school that I visited in the morning had a beautiful building surrounded by green spaces. I passed a nice library and playground to get into the seventh grade classroom. With the bell, students came into the classroom with heavy roller bags. Some students sat on a comfortable couch in the corner of the classroom and the others sat on tall chairs next to adjustable desks. I saw students engaging in various academic tasks while producing personal blogs to communicate their learning with the world. The teacher, my former student, was excited to work with students while experimenting with various program-recommended tools and strategies, such as modeling tools and discourse strategies. I saw glimpses of the science learning that we had imagined together in my methods class. After observing the first classroom, I left to observe the second teacher, whose school was located in an inner city that served low-income, Latinx communities. The tiny parking lot was attached to a one-story portable building. All students wore the same yellow colored school uniform. I had to stand in the corner to do this observation because with over 40 students in the room, there was little space for me to fit. The first thing that caught my attention was the atmosphere. Both students and the teacher looked exhausted. Several students put their heads down throughout the lesson. Some boys were kicking their backpacks, and throwing materials at each other. The teacher frequently stopped instruction to give warnings with an angry tone of voice. I barely heard any intellectual conversation throughout the lesson. The teacher, who I had considered to be a thoughtful student in my methods class, had been suffering

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emotionally due to a combination of factors, including: non-stop testing, constantly changing school expectations and policies, and various trauma and forms of violence that students brought into her classroom. After sharing stories about recent gunshot violence in a school bus stop and students' repeating suicide attempts during the post-observation interview, she said she wished to have a psychology degree. On my way back home, I couldn't stop asking myself: *To what extent do the things that I saw in these various classrooms reflect the capacities of well-intended individual teachers?* I felt a huge disconnect between the "ivory tower" where I worked and the world where people live, learn, and struggle. The more I visited classrooms and spoke with former students now teaching in different educational spaces, the more I noticed disparities in students' opportunities to access and engage in meaningful disciplinary learning, opportunities that were largely predictable along the line of race, socioeconomic, and language status. I started re-thinking my own work as a teacher educator and science education researcher. One thing that was clear to me was that what I was doing was not enough. I would not make substantive differences in students' science education experiences by *only* working with future teachers in the context of methods courses within the university campus.

I started seeking different approaches beyond studying individuals' changes. In order to work on, against, and improve the *system*, it was necessary to work collaboratively with teachers, administrators, parents, scientists, and district leaders. I was convinced that sustainable partnerships would be a promising approach to make a *real* and *consequential* impact on students' experiences in classrooms. My long-term relationship with the teachers (my former students) through my teaching and early research provided the entry point for me to start my partnership with one particular high school located in predominantly Latinx, low-income communities. During the 13 months of our preparation program, my students and I discussed and

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tried out new modes of science learning at schools while imagining what is possible. I secured a small amount of funding to start this partnership work with one school. My former student played the role of ‘broker’ (Davidson & Penuel, 2019) connecting me to other science teachers and administrators. Fortunately, I was warmly welcomed by the school community because my former student did well as a science teacher, and the school was looking for some help as they transitioned into adopting the Next Generation Science Standards (NGSS). In short, the beginning of this partnership was initiated by a female junior scholar of color’s aspiration to transform students’ experiences in science classrooms as she came to see structural inequity and developed critical consciousness. Her long term relationships with preservice teachers set the foundation for initiating the partnership.

Part 2 - Power and relationality manifested in the moments of tension

Tension #1: Navigating competing expectations across communities as a woman scholar of color. It did not take much time for me to realize that spending time with students and teachers at schools, instead of writing manuscripts in my office, could jeopardize my career as a pre-tenured faculty in a research oriented institution. The formal and informal recognition system that played out in the university community, including daily interactions as well as the merit and promotion system, sent a clear message of what it meant to be a ‘good’ or ‘successful’ assistant professor in that particular space. For instance, on a daily basis I received multiple emails that acclaimed my colleagues’ new publications, awards, and/or grants. I witnessed a newly hired (White male) assistant professor start with a higher salary because he had more publications. He was also then promoted to the associate level in two years instead of five years. Merit materials, which I had to submit every other year, were another constant reminder of what was valued. I

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frequently woke up at 4 am and stared at my computer screen with fear of ‘what if I have nothing to submit in my next merit review?’ My anxiety grew as I aspired to start a partnership with my former students’ school, a partnership that would remove me from my office and ground me in the needs and everyday experiences of students and teachers in schools.

