Families Matter: Family Learning as a Central Component to Equity in STEM Education

Related Paper Set Presented at NARST Annual International Conference

March 17, 2024

Abstract

In this related paper set, our goal was to advance a more holistic vision of equity and social justice in science, technology, engineering, and mathematics (STEM) education by drawing attention to an often-overlooked social asset for learners—their families. While families are usually secondary in discussions of equity in STEM education, a growing number of researchers have highlighted the need to consider and partner with families to establish anti-racist, asset-based educational practices in both informal and formal learning environments. In this related paper set, the first two papers directly challenge the ways deficit-based perceptions of families from historically marginalized communities undermine the critical role that family members play in supporting youth STEM engagement, learning, and identity development. In the second two papers, investigators examine how educators and researchers can use insights from families to inform the design of learning environments inside and outside of school. Collectively, the four papers emphasize the critical importance of working with families to address inequities in STEM education and demonstrate the unique opportunities for envisioning new learning possibilities through these partnerships.

Introduction

Scott Pattison, Smirla Ramos Montañez

In her writings on critical race theory and deficit language in education, Gloria Ladson-Billings argued that the education system is guided by a network of implicit and explicit beliefs about children and their families that shape our approaches to equity. These include beliefs that families do not value education, parents lack the skills and knowledge to support their children's learning, and children start school "impoverished" and without the basic skills to be successful in the classroom (Ladson-Billings, 2007, p. 318). These deficit-based perspectives are pervasive and continue to shape education research, practice, and policy. As Ladson-Billings and others have argued, the ways that educators and researchers think about families and their relationship to learning and education are central to racism and injustice (Ladson-Billings, 2021; Mapp & Hong, 2010; Yosso, 2005).

There are a variety of compelling reasons for centering families when addressing issues of equity and justice in STEM education. As noted, beliefs about families shape our assumptions about children and our approaches to family and community engagement (Rogoff, 2003; Scheidecker et al., 2022). Families also possess deep funds of knowledge and STEM-related assets and skills that are often overlooked but, when recognized and valued, provide models and insights for shaping more expansive ideas about STEM and education (Calabrese Barton & Tan, 2009; González et al., 2005; R. Gutiérrez, 2018; Pattison et al., 2023). And addressing power imbalances between families and educational institutions, both current and historic, highlights the foundations of injustice in our society and creates opportunities for transformation (Bang et al., 2016; K. D. Gutiérrez & Jurow, 2016; Quintos et al., 2019).

Despite these compelling reasons, families have often been secondary in discussions of equity (Barajas-López & Ishimaru, 2020; Ishimaru & Bang, 2022). This is partly an artifact of the historical siloes that characterize the STEM education field. There is a deep and rich equity scholarship focused on classroom learning and policies and practices within schools (e.g., Harper & Kayumova, 2023; Russo-Tait, 2022; Wilson-Lopez & Hasbún, 2023). At the same time, there is a growing body of research on family learning outside of school with an increasing focus on equity and asset-based perspectives (e.g., Castañeda et al., 2022; Pattison et al., 2022; Thompson et al., 2023). However, these two communities have rarely connected.

In this related paper set, our goal was to elevate families and family learning as central to discussions of equity in STEM education and to span the boundaries of formal and informal learning research to advance a more holistic vision of equity across learning contexts. At the outset, we invited participants to reflect on existing barriers and assumptions within the field, including deficit-based perspectives, the problematic history of family engagement, and narrow views about STEM. The first two papers then directly challenged deficit-based perspectives on families from historically marginalized communities and demonstrated the critical role that family members play in supporting STEM engagement, learning, and identity development for children and youth. Paper 1 focuses on Black middle school-aged youth and their families participating in a series of afterschool STEM nights, highlighting the important roles that parents, extended relatives, and siblings play in encouraging and supporting STEM learning for youth during and beyond the program. Paper 2 closely examines the discourse and identity development of first-generation migrant families from Latin American and Caribbean countries, exploring processes of identity development within the family over time and implications for long-term STEM engagement.

