



Understanding Engineering Identity Experiences for Asian American Women in Higher Education

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ABSTRACT

Background: Research has demonstrated the importance of engineering identity as a precursor to persistence within engineering education. Asian American women (AAW) college students possess unique engineering identity experiences during college, yet little research to date has focused on their educational journeys.

Purpose/Hypothesis: This qualitative, phenomenological research study explored how Asian American women college students developed and maintained engineering identities.

Design/Method: The study uses a phenomenological approach to explore the lived experiences of seven Asian American women college students. Interviews sought to derive the essences of how Asian American women (AAW) college students understood their engineering identities, including how they became interested in engineering, gained (or did not gain) recognition as an engineering person from others, and performed their engineering identities. Students participated in two to four interviews, depending on their time within the larger longitudinal project, funded by the National Science Foundation (NSF).

Results: The study found that intersectionality was a key element for the engineering identity experiences of AAW. In addition, the ability to bring one's whole self to engineering was influential in feeling more like an engineer. Finally, this study also demonstrated a range of identity experiences across the AAW subgroup.

Conclusions: The findings demonstrate the need for AAW students to be able to bring their whole selves to engineering settings and highlight the importance of intersectionality for engineering identity experiences.

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With the increased national emphasis on diversifying and broadening participation in Science, Technology, Engineering, and Math (STEM), it is important to build a robust, diverse engineering workforce. To do so, there is a direct need to develop a diverse engineering pool, mainly focused on marginalized students like women and racially excluded students (Hurtado et al. 2010; Johnson 2012; Rodriguez et al. 2019a, b; Williams et al. 2019). In the 2020 US Census, 20.6 million people identified as Asian, Native Hawaiian, or Pacific Islander (Monte & Shin 2022). Asian Americans are defined as individuals who have origins from the continent of Asia including but not exclusive to regions such as the Far East, Southeast Asia, or the Indian subcontinent (US Census Bureau 2022). Native Hawaiians or Pacific Islanders are defined as individuals having origins from Hawaii, Guam, Samoa, or other Pacific Islanders (US Census Bureau 2022).

Approximately 59% of US Asian Americans between the ages of 18 and 24 enroll in college. College enrollment rates among Asian American students are significantly higher compared to other racial groups (e.g., 41% across all college-age groups) (National Center for Education Statistics 2018). As Asians value education, the higher the education degree, the more significant the accomplishment is perceived in the Asian American Community. In 2018, Asian Americans comprised roughly 7.6% of all US college students (National Center for Education Statistics 2018). Although Asian Americans are a rapidly growing racial group in both the nation and higher education, few studies on issues relating to Asian American college students exist (Museus 2013; Suyemoto et al. 2009). In science, technology, engineering, and mathematics (STEM) fields, Asian American Women (AAW) are both overrepresented by race and underrepresented as women (Castro & Collins 2021; Ong et al. 2011; Wu & Jing 2011). Asian American students in engineering often encounter racial bias that assumes Asians are smart, devoted to education, and naturally highly gifted in the engineering field under the impact of the Model Minority Myth (MMM) (Le & Gardner 2010; McGee et al. 2017; Poon et al. 2016; Trytten et al. 2012). However, the MMM and racial bias toward the Asian American population often minimizes the hidden realities of Asian American students who experience academic difficulties, pressure to succeed, and racial trauma (Inman 2006; Sakamoto et al. 2012; Sue et al. 2007). These historically embedded negative stereotypes of Asian people are rooted in Westernized ideology and relevant in the institution's biases, which negatively impact AAW identity and identity development (Iftikar & Museus 2018; Liu 2009; Moses et al. 2019; Teranishi et al. 2009).

To start unpacking the experiences of AAW in engineering, engineering identity can be one way to explore their experiences. Engineering identity refers to how engineering students come to understand themselves as engineers and negotiate their role within the engineering community (Tonso 2006). Students who do not see themselves as engineers are at higher risk of switching majors or dropping out of college altogether (Geisinger & Raman 2013; Meyer & Marx 2014; Pierrakos et al. 2009). Within these conceptual factors, the unique experiences of AAW are likely to include a variety of marginalizing experiences on campus (Museus 2013). These experiences may include assumptions about their intelligence or origins, invisibility or denial of interethnic differences, or othering due to cultural values (Sue et al. 2007). AAW students may experience the MMM, which depicts Asian American students as “geniuses or wizards in math/science” whose traits of hard work, determination, high educational attainment, and upward mobility have helped them overcome challenges of discrimination, immigration, and linguistic barriers (McGee et al. 2017; Poon et al. 2009; Trytten et al. 2012; Wong & Halgin 2006). AAW may also be gender stereotyped as submissive, feminine, and permissive of objectification (Shrake 2006), which may contrast sharply with the dominant, masculine, white engineering environment.

