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Asian American women in STEM in the lab with "White Men Named John"

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Abstract

Asian American women occupy a paradoxical space within the context of science, technology, engineering, and math (STEM) fields, simultaneously overrepresented as Asian Americans and underrepresented as women. For Asian American female doctoral students, the complex layering and weaving of these intersections involves the constant negotiation of science, racial, and gendered identities. This study explored how the intersections of science, race, and gender shaped their student experiences. We positioned these frameworks not only as mutually constitutive systems but also emphasize science as an epistemology, which informs conceptions of knowledge, the practice of inquiry, and who has epistemic authority. As a qualitative study, we utilized intersectionality theory to explore identity development in the context of STEM environments and grounded theory methods in our analysis. We interviewed 23 women who self-identified as Asian Americans and were either currently in a doctoral program or were within 5 years of earning their degrees in STEM fields.

Examining the intersections of science, race, and gender for Asian American female doctoral students in STEM allows a richer, more nuanced exploration of science as it is currently defined and understood and permits the conceptual critique of science to remake STEM environments into more inclusive spaces

KEYWORDS

Asian American students, doctoral students, women in STEM

1 | INTRODUCTION

There is a strange contradiction among scientists: Science is supposedly about asking questions, except about scientists and how science is done.

—Prescod-Weinstein, 2017

Asian American women occupy a paradoxical space in science, technology, engineering, and mathematics (STEM) fields, simultaneously overrepresented as Asian Americans and underrepresented as women (Ong et al., 2011; Wu & Jing, 2011). The experiences of women of color in STEM have been studied through the lenses of race and gender, but the socially constructed system in which they are situated must also be critically examined. In this study, we explore power and hierarchy within the socially constructed systems of science, race, and gender for Asian American female doctoral students in STEM. The central research question is: How does the intersection of science, race, and gender shape the doctoral student experience for Asian American women in STEM fields?

The research question shapes our focus on participant experiences not only as individualistic perspectives, but also as clues to the larger social construct that is science. We position science as a frame of identity as well as an epistemology, which informs conceptions of knowledge, the practice of inquiry, and who has epistemic authority (Harding, 1993, 1998). Examining the intersections of science, race, and gender for Asian American female doctoral students in STEM not only allows a richer, more nuanced exploration of science as it is currently defined and understood, but more importantly, permits the conceptual critique of science to remake STEM environments into more inclusive spaces, which value epistemic knowledge from all groups and perspectives.

This paper is organized into three overarching sections. First, we explore the STEM landscape for Asian American female scientists, science as a social construct, and previous research on identity development in STEM fields, women and women of color in STEM, and Asian Americans and Asian American women. Next, we detail the study itself, including the theoretical framework, methodology, findings, and discussion. Finally, we outline recommendations for policy and practice, areas for further research, and the implications.

2 | THE STEM LANDSCAPE FOR ASIAN AMERICAN FEMALE SCIENTISTS

Asian American women signify an underrepresented group whose "knowledge, values, and practices… [are] missing from the knowledge base established by the dominant group" (Chinn, 2002, p. 320). Reflective of the invisible and model minority stereotypes, Asian Americans are often cast as high-achieving students who are doing well, therefore irrelevant in discussions about social and educational mobility (Teranishi, 2010). The easy visibility of Asian faces in STEM fields leads to the deceptive notion that Asian women are succeeding and can be found at the highest levels of STEM industry, academics, and government when in fact, very small numbers of Asian Americans advance to full-faculty positions, deans, or university presidents in academia (Wu & Jing, 2011). Wu and Jing (2011) note that 80% of Asian Americans are found in nonfaculty positions, such as postdocs, researchers, and lab assistants, or nontenured faculty positions. These perceptions contribute to a lack of attention on Asian Americans and highlights the need for studies that explore the complexities of the Asian American community.

In addition, the majority of research on STEM fields has focused on undergraduate student experiences. Doctoral students represent the talent pool of research scientists, and the PhD is regarded as the pathway to academia and cutting-edge research (Goulden et al., 2009). The Survey of Earned Doctorates Report (NSF, 2017) indicated that in 2015, 75% of all earned doctorates were in science and engineering (S&E) fields, with 42% of S&E doctorates awarded to women. Although this appears quite promising, a closer examination of the data revealed gains made by women vary by field. In 2015, women earned 55.4% of the doctorates awarded in life sciences, but only 33.6% of the degrees awarded in physical and earth sciences, 24.7% in math and computer sciences, and 19.7% in physics. In general, men continue to represent a majority of doctorates in STEM fields. Tao (2015) notes that for female students, decisions to pursue doctorate degrees may be influenced by social and institutional factors

"because only a very selected proportion of women who are pernicious [sic] enough to have overcome social and institutional barriers at an earlier age and are prepared to overcome barriers during doctoral studies would be able to complete their doctoral education in engineering" (p. 5).

With the increased focus on STEM fields, a better understanding of the Asian American graduate student population in research-intensive universities is warranted, particularly deeper explorations of science contexts for doctoral women of color. In the next section, we position science as a social construct and ground our study in previous research on science identity development, women and women of color in STEM, Asian Americans generally, and Asian American women specifically.

3 | LITERATURE REVIEW

3.1 | Science as a social construct

Critically examining science begins by conceptualizing science as a social construct, reciprocally shaped and transformed by and related to social, political, and cultural forces (Harding, 1998). In other words, various socio-cultural systems mutually shape and influence each other over time so one cannot be understood fully without the other. This reciprocal shaping influenced the philosophical underpinnings of science, the established norms and assumptions, mechanisms, as well as value systems that have traditionally defined science (Shanahan, 2009). Science, as it is currently perceived, may then be broadly understood as a Western development, which evolved as a result of the European Scientific Revolution and transmitted via colonialism and imperialism (Godfrey-Smith, 2009; Petitjean et al., 1992; Principe, 2011). This approach of science is embedded with Western, Eurocentric, White, male paradigms and informs the construction of (1) race and gender within science, (2) what is legitimate knowledge and inquiry, and (3) who gets to do science (Godfrey-Smith, 2009; Harding, 1993, 1998).

With this lens, science may be viewed as a body of knowledge, an epistemology, and as a frame of identity. As a body of knowledge, science is equated with specific methods of validation characterized by rationality, logic, and curiosity (Harding, 1993; Nader, 1996). Science, however, is more than a body of knowledge. It is also an epistemology, rooted in a knowledge system that prizes human objectivity (Coil, 2017; Harding, 1993), a way of "knowing that embodies curiosity with empiricism" (Nader, 1996, p. 1). In addition, science functions as an expression of identity (Calabrese Barton & Osborne, 2001). Therefore, remaking science and resignifying what it means to be a woman of color scientist begins with understanding science not only as a social construct, but also as a frame of identity and epistemology positioned within a field founded on and as an expression of Western, Eurocentric values.

3.2 | Science identity development in STEM fields

The women who participated in this study are scientists, Asian Americans, women, and doctoral students. The complex layering and weaving of the intersections of their identities requires the constant negotiation of racial and gendered identities within the context of higher education, particularly research focused environments in STEM (Way et al., 2008). Successful science identity formation, or the ability to positively identify themselves as scientists, has been positively correlated with student persistence. Carlone and Johnson (2007) identified three overlapping dimensions which influence successful science identity: (a) competence, acquiring the requisite knowledge of science content and method; (b) performance, the ability to demonstrate that competence through their abilities; and (c) recognition, the capacity to internally construct a science identity and seek and receive external validation and affirmation from meaningful others.

However, successful science identity integration can be problematic for women and women of color. Competence and performance, for example, present challenges when one questions not only where and how existing and prevailing notions of science emerged, but also how the values of rationality and logic became embedded, legitimized, and institutionalized (Harding, 1993). Because of these narrow constraints, Herrera et al. (2012) expanded on the science identity model and argue that multiple social identities as well as multiple *cultural contexts* (i.e., nonscience, racial/ethnic contexts such as families and communities) not only positively affect science identity integration but may also contribute unique insights that potentially lead to science innovation.

Moreover, women of color do not always conform to the prototypical image of a science person (i.e., White and male) or the epistemology linked to that image (Carlone & Johnson, 2007; Harding, 1998). Therefore, the interplay between the sometimes fragile, individual notions of the self as a scientist and the social constructions of science involve varying degrees of performativity and cultural production to be viewed as legitimate members of the science community (Carlone & Johnson, 2007). Cultural production, or the "meanings developed by groups in their everyday activities" provides a critical tool to examine how students potentially produce and make sense of the meanings of science and scientists relative to their academic journeys within and against the context of the larger, more pervasive and powerful socially constructed meanings of science (Finkel & Eisenhart, 1998, p. 44). In this way, cultural production both constrains and enables identity development, in that external forces powerfully shape what constitutes science identity; therefore, "one is not free to create *any* meaning of science" (Carlone, 2004, p. 396). Rather, the various permutations of science meanings are shaped in large part by history, "reified in the forms of values, beliefs, and taken-for-granted actions of peers, teachers, and administrators, all of which imply certain meanings of… 'good' science participants" (Carlone, 2004, p. 396).