After articulating my concerns and anxieties to a few friends and close mentors, I reached the conclusion that it was not possible to meet everyone’s expectations. I thought about whose expectations I valued and wanted to meet, and whose expectations I needed to disregard in order to protect my mental health and well-being. All of the scholars whom I deeply respected, such as Dr. Angela Calabrese-Barton whom I had the privilege to work with as a graduate research assistant, were people who built their scholarship on the ground and worked with and for people. I aspired to do the same. I wanted to do work that was consequential to the people whom I care about, which may or may not align with conceptualizations of “good” or “successful” assistant professors in research oriented institutions. This realization prompted me to set up my email to make accolading institutional emails go to my junk box. I decided to write a grant that would provide resources to do the work and legitimize my partnership project. Since grants are one thing valued in the institution, it provided validation about my work and my scholarship. I felt this was the only way to prove that I deserved having an office in the institution, despite my slow writing.

Tension #2: Negotiating the goals—what I want versus what my partner wants.

Located in an early NGSS adopting State, the school district that I collaborated with served a large population of students from Latinx, low-income families. About 46% of students were Latinx or Hispanic, followed by 23.8% White, 20.0% Asia, 2.2% Filipino, 1.7% African American. About 40% of students were eligible for free and reduced-priced meals, and about

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16% of students were officially identified as ‘English Learners.’ The principals and teachers in my partner school district welcomed the collaboration with me largely because they were in the process of adopting the NGSS. The complex layout and new languages of NGSS were hard for teachers to decipher. With the upcoming full implementation of the new standards in California, many teachers felt they needed some help. This broader policy change created a conducive context for legitimizing the PD that I intended to offer through the partnership. People felt they should do something different, but were not sure what that entailed. Whereas the intention of the PD was largely communicated with teachers in relation to learning how to enact the new standards, the primary reason I wanted as I started my partnership was to explore what is possible with minoritized students in secondary science classrooms toward transformative and consequential learning. Addressing the NGSS was too low a bar for me.

Navigating these tensions without privileging one voice over the other was crucial to building a trustful relationship. Considering the needs of my district partner and teachers, it was important to unpack and show how to address the NGSS as part of PD. Instead of mainly focusing the goals of PD on learning the NGSS, however, I decided to frame the goals more broadly. On the very first day of meeting with teachers, I started the conversation by asking each teacher a) why did you join the PD, and b) what things are super important to you as a science teacher? This activity prompted teachers to share their core values, concerns, problems of practice, and struggles. One teacher said, “One of the things that brought me here is that students seem to look at science as something to memorize. Science is far more than facts.” Another teacher shared, “The love of science has been drilled out of them because they have been told they were not successful, because they had to memorize all the things. Or they were heard they were wrong, constantly. So they come up with barriers like, ‘I can’t do science’ and ‘I am bad at

science,’ because of the ways that they have been taught science...” A teacher added: “My students like the shortest, the littlest answer. When I ask how did you get this answer, they can’t answer the question.” The teachers talked about their frustration about students’ tendencies of: searching for only the right answer instead of engaging in the process, focusing on memorization instead of engaging in deep thinking, losing their love of science, and passively following directions, instead of taking initiative or taking responsibility for their own learning. As a part of the team, I also shared what was super important to me--attending and addressing ongoing marginalization of students of color and multilingual students in sciences. Using the languages surfaced through this conversation, we co-constructed the goals of the PD, which are seen in Figure 1 below.

--Insert Figure 1 about here--

These goals were revisited whenever we started our meetings to remind ourselves of our commitment within our partnership project. The teachers engaged in the model unit that I designed as science learners at the beginning of the PD. After the teachers completed the activities, I linked their experiences to the NGSS while inviting teachers to point out when, where, and how the three dimensions of the NGSS (i.e., disciplinary core ideas, cross-cutting concepts, and science and engineering practices) were addressed while they were making sense of a focal phenomenon or solving a complex problem that mattered to them. Attending and accommodating the needs of both “sides” was crucial to form a trustful relationship.

Tension #3: Co-designing PD activities with teacher researchers. Several articles (e.g., Bryk et al., 2015; Hendrix et al, 2017; Santo et al., 2018; Penuel & Gallagher, 2017) drew my attention to power dynamics in partnership, highlighting the importance of honoring and leveraging teachers’ experiences and expertise to create a truly collaborative partnership. While I