In addition, considering pervasive gender inequality in engineering among the Asian population, AAW is a double minoritized group with both their gender and race (Castro & Collins 2021). According to ASEE's 2021 By the Numbers report, 3.76% of bachelor's degrees in engineering were awarded to AAW (ASEE 2021). Due to the unique cultural norms and expectations toward AAW (e.g., being feminine, being supportive, and helping others with their resources), AAW are expected to pursue more women-dominant majors and careers such as becoming a teacher, social worker,

or taking on administrative positions. Families may not encourage their AAW students to pursue engineering programs (Koo & Nyunt 2022) and make this population further marginalized. It is important to employ an intersectional lens to understand the engineering identity experiences of AAW more fully, interlocking forms of oppression that may influence their experiences, and the Asian cultural impact on this group (Lewis & Grzanka 2016; Moradi & Grzanka 2017).

This qualitative, phenomenological study used the lenses of engineering identity (Godwin et al. 2013) and intersectionality (Crenshaw 1991) to explore the lived experiences of AAW college students' engineering identity development. Two research questions framed the study:

1. How do AAW undergraduate students develop and maintain their engineering identities?
2. How does intersectionality influence the meaning-making process of engineering identity for AAW undergraduate students?

With these two frameworks, we explored how AAW students made meaning between their personal identities as engineers, as Asian Americans, and as women (Iftikar & Museus 2018; Moses et al. 2019).

LITERATURE REVIEW

While only a limited number of studies on Asian American college students have been documented, research on Asian American students on campus has been approached from different perspectives and topics, varying from student retention to academic success, social experiences, racial identity, race and racism, and their mental health (Tummala-Narra et al. 2021). In each of these areas, Asian American (AA) students in higher education have unique experiences, development, and challenges that must be addressed and understood in order to better support the growing AA student population on college campuses.

ASIAN AMERICANS STUDENTS AND THE MODEL MINORITY MYTH

In the 1960s, the media represented Asian Americans as the “model minority” and shaped public opinion (Lee 2015; Nakayama 1988; Pettersen 1966; Zhou & Lee 2017). The “model minority” is described as “well-behaved, diligent, high achievers who persevere and are educationally successful despite socioeconomic and linguistic obstacles” (Hune et al. 1996, p. 39). These stereotypes placed upon Asian Americans have been pervasive in the higher education context, attributing to the racist notions of isolating and creating a monolithic experience for Asian Americans (Moses et al. 2019). Creating this monolithic stereotype limits the various culture, experiences, and existence of Asian American communities especially when contrasting the experiences of white Americans (Liu 2009; Moses et al. 2019). As white Americans continue to have power nationally, in education, policy and as gatekeepers in positions of power, there are additional rules that the dominant group adapts to keep their position (Moses et al. 2019).

With the stereotype of the MMM, the impacts of invisible pressure to be academically successful is prevalent among AA students. This pressure may affect AAW's academic performance, general satisfaction, and well-being within their own college experiences that would negatively impact AAW's overall experiences and their identity. Osajima (2003) has asserted that the narrative of the model minority stereotype is a tool to exploit Asian Americans for the benefit of the elite in the US racial hierarchy. Studies have shown various ways that the proliferation of the MMM creates problems and issues experienced by AAW college students (McGee et al. 2017; Museus & Kiang 2009; Trytten et al. 2012; Wong & Halgin 2006). The MMM stereotype includes descriptions of Asian Americans as hardworking people who are academically and socially accomplished. Thus leaves the perception of not needing much support in comparison to other racially minoritized groups on campus and underestimating the needs of Asian Americans (Museus & Park 2015). Because of common stereotypes associated with this population that Asian Americans show higher academic achievement because they possess the knowledge and skills to succeed at all levels of education (Kim & Yeh 2002), faculty members often have the MMM ingrained in their views of Asian American

students and do not recognize that this population contends with issues similar to those that other minority groups face (CARE 2008).

Furthermore, Asian Americans may experience extra pressure and anxiety to meet the expectations of this stereotype from their society, family, teachers, and peers (Rodriguez et al. 2017). With this aforementioned background, faculty and staff may assume that Asian Americans do not need help or that they can endure under any conditions, and Asian American college students may strive for success, have difficulties to ask for help when needed, and minimize or ignore their needs (CARE 2008). Another perspective to consider in studies of Asian American students is within group heterogeneity. The Asian racial group itself is diverse in terms of culture, heritage, language, and background. Researchers have paid attention to explore within group diversity in Asian American groups (Ing & Victorino 2016; Mac et al. 2021; Saelua et al. 2020). These studies show how group differences exist and how heterogeneity is important to consider in the Asian American community.

Few studies have investigated experiences of AAW in higher education. Most studies of Asian American college students explore Asian American students as one group, not focusing on specific genders within the group. Of the limited studies on AAW in higher education, topics have included AAW students' struggles with eating disorders, body image, family relationships, and psychological distress (Lau et al. 2006; Park et al. 2009; Phan & Tylka 2006). While public perceptions view AAW college students as academically thriving, professionally successful, and needing less support compared to other marginalized groups, AAW college students demonstrate more vulnerability regarding mental health and psychological well-being (Museus & Maramba 2011). Thus, it is imperative to provide timely and culturally responsive support to AAW in higher education and to further explore their unique experiences and development during their college lives. Due to perceptions and misunderstandings of AA students in higher education research, AAW college students are rendered invisible in higher education research (Moses et al. 2019; Museus & Maramba 2011). Therefore, it is crucial to investigate AAW students in higher education and their experiences on campus.