In addition, the third aspect, recognition, proves complicated because it hinges so critically on other individuals. Appropriate behaviors, language, and dispositions are not enough, nor is recognition from nonscientist friends and family. One must be recognized as a scientist by meaningful others, typically faculty members or peers. Such external validations therefore become important measures of self-worth (Malone & Barabino, 2008).

Successful science identity formation, then, can be particularly challenging for women of color when considering the barriers inherent in the process itself. Conceptualizing science as embodied acts, or performances, that incorporate a scientific habitus (habits, dispositions, and even value systems) emphasizes the influence of social relations as well as social contexts that limit and constrain identity formation (Bourdieu, 2000, 2004). However, even within the constraints of learned performances, habitus, and cultural production, the possibility of agency exists: It is conceivable to transcend and transform meanings of "science people" to create novel conceptions, one that allows for the inclusion of women of color within communities of science (Carlone & Johnson, 2007, p. 1192). These processes, to conceptualize a different view of science and scientist and embrace multiplicities, requires persistence and a level of maturity to be able to embrace ambiguity (E. S. Lee, 2016). This not only begins with a symbolic foundation, the belief that one is worthy of participation (Malone & Barabino, 2008), but also requires the active resistance, reframing, and sometimes manipulation and negotiation of negative stereotypes to redefine the abstract notion of women in science to include themselves (Carlone & Johnson, 2007; Ong, 2005; Ridgeway & Kricheli-Katz, 2013).

Thus, it is important to recognize STEM identity development for women of color is constrained and influenced by the larger and more pervasive meanings of science derived from the sociohistorical legacies of science and the historical and political contexts of being a woman of color (Carlone & Johnson, 2007; A. C. Johnson, 2007). When students' bids for validation is withheld because of pre-existing biases based on gender and/or race, students' abilities to author satisfying science identities are impeded (A. Johnson et al., 2011). A. Johnson et al. (2011) further argued, "When the women [are] in their most constrained positions in the matrix of power,… some identities [are] simply closed to them, simply not an option" (p. 399).

3.3 | Women and women of color in STEM fields

3.3.1 | Contemporary structural barriers and obstacles in STEM fields

Studies suggest that barriers and obstacles for girls and women in STEM fields often originate from cultural notions of traditional women's roles and gender stereotypes related to academic performance (Hill et al., 2010; Nosek et al., 2009; Stout et al., 2011). These views start from a young age and contribute to low academic expectations in science and mathematics for young girls and beyond (Saucerman & Vasquez, 2014), even though girls earn more credits and consistently earn higher grades in high school math and science (NCGWE, 2012). Cultural messages communicate to women that they are less capable in the sciences and are best suited to fields that emphasize nurturing and caregiving (Ecklund et al., 2012; Hill et al., 2010; NCGWE, 2012; Saucerman & Vasquez, 2014). In contrast, hard sciences, such as physics, is related to hard, abstract math, viewed as a traditionally male endeavor (Ecklund et al., 2012).

Science then becomes perceived and accepted as an elite male domain. Leslie et al. (2015) found a direct correlation between the underrepresentation of women in fields like physics and mathematics and a belief that innate brilliance and genius are a requirement for success. In other words, the more theoretical the field, the stronger the belief that inherent aptitude is required to succeed and the less likely women are to occupy those fields. These findings suggest the negative stereotype that women have lower intellectual capacities creates inhospitable environments for females; the stereotype also fosters the belief that women do not possess the same innate talents as their male counterparts (Leslie et al., 2015). Indeed, these stereotypes and gender ideologies regarding women contribute to role incongruity or the failure to see women as possessing the characteristics necessary to become successful scientists (Carli et al., 2016; Eagly & Karau, 2002). This reflects the co-constitutive nature of the narrative of science as a male domain and beliefs that sex differences correspond with the ability to engage in science and mathematics (Nosek et al., 2009).

Moreover, science environments with cultural norms based on White, Eurocentric, masculine ideals not only limit and constrain access but also become "chilly" environments for women and women of color (Ferreira, 2002, p. 85). These environments are characterized by harassment and inappropriate comments and jokes, sometimes in the form of microaggressions (Barthelemy et al., 2016; Parson & Ozaki, 2017). Often obscured, these subtle discriminations, or microaggressions, are defined by Sue (2010) as "the brief and everyday slights, insults, indignities and denigrating messages toward socially devalued groups" (para. 12). Microaggressions range from conscious, intentional actions to more subtle, often unconscious forms of communications that are largely invisible and therefore potentially more insidious (Sue, 2010). As a result, female students feel the need to become "inured to sexual language or comments that were derogatory to women in order to be successful in the male-dominated STEM environment" (Parson & Ozaki, 2017, p. 42).

3.3.2 | Unconscious bias and socialization

Even faculty exhibit unconscious bias toward male students deeming them more hirable and competent than their female counterparts (Moss-Rascusin et al., 2012). These views are often transmitted through the process of socialization, where students learn, internalize, and reproduce normative behaviors, such as the accepted practices, modes of behavior, and styles of communication, as they become part of a community of scientists (Golde, 1998). They not only learn a specific approach, knowledge base, methodology, and expectations for research, but they also internalize norms, standards, and a worldview associated with their professions (Weidman, 2010), which then become reified in scientific practices (Takaki, 1993).

However, the socialization process is not the same for all students and is further complicated by students' racial backgrounds and gender, which shape students' experiences and access to opportunities (Chang et al., 2011;

Gardner & Mendoza, 2010; Sallee, 2011). Gildersleeve et al. (2011) characterized the experiences of Black and Latino/doctoral students as dehumanizing and highlighted the tendency of students of color to internalize the oppressive framing inherent in doctoral education. This is also evident in Asian American women who experience the same feelings of marginalization and isolation that other students of color face despite a critical mass of Asian Americans in STEM fields (Malcom & Malcom, 2011; Ong et al., 2011).

3.4 | Asian Americans

3.4.1 | Asian American stereotypes and ideologies

Throughout American history, Asian Americans have been portrayed as a monolithic group, depicted as a yellow peril, forever foreigner, and model minority or deviant minority, sometimes simultaneously (Museus, 2014). These distinct but interrelated stereotypes can be seen as a way of defining Asian Americans against the sociopolitical landscape, illustrating how race works in the United States (E. Lee, 2015). Historically used as a wedge group, Asian Americans are racially triangulated in the field of race relations, simultaneously valorized and ostracized to shift the debate from structural and institutional racism to maintain White racial dominance (Kim, 1999).

One common thread in the various Asian American narratives is the depictions of Asian Americans as unassimilable and falling outside the bounds of American normalcy (Shah, 2019). The model minority presents Asian Americans as universally successful, both academically and occupationally, an image that has consistently been used to pit Asian Americans against other minority groups, particularly African Americans (Museus, 2014; Poon et al., 2015). As model minorities, Asian Americans are also viewed as passive, compliant, and apolitical (Kim, 1999; Shah, 2019; Shrake, 2006). At the same time, they are depicted as foreign (Kim, 1999; E. Lee, 2015), which highlights the conceptualization of Asian Americans as incapable of assimilating into American society and reinforces the ideal of the White American (Museus, 2014). Defined as the racial other, physically and culturally different from Whites, Asian Americans have never been accepted as true Americans (Kim, 1999; Lowe, 1998; Pak et al., 2014).

In addition to the racial other, Asian Americans are depicted as intellectually other. Shah (2019) argues that Asians are good at math stereotype, a derivative of the model minority, positions Asian Americans as deviant from the norm and can be deployed in various ways to limit and constrain Asian American identity. As a result, Asian Americans are siloed into certain fields, specifically STEM, where they are viewed as socially awkward, robotic, over-evolved human machines, and therefore subhuman (McGee et al., 2017; Shah, 2019).

In direct opposition to the model minority image is the deviant minority stereotype. Museus (2014) and Ngo and Lee (2007) noted that Southeast Asian Americans as a subgroup (Vietnamese Americans, Hmong Americans, Cambodian Americans, and Lao Americans) are uniquely characterized, either collectively with other Asian Americans as the model minority or singled out as deviants, gang members, and low achieving dropouts dependent on welfare (Ngo & Lee, 2007). The deviant minority stereotype is used to silence other minorities, even from within the Asian American community (Ngo & Lee, 2007). Moreover, Southeast Asians, as a distinct subgroup, illustrate the danger of viewing Asian Americans as a monolithic group. In contrast to the model minority image, educational attainment data show that 30% or higher of Southeast Asians have not earned a high school diploma and continue to face barriers to education (Teranishi & Nguyen, 2012). Thus, the pervasiveness of the successful model minority image contributes to sweeping generalizations about Asian Americans as academic overachievers who do not need support services or assistance and masks the complexities of the individual Asian American experience (Museus & Kiang, 2009; Teranishi, 2010).

Researchers also found that internalizing even a positive stereotype results in diminished motivation to engage in the learning process and high pressure to conform to the stereotype (McGee et al., 2017; Museus, 2008). Indeed, the model minority stereotype has become so embedded in social consciousness that even Asian American scholars

feel the need to counter the model minority stereotype, which results in casting Asian American students as the problem (Poon et al., 2015). This not only approaches Asian American scholarship with a deficit mindset but also reproduces deficit thinking (Poon et al., 2015).