In the second two papers, investigators examined how educators and researchers can use insights from families to inform the design of learning environments inside and outside of school. Paper 3 documents the resourceful ways that Spanish- and English-speaking families with preschool-aged children leverage components of an early childhood engineering education program to support their own goals, demonstrating the importance of centering family goals in the design of curriculum and programs. Paper 4 describes a co-design process with families and teachers and identifies promising strategies for both legitimizing family experiences in the classroom and authentically incorporating community cultural wealth in classroom lessons. Collectively, the four papers in this session represent a range of educational settings, STEM topics, child ages, audiences, and community settings. Each paper, however, emphasizes the critical importance of considering and working with families to address inequities in STEM education. Furthermore, each paper demonstrates the unique opportunities for envisioning new learning spaces and possibilities that come when we partner with families.

Paper 1. Recognizing Black Family Members as Partners in STEM Education

DeLean Tolbert Smith, Monica Cardella

Cultural environments can provide critical opportunities for Black youth to engineer, and these experiences can inform the redesign of formal and informal education to increase engineering pathways for more Black youths (Samuelson & Litzler, 2016; Tolbert Smith et al., 2022). Black communities are rich with innovative engineering and design histories, practices, and experiences (Fouché, 2003; Sluby, 2008). Families exist within these communities and can provide access to knowledge, resources, social capital, navigational strategies, and racial-identity socialization that youths can leverage along engineering pathways (Dierking & Falk, 1994; Flowers III, 2015; Jayakumar et al., 2013; Yosso, 2005). Black Families are vital agents of STEM education, yet there is a limited understanding of the impactful ways the family members together explore and encourage STEM knowledge. Perhaps, this is due to the historical framing of Black parents as disinterested and unavailable, which has enabled deficit-based scholarship to build bodies of knowledge upon this assumed characterization. Despite this, scholars have long argued that Black cultural values and pride enable academic persistence and success in Black youth in and beyond STEM pathways (Hrabowski et al., 1998; Latunde & Clark-Louque, 2016). Recent work has identified Black families' supportive STEM practices and thus demonstrates how the framing of parental engagement that centers White middle-class practices excludes valuable knowledge, practices, and behaviors demonstrated by Black parents (Tolbert Smith et al., 2022). Additional research should center Black family members' role in learning and further examine their diverse practices, behaviors, and knowledge from a place of power to deepen our knowledge of the impact of family learning and address equity in STEM education.

Centering Black Families

History records that when faced with oppression and injustice, Black communities demonstrated resolve as they created the innovative solutions needed to thrive—treating education as a form of resistance (Anderson, 1988). Similarly, many Black families today continue to model resiliency, strong educational values, knowledge, and innovation that to can help avoid irrecoverable bottlenecks in the education pipeline for Black youth in the United States and in STEM more specifically—despite systemic social and educational inequities. This current work builds upon

previous asset-based empowerment family-centered scholarship to explore the following question: How do Black families engage in innovative engineering practices?

Study Design

In this study, we explored the experiences of 125 Black 6th grade aged youth and two Black families as they completed an engineering design activity during an after-school STEM night. The research team conducted three separate school visits to facilitate and test the activities with (~200) Black 6th-grade aged (10-12 years) youth, facilitated an engineering design session with three families during an after-school family STEM Night, and 12 families participated in session at the Henry Ford Museum. The in-school activity and post-activity survey helped recruit for the family research sessions and generated baseline data for the research question. At one site the family STEM night immediately followed the in-class engineering design activity; two of three families consented to share the video recordings of their design work. During the Saturday museum sessions, some families worked on an ongoing project and others were introduced to a new project at the session.

Insights

Of the approximately 200 students who participated in the engineering design sessions, 125 responded to an anonymous survey. The students were asked, “Do you do design, building, and creative activities at home and outside of school?" Of the 119 students who responded to this question, 78 students responded ‘Yes.’ Many of these youths reported working with family members.