ASIAN AMERICAN WOMEN IN STEM EXPERIENCES

AAW contribute a fundamental role in diversifying the workforce. AAW earn around 25% of the degrees awarded to Asian Americans in engineering (US Department of Education 2018). Various negative stereotypes center on the complex experiences of AAW in engineering. As women of color who are simultaneously subjected to cultural, racial, and gender stereotypes (Carlone & Johnson 2007; Inman 2006; Marra et al. 2009), AAW have unique challenges, which may complicate their ability to feel a sense of engineering identity. AAW in engineering majors face these stereotypes and obstacles rooted in a predominately white, male field (Hune 2011).

With the current literature on AAW in engineering, we see how it is important to admit, retain, and support AAW in engineering. Through combating and persisting through the "model minority stereotype," there are various obstacles that AAW endure in engineering (McGee et al. 2017; Trytten et al. 2012; Wu & Jing 2011). Being in a predominantly white male field, AAW struggle to find a sense of belonging through their engineering identity (Castro & Collins 2021). This contributes to the added pressure to combat the stereotypes that are instilled in their existence in engineering and in the future workforce (Dasgupta & Stout 2014; Hart 2016; Kim & Zhao 2014; Tao 2015; Trytten et al. 2012; Van Veelen 2019; Varma 2010; Wu & Jing 2011).

In research on women of color in STEM, Williams et al. (2014) reported that AAW felt more pressure to provide certain evidence of ability than their male counterparts to be respected as equally competent compared to other racial groups. Furthermore, AAW in STEM's experiences and perceptions were impacted by different layers of biases that women are less competent in job performance compared to men and Asian women are naturally excellent in science and career. In Patel's (2008) study, AAW experienced racialized harassment and were more likely to experience psychological distress and experience more negative self-concept and challenges to identity. As aforementioned, many AAW show more negative identity development compared to male peers and non-Asian peers, and culture, race, and gender all play important roles in AAW's identity

development. Thus, it is important to further understand how engineering identity is viewed through this racialization and marginalization of individuals in engineering.

THE IMPORTANCE OF ENGINEERING IDENTITY FOR ASIAN AMERICAN WOMEN

Prior research has established the importance of engineering identity to an enhanced educational experience and persistence within the field (Godwin et al. 2013). While developing an engineering identity often starts at a young age, engineering identity can be developed and maintained throughout the college experience. Students form engineering identities through a series of in- and out-of-class experiences, including interactions with faculty, staff, and peers as well as with families and communities (Rodriguez et al. 2019a). These interactions can move students to or away from a sense of engineering identity and the ability to see themselves in the role of a professional engineer.

As women of color, AAW may face challenges in building and maintaining an engineering identity due to racialized and gendered experiences, particularly within the college setting (Carlone & Johnson 2007). In particular, women of color often experience difficulty feeling a sense of belonging within the engineering environment and may choose not to major in engineering or switch majors before degree completion. Women of color may also feel a greater sense of stigma consciousness and lower levels of engagement than white women (Casad et al. 2019). Studies have shown how Asian American girls strongly identify with STEM-related careers compared to other women (Kang et al. 2019). However, AAW rates themselves significantly lower on critical thinking, research, communication, and professional skills compared to other women (Ro & Kim 2019) and retained at the lowest rate in engineering careers (Tao & McNeely 2019). In the engineering workplace, Asian American women felt their ideas were not given as much respect and had to repeatedly prove themselves to gain the same level of respect as their colleagues (Li et al. 2017).

Although much research has been conducted on women in engineering and a growing number of studies now focus on women of color in engineering (Rodriguez et al. 2019a), few studies have focused on the engineering identity experiences of AAW. While researchers may find similarities among the experiences of women of color in engineering, due to the history and socio-cultural contexts in which AAW exists, key engineering identity differences exist between those experiences. Based on what we know about the experiences of Asian American students within higher education more generally and within engineering more specifically, this study sought to not only fill this gap in the literature but also provide nuance to the engineering experiences of AAW. The experiences of AAW in higher education provide the perspective of intersectional beings through a non-monolithic lens of their experiences.

THEORETICAL FRAMEWORK

The study utilized engineering identity theory (Godwin et al. 2013) as well as elements from intersectionality (Crenshaw 1991). Engineering identity theory enabled us to investigate how students made sense of their engineering experiences. Engineering identity, a type of role identity, refers to characteristics students have as engineering students, including interest, performance/competence, and recognition.

Interest refers to students' preferences or affinity toward a subject which, in turn, influences their understanding and motivation to engage in an engineering role (Dunst & Raab 2012; Geisinger & Raman 2013; Lent et al. 1994; Vygotsky et al. 2012). Within this study, performance/competence refers to the students' ability to understand and carry out the tasks associated with being an engineer. One's ability to perform in this role influences one's self-efficacy, beliefs, and persistence (Marra et al. 2009; Mau 2003). Recognition refers to the students' ability to see themselves as a future engineer. Particularly in the college setting, recognition from engineering faculty and peers is essential to gaining a sense of recognition within the identity development process (Mannon & Schreuders 2007). Within this theory, a student's engineering identity is also closely tied with both their personal (i.e., characteristics at an individual level) and social identities (i.e.,

characteristics as a group member). In order to more thoroughly address these ties, we also employed intersectionality as a theoretical lens.