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appreciated and agreed with these ideas, I wanted more details and explicit examples about addressing power dynamics. How could I disrupt traditional relations and engage in ‘role-remediation’ (Bang & Vossoughi, 2016) in my own partnership setting? As someone who had studied teacher learning, it was important to design the PD activities in a principled way using the decades of research knowledge around how and under what conditions teachers engage meaningfully toward transformative changes. This desire triggered a wave of questions including: *When and how should I invite teachers and/or my district partners in decision-making processes as I begin forming the partnership? What if bringing in multiple perspectives makes things complicated?* In fact, a real deep-seated tension was my insecurity and vulnerability as an Asian, female immigrant scholar who always introduces myself first and foremost as a learner--which I truly mean. I had had several prior encounters - mostly with White students or teachers - who gently reminded me that I am an outsider. For example, I facilitated a professional development activity with high school science teachers in a pilot project. The group consisted of two White males, one White female, and one Latinx male teacher and myself. After the morning session, I called on a lunch break, saying “It is noon thirty. Let’s take a break.” One of the White male teachers, who had an uncanny resemblance to photographs I have seen of Charles Darwin, approached me with a mysterious smile and said, “You were not born here, right? We don’t say noon thirty.” I had a hard time facilitating the remainder of the PD after the lunch break - throughout the rest of the conversations the teachers mostly talked amongst themselves. The atmosphere was dramatically shifted, however, when a guest arrived in the room--a White female scientist at my institution. I invited her to the PD to leverage her content expertise as a scientist. All of sudden the teachers gave their full attention to her, asking various questions about how to teach science. I saw this White female faculty being positioned as a science

teaching expert after I struggled throughout the whole morning to convince them to think of their teaching in a different way. Having a PhD in Science Education from a well-regarded institution had not helped legitimize my voice in that space at that time. With this experience in mind, what could I do to form a collaborative partnership to leverage everyone's expertise as I designed my PD activities?

While navigating these tensions, I decided to rely on the people whom I could trust at this beginning stage of the partnership. I asked two of the school district teachers, who were former students of mine, to help with the design of PD activities. Although both were White (one male and one female), we had a long-term relationship in which we had developed trust, respect, and confidence towards each other. With the advice of a mentor of mine, Dr. Bill Penuel, I invited them to work with me as 'teacher researchers' over the summer before the partnership project launched. In these roles, they helped analyze the data collected from the pilot project. They also provided feedback on the PD activities that I came up with to adjust activities tailored to teachers' needs and the local contexts, although the overall design was grounded in the research knowledge. The teacher researchers also took on roles as co-presenters during certain activities where they could leverage their strengths and assets (e.g., a community building activity, presenting the findings from the data analysis). This co-designing of PD activities with trustful partners opened the door for me to expand my relationship with teachers (who I did not know before) through successful enactment of activities appropriate to local needs of the teachers and students in the community.

Narrative #2: *María's Story*

Part 1 - Initiating partnerships to disrupt the status quo of multilingual students' science learning in schools. A loud and vibrant conversation was taking place in my middle school science classroom as students heatedly discussed the potential impact of a new housing development being constructed near the local wildlife refuge. My students were sharing brilliant ideas about the environmental changes that would likely take place, how these changes might impact the plants and animals living in that area, and what humans might do to mitigate negative effects. These kinds of learning moments - when students were deeply engaged and invested in the topic we were exploring - tended to occur only when I closed my classroom door, and students felt the freedom and support to be themselves. While school administrators made it clear that teaching and learning should occur in English, there was an unspoken agreement in my classroom that students could express themselves however they felt most comfortable. To encourage them to use their native language, I would weave Spanish into my own speech as well. Sitting amongst my students during this particular conversation, I remember thinking that their ideas, concerns, and proposed solutions would not be recognized in the current school system because they were taking place across Spanish and English. This frustrated and angered me as I thought: *The ways my students understand, and express understanding about, the natural world are not captured by the standardized test they take in May, or by the numerous benchmark tests that occur throughout the school year in preparation for that assessment. What are those tests even testing? They rarely, if ever, offer students opportunities to apply scientific ideas to contexts that matter to them. Moreover, why does doing science in school and demonstrating what one learned in science class only “count” if it happens in a particular type and proficiency level of English?* These ideas frequently crossed my mind when I taught eighth grade science in a small town along the US-Mexico border. Ultimately, these ideas also drove me to my graduate studies.

Initially, I pursued my Master's degree believing that developing a stronger grasp of pedagogy across both science learning and language development would help me become a better science teacher for my students learning English as an additional language. At that time, I thought changing my own practices was what mattered most for improving my students' learning experiences. However, toward the end of my Master's studies I took an educational research course focused on bilingual students' schooling in the US. This course changed my perspective, and career trajectory, as it made me aware that the scope of what I wanted to tackle was not at the individual level (i.e., only in my classroom), but rather systemic. This realization motivated me to pursue my PhD. During my doctoral studies at Boston College I worked as a graduate research assistant for Dr. Kate McNeill on a project that examined the impact of multimedia educative curriculum materials on teacher learning around the science practice of argumentation. Within the context of this larger research project, I had the opportunity to lead a few studies focused on the argumentation experiences of multilingual students. At the time, I referred to this student population as English language learners because it both aligned with how these students were labeled by schools, as well as with terminology used in science education literature. I have since realized the ways that this term influenced what I thought needed addressing to make schooling experiences equitable for these students (González-Howard & Suárez, 2021). For instance, in graduate school I explored the relationship between aspects of a middle school sheltered English instruction (SEI) science classroom and multilingual students' opportunities to engage in argumentation (González-Howard & McNeill, 2016). Within this same classroom context, I also examined the teacher's instructional practices to identify the types of language strategies that she used to help her multilingual students engage in argumentation (González-Howard et al., 2017; González-Howard et al., 2015). My intention for exploring this