Family observations

Case 1 (mom, dad, daughter, STEM night): The daughter developed a vehicle concept in-class but did not believe her concept would make a good prototype. She verbally expressed interest in the activity but needed encouragement from the facilitator and parents that she had a good design and good ideas. As the session continued, both mom and dad vocally empowered her to keep working and generating ideas. Even though dad chose to work outside of the frame of the camera, he helped to build the prototype and asked his daughter questions about her design.

Mom observed the design work and helped conceptualize how varied materials could be used to make the prototype that the daughter sketched.

Case 2 (granddad and grandson, STEM night): The grandson introduced his prototype from the in-class session. Both grandson and granddad brainstormed and built prototypes. Then they combined their ideas, considered material introduced in the design activity lesson and developed a new iteration of the grandson's first prototype. Grandad asked his grandson lots of questions and was intentional about following the design steps introduced in the lesson. He referred to the steps often and used them to help his grandson stay focused on the task.

Case 3 (sister and younger brother, Museum): The sister initially expressed a desire to work alone. The research team and her mom encouraged her to collaborate with her younger brother. They designed a device that would help soil scientists collect samples. The big sister was shocked that her 5-year-old brother came up with the idea to make a type of shovel. They gathered materials, developed a prototype, and tested the prototype together. Then the sister began to focus on strengthening the integrity of the shovel design and her younger brother started designing a prototype of his own.

Contributions to the Teaching and Learning of Science

This work demonstrates that Black families have an active role in their students' STEM learning and application experiences. Through this work, we begin to identify how family members serve as critical agents in STEM learning through actions such as: working on engineering-type projects at-home, encouraging problem exploration, following the invention process, and celebrating ideation. The inclusion of family members as STEM co-learners and supporters helps us to advance equity by thinking about the whole child and their full context for learning. Additionally, this addresses some major challenges in STEM education: (1) it communicates rightful presence—that is students see that Black people and their ideas belong in STEM learning environments (Calabrese Barton & Tan, 2020), (2) it creates safe learning spaces for students to receive encouragement as they practice applying their understanding of STEM concepts to real world problems (Cooper, 2009; Jeynes, 2003), and (3) the inclusion of families promotes the value of their knowledge and empowers them to support STEM learning and to encourage their youth to design, build, and create across varied contexts (Gaskins, 2016).

Paper 2. Considering the Family-Centric STEM Identity Development (FSID) Model to Support Cultural Inclusivity in the Design of STEM Learning Experiences

Remy Dou, Heidi Cian

The development of youth's STEM interests, identities, and career aspirations are often explored within the context of family engagement (Dabney et al., 2013; Ennes et al., 2023; Ishimaru & Bang, 2015; Šimunović & Babarović, 2020). However, a comprehensive model for conceptualizing the ways in which parental caregivers contribute to STEM identity development is lacking. [illegible] concept of children's engineering interest development as a systems-based phenomenon, we consider identity development in the context of family systems. We make the case for examining children's STEM identity development as an inextricable factor of their familial milieu, presenting the Family-Centric STEM Identity Development (FSID) model as a conceptual framework that closely attends to family-related factors shaping children's self-concept in relation to STEM. We believe this framework offers opportunities for designing out-of-school STEM programming that authentically embraces children's cultural identities.

Development of Children's Self-Knowledge and Social Identities

Understandings of STEM identity development in educational research have primarily emerged from work with post-secondary students (Simpson & Bouhafa, 2020). However, much can be gained from attending to research with younger children and the consequential role of caregivers. Rochat (2001) provides an overview of this research, presenting a clear consensus that early socialization with caregivers is like a "social mirror" through which children develop self-knowledge, both through imitation and caregivers' reciprocation of children's behaviors (Gergely & Watson, 2010). James Paul Gee's (1989) notion of discursive identities, that is, the attitudes, values, behaviors, language, and ways of being that constitute an individual's various identities, attends to this, positing that children's "primary Discourses" are developed through early socialization that occurs in the home. This understanding is implicitly embedded in contemporary theories of STEM identity development (e.g., Carlone & Johnson, 2007; Holland et al., 1998) that attend to relational interactions shaping identification with a STEM "ingroup" (e.g., Kim et al., 2018), such as within the context of Social Identity Theory (Tajfel, 1978).