Intersectionality refers to how multiple identities (i.e., race/ethnicity, gender, class) may result in patterns of systemic inequities both at the individual and group levels (Crenshaw 1991). This concept grew out of Critical Race Theory (CRT) and similarly examines how power and oppression are ingrained in systems (Museus & Griffin 2011). Intersectionality focuses on how individuals live and convey their numerous identities in the way they interact and live daily as well as how those individuals are situated within larger systems of oppression (Crenshaw 1991; Museus & Griffin 2011). An intersectional lens enabled us to understand both the racialized college experiences of AAW in engineering and how multiple oppressions (e.g., gender, class) may have influenced these experiences.

Through the use of these two frameworks, our analysis addressed gender identity, racial and ethnic identity, and AAW's engineering identity. It is crucial to understand how each of these aspects influenced the lived experiences that AAW had as they navigated a white and Asian, male-dominated area that inhibits a culture of white supremacy and stereotypes in their higher education experiences. Furthermore, the use of an intersectionality framework enabled the work to move from understanding individual lived experiences of AAW to understanding larger systems of oppression (e.g., racism, sexism) that create unique experiences for these women within historically exclusionary engineering spaces.

METHODS

This study utilized a qualitative, phenomenological research approach to understand how AAW college students developed and maintained their engineering identity. The study is part of a larger, ongoing longitudinal National Science Foundation (NSF) project focused on broadening participation by providing financial assistance and programming for engineering students with financial need as defined by the US Department of Education rules for need-based federal financial aid Free Application for Federal Student Aid (FAFSA) (National Science Foundation 2021). A phenomenological approach enabled us to explore lived experiences of meanings that AAW undergraduate students attached to their experiences and to derive the essences of their engineering identity development (Moustakas 1994). By utilizing phenomenology, this research aims to provide a holistic understanding of the realities and lived experiences of AAW in engineering and an appropriate way to understand the multifaceted nature of identity formation.

RECRUITMENT AND DATA COLLECTION

This study was approved by the institutional review board (IRB) at the research site (ISU IRB 16-161-00). Participants were recruited from an NSF-funded engineering program at a large, public, predominantly white, R1 institution in the Midwest using snowball sampling. Students included seven AAW undergraduate students (more information in Table 1). This table includes self-identified demographic information like the students' self-chosen pseudonyms, majors, future degree aspirations, number of interviews, age, race, ethnicity, and, as the Asian American population in the United States is still a relatively newer generation of immigrants, we include the student's immigrant generation. First generation refers to someone who is born outside of the United States. The 1.5 generation refers to someone who was born outside of the United States but immigrated to the United States as a child (Sakamoto et al. 2022). Second generation refers to someone with two foreign-born parents but was born in the United States. The 2.5 generation refers to someone who was born in the United States and has one foreign-born parent and one native born parent. Third and plus generations refer to someone who was born in the United States and both of their parents were born in the United States (Ong et al. 2016). The student population included two electrical engineers, three computer engineers, and two software engineers.

SELF-CHOSEN PSEUDONYM	FAMILY ORIGINS	ENG MAJOR	AGE	1 ST GEN COLLEGE STUDENT	ASPIRATIONS	IMMIGRATION GENERATION	NUMBER OF INTERVIEWS
Anita	Asian American (Filipina)	Electrical	29	No	Doctorate	1.5	3
Candy	Asian American (Chinese)	Electrical	18	No	Master's	First	3
Celia	Asian American (Chinese, Adopted)	Software	18	No	Doctorate	First	5
Cupcake	Asian American (Chinese & Taiwanese)	Computer	19	No	Master's	First	4
Hannah	Asian American & White (Indian)	Software	20	No	Master's	2.5	2
Samantha	Asian American (Indian)	Computer	18	No	Master's	Unknown	4
Theresa	Asian American (Laotian)	Computer	18	No	Bachelor's	Unknown	3

Table 1 Student Profile – Asian American Women in Engineering.

Primary methods for data collection were pre-interview student questionnaires and phenomenological semi-structured interviews. The pre-interview questionnaire was administered to gather basic demographic and background information about their engineering educational experiences. The questionnaire aided in understanding participant experiences and contextualizing findings. This study used Seidman's (2006) model for conducting phenomenological, individual in-depth semi-structured interviews. Interviews were chosen to further understand the complexities of students' experiences (Seidman 2006). Interviews sought to derive the essence of how AAW students understood their engineering identities, including how they became interested in engineering, gained (or did not gain) recognition as an engineering person from others, and performed their engineering identity. Interviews were conducted face-to-face, lasted approximately one hour, and were digitally recorded and transcribed for analysis. Students participated in two to four interviews, depending on their time within the larger longitudinal, NSF-funded project. Three of the five authors contributed to conducting the interviews as well as the analysis.