phenomenon was to determine ways to support these particular students in using their developing English so that they could have successful argumentation experiences with peers. However, by focusing on aspects of the SEI program structure and on the teacher's English language supports, I inadvertently fell back on a definition of "success" being one that privileged English - specifically, a particular version of English that was used in a certain kind of way - as the means by which students should do and express science in schools. Thus, despite my own frustrations as a teacher with my students' ideas not being recognized if they were not being communicated in English, as an aspiring educational researcher I was unintentionally reproducing, instead of disrupting, the status quo.

Upon starting as an Assistant Professor of STEM Education at The University of Texas at Austin (UT Austin) I was determined to begin developing a line of research that was more critical of the current science education system for multilingual students. I wanted to address issues that were at the core of these students' experiences in schools in order to transform classroom spaces to be ones in which *all* students' varied ways of thinking, knowing, doing, and communicating science are noticed and valued as meaningful sensemaking repertoires (Bang et al., 2017; Warren et al., 2020). Because these issues are complex and multifaceted, I considered my prior research experiences, as well as aspects of my position at the university that I could hone in on and leverage to dive into this work. One of my responsibilities at UT Austin involves teaching the elementary science methods course to preservice teachers (PSTs) seeking general or bilingual certification. This context provided me the opportunity to consider how I might work within the space of teacher education to address multilingual students' experiences learning and doing science.

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In short, the school-university partnership described in this narrative was initiated by me - a junior female scholar of color driven to transform multilingual students' unjust experiences in science classrooms. Furthermore, this partnership work was embedded in my attempt to secure funding to carry out the justice-oriented work previously described. Summer 2019, I wrote my first grant proposal - which was fortunately awarded - focused on developing PSTs' understandings and pedagogies for supporting multilingual students' sensemaking, specifically through meaningful and authentic engagement in science practices. To ensure that this project was grounded in socially transformative objectives, it was critical that it encompass a partnership with Austin Independent School District (AISD). The reason for this was twofold: (1) this district collaborates with UT Austin's teacher preparation program, and graduates from this program frequently remain in the area to teach, and (2) the district's student population is 55.5% Hispanic, and 27% multilingual, and thus shifting future teachers' dispositions and instructional practices had great potential to positively impact the focal student group. In Part 2 that follows, I describe tensions that have emerged in the process of beginning this particular school-university partnership, tensions that have brought to the forefront issues of power and relationality. These tensions include navigating the goal of conducting meaningful work while being on the tenure clock at a research institution, and figuring out ways to ground the partnership in both the needs of the schools and the researcher's interests.

Part 2 - Power and relationality manifested in the moments of tension

Tension #1: When time is of the essence: Conducting meaningful research while being on the tenure clock. In graduate school, my advisor, Kate, shared with me a seemingly simple, yet deeply important and profound piece of advice - "Relationships with schools should

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begin by being grounded in the school's response to the question, '*What do you need?*'" This question is one that regularly echoes in my mind, especially now as an Assistant Professor at UT Austin. The school-university partnership work that I was fortunate to be a part of during graduate school is the kind of work I aspire to carry out in the context of my own grant. As I began conceptualizing this project, I knew that there were aspects that were really important to me to address (i.e., helping PSTs develop expansive views of scientific sensemaking). Yet, as I had learned years ago from my experience working alongside Kate, Pam Pelletier (the Director of K-12 Science and Technology/Engineering for Boston Public Schools [BPS]) and various groups of teachers from BPS, focusing solely and/or primarily on what I wanted to do (even if well intended) was not the best way to approach partnering with a district. I needed to figure out what *they* wanted and why - what challenges were their multilingual students experiencing in science that they would be interested in tackling together? Yet, being new to the Austin area, I did not have connections to my new context, and I knew that time and numerous shared experiences were crucial for building trusting relationships with school districts. As a junior faculty, time is not always on your side.