The constructions of Asian Americans interact in complex ways that expose the precarious positioning of Asian Americans relative to the political and social climate (Chou et al., 2016). Historically co-opted through misrepresentation and manipulation, the Asian American community is consistently used to promote divisions among and between other minority groups and maintains White supremacy (Cho, 1998; Kidder, 2000). In STEM fields, Asian Americans are simultaneously viewed as idealized labor, quiet, hard-working, naturally talented in STEM but also perceived as the yellow peril, overrunning elite American colleges and universities to the exclusion of others and posing a potential threat to the normative structure of race relations (CARE, 2008; Chen & Buell, 2018; Pak et al., 2014). In the process, Asian Americans are dehumanized; therefore, the racialization of Asian Americans is ultimately about personhood and who gets to be seen as fully human (Shah, 2019).

3.4.2 | Asian American women in STEM

Asian American female students experience educational environments as both racialized and gendered spaces and face additional challenges when the model minority myth and the perception Asians are innately good at science and math collide with stereotypes of women as low performers in technical fields as well as perceptions of Asian American women as submissive, passive, and obedient (Hune, 2006; Patel, 2008; Williams et al., 2014). Some Asian American women also experience distinct forms of marginalization, sometimes from within their respective communities. S. J. Lee (2006) found conflicting cultural values and traditions around gender roles within the Asian community inhibited the educational aspirations of girls. For example, Asian immigrant communities, such as Cambodian and Hmong immigrants, often held very distinct and rigid notions regarding gender roles, which in turn influenced attitudes toward education (Chinn, 2002; S. J. Lee, 2006).

Compounding traditional values from parents or Asian communities, Asian American women must also contend with gender and racial biases from peers and society at large, including questions of credibility due to gender and language ability as well as various linguistic, cultural, and academic differences (Li & Beckett, 2006). In a study of women of color scientists, Williams et al. (2014) revealed that Asian American women felt the need to provide more evidence of competence than men to be viewed as equally competent than any other ethnic group, including White women. In fact, the findings suggested Asian American women's experiences were shaped more by the negative stereotype of women as low performers in science or not as technically competent as men than the positive stereotype that Asians naturally excelled in science. Asian American women were also more likely to experience backlash for behaving in stereotypically masculine ways, such as being assertive or self-promoting and felt more pressure to conform to traditional feminine roles such as "office mother" or "dutiful daughter" (Williams et al., 2014, p. 6). In addition, Asian American women experienced racialized sexual harassment as a result of stereotypes of Asian women as exotic, leading to compounded vulnerabilities linked to psychological stress, negative body image, and negative self-perceptions and identity (Cho, 2003; Patel, 2008).

In essence, Asian American women experience distinct forms of bias based on their experiences both from within the Asian community and society at large, producing "understandings of multiple social worlds requiring the holding and performance of conflicting self and social identities" (Chinn, 2002, p. 320). Thus, for many Asian American women, negotiating traditional cultural values and gender and racial stereotypes and biases reflect the complexity of multiple roles within various value systems and leads to an intersectional framework (Li & Beckett, 2006).

4 | INTERSECTIONALITY AS A THEORETICAL FRAMEWORK

We utilized intersectionality as the theoretical framework to provide multiple layers of analysis. Intersectionality examines categories of difference, such as gender, race, and class, the ways the various categories interact with each other, and the dynamics involved in the way these identity categories mutually change and constitute each other in the process of interaction.

4.1 | Roots of intersectionality

The notion of intersections conveyed the realities of overlapping oppressions, articulated by writers dating back to the 19th century who expressed the convergent nature of race, gender, class, and sexuality in their experiences (P. H. Collins, 2009; Dill & Zambrana, 2009; K. Lee, 2012). In the science context, Malcom et al. (1976) introduced the concept of the double bind in an article that reported on a conference on minority women scientists. The double bind referred to the multiple layers of discrimination faced by women of color—as a woman and as a person of color. Participants of this conference came together to raise awareness of the unique experiences of women of color who simultaneously experienced racism and sexism as scientists and who felt the programs aimed at serving women or minorities benefitted White women or minority males, to the exclusion of minority women (Ong et al., 2011).

Crenshaw's (1991) now landmark legal analysis in which she named intersectionality to metaphorically illustrate overlapping oppressions represented a turning point in the field of intersectional theory (P. H. Collins, 2009). Naming intersectionality effectively brought a sense of legitimacy (P. H. Collins, 2019), and from its roots in the experiences, writings, and scholarship about and by people of color, intersectional studies emerged as a burgeoning field (Cho et al., 2013). As a theoretical framework, intersectionality generated a new wave of studies, providing a lens from which to view the mutually constituting nature of identity development, individual experiences, and social structures (Warner & Shields, 2013).

4.2 | Rationale for intersectionality

Intersectionality, however, is more than a theory of individual identity; rather, it "is a way of understanding and analyzing the complexity in the world, in people, and in human experiences," which go beyond the influence of a single factor (P. H. Collins & Bilge, 2016, p. 2). P. H. Collins and Bilge (2016) advance a more holistic approach arguing that intersectionality's attention to the intricacies and overlapping qualities of power, social relationships, contexts, and inequality acknowledges the complexity of humanity that prevents the use of a linear or simplistic methodology. Thus, by examining power relations both *through* intersections and *across* domains of power (e.g., interpersonal, disciplinary, cultural, and structural), the role of identity can be evaluated in relation to the larger social settings that either affirm or deny the existence of that identity. Critical praxis also recognizes that individual experiences in the context of science settings diminishes the separation between scholarship and practice, or theory and experience, thereby "creat[ing] space to rethink this relationship between intersectionality and the politics of identity" (P. H. Collins & Bilge, 2016, p. 131). With this lens and drawing from qualitative analytic methods, the experiences of the study participants expand on and interact with the previous knowledge and scholarship on the complex themes and identities presented here.

5 | METHODOLOGY

The research question centers the intersection of race, gender, and science, which emerged with a phenomenological inspiration, and we began with a desire to understand how participants make meaning of their life and work at the intersection of these identities and contexts (van Manen, 2007). Phenomenology involves the interpretation of human actions and the product of those actions (Mantzavinos, 2016). The phenomenological tool kit puts forth an individuals' perceptions of their experiences to provide a central meaning and unity to arrive at the essence of the experiences (Moustakas, 1994; van Manen, 2011).

As we continued through the study, we began to systematically process our understanding of participant perceptions through the lens intersectionality. As our analysis became increasingly thematic, we drew more deeply from grounded theory methods with the use of prescriptive coding cycles, analytic memos, and the development of thematic categories (Charmaz, 2014). Developed by Glaser and Strauss (1967), grounded theory posits that theory can be generated and developed through focused and intimate relationship with the data itself (Richards & Morse, 2013). Thus, theory emerges from the data by utilizing various stages or phases of coding to determine connections and linkages (Richards & Morse, 2013).

The study therefore begins with a foundational phenomenological lens but ultimately employs grounded theory and thematic analysis to create another layer of inquiry to incorporate the perceptions of the participants into the theoretical framework of the article. For example, during the interviews, we focused on participant perceptions and constructions of the world in which they lived while setting aside our notions (a phenomenological practice known as bracketing when done throughout the study). However, in the analysis and production of our findings, we shifted to a strong intersectional lens to place their perceptions of the world into a larger contextual understanding of the science environment. While employing intersectionality, we used the findings to generate a theoretical construction of the interaction between the individual Asian American Woman Scientist and the larger science environment in which they were navigating. The formulation of a theoretical understanding to explain a phenomenon is the original notion of grounded theory as developed by Glaser and Strauss (1967).

5.1 | Study participants

We interviewed 23 women from research-intensive universities, identified through snowball sampling. The initial participants were recruited through the lead author's networks, a form of convenience sampling, and snowballed from there. Participants self-identified as women, Asian Americans, and who were at least in their second year of a doctoral program in a STEM field or had received their PhDs within the last 5 years. Of the eight participants who had earned their degrees, four were postdoctoral scholars, two worked in academia, and two worked in technical industries. The majority (80%) attended research-intensive universities on the West Coast, and the rest were scattered across East Coast and Mid-West universities. The colleges and universities they represented reflect both small and large public and private institutions.

Participants spanned research areas in physical and earth sciences, life sciences, engineering, physics and astronomy, and mathematics. Their ethnicities included: Chinese American, Indian American, Korean American, Japanese American, Pilipino[1] American, and Indonesian American. Five students were biracial. Additionally, family

[1]Although both *P*ilipino and *F*ilipino are generally accepted terms, we prefer to use Pilipino to refer to individuals from the Philippines or of Pilipino descent. In the original Tagalog alphabet, there is no equivalent letter for the "F" sounds (Nadal, 2004). Filipino is adopted from Spanish colonizers and formalized in 1987 as the Philippine alphabet was modified to incorporate other letters such as "F" and is therefore an Anglicized version of Pilipino (Nadal, 2004). Viewed in the context of colonization, this Anglicization reflects and perpetuates a colonized mindset (Carnaje, 2015).