DATA ANALYSIS AND TRUSTWORTHINESS

The data were analyzed in a multi-step process that first included a read of the transcripts to determine the overall essence of each person's experiences as well as those across the group. First, as part of the larger project, all interviews were analyzed using a codebook made up of a priori concept codes derived both from the literature as well as the engineering identity and intersectionality theoretical frameworks as well as emergent codes that surfaced within the coding process. To establish the overall codebook, we took concepts from our literature and theoretical framework and created a priori codes of concepts that we knew we wanted to include in our analysis. Sample a priori codes included: identity recognition, racial/ethnic identity, gender). After establishing these concept-based a priori codes, we went through a group process of further refining the codebook by coding a small sample of transcripts to add emergent codes and refine our coding process and interpretations. Using the established codebook, we coded all of the transcripts of the larger project, taking care to add codes as needed. To do so, the research team analyzed the data for existing literature- and theory-based concepts pertaining to the racialized and gendered experiences (e.g., MMM, gendered stereotypes) of AAW.

The research team took several steps to ensure trustworthiness, including a rigorous memoing and triangulation process throughout data collection and analysis as well as an exploration of

positionalities. Memos were created after each interview and included information regarding the most significant essences of the participants' experiences as well as explored possible explanations and areas for future exploration (Saldaña 2013). The study triangulated findings from multiple forms of data (e.g., interviews, memoing) to understand the engineering identity experiences of students. The team then discussed these memos and interview transcripts to come to a shared understanding of each individual AAW's experience. Finally, to build trustworthiness, the researchers also explored their positionalities to identify potential connections and biases (see below).

PROTECTION OF VULNERABLE POPULATIONS

To warrant the trustworthiness and protection of vulnerable populations, the privacy and confidentiality of the participants were protected by several measures. First, all participants were allowed to choose pseudonyms by which they were referred to throughout the study. Second, the authors were purposeful in building long-term connections with participants across several years to build trust, encourage openness, and express gratitude to participants. Lastly, the authors removed individually identifiable information or aspects from participant responses and modified details to protect the identities of the students.

AUTHORS' POSITIONALITIES

Although this project began as a much larger work focused on the engineering identity experiences of Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) students, over time we recognized the value of focusing on our AAW students and allowing their voices and experiences to be heard. Together, we approach this work with an equity lens and understanding of structural challenges present within higher education. Maria L. Espino is a Latina postdoctoral scholar whose research focuses on student educational experiences and the intersections of race, class, gender, and sexuality. Michelle C. Ausman is a biracial Asian and white woman graduate student whose research focuses on Asian American and mixed-race engineering students. Brian D. Le is an Asian man who has served as a practitioner working with families and students transitioning to STEM majors at a four-year university and is currently a graduate student in the field of education. Sarah L. Rodriguez is a Latina woman faculty member whose expertise focuses on higher education equity, including issues of intersectionality and engineering education. Katie Koo is an Asian woman faculty member in the field of higher education whose expertise focuses on the well-being and mental health of marginalized students, with a focus on Asian students. Because we represent a mix of gender, cultural, and racial backgrounds, we are able to interrogate our data in different ways and from a variety of standpoints. In particular, the expertise of our second, third, and fifth authors allowed us insights into the Asian American experience and enabled us to connect and situate our work within the broader cultural and educational conversations surrounding the experiences of Asian American women.

FINDINGS

This study sought to understand the essence of how AAW college students developed and maintained their engineering identities. From our interviews, there were three major aspects of being AAW in engineering that were articulated. First, patterns of intersectional systemic inequalities determined how AAW developed their engineering identity. Second, AAW who felt they could bring their whole selves to engineering, felt a strong connection with their engineering identity. Third, despite only having seven AAW interviews, students captured a wide range of various Asian American identities, showcasing how Asian Americans are not a monolithic group.

INTERSECTIONAL INEQUITIES SLOWING ENGINEERING IDENTITY DEVELOPMENT

AAW expressed how racism and sexism influenced their engineering identity and ability to embrace their role within engineering fully. They found it difficult to gain recognition of their

engineering identity from men in their programs despite their performance in classes and in work settings. AAW acknowledged the existence of intersectionality in their experiences. Participants highlighted the simultaneous forms of sexism and racism that existed for AAW (Castro & Collins 2021). Classmates often took notice of AAW in their courses, but not recognizing them as fellow engineers, but just as women or “girls.” Cupcake stated,

I think ... Well, especially in [engineering], there’s not a lot of female students. At first, I think that I don’t know how to talk to others [white men peers], like I am so different, that I’m a Asian girl, and majority are white male.

In Cupcake’s experience, she shared how she wanted to be seen as an individual and acknowledged besides being the only “Asian girl.” With Cupcake being in a field that is predominantly white and male, she sees her identity of being Asian, as salient in these aspects. This feeling as the “Asian Girl” further exemplified that underrepresentation in the engineering field more because of the intersection of being a woman and an Asian American in the engineering classroom. Some students described a fear of being “boxed” into their identities as AAW and were sometimes relegated to cultural and gender stereotypes as the “super minority” (Asian) or less competent (woman).

Anita, an electrical engineering major, related how the men in her program made her feel othered due to her gender: “All the males look at me because I’m one of the few females. I should be used to this by now, but it still bothers me. It bothers me that I’m still treated like ‘other...’” As a Filipina woman, Anita recognized the treatment of her peers as problematic. Anita felt further isolation through these gendered experiences with men in engineering, particularly as an older, community college transfer student (Casad et al. 2019; Castro & Collins 2021; Kim et al. 2022).