Since joining the faculty at UT Austin, I have frequently felt a tension between beginning meaningful relationships with local school districts, and being on the tenure clock. Regardless of colleagues' messages expressing that many aspects of our position are important and valued within the College of Education (e.g., service to the institution and professional organizations, teaching undergraduate and graduate students, etc.), to maintain employment there are certain expectations for "productivity" in the few years one holds status as an assistant professor. In both research-focused and teaching-focused institutions, assistant professors must navigate their passions and what they want their work to center on, with doing what needs to be done to obtain

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tenure (e.g., a set number of publications and/or particular scores on course evaluations). Yet, school-university partnerships, especially those aimed at transformative social changes, take time to cultivate. Individuals working within public K-12 schools have frequently experienced one-sided relationships with those working at institutions of higher education (i.e., being “researched,” with the outcomes of such activities often not being shared with, or useful to, schools). Moreover, such one-sided partnerships tend to foreground the needs and interests of those working at universities, and their desires to carry out research in and on (not with) schools, teachers, students, etc. Thus, individuals working within schools can understandably be hesitant to connect with someone new, and to let them into their spaces. Even when this connection is made quickly, it is natural for a period of time to pass for those working within schools to get to know and build sufficient trust with university personnel to share their problems of practice, and see value in a potential partnership between institutions. This has made me wonder: *Is attempting to develop new and meaningful partnerships with schools feasible, and wise, during the pre-tenure years?*

I do believe the answer is yes, all the while acknowledging that particular structures need to be in place, and certain actions need to be taken, to support such work. For example, colleagues who already have existing relationships with schools might help make introductions, and share insight into the local context and the ways things work. My first year at UT Austin, a colleague informed me that research activities with AISD could only occur in the Fall because of the district’s focus on standardized testing during the Spring. Additionally, they shared that despite receiving approval from district-level personnel to engage in research, nothing happens unless you have buy-in from school principals. I also found volunteering my time and expertise with various educational stakeholders to be important (e.g., conducting free PD during the

district's annual summer professional learning workshops), as these actions allowed others to get to know me in authentic ways. Such actions attended to the fact that although in some ways I am an "insider" familiar with experiences of Latinx students in AISD (i.e., my family and I immigrated to the US, Spanish was my first language, and I experienced ESL programming through primary school), I am also an "outsider" to this particular context and to the unique experiences and identities of multilingual students in this district (Merriam et al., 2001).

I have been able to make connections with my new local context because I was fortunate to have certain structures in place, such as colleagues inviting me to join a lunch with them and a school principal with whom they were working. I have also taken heed of advice from mentors around finding ways for partnerships and tenure expectations to overlap. In my case, this entailed having the school partnership work serve as the context for research activities, a suggestion I took up when conceptualizing the school-university partnership that is central to my grant. However, even with such connections relatively quickly in place, it was critical that I find a way to address the needs of the district knowing that this context was not adopting the NGSS, and hence I could not leverage that reform effort as the rationale for the kind of transformative social change work that I aspired to do.

Tension #2: Figuring out the common ground for the school-university partnership.

My first few meetings with AISD's science coordinator and various elementary school principals went well. These individuals were pleased that I was sincerely interested in learning about their schools, students, and the communities they served. We got to know each other over the course of my first two years in Austin through meetings and numerous shared experiences. This included the summer PD I mentioned earlier, as well as my developing and piloting - upon a principal's request - a field-based science methods course where my PSTs taught science lessons

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to fourth graders. By asking “what do you need?” and doing my best to respond to their replies, I began to make connections and build relationships with my new local context. Through these experiences I came to learn that many of the district’s bilingual elementary schools were closing due to diminishing enrollment tied to gentrification taking place in and around the city (Green et al., 2022). I also learned that there was a need for elementary school teachers who had training around supporting multilingual students in the context of science. As such, there was apparent alignment between what the schools wanted in a possible partnership with what I wanted as well. However, after many conversations grounded in the question “what do you need?” I came to realize the school district’s science learning goal of fifth graders scoring well on the standardized test in science did not match my beliefs about transformative social change in science education for multilingual students. Furthermore, because Texas is not adopting the NGSS, I could not use language from these reform standards as impetus for our partnership work.

This dissonance prompted me to take a step back and think about how the school-university partnership that AISD and I sought to develop could be designed to address the interests and goals of all involved. I did not want to give the impression nor act in ways that signaled that my perspective and goals matter most. This would only reinforce the traditional, and highly problematic, powered relations that exist between schools and universities (Carlone & Webb, 2006), which often manifest in activities such as who gets to make decisions about the partnership, and why. Yet, I worried that a partnership focusing on increasing test scores would only perpetuate instructional practices aligned with “teaching to the test,” practices that are inherently biased by privileging a settled view of the discipline and not taking into account minoritized students’ ways of thinking, doing science, and expressing scientific ideas. Moreover, that approach to teaching science takes away students’ opportunities to meaningfully apply and

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consider science in contexts that matter to them, pursuing and investigating questions they have about natural phenomena. Despite my disagreement with “teaching to a test,” I understood why district personnel were concerned about that particular outcome - school funding is tied to students’ performance on these tests, an effect that is felt even harder by schools on the cusp of closing.