The Role of Family in STEM Identity Development

Given the challenges faced by children embodying non-dominant ("outgroup") identities, a growing line of research points toward family contexts as spaces where children's budding dispositions toward STEM are more likely to be nurtured alongside their sociocultural identities (Pattison et al., 2022), while simultaneously healing, protecting, and restoring youth's identities when faced with racism, sexism, and other marginalizing practices in STEM contexts (Cian et al., 2021). Much of this research provides evidence of caregivers—across cultural backgrounds—as agentic actors in the development of children's STEM identities, regardless of caregivers' backgrounds and/or expertise (Dou et al., 2019; Dou & Cian, 2022; Ennes et al., 2023a; Ennes et al., 2023b). Aligned with this understanding, Pattison and colleagues (2020) emphasize the consequential value of attending to the family unit by referring to children's interest development as a "systems phenomenon", that is, "the reciprocal, back-and-forth interactions between children and their primary caregivers" (p. 76). Nevertheless, Šimunović and Babarović (2020) contend that "mechanisms through which parents may convey their STEM-related beliefs to their children are still unclear" (p. 701).

Design/Procedure

Informed by our prior work examining how science related conversations with family members shape youth's STEM identity development, we conducted a longitudinal, multi-case study of three families (i.e., primary caregivers and children, including siblings) to understand STEM identity development in the context of the nuclear family unit. We invited families to participate in a series of five interviews and two video recordings of engagement in STEM activities that took place while children were not attending regular schooling. All parents identified as first-generation migrants from Latin American or Caribbean countries. Rather than defining "STEM", we attended to how participants defined STEM and/or related subfields and mirrored their language and framing. We examined the ways participants described the characteristics of individuals who engage in STEM or its subfields and used comparative analysis informed by guidance for case studies situated in complex sociohistorical environments (Bartlett & Vavrus, 2017). We attended to the social circumstances in which children and caregivers described developing and expressing their STEM identities to study how development appeared to co-

occur with social partners.

Findings & Analysis

We encountered evidence of children's adoption of caregivers' STEM related discourses, which appeared to re/shape the language children used to describe their beliefs about STEM and their aspirations to pursue careers in STEM fields. We triangulated our findings through follow-up interviews to test our developing interpretations (i.e., member checking) and by iteratively reconstructing our themes according to researchers' independent interpretations (Morse, 2015). We then collated our themes in the form of an explanatory model of Family-Centric STEM Identity Development (FSID), which we tested against our data, intentionally seeking counterexamples and reconstructing the model to better account for the evidence we collected. We limit ourselves to a summary of our FSID model in this proposal.

Our data showed how caregivers shape children's understanding about the boundaries of STEM (i.e., what/who constitutes STEM and/or related disciplines) while simultaneously positioning their children within or outside of those boundaries. We found that caregivers made use of three primary approaches informed by perceived alignment between their beliefs about STEM and their family and cultural values: (1) engaging children in conversations about STEM; (2) evaluating and dis/affirming children's STEM identity expressions; and (3) facilitating, modifying, or obstructing repeat engagement in STEM activities. Children's affective reactions and responses to these, in turn, contributed to caregivers' perceptions of the boundaries of STEM and where they positioned their children in relation. Children maintained various levels of agency throughout this process, though adoption of caregivers' beliefs appeared to be the norm.

Contribution to the Teaching and Learning of Science

Given the interconnectedness we see in relation to caregivers' beliefs about and attitudes toward STEM, which are often rooted in the context of family values, culture, and goals, *our findings highlight the impracticality of thinking about children's STEM identity development without accounting for caregivers' contributions.* We believe the FSID has implications for STEM identity research and measurement in how the mechanisms described by our model provide plausible justification for the need to attend to the family context. We also believe this has

meaningful implications for program development by providing a conceptual framing that may guide the design of caregiver engagement. The FSID model attends to the marginalization of children's sociopolitical identities (Heybach & Pickup, 2017) by centering caregivers' values and goals, which shape how children interpret STEM messaging they encounter outside of the family context (Gee, 1989).