Similarly, Hannah, a software engineering major, shared how her internship teammates would cast her as the “other” due to her gender:

The guys on my team would make it obvious that I was the only woman there with comments like “hey guys, and girls, can’t forget you”...These comments made me feel like I was different than everyone else and was being called out for being a different gender, making me feel like I was less of a part of the team...makes you feel like you are different and don’t belong.

Hannah, who identified as both Asian American and white, articulated how her male colleagues negatively influenced her sense of belonging and being recognized as an engineer. While perhaps intended to project inclusivity, these men made her feel like she did not belong in an engineering context because of being a woman. These feelings of otherness were often exacerbated by various intersectionalities (e.g., gender, class, age). The varied power of being in an environment of majority white men affected how the AAW navigated the engineering system (Castro & Collins 2021).

For example, Candy, an electrical engineering student, described how dually being seen as a racial/ethnic minority and a woman exacerbated her sense of marginalization in engineering: “I feel like I’m a super minority in engineering because I’m an ethnic minority and I’m one of the few girls in engineering, so I’m also a minority that way.” Thus, Candy indicates how her intersectional identities converge as both an ethnic minority and gender minority into a “super minority.” This further indicates the ways of how AAW are seen as outsiders due to larger systems of racial and sexist oppression.

ONE’S WHOLE SELF SENTIMENTS “OTHERING” OF AAW’S ENGINEERING IDENTITY

As a result of the marginalization that AAW in engineering often experienced, it became important to them that they were able to bring their whole selves into engineering settings and author their own stories of what it meant to be an engineer. AAW who felt as though they could bring their whole selves to their engineering experiences felt a greater sense of engineering identity. Candy,

an electrical engineering student, related how early in her college experience she attempted to suppress her feminine attributes in order to appear more in line with her masculine engineering peers. However, she suffered emotionally because she was not able to reconcile her gender identity and femininity with her engineering identity:

Although I have always tried to not care about being one of the 8% of female engineering students at our school, I think it really did get to me. Looking back, yet another reason why I was suffering emotionally, was that I wasn't fully being myself...I wanted to appear less noticeably a girl in freshman year, and I started dressing like a boy. I don't do well at anything if feel like I don't know who I am.

Candy wanted to assimilate to feel included and blend in with her male peers. She attempted to assimilate her freshman year, as she believed that her intersectional identities would be included and better supported if she stripped her femininity as she pursued being an engineer. While participants felt pressured to assimilate to masculine norms within engineering, these strategies failed. Rather than gaining a sense of recognition as an engineer, students could not feel a sense of authenticity about their role which negatively influenced their engineering identity development (Moses & Paguyo 2019).

In contrast, students highlighted how collaboration, connectedness, and women's organizations enabled them to fully realize engineering identities, despite the traditionally masculinized spaces that surrounded them. Celia, a software engineering student, stated:

[I] have been interning at a software company this whole summer, and doing real world work has made me feel more like an engineer. I'm doing things that are actually being used by others, and the team atmosphere that I have really breaks down a lot of the borders that are advertised in going into a tech company as a woman... My internship also has a group for women in tech.

Students were able to redefine their roles as engineers and challenge the dominant narrative that depicts engineering, particularly technical and computer engineering disciplines, as masculine and individualistic (Castro & Collins 2021). For Celia, having the collaborative and intentional spaces positively influenced her engineering identity by recognizing her needs and allowing for her intersectional identities to be integrated. The ability to bring one's whole self to engineering and the program was influential to feeling more like an engineer.

Similarly, Anita mentioned how important it was for her to be able to not only be herself, she wanted to be able to celebrate her culture in all aspects.

I think for me it's better to just embrace that this is part of my culture, this is part of my history and this is what I am. Take it or leave it, but I'm not asking you to accept me. That's your choice. It's definitely become easier to say that I'm Filipino nowadays...

Like Anita, AAW who felt as though they could bring their whole selves, cultural, ethnic, womanhood, to their engineering experiences felt a greater sense of engineering identity. Being able to understand that they are engineers, with their intersecting identities, the women wanted and desired to perform their identities without being judged by their interest or intersecting identities.

MONOLITHIC, I THINK NOT! RANGE OF IDENTITY EXPERIENCES OF ASIAN AMERICAN WOMEN IN ENGINEERING

Finally, this study also showed the range of identity experiences among these seven AAW. For instance, Anita describes the ways she has taken agency in unpacking her background:

My family's from the Philippines. I'm a second generation Filipino here in the states and yeah, second generation immigrant...[E]specially coming to Iowa from the West Coast, I was definitely dealing with some identity crisis. A large part of that is mostly because this is the first time I've been away from my family... I decided to study abroad in Spain

to learn about the relationship between Spain and the Philippines. Learning about that really put into perspective how my family came to the US and some of the cultural habits that my family has, and as well as the traditions.

As she developed her identities, she further understood the racialization of her Filipino background from her study abroad experience. Partaking in this study abroad experience not only allowed her to connect with her roots, but this opportunity also allowed her to take courses towards her engineering degree. For Anita, study abroad allowed her to connect further into her cultural history and positively influenced her engineering identity by allowing her to navigate coming back as her authentic self.