The various educational stakeholders from AISD who I had been in conversation with (e.g., the district science coordinator, school principals, teachers) and myself all wanted to improve the science education experiences of multilingual students. This was our common ground, even if the ways we conceptualized what that might entail looked differently. Educational research findings are often not disseminated in useful ways (if at all) to those that deal with the ins and outs of schooling on a daily basis. Accessing publications in many science education journals, especially those deemed high-impact, requires institutional subscriptions or payment (which makes one question who the journals are “highly impacting”). I believe this issue was partly influencing my situation because few freely available sources existed for AISD personnel to learn about reform-oriented approaches to science teaching that were grounded in evidence-based research. This became my avenue to finding a compromise for our partnership together. I shared research findings with different district personnel, including principals and teachers, and provided tangible examples of these findings, showing the ways that instruction grounded in science practices could enhance students’ science learning across many outcomes (e.g., students’ attitudes about science, science identity development, test scores, etc.). Thus, supporting PSTs at UT Austin - many of whom would likely be hired by AISD upon graduation - in learning to integrate science practices into their future classrooms worked towards a main goal that the district had for our partnership work.

In seeking a common ground for the partnership, we also discussed ways to meaningfully share findings associated with the work we were carrying out together. Part of this discussion shed light on the importance of ongoing dissemination to support teachers in the here and now. For the district, this meant the developing evidence-based resources to support professional learning experiences for teachers, and that such resources be revised and/or expanded upon as the partnership progressed. Further, to ensure our newly formed partnership was transformative, I began working with critical teachers and teacher educators with expansive views of language and its role in scientific sensemaking; this was key to helping me identify and design methods and resources for developing PSTs' understandings and pedagogies around these areas (González-Howard et al., 2021; Grapin et al., 2022).

These narratives capture moments in time during the beginning stages of school-university partnerships striving to improve and make more just science teaching and learning in public schools. The moments of tensions illustrated in these narratives provide some insights into the complexity of forming school-university partnerships toward transformative social changes, which is inevitably tied with the personal histories and contexts of all participants, including teachers, district partners, and researchers.

Discussion & Conclusion

The two narratives of beginning school-university partnerships - notably, partnerships initiated by two female scholars of color in the field of science education - illustrate the complexity of educational institutions working collaboratively towards transformative social changes in local contexts. Here, we discuss three emerging themes and patterns across the two cases in light of the three key dimensions of participatory design research (PDR) – critical

historicity, power, and relationality. Building upon this information, we provide specific recommendations around ways to better support educational researchers who aspire to promote and work towards equity through PDR projects with public schools, recognizing that - although some needed changes span educational institutions - the recommendations we outline only address part of the partnership. Specifically, these recommendations cut across various aspects and tiers embedded within systems of higher education, including for individuals working in administrative roles, as well as for those who run peer-reviewed academic journals. Substantive changes need to take place at all levels so that school-university partnerships working to reimagine and make more just science education can begin and thrive.

Recommendation #1: Creating spaces for generating collective goals with school partners centering transformative learning

The notion of critical historicity led us to attend to the historical genealogy of our partnerships. Both school-university partnerships were initiated by the researchers - in particular, women of color - who transitioned from being science teachers in public schools to science education researchers whose work centers on issues of equity. Our experiences as classroom teachers combined with our identities along multiple intersecting factors (gender and race, as well as linguistic, socioeconomic, and immigrant status), drove us both to attend to struggles and injustices experienced by minoritized students in the context of learning science in schools. Although we worked in starkly different contexts (i.e., different states, different grade levels), our desire to make an improved experience of minoritized students' science education led us each to a particular kind of research program grounded in collaborative and trustful partnerships centered on transformative science learning.