TABLE 1 Overview of participants

Pseudonym	Broad field	Stated identity	Generational status	Status at time of interview
Sonia	Engineering	Indian American	2nd generation	5th year
Angela	Physical Sciences & Earth Science	Japanese American	4th generation	6th year
Lisa	Physics & Astronomy	Chinese American	1.5 generation	Postdoc
Jessica	Physics & Astronomy	Pilipino American	1st generation	3rd year
Brittany	Physical Sciences & Earth Science	Chinese American	1.5 generation	5th year
Andrea	Life Sciences	Pilipina	1st generation	Postdoc
Amanda	Physical Sciences & Earth Science	Pilipina	1.5 generation	2nd year
Heather	Physical Sciences & Earth Science	Chinese American	1.5 generation	6th year
Michelle	Life Sciences	Chinese American	2nd generation	2nd year
Vanessa	Engineering	Chinese American	2nd generation	3rd year
Samantha	Physical Sciences & Earth Science	Asian American	2nd generation	4th year
Claire	Physical Sciences & Earth Science	Chinese American	2nd generation	2nd year
Serena	Life Sciences	Korean American	2nd generation	Postdoc
Ann	Engineering	Asian American/Chinese American	2nd generation	Academia
Caroline	Mathematics	Asian American	2nd generation	Industry
Rachel	Engineering	Asian American	2nd generation	Academia
Melanie	Life Sciences	Japanese American	2nd generation	3rd year
Maya	Life Sciences	Asian American	2nd generation	6th year
Jasmine	Physical Sciences & Earth Sciences	Asian American	2nd generation	Postdoc
Sophia	Engineering	Asian American	2nd generation	Industry
Evelyn	Physical Sciences & Earth Science	Asian American	2nd generation	4th year
Sarah	Physical Sciences & Earth Science	More Asian than White	1.5 generation	3rd year
Nori	Physical Sciences & Earth Science	Japanese American	4th generation	3rd year

backgrounds differed, including socioeconomic status, individual immigration stories, and generational status[2] in the U.S. Participants were assigned pseudonyms by the primary researcher, except for two students who chose their pseudonyms. Table 1 provides an overview of participant demographics, including their pseudonyms, broad fields, how they identified, generational status in the United States, and academic/professional status at the time of the interview.

[2]Generational status describes individual positionality and status in the United States. The term first-generation refers to people who were born outside the United States to foreign-born parents. 1.5 generation describes people who were born outside the United States but immigrated before their teens, while second-generation describes those who were born in the United States to at least one immigrant parent. Fourth-generation refers to US born people with US born parents and grandparents.

5.2 | Analysis, trustworthiness, and roles of the researchers

The resulting data were analyzed, grouped, and coded to identify essential themes and to elicit the essence of student perceptions regarding their unique experiences, utilizing both inductive and deductive strategies (Richards & Morse, 2013). Based on the literature and analytic approaches in grounded theory, we identified several predetermined codes to be uncovered in consecutive cycles of coding, summarized in Table 2. We initially identified environmental factors and experiences within the lab group and campus; gendered or racial interactions or incidents with peers, faculty, and the community; and identity formation either as a scientist, female, or Asian American. In the next cycle, we identified student perceptions of how others in the community view them and their reactions to these interactions and incidents, stratification or integration of identities, and how they perceived themselves in their respective fields. In the last cycle, we collapsed smaller codes into larger themes and synthesized our findings. In addition to these presuppositions, we sought emergent themes (i.e., threads) previously unidentified, thereby creating space for emergent narratives and stories to surface. We used multiple cycles to analyze the data in varying contexts, from individual to lab/campus/institutional environments to the broader field of science.

We paid close attention to two layers in our analytic approach: (a) the subject's interpretation of her experiences, and (b) the influence of our perspectives cast with our theoretical framework of intersectionality. This reflective process is accomplished through multiple readings of the transcripts, memos, discussions, and the act of writing itself (Saldaña & Omasta, 2018; van Manen, 2014). These levels involve the full participation of the researchers in actively engaging the text—in this case the subject and her perceptions—to interpret and reinterpret meanings.

We used several strategies to ensure trustworthiness, including member checking the interview transcripts by sending them to participants and asking for feedback, using multiple forms of data, including field notes and memos, and searching for discrepant and negative cases to ensure that there was variation in the responses that reflected the complexity of human experience and did not simply conform to our ideas (P. H. Collins & Bilge, 2016; Maxwell, 2013). Not only did we look for emergent themes, but we also sought to identify threads that went against the dominant narrative themes that were contrary to our presuppositions or predetermined codes. In doing so, the data reflected the full spectrum of student experiences.

The lead author of this paper is an Asian American woman (Castro) and conducted all of the interviews. As a Pilipina immigrant, I work in a research-intensive institution. Having heard many stories, both positive and negative, and having participated in many intense discussions about the racialized and gendered nature of student experiences, I was motivated to learn more about the intersection of race and gender within science

TABLE 2 Coding cycles

Cycle 1	Environmental factors • Lab group and campus • Interactions with peers, faculty, and community • Influence of environment on identity formation
Cycle 2	Perceptions of and reactions to how others perceived them • Gendered and/or racialized experiences • Stratification or integration of identities • Self-perceptions as scientists
Cycle 3	Collapsed smaller codes into larger themes Synthesized findings Incorporated emergent unidentified themes

contexts. I approach my research from a feminist perspective, and this study represents an on-going interest in gender, race, and identity development for Asian American women. My scholarship and profession are in social science and student success, and my daily work is with students from a notable science research institution.

As the second author (Collins), I am a White man who assisted in the design and analysis of the study. Although my disposition in life has been socialized to use White logic, my scholarship around the architecture of the mind and commitment to justice and equity gives me a different lens for analysis. I am a social scientist and believe in the importance of a diverse ecology of knowledge production—meaning that diverse ways of knowing should be included in the realm of not only acceptability but appreciation (C. S. Collins & Mueller, 2016). It is important to note that the primary analysis was conducted by the first author, whose identity and experience are closer to those of the participants in the study.

6 | FINDINGS

The data revealed multiple findings that are closely intertwined; however, for the purpose of this article, we focus on two findings captured by in vivo codes: (1) environmental influences on identity manifested in campus experiences or *White Men Named John* and (2) the nuances of self-perceptions, or *There Really Isn't a Box For It*. Table 3 summarizes the themes, subthemes, and the number of participants who responded within this theme along with a relevant quote. Though the number of participants who expressed the sentiment of the theme does not always reflect the salience, it may be useful to get a broad overview of how many participants fell into the thematic categories.

TABLE 3 Summary of themes and subthemes

Theme	Subtheme	Example from participant data
White Men Named John Who environment is telling participants they need to be	Embedded structures and hidden barriers (23/23)	"*If someone asks you a question, you have to answer it with absolute authority, and if they interrupt you, you have to shut them down.*" Evelyn, physical sciences & earth sciences
	Hostile environments (8/23)	"*A [male lab mate] came into her office once, showed her a plot, and said, 'Hey, doesn't this look like [insert male genitalia]?'*" Lisa, physics & astronomy
	Intersections of science, race, and gender (23/23)	"*I'm treated differently than other people. Not necessarily by my merit as a scientist or engineer but just the fact that I am a woman…. I do get a lot of 'Oh, you're not what I expect of an Asian girl' a lot.*" Michelle, life sciences
There Isn't Really a Box For It Nuances of identities--who they are and who they want to become	Identity variations (23/23)	"*Like who am I?… I guess I feel like there's different parts of my identity,… that creates my identity as a whole.*" Rachel, engineering
	Degree of effect (13/23)	"*We have a certain degree of effect in how things could play out in society, and if I could help diversify that… we'll enlarge… the sciences.*" Amanda, physical sciences & earth science

6.1 | White men named John

> *I don't know if you've seen the study of… White men named John.*
> (Sonia, 5th year engineering student, 2nd generation Indian American)
> *Mostly White guys named John. There are four Johns in our lab.*
> (Vanessa, 3rd year engineering student, 2nd generation Chinese American).

One student referenced an article that described how there were more White men named John heading Fortune 500 companies than there were female CEOs (Wolfers, 2015). Similarly, another participant noted that there were four White men named John in her research group. This theme both literally and figuratively captures the dominantly White and male-normed campus environments described by the participants, systems created and maintained by White men named John. Within this category, participants related experiences of marginalization in their lab groups and, more broadly, on campus manifesting in hidden barriers, hostile environments, and racialized gender harassment.

6.1.1 | Embedded structures and hidden barriers

All of the participants shared many examples of microaggressions to outright harassment, either personally experienced or observed in campus spaces. Samantha, for example, described how a male faculty member introduced his advisees, one male and one female, who were giving back-to-back seminars:

> *For the female student he… noted that she was great at organizing events for the group and baking things… and really contributed to a great culture in the lab… When he introduced the male student, he noted that this student had done great research in his lab, had made a lot of interesting scientific contributions.*

Although the faculty member's introductions were equally complimentary, it was clear to those who attended that these students were characterized differently due to gender conceptualizations (Ecklund et al., 2012; Hill et al., 2010; Saucerman & Vasquez, 2014).