To further understand the differences in AAW experiences, there are differences Hannah further discusses her experience through being biracial as Indian and white. Hannah says,

This is something that I've always been weird about because ... I'm half White, so a lot of people ... I've never known how people see me, like do they see me as Indian or do they see me as White? I don't know. I've never really dealt with that fully...It's always been a point of awkwardness for me. I'm like, "Do people know I'm Indian? Probably. I don't know." Yeah, that's just something I've dealt with my whole life pretty much.

Hannah describes how her being biracial is perceived in different academic environments. As she navigates her engineering identity, she also discusses how navigating being a AAW in engineering gets erased due to being half-white. Similarly, Theresa connects her white identity as a part of others perception of her, as she is white passing. Theresa's addressed concern over perception as the "white savior" of her community because she is white passing.

I don't want to seem like that [White savior]. But I definitely think giving people education empowers people. So if I can teach long term or in my future career, I think that that would help me do good in the world.

Theresa was able to understand how her passing could influence her future roles combining her passion of engineering and teaching.

In other instances, students who identified as Filipino or Southeast Asian described how their experiences as women of color in engineering differed due to stereotypes. Cupcake described her experience at a career fair:

I feel like maybe they didn't talk to me that much, not even trying to start a conversation with me because of my appearance...So, I think that experience from the career fair kind of made me feel bad... I also wonder if it's like my name or something, that they think, oh, you're an international student, or something. But, it's like, applying online, that's not an issue, but if it's like talking face to face, I wonder if they think that they're just going to ignore me when they're selecting their candidates, because they thought it's going to be more complicated if they wanted to use me.

In Cupcake's experience, the in-person nature of the career fair exposed her intersectional identities. It created a fear for Cupcake that future employers or hiring managers may question her engineering identity based on their assumptions of AAW, including those tied to her gender, racial/ethnic, and national identities. Thus, racism, sexism, and xenophobia complicate the ways in which potential employers and male peers viewed Cupcake as an engineer. These experiences do not occur in a vacuum and as research continues, it is crucial to understand how important it is to disaggregate and further understand the role of AAW peers in engineering. Lastly, students' experiences range among AAW; their identities are not monolithic.

DISCUSSION

To fully address the needs of AAW in engineering who have unique cultural backgrounds and development, scholars must understand AAW's unique engineering identity experiences in

this historically white, masculine environment. To combat these oppressions, students sought to redefine engineering identity. Students who were able to bring their whole selves (e.g., collaborative, women, feminine) to engineering settings felt more like engineers. Utilizing concepts of engineering identity (Godwin et al. 2013) intersectionality (Crenshaw 1991), researchers understand the complex nature of multiple identities and engineering identity development. This process and experiences are unique to a certain population of college students, especially in this study focusing on AAW college students. These two frameworks allow scholarship to recognize how multiple identities affect engineering identity development. This study provided three major findings that focus and analyze how a racialized and gendered experiences cannot be separated from one's race/ethnicity, gender, class, and other types of identities. These findings question how institutions and environments want AAW to navigate and be successful in predominantly white, masculine engineering fields.

Our first finding focuses on the range of experiences that AAW has as Asian American. Navigating and combating the constant white male gaze and male dominated spaces in engineering and demystifying the “model minority stereotype” take part in their engineering identity development. The students in this study showcased various ways on how the “Model Minority Myth” is embedded into engineering and society (Moses & Paguyo 2019; Museus 2013). While MMM impacts Asian American students, it is also connected to other forms of racial discrimination as it impacts racially minoritized communities. Asianization, “perpetual foreigner,” and otherness were all stereotypes that students attributed to their interactions with peers that made them feel othered, instead of being engineering students (Koo 2021). Racially, Asian is a monolithic racial category that limits the lived experiences, cultures, and ways of knowing (Eleno-Orama & Ross 2019; Ing & Victorino 2016; Inman 2006; Kang et al. 2021; McGee et al. 2017). Similar to a growing number of studies which have pointed out these differences (Castro & Collins 2021; Hune 2002; 2011), this study demonstrates, too, that the experiences of AAW vary depending on the racialization of family origins, immigrant generational status, and multi-ethnicity. Although there are many subgroups in this racial identity, this study reinforces the notion that there is great diversity even among those identifying as Asian American and these differences should be recognized in the larger landscape of research including Asian Americans. Critical frameworks such as Critical Asian Theory, or AsianCrit, can be helpful for unpacking more of the nuances related to the experience of being Asian American in various settings, including the engineering space.

Second, spaces of engineering continue to exude masculinity. For these women, sexism was pervasive in their experiences with engineering peers. Jokes were seen as a vehicle to disguise sexism by teasing and faux inclusion of our AAW participants. As one AAW put it, women in the engineering space “should be used to it” and thus appears to be an everyday experience for AAW. While acknowledging the importance of their gender, they also felt that there was much more to their engineering identities than just gender. The development of AAW engineering identity is situated through how the person views themselves and how others perceive them through merely one identity rather than as an individual with many identities.