Paper 3. Agentic Interest Pathways: Understanding the Ways that Families Shape Their Own Interest Development to Inform a More Equitable STEM Education System

Scott Pattison, Smirla Ramos Montañez, Viviana López Burgos, Gina Svarovsky, Julie Allen, Annie Douglass, Catherine Wagner

In STEM education, the goals of families are almost universally positioned as secondary to the goals of educators and researchers, if they are considered at all (Ishimaru & Bang, 2022). In our own work on STEM interest development (Pattison et al., 2022), we see these challenges reflected throughout the literature. Studies often focus on STEM-related interest as something that children and families lack and that programs must be designed to provide (Renninger & Hidi, 2020). Similarly, STEM-related interests are often predefined, without considering the existing interests or practices of families or how the goals of STEM-related interest development relate to family priorities. These approaches align with deficit-based perspectives that pervade the literature, and they perpetuate historic power imbalances that serve as a foundation for inequity and injustice in the education system (Ladson-Billings, 2021; Schenkel & Calabrese Barton, 2020; Yosso, 2005).

In this paper, we propose a new framework (*agentic interest pathways*) for thinking about STEM-related interest development for families with young children that centers the goals of families and highlights the ways that they demonstrate creativity, resourcefulness, and agency in leveraging STEM learning experiences to support these goals, both related to STEM and more broadly.

Design

This analysis was part of a 5-year design-based implementation research (DBIR) project (Fishman et al., 2013) in partnership with our local Head Start program situated in a mid-sized metropolitan region in the Pacific Northwest, USA. During this project, we partnered with Head Start families and educators to develop and iteratively refine a bilingual (Spanish/English), family-based informal engineering education program intended to engage preschool-age children (3 to 5 years) and their families in engineering design and connect with the existing engineering-related knowledge and practices of families (Pattison et al., 2020). The 6-month program

included a series of caregiver workshops, take-home family engineering activity kits, online videos and resources, complementary classroom activities, educator professional development, and a culminating field trip to the local science center. Embedded data collection involved caregiver interviews before, during, and after the program; participant observations and documentation of program events; videos, pictures, and reflections from family engineering engagement at home; and Head Start staff interviews. A subset of families each year also participated in more in-depth case study research, including follow-up interviews approximately a year after the program.

For this paper, we analyzed data from 12 case study families across 2 years of program implementation (2020–21 and 2021–22). These families had completed the majority of data collection activities and were selected to represent the cultural and linguistic diversity of program participants. For this group, we developed in-depth case study narratives (Yin, 2018), synthesizing the data across methods and focusing on family experiences, evolving perspectives, and patterns of interest development. Initial case study review highlighted the importance of family goals and the ways these shaped their program experiences. Borrowing from the narrative research technique of "restorying" (Creswell, 2013), we then restructured the case studies to further explore these aspects of the data and conducted ongoing cross-case analysis using grounded theory coding and constant comparative analysis strategies (Charmaz, 2006). Throughout, the analysis was guided by an asset-based family learning framework, which applies a sociocultural lens to STEM learning research, emphasizes the existing knowledge and assets of families, and positions learning and interest development as family-level systems phenomena (Pattison & Ramos Montañez, 2023).

Findings and Analysis

Through the analysis, we developed a deeper understanding of the *agentic interest stories* of families and how this process shaped their evolving connections to engineering and STEM. Centering the voices and perspectives of families highlighted three themes, as described below.

Families began the program with a variety of goals. In pre-program enrollment interviews, caregivers clearly articulated the goals that motivated them to join the program and the ways that they hoped the experience would support their children and families. Common goals included supporting children's learning and development in general and related to

children's specific learning needs; finding new hands-on activities, especially during the global health pandemic; supporting children's existing interests, including interests related to science or STEM; and finding ways to spend more time together and strengthen family bonds.