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In both narratives, we discussed tensions that emerged as researchers striving to create collective goals with school partners in our local contexts. In some ways, it was predictable that there was mis-alignment between researchers' goals (in our case, striving to critically transform educational systems) and the goals and needs of school-based partners under the oppressive accountability system. Historically, K-12 school spaces reproduce and maintain the status quo, rather than facilitate imagination, creativity, criticality, and new possibilities for here-and-now activities (Bang & Vossoughi, 2016) around what it could mean to engage in science teaching and learning. Furthermore, as our cases revealed, public schools are part of a larger system that urgently needs to be reimagined as well. As such, those actively working within educational systems experience strong and consequential pulls in different directions, many of which are contradictory and competing. These forces often coincide with actions that run counter to fostering meaningful learning environments for minoritized students. To us, these tensions raise important questions for educational researchers: *How can we ensure that when in the process of forming a school-university partnership our commitment and goals around transformative social change are not lost? How do we generate collective agreement from a partnership's outset without compromising commitments at the core of the work we aspire to do?*

Analyzing both narratives through participatory design research highlights the importance of considering when and how to create spaces for generating collective partnership goals. For such work to occur, it is necessary for members of the partnership to develop trust with one another. This kind of relationship enables partners to honestly share their ideas and concerns around the question, "what do you need?" all the while considering how they might meaningfully support the other. Similar to a "value mapping" (Bang & Vossoughi, 2016, p. 183), the partnership projects described in this piece created space for school and university partners to

discuss their values and problems of practices while initiating the partnership. Individuals from a range of backgrounds and in various educational roles likely bring diverse values, commitments, and priorities to the partnership space; all are important and necessary to consider as the partnership forms. We have found it particularly useful to document the process of generating collective goals, as activities and tools are applied toward transformative science learning. This documentation is dynamic, and should be revisited and revised as the partnership develops.

Recommendation #2: Attend to and address the presence of race and language in shaping partnership role re-mediation

Partnership activities between K-12 school-based educators and educational researchers who often (but not always) work in higher education, can take various forms. Traditionally, the role and relations between researchers and “the researched” represented unequal distribution of power and structures of privilege among the partners. In contrast, within partnerships aspiring for transformative social changes, researchers commit to addressing normatively powered dynamics with school partners. Attending to, and actively disrupting, these dynamics occurs through the process of role re-mediation – an important feature of PDR (Bang & Vossoughi, 2016).

Our personal narratives of school-university partnerships revealed how power and relationality - two key dimensions of PDR - manifest in complex and dynamic ways during the process of forming partnerships in local contexts. Along the way, power and relationality transcend the view of partners holding static roles – either as the researcher or “the researched.” As explained in their discussion around the notion of politicized trust, particular identity markers among partners, specifically race and language, present in ways that either sustain or undermine credibility of individuals’ voices and their positionality (Vakil et al., 2016). Recall the shifting

power dynamics among the researcher, participating teachers, and a scientist from Hosun's partnership narrative. Teachers with whom the researcher was working during the PD exhibited behaviors (e.g., microaggressions around English language use, giving the guest speaker their undivided attention) indicating their preferences to learn about teaching science from the White female scientist. As illustrated in that narrative, the authority and positionality of individuals within a partnership can dynamically change along the lines of race and language backgrounds, in ways beyond what is often perceived to be a static status of the researcher and "the researched." This issue is particularly important given that the majority of science teachers in US public schools are White (NASEM, 2018) whereas many school-university partnerships towards transformative social change are likely initiated by scholars of color who bring criticality based on their lived experiences as students and/or teachers within public schools.

Scholars from minoritized backgrounds are likely to encounter the types of resistances and experience the complex relationships with school partner members that we described. Fundamentally, aspiring researchers must be critically aware of their positionality, intersecting identities, and implicit privileges that some of their identity markers carry. We recommend that researchers be cognizant of the dynamic nature of relationships and roles, and the many ways that they can manifest and change. Particularly for scholars of color who aspire to initiate this kind of partnership, we recommend actively seeking mentors who can help make sense of various tensions that might emerge during professional interactions (King & Upadhyay, this issue). The support of a more senior and like-minded colleague—even if of different demographic categories (Haverly & Brown, this issue)—could support the researcher in making sense of their experiences and struggles in a new and critical way. In addition to supporting emotional well-being, such mentorship can also provide a backboard for troubleshooting issues

so that the partnership is ultimately made stronger and more just in the process. In order to generate school-university partnerships towards transformative learning, it is important that researchers anticipate, attend to, and address the role of race and language in shaping professional interactions within partnership activities – and by extension, how science teaching takes place in the partnership classrooms. Only through such intentional work can role-remediation between school members and researchers take place.