Some women perceived that they had to adopt more aggressive behaviors and assert themselves to be heard. Sonia, a sixth-year engineering student, observed, "You got to say it louder and more insistent… for it to be true." Relatedly, Evelyn, a fourth-year student, recalled advice her male advisor gave her following a presentation:

> *Afterwards, my advisor pulled me aside and he's like, "I believe that you know your stuff but you need to be more confident about it. If someone asks you a question, you have to answer it with absolute authority, and if they interrupt you, you have to shut them down."*

In Evelyn's case, confidence is framed as aggressive behavior, viewed as having complete command and authority.

Melanie, a third-year student, shared a similar experience in which her female advisor cautioned her about her "friendly personality." She recalled that according to her advisor, "Maybe I shouldn't laugh so much, smile so much since… sometimes, women aren't taken that seriously… when they do so." These are just a few examples of the many participants who felt they had to modify behavior to be regarded as legitimate scientists (Malcom & Malcom, 2011).

Although students received messages that they had to be more aggressive to be perceived as knowledgeable to succeed or survive in academia, some students expressed conflict. Two participants cited negative examples of female faculty members who had "hardened" personalities as deterrents. Ann described some successful female

faculty members as "super type A, super vocal" and who were negative role models. She felt that some women turned to alternative careers precisely because they "worried about turning into some of the females that they see as academics, and they're not sure if they want to become like that."

6.1.2 | Hostile environments

Other examples included inappropriate comments and jokes that were sometimes sexual in nature, resulting in chilly environments for female students. For instance, Rachel described an experiment in which her male lab mates dropped metal balls to observe how they rebounded off the surface; during the experiment, the male lab mates made numerous jokes about "balls and dropping balls, a lot, like all the time." The continuous joking was a distraction, and Rachel sometimes worked in the library to avoid the situation.

Some study participants who experienced microaggressions had difficulty labeling harassment as such because microaggressions had become the norm. Evelyn described her lab group as very supportive but went on to relate how people in her group sometimes made "off-color jokes." She did not initially think anyone was offended by such remarks, but toward the end of our conversation, she noted:

> *One thing I did realize just talking to you is how hard it was or how weird it felt to talk about the guys joking around at night. I feel like I was making excuses for their inappropriate jokes and trying to decide for myself if they were really inappropriate… and how I should feel about that, and if I should speak up more if I hear stuff like that. Maybe I'm just so used to it that it's like, "Oh yeah. It's 10 pm and they're making dick jokes or whatever." Saying it aloud made me think about it differently.*

For Evelyn, the process of verbalizing what she originally felt was innocuous behavior and unintentionally inappropriate jokes gave her a different perspective by the end of the interview.

Similarly, Lisa, a postdoc in physics and astronomy at the time of the interview, recalled an incident while she was a graduate student, which involved a female colleague. She explained her colleague's male group members "would leave offensive notes on her desk or make offensive jokes…. A [male lab mate] came into her office once, showed her a plot, and said, 'Hey, doesn't this look like [insert male genitalia]?'" Even with these incidents, Lisa was quick to comment that these colleagues did not have "bad intentions." Lisa's reluctance illustrates the accommodations women made for sexist, racist, misogynistic behavior. Her commentary around intention excludes a systemic approach to impact, which in our view, is harmful to the overall science environment. In other words, existing science structures enable negative environments by normalizing bad behavior; thus, the impact of these jokes and comments, regardless of intent, is a hostile environment for others and only serves to deflect responsibility from the offender (Barthelemy et al., 2016; Parson & Ozaki, 2017).

6.1.3 | Intersections of science, race, and gender

Although students were asked to share how race and gender played a role in their lives, participants most commonly related gender experiences first. They discussed campus workshops aimed at gender harassment, Title IX, and a recent high profile case of sexual harassment involving a female doctoral student and her advisor. Nevertheless, racialized experiences, sometimes combined with gender, were embedded in many participant stories and emerged during the course of the interviews. In fact, participant identities as female and Asian American intersected with that of scientists in various ways.

Michelle is a prime example. As a second-year student in engineering in a predominantly rural university, she felt the effects of the double bind and confronted the forever foreigner stereotype and perceptions of Asian

American women as submissive, passive, and obedient as one of very few female Asian Americans in her department. She commented:

> *I'm treated differently than other people. Not necessarily by my merit as a scientist or engineer but just the fact that I am a woman…. it's a bit of an isolating feeling at times because I am the only… woman who is regularly in the lab…. I do get a lot of "Oh, you're not what I expect of an Asian girl" a lot which is really—well, it's frustrating because that implies a stereotype.*

Later in the interview, Michelle revealed that one of the issues for her was unwanted attention, and other male students saw her as a "potential romantic interest." She was frustrated that her male colleagues did not see her as a fellow scientist or recognize her creativity.

Michelle also related that other students assumed she was an international student and was accused of "trying to be White." She further noted:

> *It was kind of a shock when I came here, because I do identify as American so a lot of the people around me who also identify as American would say stuff about things that I embrace or I just do regularly and be like, "That's so weird. Why are you such a weird person like that?"… But here, I don't fit into what the definition of American is.*

In other words, Michelle was cast as the forever foreigner (Kim, 1999; E. Lee, 2015). She was also not the stereotypical passive, delicate Asian American female, which confounded her male colleagues. She called out racist and sexist comments and behavior, and she was not interested in a romantic relationship. She simply wanted to do science and be treated as an equal. She expressed frustration because she felt limited by the "simplification, the simplification of who I am as a person" in which her identity was reduced to stereotypes (Shrake, 2006). When asked how it felt to constantly battle people's perceptions, she responded, "Frankly, it's shitty because when you have to deal with something like that, it means that… they didn't see my identity as a legitimate identity."

Heather provides another example of the ways in which science, race, and gender identities intersected. She recounted how others in her lab described another Asian American female lab member, who was now a faculty member at a different university. She recalled, "They were like, 'Oh well, she was just raised robot. There was nothing special about her.' It wasn't because she was more competent but she was just like a robot who could crank things out." Thus, this faculty member's talents and accomplishments were depersonalized, furthering the perception of Asian Americans as deviant from the norm, overly-evolved, and therefore subhuman (Shah, 2019).

In addition, Heather discussed her interactions with other Asian American colleagues, who she described as "self-hating Asians" and who did not want to necessarily associate with other Asian Americans. She recalled a conversation with her lab manager, an Asian American male, who refused to date other Asian Americans or Blacks, telling Heather "no poo or pee, like no Black or Asian people." Heather admitted that for a long time, she also identified as a self-hating Asian herself, having internalized negative Asian stereotypes earlier in her life (Urry, 2005). She began to associate being an Asian American female with being incompetent while she was an undergraduate student stating, "I think there was always an element subconsciously early on that I felt like I'm intrinsically incompetent because I'm Asian American and I'm a woman and therefore I don't deserve to be here and I'm always less competent."

In contrast to these negative experiences, nine participants indicated that they had largely positive experiences in their labs even though they reported either directly experiencing or observing microaggressions with lab mates or on a larger scale within the department or university setting. Three of these students began with highly negative experiences with their advisors; two switched advisors and/or departments and one transferred universities.

Positive experiences were largely attributed to supportive lab mates as well as involved and engaged faculty who called out bad behavior, promoted collaboration rather than competition, and actively worked to make the culture within their groups inclusive and diverse. Sonia, for example, reported that several babies had been born to group members while she was a student, stating:

> *There were [several] babies born … to people affiliated with the group, either postdocs, one graduate student woman which is definitely a rarity on campus. So, I think there's a level of understanding that people are more full-bodied people, and I don't think that necessarily happens everywhere.*

Sonia's male advisor clearly developed a supportive climate in which group members felt it was possible to balance family and research. Despite the largely positive experiences she described in her group, Sonia expressed feelings of self-doubt, largely stemming from questioning the validity of her experiences. For example, she shared she had difficulty identifying other people's behaviors as discrimination:

> *I think it's that doubt like we don't know. It's not in places where it's super obvious… I don't have the satisfaction of being able to label something as unequal or anti-woman… it is that, well, maybe this is and maybe this isn't. And so, it's easier to internalize, it's hard to identify and easy to internalize and create self-doubts.*

Like Heather, Sonia articulated the long-term effects of microaggressions and the often unconscious forms of communications that are largely invisible and potentially more insidious, causing those on the receiving end of a microaggression to doubt their realities (Sue, 2010). Consequently, the constant messages and negative feedback become internalized, eroding self-confidence and reinforcing to women that they do not belong in science (Urry, 2005).

In White Men Named John, we detailed participants whose identities as female and Asian American intersected with that of scientists in various ways. They felt the negative effects of stereotypes ascribed to them and the constraints of hostile environments, where they received messages, both implicit and explicit, they did not belong or had to behave a certain way to be viewed as legitimate scientists. In the next section, we explore students' self-perceptions of their identities and how they reimagined science to create space for who they hoped to become.

6.2 | There Isn't Really a Box For It

> *It's always hard because when you fill out those forms, there isn't really a box for it.*
> (Andrea, postdoc in life sciences, 1st generation Pilipina).