Family goals evolved and expanded through their experience with the program. Many caregivers described how their original goals evolved or new goals emerged as they saw opportunities within the program. Families talked about new goals related to spending time together and building relationships as a family, observing their children's learning and development, being motivated to share the program activities and resources with other families, and supporting children's creative problem-solving skills, which was often connected to a growing appreciation of the engineering design process presented through the program.

Families leveraged the program in a variety of ways to support their goals. Families demonstrated creativity and resourcefulness in leveraging and adapting different program components to support their goals—especially the take-home family activities and the engineering design process presented through the program. For example, parents talked about how they structured their time with the activities to support family relationships, involve more family members (e.g., spouses, siblings, grandparents), help their children practice collaboration skills, and adapt the design challenges to focus on family bonding (e.g., using the fort building activity to create a fort big enough to fit the whole family inside). Many families also connected with the framing of engineering as related to everyday problem solving and used this framing to integrate and support problem solving for their children within and beyond the program. For example, families used vocabulary and steps from the engineering design process to scaffold problem solving for their children and used the program as inspiration to create new engineering and problem-solving experiences (e.g., building a real chicken coop inspired by the activity about a chicken family). In addition, when families perceived value in the program towards achieving their own goals, we observed how they skillfully navigated external challenges and barriers (e.g., busy schedules, technology challenges, health problems) to persist in the program and maximize the experience for their children.

Contribution to the Teaching and Learning of Science

To achieve a more equitable vision of STEM education, family and community goals must be central. This research highlights how attending to these goals demonstrates the agency and

resourcefulness families exercise in leveraging educational experiences and navigating barriers and challenges in order to chart their own learning paths. The study also provides a strength-based framework for understanding STEM-related interest development that reflects the prior knowledge and interests of families, expands traditionally narrow conceptualizations of STEM interest, and positions learners as active agents in their own learning (K. D. Gutiérrez & Calabrese Barton, 2015; K. D. Gutiérrez & Jurow, 2016). These findings can in turn guide efforts to design learning opportunities inside and outside of school that meaningfully advance the goals of families and communities as part of a more just STEM education system.

Paper 4. STEM Fam: Fostering Rightful Familial Presence in Middle School STEM

Angela Calabrese Barton, Wisam Sedawi, Edna Tan

This study investigates research and instructional practices that support *rightful familial presence* in STEM to address the continued racial/class inequities in STEM learning. We ask: W*hat practices grounded in research-practice-partnerships support rightful familial presence, and how do these practices facilitate capital movement between families and schools for STEM teaching and learning?*

Framework

A macro-structural inequality in STEM education for youth of Color is how parents/families are valued in school settings. Most models of parental/familial involvement are rooted in White, middle-class power structures that reproduce racial/class inequalities (Paredes Scribner & Fernández, 2017), and obscure familial social/cultural capital (Delale-O'Connor et al., 2020). Deficit thinking and narrow views of what is considered involvement of parents of color limit interactions between schools and parents (Marchand et al., 2019). Studies are needed on how parents of Color can be rightfully invited to contribute to STEM learning designs and how teachers can be supported in leveraging their contributions (Stoehr & Civil, 2022). We need to explore how to activate parental funds of knowledge (González et al., 2005) and familial community wealth (Yosso, 2005) into school and STEM-relevant capital in ways that simultaneously elevate and amplify its role in STEM teaching and learning.

We ground our work in the Rightful Presence Framework for justice-oriented teaching/learning (Calabrese Barton & Tan, 2020), and Yosso's (2005) Community Cultural Wealth. *We define rightful familial presence as a form of authentic family engagement that legitimizes families' community cultural capital and fosters capital movement between families and schools, especially when these forms of capital have historically been marginalized within STEM learning.*

Research Questions

What are parents/families' experiences throughout the STEM FAM collaborative project approach? What are the impacts of specific experiences on the relationship between parental presence and students' STEM learning?