Recommendation #3: Create the infrastructure necessary to develop school-university partnerships toward transformative social changes

Our narratives highlight the importance of infrastructures for starting partnerships toward transformative social changes. One important aspect of infrastructure is *financial resources*. Both partnerships we described gained credibility and capital because of awards through National Science Foundation (NSF) CAREER grant funding (see Note section at the end of this manuscript for details). While those grants provided time and resources for us as researchers to work with school partners, they also legitimized and validated our work - as junior female scholars of color - in our respective institutional contexts. In some ways, this grant funding also likely elevated our statuses and helped us gain credibility, enabling us each to initiate partnerships with local public schools. This suggests that in order to support school-university partnerships, especially those working toward transformative social changes, funding needs to be allocated strategically and intentionally. Specifically, institutions of higher education should enhance (or create if they do not already exist) opportunities for financial resources to support critical partnership work. One such strategy is to supply seed money for pilot studies, which external funding agencies look upon favorably when evaluating grant proposals.

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Financial resources were crucial to begin the partnership, but they alone were not sufficient. Another important aspect of infrastructure is *human or relational resources*. Without trusting relationships between researchers and school partners - partnerships toward transformative social changes are simply not possible. Building such a relationship takes substantial amounts of time and effort, which poses challenges for researchers who are new to a particular context. As illustrated by the second case, that partnership began with the researcher leveraging existing networks and relationships her colleagues had with schools. In the first case, partnership work was greatly facilitated through a long-term relationship cultivated within a university-housed teacher education program and as the graduates of that program became classroom teachers. For those who hold leadership roles in higher education institutions, we recommend critically evaluating relational resources, and creating systems that make such resources accessible to faculty. This is especially important for junior faculty, who are often new to their institutions' local context. When doing this work, it will be important to consider the following questions: *What formal and informal practices might help a newly hired faculty build school-university partnership toward transformative social changes? How might interested faculty be connected to local community members, especially individuals who might play the role of broker or mediator to facilitate the partnering process? What structures, activities, or systems might help aspiring researchers become connected with important social-relational brokers?*

A third aspect of infrastructure for partnership towards transformative social change is *the social recognition system* that consists of norms, practices, and expectations tied to dominant conceptualizations of what makes an educational researcher 'good.' In both cases, meeting institutionalized expectations for 'good' or 'successful' assistant professors was an important source of tension that we, as women of color, faced while navigating the tenure system in

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research-oriented institutions. As much as we work toward expanding what it means to be good at sciences in K-12 science classrooms, the notion of a ‘success’ or ‘good’ researcher also needs to be critically reimagined. This reimagining work should embrace diverse kinds of scholarship, including ones grounded in PDR. Toward this aim, we provide the following three recommendations. First, at the institutional level, we recommend creating a locally tailored social recognition system, both through formal (i.e., merit, promotion, and tenure system) and informal activities (e.g., e-mails highlighting acclamations, university-sponsored websites and/or newsletters, daily interactions), that elevate this kind of partnership work. This might encompass regularly featuring stories of partnership activities through the voices of school partners in public communication (e.g., newsletter, website, social media). Another idea would be to include partnership building activities as a part of merit review. Second, as a field of science education, we recommend creating a space for researchers who engage in this kind of partnership work to collaborate, communicate, and to be recognized. For example, professional organizations and societies focused on science education (e.g., NARST) might consider intentionally featuring or recognizing those who have been involved in this kind of partnership activities. Lastly, for those who are leading the major journals in the field of science education, we recommend re-evaluating the journals’ review criteria, stance and openness toward non-traditional forms of work. Inherently, scholarly work produced from partnership projects based in PDR privileges the needs and voices of practitioners, more than research literature or the voices of researchers. Therefore, scholarly work produced from these kinds of partnership projects can look different from research articles traditionally published in journal spaces. Furthermore, researchers who partake in transformative school-university partnerships often engage in multiple cycles of iterative design and revision work while collaborating with practitioners. This cyclical approach

to meaningful work is not currently compatible with what gets published in our field's journals. Publishing an article in a well-regarded journal is an important benchmark of success for pre-tenured faculty. Yet, privileging and publishing only "final products" - those that can be discussed once partnership activities conclude - results in seemingly low productivity. However, what if journals created a designated space for sharing materials from partnership projects? What if journals allowed and encouraged researchers who engage in social change making projects to share stories-in-progress, instead of only findings from the completed work? Alternatively, we recommend reimagining other venues for sharing our work (e.g., social media, podcasts) in order to reach more people, in particular the people who actually work in school spaces. If we truly want to help nurture partnerships toward transformative social change, we need to reimagine and change the system and culture of the science education community regarding what it means to be a good researcher or what counts as good work or how to communicate our work with people in the community. Only through transforming the many systems in which educational activities take place, including those in which they are recognized, can school-university partnerships aimed at improving K-12 science classrooms flourish.

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Meanwhile, María's partnership was embedded within the project, *CAREER: Developing elementary preservice teachers' understandings and abilities to support emerging bilingual students' scientific sensemaking* (NSF Grant # 1942912).

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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