The findings reflect the paradoxical situation of Asian American women in STEM and the conundrum that some students faced when asked to define themselves. Their identities did not fit neatly in a box, and the categories imposed on them often failed to reflect the intricacies and contexts of their identities. In this theme, we explore the nuances of their self-perceptions, focusing on who they are and who they want to become (Malone & Barabino, 2008).

6.2.1 | Identity variations

The participants in the study had divergent perceptions of the degree to which aspects of their identity were merged, coherent, and salient. Some students embraced their science identities. For Amanda, science was her passion:

> *I found something that I love, that I like to do, and with that, that's how I can say I'm a scientist. That's what I know. That's what I love… if you add I'm female, I'm Pilipino, I could just see it as like they're all accessories, and then as a whole, I'm a scientist.*

As Amanda's self-perceptions evolved and as she identified herself as a scientist, it developed into her primary self-concept, subsuming all other categories of self.

For others, science identity was a vocation, something they did or attached to an accomplishment and earning that PhD. In the end, the majority of participants identified as a scientist or qualified that they would after they received their PhDs and earned the title. However, a small group, three participants, did not identify as scientists at all. Heather, for example, was hoping to graduate in the next year and still did not feel like she was a scientist, stating, "I know I'm pretty good at thinking scientifically. I'm pretty good at reading papers, but I still don't feel like I'm a scientist." Imposter syndrome is a part of graduate education for many students, but the intersections and layers of race and gender create additional complexities that are present in the women in this study (Clance & Imes, 1978; A. Johnson et al., 2011).

Despite the constraints within the various environments inhabited by the participants, attempts at agency and resistance emerged. These examples of agency become more evident when the struggles between individual and social identities are exposed and made visible. For example, Ann revealed that she minored in English Literature as an undergraduate. Amanda described herself as a rogue student by attending graduate school rather than settling down and having a family. Sonia decided to pursue pure science rather than engineering or medical school and reflected her path was different from her other female relatives:

> *They did not go to school out of the state. They didn't go to school out of the city. They… did the father's house to husband's house move, out of the workplace once they had kids. So, there's such a stark difference between my reality and their reality.*

Sonia did not follow the prescribed path for young Indian American women and realized that having these options was in itself a privilege.

Rachel illustrated another variation of resistance. During the course of the interview, we asked nearly all participants how they identified. Unlike other participants who replied with some variation of gender/race in their stated identities, Rachel mused:

> *Like who am I?… I guess I feel like there's different parts of my identity,… vocation is definitely part of it. But there's also interests in things that I spend time doing that I think go into, like creates my identity as a whole. And it's not completely dominated by my profession or field of work.*

She also commented she did not consider race or gender to be prevailing elements of her identity because those categories were more about how others viewed her than how she perceived herself. Instead, she chose to focus on the totality of her interests and those components she felt were more important, such as her faith and love of music. Thus, although these examples varied in terms of magnitude, they still demonstrate participant attempts to author different identities than the ones ascribed to them (Carlone & Johnson, 2007; Ong, 2005). Their choices reflect the multifaceted dimensions of their identities and the narrow constraints inherent in their environments. These acts of resistance extend to an expressed desire to positively affect the STEM landscape (Tran et al., 2011, p. 38).

6.2.2 | Degree of effect

Many of the women demonstrated resilience in the face of obstacles and displayed a sense of optimism. They refused to allow their negative experiences to deter them from earning their degrees and expressed a strong

desire to translate their experiences into something positive. Amanda, for example, participated in STEM affinity groups and outreach programs and believed that active involvement allowed her to expand representation in STEM and contribute to the field in a meaningful way. She stated, "We have a certain degree of effect in how things could play out in society, and if I could help diversify that,... we'll enlarge... the sciences." For Amanda, science held the potential of bringing together disparate groups where science was a common bond and a unifying identity. She transformed the narrow definition of science to incorporate an active role in cultivating a diverse STEM culture.

Similarly, Lisa joined a Women in Astronomy and Physics group because she saw other female students leaving the field, "We were trying to do our part in creating a community that undergraduate women would feel safe and comfortable hanging out... eventually, we got to a point where we were assigning mentors and mentees." For Lisa, creating a safe environment for women to talk with other female scientists who had experienced similar situations made a positive difference, particularly in counteracting feelings of isolation many women felt due to small numbers in physics and astronomy. In addition to creating a safe space, the mentoring program allowed younger students to see other successful women in the field. Thinking back, Lisa recalled a female postdoc in her lab who embodied possibilities:

> *It's a huge boost to my self-identity, my self-confidence. You know, seeing her be very successful in her second postdoc after having two kids and a husband who also got a PhD so I think even students themselves don't realize the importance of that until you are looking back at it... to kind of show [you] that it's possible.*

Because role models represented opportunities for students to see themselves succeeding in various roles, this postdoc allowed Lisa to imagine her future self, one that included a family.

Other women reflected on the lessons they learned as a result of their experiences and translated those into their own careers. Rachel, for example, was mindful of how she treated her students in her lab, making sure she treated them equally. As a faculty member, she affirmed, "I need to give them equal attention and equal expectations... You have to kind of motivate them in many ways. I'm definitely kind of cognizant of having a healthy atmosphere in my group."

Similarly, Serena immersed herself in outreach programs, actively engaging with underrepresented students to encourage and support them in their STEM pursuits. Serena's ultimate goal was to work in a liberal arts or public university, where she felt teaching remained the primary focus. She attended workshops to improve her teaching skills, and she aspired to be a positive role model and mentor. She felt that diversifying STEM benefitted society as a whole:

> *I also feel from reading that a diverse workforce would be better for society to progress. Like even among engineers, we don't get very diverse ideas if everyone is Caucasian and male. Women bring a lot of ideas to people that maybe men wouldn't think about first because of their context in whatever role they play in their family or society.*

Serena had endured years of feeling unsupported as a graduate student, male lab mates whom she described as perpetually angry, and a lack of attention from her male advisor who gave her no direction or encouragement. She now focused on the future and hoped to reach underrepresented students with the larger goal of improving science and society in general.

For many of the women, there was a strong desire to act, to improve, and expand science, despite past negative experiences. They saw themselves as playing a critical role in changing the STEM landscape and displayed optimism and resilience. There was a sense of clear determination to carve a different path for themselves and not

perpetuate the type of negative behaviors and hostile or toxic environments they had to endure, thereby remaking and reimagining science itself (Carlone & Johnson, 2007; Ong, 2005; Tran et al., 2011).

7 | DISCUSSION

7.1 | Competing social realities

Identity is inherently intersectional and although there may be a visible or dominant identity, the process of *becoming* is more complex when considered at the intersections of other forms of identity. However, signification is more than about individual categories of self, but also contains a social dimension because some identities (e.g., scientist) need to be performed satisfactorily, then externally verified and validated by meaningful others (Carlone & Johnson, 2007). Science itself is socially constructed as a result of a process by which certain acceptable acts and beliefs move from habit to routine to become legitimate as a socially constructed reality (Berger & Luckmann, 1966). Once a social construct is fixed and in place, it bears the weight of reality. When competing definitions of reality arise, only two options exist for dealing with that competition: (1) assimilation or (2) annihilation (Berger & Luckmann, 1966).

Asian American women scientists exist in competing realities at the intersection of identity and validation—namely race and gender because they do not fit the standard definition of a scientist, meaning White and male. In terms of an internalized and externalized reality, the existing social constructs of science culture does not allow space for intersections of race and gender. Consequently, because the full creativity, intellect, and cultural wealth brought by Asian American women are not fully validated in this space, an integrated sense of self, namely Asian American Woman Scientist, categorically represents a competing definition to the existing norm. Accordingly, they must be assimilated into the dominant reality or annihilated, and the findings from this study demonstrate the ways in which the system signals to them their status as outsiders and the binary options from which to choose. The array of other actors in the reality of the science social structure and power relations include lab partners, advising professors, curricula, professional organizations, and centuries of science history laced with degrees of racism and sexism. Thus, as A. Johnson et al. (2011) argue, because participant identities operate within the matrix of oppression, some identities are closed to them.

The following section addresses the effect of science as a dominant reality on participant self-perceptions, the struggle between competing social realities in the face of normalized cultures of harassment, and attempts at assimilation. Finally, we reflect on participant efforts at individual agency and empowerment.

7.2 | Normalized cultures of harassment

For the participants who described hostile environments, instances of microaggressions and harassment were the norm. Every woman in the study either personally experienced or observed—sometimes on a daily basis—bullying, sexual innuendos, and racialized sexual harassment that objectified, devalued, demeaned them, and their Asian American female colleagues specifically or women in general. Male and White dominant environments enabled numerous instances of bullying, harassment, and microaggressions to continue unchecked. All of these actions signaled to the participants that something about their presence was unwanted. As a result, many attempted to escape the environment by physically changing offices or removing themselves from the lab. In extreme situations, some women changed labs due to issues with their advisors, and one woman transferred to a different institution altogether.