Methods

Drawing upon DBIR with researchers, teachers, parents, and youth in two urban school districts, we enacted the Rightful Familial Presence in STEM "STEM FAM" project, through four collaborative activities: 1) Exploring familial capital for STEM learning, 2) Curricular explorations/adaptations through parental capital, 3) Enactments, and 4) Reflective Dialogues. Parents, youth, teachers, and researchers engaged in co-design meetings for activities 1 and 3. Classroom enactments (3) then followed, and Reflective Dialogues (4) included interviews with parents, youth, and teachers during and after the classroom enactments.

In addition to participating in pre-enactment sessions, we studied 4 classrooms in two settings, taught by partner teachers. Teachers focused on a life science unit (Stressed!) in one state and an engineering unit (Sustainable Communities) in another. Classrooms were visited daily for 6-week enactments of two units: Sustainable Classrooms & Stress. Data sources include: Student practical measures (e.g., feedbacks via electronic exit tickets); classroom observations; teacher reflections; student work (e.g., sketches and artifacts); and teacher, parent, and student interviews. Analysis involved multiple stages and levels of coding based on constant comparison procedures.

Findings

We identify two cross-cutting practices (both settings/units) that created spaces for authoring familial presence in STEM learning, even when parents were not physically present during classroom enactments. These cross-cutting practices were threaded through the pre-enactment co-design meetings (involving parents, youth, teachers, and researchers) and the subsequent classroom enactments of the curricular units. We also discuss tensions in these change-making efforts, in relation to shifting normative practices/perspectives of parental engagement and familial capital in STEM.

Cross-cutting practice 1: *Rooting/tending to emergent STEM epistemologies in familial values/wisdom*: Youth and families centered their experiences, expectations, and aspirations during co-design meetings. For example, they expanded the definition of sustainable communities to include "loving" and "respecting" in addition to more canonical ideas such as localizing community input and drawing from community expertise. Teachers grappled with how to include "loving" as an engineering criterion and turned to students to operationalize it in their electric art projects and applied these insights to the sustainable classrooms challenge. We share sample artifacts and trace the thread of rightful familial presence from ideation through the iterative engineering prototyping process. As Mr. P. stated on adapting the engineering curriculum: "During the engineering process, some kids saw the projects more as an opportunity for the community rather than identifying a problem within the community (*pointing to design cycle*). That's how we adapted and used "needs/opportunities" to emphasize opportunities for the community, linked with 'love' as a new engineering criterion, opportunities, not problems, to express love and build community."

Cross-cutting practice 2: *Storying ourselves into STEM*: During co-design meetings, parents described children's school-related embodied stress and how their stress impacted both their schooling and family life. These stress stories became a central theme to the Stressed! curriculum that was subsequently enacted: 1) Students produced school-stress maps, designed a key to indicate where, how, when, and what they experienced/witnessed stress; 2) Students conducted a community survey to further map their stress school-scape that included factors like racism, bullying and school disciplinary measures as well as specific spatial locations in the school grounds; 3) The 4 youth who were part of the co-design team in one state collaborated on writing their stress story as a curricular resource that was part of the Stressed! lessons; 5) Students created a 60-to-75 second Public Service Announcement educating their peers about stress at their school. Teachers who enacted the Stressed! unit were challenged to connect this local, authentic focus on the sociopolitical environment of their students in the everyday transition from home to school life, to teaching long-term stress models on the body.

Across the two practices, we trace how rightful familial presence was evident in teacher discourses, the co-design activities and curricular classroom enactments. We conjecture on how such an arc across time and space supported a form of rightful familial presence in STEM teaching and learning and the implications for student and teacher learning. We also discuss

tensions that arose, including how teachers negotiate the STEM FAM activities in their classrooms.

Significance

Parents of Color have historically been marginalized in school-parent interactions in disciplinary-consequential ways. This study provides insights into how rightful familial presence in STEM might be infrastructured and supported through design-based implementation research, and how teachers learn to grapple with the emergent tensions. The study's implications contribute insights to advancing justice-oriented STEM teaching and learning.

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