The most effective and dominant realities (i.e., science) have a powerful ability to exist, even within the minds of those who occupy competing realities (i.e., race and gender). In other words, the force of science (and the

corresponding identity, "scientist") had a strong grasp over self-concept, especially in their bids to obtain validation within the science environment. Cultures, values, and norms become internalized and shape perceptions of being in the world. Some of the women therefore internalized the racism and sexism they experienced within their environments or normalized problematic behaviors to the point they had difficulty labeling their hostile experiences as harassment (Parson & Ozaki, 2017). Thus, these often obscured, subtle discriminations served as powerful signals to the women that they did not belong (Sue, 2010).

In these instances, one woman described herself as a self-hating Asian, others removed themselves from uncomfortable environments, or attempted to ignore the behavior to focus on their work rather than confronting the offense/offender. One participant noted she did not realize the problematic nature of these so-called unintentional jokes until she heard herself describing them. These hostile environments are essential to the maintenance of the existing reality. Institutions sometimes attempt to ameliorate the issue of harassment by engaging in basic behavior modification through a system of rewards and punishments. However, the deeper systemic issue is that harassment and discrimination maintain a specific ideological disposition by signaling what exists and constitutes reality within or without the dominant reality. Harassment not only needs to end, but the underlying system that promotes harassment also needs to be altered.

7.2.1 | Assimilation

To assimilate, the participants potentially question their own realities, thereby practicing a form of gaslighting, to silence that part of their knowledge and understanding of behavior. For example, Evelyn initially attributed sexually explicit jokes to late nights working in the lab and the casual environment. Another student shared that male lab mates had "no bad intentions" when leaving "off-color" jokes and crude pictures of male genitalia on her female colleague's desk. But intentions are not the issue. From an environmental, reality-constructing perspective, the impact of these actions served to reinforce the dominant, normative power in place.

These examples indicate patterns of harassment and efforts to maintain science spaces as White, male environments. These experiences mirror the thoroughly documented cultures of sexual harassment in a 2018 report from the National Academy of Sciences (NAS). Although the report also includes race as a compounding factor in harassment and identifies the importance of an intersectional lens, it also notes that research in this area is "very limited" (NAS, 2018, p. 45). Based on our study, this limitation may be attributed to the hesitancy of women to recognize the overlapping nature of harassment, stemming from an inability to develop an intersectional self-concept, which may emerge, in part, from the sheer force of the intersectional norm of White and male. For Asian American women and other women of color, the conflicts between social and individual identities are constrained by hegemonic understandings evident in White racial and gender framing, as well as science ideologies. These interrelated power dynamics are evidenced in varying ways within the social contexts inhabited by the participants, affecting confidence levels and creating fragmented and hierarchical sense of selves.

7.2.2 | Externally imposed stereotypes

Many students in this study initially conveyed that, for them, gender was more salient than race in their daily lives even though racial experiences were embedded within their stories. Students felt particularly susceptible to negative views of women heightened by an institutional focus on gender issues. Examples of gender microaggressions and sexual harassment came more readily as students discussed sexual harassment lawsuits, Title IX, and campus programs, workshops, and trainings focused solely on gender. However, racialized experiences emerged during the

interviews, even if participants did not articulate the combined racialized and gendered nature of their interactions. That gender experiences remained at the forefront of the discussion reflected the stratification of identities, female and Asian American.

For some students, Asianness was seen as antithetical to Americanness, and their self-perceptions and carefully crafted identities as Americans were confounded by White racial framing (Chou et al., 2016). Michelle, for example, was constantly mistaken for an international student and was accused of trying to be White. Heather related how an Asian American female colleague's accomplishments were dismissed because colleagues described her as "just raised robot." Heather also internalized the negative perceptions of Asian American women and revealed that she became a "self-hating Asian," doubting her own competence. Her own process of self-signification became dominated and limited by how others perceived her. This is echoed by Michelle's words, "They did not see my identity as a legitimate identity," and she lamented the "simplification" of who she was as a person.

Michelle and Heather reflect the vulnerability to negative stereotyping and the power of the forever foreigner and model minority narrative; one casts Asian Americans as unassimilable and the other portrays them as overly evolved androids (Kim, 1999; Lowe, 1998; Pak et al., 2014; Shah, 2019). In the context of science spaces, where scientist is equated with White males, Asian American women are viewed as outside the bounds of normalcy, both within science and American culture (Lowe, 1998; Pak et al., 2014; Shah, 2019). Viewed as subhuman, Asian Americans "never seem to have just the right amount of the 'right stuff' to qualify as human beings" (Shah, 2019, p. 679). Thus, the process of dehumanization via externally imposed identities and the attribution of negative stereotypes limited identity development, constraining positive sense of selves and successful identity integration.

Moreover, participant narratives illuminate how hegemonic power is expressed in stereotypes and social understandings of the Asian American population (Dill & Zambrana, 2009). The monolithic view of Asian Americans, the visibility of Asian faces in STEM, and the broad diversity within the Asian American category obfuscates the needs and specific circumstances of individual students. This illustrates a deminoritizing effect, where Asian Americans are portrayed as having realized comparable privileges of Whites because they have achieved success through educational mobility (S. J. Lee, 2006; Ng et al., 2007). The deminoritization of Asian Americans effectively delegitimizes the Asian American identity and renders them invisible (Museus, 2008, 2014; Ng et al., 2007; Teranishi, 2010). This systematic erasure, or "White Out" (C. S. Collins & Jun, 2017), is an attempt to "obscure others' experiences in lieu of a competing definition of reality" (p. 2). This metaphorical blotting of Asian American realities creates a void that is then filled with the false narratives that Asian Americans have attained a privileged status and have no need for assistance. Consequently, Asian Americans experiences are reduced to stereotypes, maintaining White dominance, highlighting how the racialization of Asian Americans is ultimately about personhood and who gets to be seen as fully human (Shah, 2019).

7.2.3 | Legitimate scientists

The signal that extends from space claims through sexual harassment/racist statements is an indication to those who do "not belong." Labels like "worker bees" and "dragon ladies" fuel a stereotype of perpetually being a tenacious assistant, but never the intellectual center (Williams et al., 2018). Consider the example of the faculty member who applauded his female student for baking and organizing social events for the group. Additionally, Michelle was frustrated that her male colleagues failed to see her creativity as a fellow scientist and instead saw her as a potential romantic connection. In these examples, women students are often not recognized for their contributions as scientists but instead lauded for contributing to the positive culture of the group or viewed as a romantic interest. These biases confine women's roles in the lab to traditionally feminine responsibilities and therefore more acceptable roles in male-normed environments (Ecklund et al., 2012; Takaki, 1993).

To be viewed as legitimate scientists, women try to assimilate and modify their behavior to fit in (Malcom & Malcom, 2011). Programs and interventions designed to help female students are "often aimed to 'fix the [female]

student' and [do] not seek whole-scale cultural change at the institutional, departmental, and faculty levels" (Malcom & Malcom, 2011, p. 166). Therefore, women learn to behave accordingly and learn to ignore or normalize cultures of harassment (Butler, 2007; Carlone & Johnson, 2007; Ong, 2005). For example, some faculty members advised participants not to smile too much, exude absolute authority, and shut people down when asked questions during research presentations. Students also perceived that they had to be more aggressive and had to assert themselves to have their voices heard. In Sonia's words, "You got to say it louder and [be] more insistent." These norms become internalized, reproduced, and perpetuated, contributing to continued stereotyping and stifling individuality, which in turn, furthers invisibility for Asian American women (Yamada, 1983). At the same time, participants cited "hardened" female scientists as deterrents and negative role models. These messages created conflict—to "fix" their own behavior and become "hardened" or not be seen as serious scientists, thus enhancing feelings of marginalization and pressure to conform.

The strength of intersectionality is the ability to examine identity within the socially constructed frameworks of the environments we inhabit. The environment is a powerful shaper of the desired identity, and participants' own narratives reveal diminished conceptions of their whole selves to participate in an oppressive environment. We are not offering a psychoanalysis of the participants, nor are we critiquing *their* dispositions. Their reflections and intersectional presence in a homogenous environment provide insights into the power structure that facilitates either the annihilation or assimilation of identity, which limits the space for the inclusion of diverse ways of knowing. Knowledge supremacy is maintained through systemically disincentivizing awareness and inclusion of the wealth of knowledge that comes through culture. For these Asian American women, they feel this acute tension, and in some cases abuse, even if they are not articulating the larger constructs of the environments they inhabit. The re-ordering of identity to participate in a restrictive science environment may maintain the current system, but it will not draw from the wealth of human knowledge that comes through diverse epistemologies that are embedded in the intersectional identities embodied by these women.

7.3 | A more inclusive STEM environment

Despite the often hostile environment women experienced, we observed various attempts by participants to reject the influence of their environments and craft their own identities. We viewed this rejection of negative environments as a form of resistance and as an expression of empowerment and agency as they quietly worked within their spheres of influence. In their goals to positively affect the STEM landscape, they redefined science and resignified what it means to be a women of color scientist (Calabrese Barton & Osborne, 2001) by embracing and engaging in social justice work to "transform science into a vehicle for social change" (Tran et al., 2011, p. 38). Participants refused to be constrained by identities ascribed to them and actively participated in outreach efforts, hoping to inspire the next generation of scientists. Those participants who were already faculty members worked to ensure positive environments in their groups. They saw themselves as playing a critical role in positively affecting STEM, and they embraced reimagined science identities as positive role models, mentors, and change agents. These incremental changes, a refusal to replicate and reproduce bad behavior and instead create positive environments, offered glimmers of hope for a more inclusive STEM culture.

However, cultivating an inclusive environment, which includes Asian American female scientists, is more than about individual efforts or critical mass. Rather, we emphasize that science as a system needs to change. The socially constructed nature of science, the culture, values embedded in science, and the epistemic and philosophic underpinnings of science exposes the Western, male, White systems on which it was founded and serves to exclude and devalue people of color broadly and Asian American female knowledge specifically. This represents an epistemic exclusion that further silences an already invisible group (Harding, 1993). Without a profound change in the science environment, people at intersections away from the powerful norm will continue to be pushed into assimilation or annihilation. The participants had a sense they wanted to exist for a

positive future, even if they could not name all of the systemic forces working against them. Physical environments like labs and classrooms do not just need sexual harassment and racial bias training—it has to be something deeper. Curricula do not merely need compositional diversity in authorship. It is not about becoming friendlier to women or "less racist." In order for the dominant reality to stop oppressing those at the margins, there must be a profound recognition and valuing of the creativity, genius, and cultural wealth brought by the intersections of people who have been minoritized. This is profoundly different from tolerance—it is epistemological inclusion, openness, and humility. The women in this study are present in the labs and classrooms of their graduate schools; yet, if they cannot bring the full storehouse of their knowledge to the table, then internal annihilation is still taking place in preference for uniformity and assimilation. It is not just these women of color who are excluded, but the ecological health of science and the potential beneficiaries throughout humanity will continue to be impoverished because of knowledge oppression in the science environment.

How then must science change to become a more inclusive environment to not only recognize but also value epistemic inclusion in the form of diverse identities and perspectives? Next, we discuss the implications for this study, recommendations for practice and policy, and areas for future research.

8 | IMPLICATIONS

To imagine new alternatives, science must practice self-reflexivity and resist its own tendencies for self-preservation. Prescod-Weinstein (2017) observed, "There is a strange contradiction among scientists: Science is supposedly about asking questions, except about scientists and how science is done" (para. 1). Indeed, reflexivity within science unsettles because it reveals the dissonance between the exalted view of science and the reality exposed by participants of this study. Interrogating science leads to an understanding of the co-constitutive nature of science and its sociopolitical forces. In addition, we need to accept that science is flawed and embedded with cultural assumptions and recognize that science does not operate on merit but rather privileges one group over another (Chen & Buell, 2018; A. C. Johnson, 2007). If we seek to foster social change, however, we also need to promote tangible actions.

8.1 | Recommendations for practice and policy

8.1.1 | Remake science spaces

As we have argued, reimagining and remaking science begins with critical self-reflexivity and with reimagining higher education itself. Rather than assimilating students to campus culture, the focus needs to shift toward institutions to engage in systemic change (Malcom & Malcom-Piqueux, 2020).

To resignify science spaces, we take our cues from some of the study participants who described positive experiences. Humanizing science spaces foster collaboration, support outside interests, and cultivate a sense of team where group members encourage and help each other. Inclusive environments also recognize individuals as "full-bodied" intersectional people, to use Sonia's words, acknowledged as multidimensional, and where group members are known for their creativities, strengths, and distinct contributions to the group. Such environments are important for all group members to thrive, but also creates space for graduate students who may have family considerations and outside interests or recognize the importance of quality of life in addition to academic or research accomplishments.

One argument for diversity is that research topics and agendas benefit from the inclusion of different perspectives. Valuing and incorporating not only varying viewpoints—including those of Asian American women—but also diverse epistemologies expands the questions researchers ask and the approaches they employ to answer

questions. This potentially leads to new frameworks, thereby changing science itself and also contributes to broadening cultural views of who scientists are and how they look. In other words, when diverse points of view are respectfully included, science no longer becomes the exclusive realm of White males.

This includes recognizing that Asian Americans are not a monolithic group. Asian Americans have vastly different immigration histories, cultures, and colonial legacies (Leonardo & Matias, 2013; Teranishi & Nguyen, 2012). The Asian American population consists of 48 ethnic groups, 100 language groups, and numerous religious groups (CARE, 2008). Asian Americans reflect the full range of the educational and socioeconomic spectrum, with striking differences when viewed individually. For example, specific subgroups are underrepresented in educational settings, such as Southeast Asians (Teranishi & Nguyen, 2012); however, because they are subsumed into the larger category of Asian Americans, students who fall into these groups are often not considered for financial aid or support programs that specifically target underrepresented or underprivileged students (Pak et al., 2014). Thus, Asian Americans encompass individual complexities, which needs to be recognized without reducing students to stereotypes.

8.1.2 | Focus on culture and environment

Creating inclusive environments also entails actively resisting stereotypes and biases (Shah, 2019). When harassment becomes embedded in culture, student success is jeopardized, not only to the detriment of the individual harassed, but also to society, which stands to benefit from student contributions. It is unacceptable that so many participants experienced microaggressions and outright harassment. It is even more unconscionable that many of them felt they had to ignore bad behavior to be successful scientists.

It is therefore vitally important to identify and recruit faculty and staff allies to set an example and actively create an environment in which the next generation of scientists can succeed. Continuing efforts must engage campus leadership and members from every academic department, including faculty, research assistants, postdocs, department administrators, and other support staff. In addition to identifying and eliminating microaggressions and harassment, campus dialogues need to address how environments contribute to normalized behavior with an emphasis on the critical roles they play in either consciously or unconsciously perpetuating negative behavior and how they can become stronger allies for their students. However, training alone is not sufficient; creating a positive environment requires a sustained and intentional effort throughout the entire institution, reflected by institutional documented commitment, supported by meaningful process, action, and resources.

8.1.3 | Create opportunities for intersectional meaning-making

Participants routinely attended gender-focused programs—including workshops, trainings, and talks—that highlighted gender experiences. Although these programs are important and necessary, these efforts are often not complemented by similar programs that emphasize racial identities, particularly for Asian American students. Programs that allow students to explore intersections of their identities and what it means to be an Asian American female doctoral student in STEM should be included in programmatic offerings. Science identity and the double bind, however, should not be limited to race and gender. Other areas of potential identities include faith and spiritual identity, sexual orientation, or specific cultural heritage.

8.2 | Areas for future research

Because Asian American and doctoral students continue to be understudied populations, there are many possible avenues for future research, including categories of difference and identity development. The all-encompassing

Asian American and Pacific Islander label simply does not do justice to the complexities that exist within this population, and the distinctions between and among groups are difficult to capture when viewing Asian Americans as an aggregate group. We recognize that this study is merely a snapshot of a very specific population and cannot account for the incredible diversity of experiences and identities within the larger Asian American community, which represents a limitation of this study. Future studies should explore the nuances inherent within and between the Asian American population, such as specific subgroups, generational positionalities, faith orientations, and sexual orientation, among the array of intersectional possibilities.

In addition, science identity development and the nuances of how students choose to identify with relation to science emerged as a significant finding. The variations, motivations, and processes by which participants developed their science identities, particularly given family influences and cultural expectations and stereotypes, was beyond the scope of this study but certainly merit additional focused research.

9 | FINAL THOUGHTS

How does the intersection of science, race, and gender shape the student experience for Asian American female doctoral students in STEM fields? Conceptualizing science as a social force that is founded on and as an expression of Western, Eurocentric values and as an extension of power allows for a critical examination of the very nature of science, its assumptions, and how knowledge gets defined and legitimated. A component of the historical and philosophical legacy of science is the belief in the primacy of European institutions, practices, and conceptual schemes to the exclusion of others (Harding, 1998). If science as a field reflects the institutionalization of dominant power structures, then Asian American women scientists, as reflected by the women in this study, manifest and personify these systems and power structures through the hierarchy in their identities, where some identities become privileged above others. This culture and environment not only diminishes the complexities and nuances of individual identities but also stifles epistemic inclusion. Thus, simultaneously unraveling and deconstructing the various threads of race, gender, and science allows a deeper, more nuanced exploration of science as it is currently defined and understood to reconceptualize science and weave these threads into new patterns, thereby redefining, revolutionizing, and transforming science at its core.

Power structures, ideologies, assumptions, and practices all represent paradigms. According to Kuhn (2012), the appearance of an anomaly stimulates a crisis, which challenges prevailing assumptions and results in adjustments of conceptual categories. A paradigm shift occurs when stereotypes are loosened and incremental data provided to catalyze a fundamental change that leads to the establishment of a new paradigm. This constitutes a revolution. Rather than requiring aspiring scientists to conform and assimilate into a flawed system, it is science that needs to change. The veneer of objectivity and meritocracy needs to be exposed. The White male logic systems that are guardians of the veneer need to be reconfigured. The epistemological window to intersectional and diverse understandings of the way the world works needs to be open and inclusive. Transforming science requires a revolution, a cognitive change in the ways we view science and scientists, to not only recognize, but also to value epistemic inclusion through diverse perspectives and identities.

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