Our third finding extends the ideas, explored in existing studies, on how AAW drew connections of their interconnected and intersectional identities and the ways others perceive them in their field. Patterns exist for women of color, but AAW occupies a unique setting of both privilege and oppression. One of our participants described this experience as being a “super minority,” coinciding with the “model minority stereotype” (Lee 2015; Nakayama 1988; Zhou & Lee 2017) that pressures students to be successful and to be at the top of their class. Some women closely tied their engineering identity with their status as a veteran, a woman of color, or a religious person. Creating a strong intersectional identity allowed the women to make meaning of their experiences as engineers. There are a number of different aspects that interconnect with their identity as they develop their engineering identity. These students often experience the pressures that pull between their racial, cultural, and gendered norms and behaviors to be negotiated with that their peers and their environment requires of them. If they do not fit in that mold, they are the anomaly. Rather than placing this “model minority stereotype” as the norm or being important

in their role, these participants focused on their career and aspirations to push forward to be the best engineers they can be.

Having past and present lived experiences in engineering environments, it is crucial to be informed and understand how their race/ethnicity, gender, socioeconomic status, and other identities can keep contributing to these experiences. These intersectional identities influence how AAW in engineering navigate being the “other” in their majors. While this “other” centers white males dominating engineering spaces and culture, collectively, these women felt empowered when they saw other women in engineering or in the workforce. Being able to bring their whole self, cultural, race, gender, region, is crucial to developing and staying in their respective majors. Having this whole self-present also allows students to create a space where being an engineer is more than a career. Peers have a significant part in allowing AAW to feel accepted in their classes which can complicate the way they develop their engineering identity.

LIMITATIONS AND IMPLICATIONS FOR FUTURE RESEARCH

We recognize several limitations of our study. First, the findings represent AAW students from a single institution and a geographical region (i.e., R1 institution located in Midwest) of the United States, which limits generalizability to AAW students studying engineering at higher education institutions in other regions of the United States. Therefore, more systematic investigation comparing experiences across different regions and institutions will provide insight into how institutions’ unique characteristics and geographic locations impact AAW students’ experiences. Second, our findings are limited to participants’ experiences and perceptions during sections of their academic journey. Thus, longitudinal research capturing changes with multi-wave time points may provide more insights into students’ development and changes over time, both prior to college and extending into the workforce. In addition, this study did not disaggregate participants by ethnicity within the group of Asian Americans. Although we presented information on the unique identity and background shaping our participants’ experiences, we analyzed AAW students as one group. Given the fact that there are approximately 50 different languages and cultural background within Asian American (Omi et al. 2020), and there are diverse cultural influence and cultural differences within the group of Asians (Rodriguez & Blaney 2021), this study indicates a need to continue to further explore experiences of specific cultural groups within Asian American groups. In particular, this study highlights the importance of a need for a continuation of research involving theoretical frameworks such as AsianCrit. Third, as this research was part of a larger study on S-STEM participants, there are two critical aspects to be considered. First, if this was a stand alone study, the research could have been better framed around the experiences of AAW. Second, this study included a very particular subset of AAW, who had financial need, indicating that their experiences may be different if inclusive at all. As shown in Table 1, there are various other identities that can be explored to further understand engineering identity experiences of AAW.

Implications for policy and practice

Findings of this study suggest several meaningful implications for practice for professionals working with AAW college students in engineering programs. First, educating faculty and staff in having a better understanding of AAW engineering students’ unique experiences, challenges, and development. Universities and colleges can achieve this through teaching and training faculty on issues unique to Asian American students, women, and AAW. This could be implemented through faculty training or workshops. Although the MMM perpetuates the belief that Asian Americans do well academically, and they do not need help, this study found that Asian American students have their own challenges and experiences and they need external support. Thus, it is important for educators and administrators who work with AAW engineering students about their unique experiences to provide culturally sensitive support (Kim et al. 2022). For this type of culturally responsive support, in addition to educators’ and administrators’ efforts, we recommend that designated student affairs divisions such as Center for Multicultural Programs, Office for Diversity Equity and Inclusion, Office for Asian American and Pacific Islander Students, or the University

Counseling Center make collective efforts to provide support programs for AAW engineering students (e.g., culturally sensitive programs for AAW, campus-wide events to support AAW students) so that the overall campus climate for AAW is more welcoming and inclusive (Koo & Nyunt 2022). In particular, this may be of interest for institutions with AANAPISI designation, which future grants may help to address.

Second, as this study found, engineering identity development is a significant process for AAW students in engineering programs. It is recommended for academic advisors and mentors for this specific student group to provide timely and continuous mentorship and guidance to help students to reflect and monitor their own process of identity development. For instance, in the aftermath of the 2021 Atlanta Spa shooting, several international Asian American doctoral students developed a study group to address issues of AAW doctoral students in education (Qiu et al. 2023).

Third, as reported in our findings, intersectional identities as a woman, as an Asian, and as a student in engineering play an important role to shape AAW students' identity development. Thus, psycho-educational workshops or outreach programs provided by the counseling center, Asian American student organizations, engineering (or STEM) organizations, or multicultural centers focusing on intersectionality for students are recommended. In addition to the outreach programs, peer-support programs or student support groups to discuss intersectionality among AAW engineering students might be helpful to support this specific group of students. In addition, partnering future research with Asian American groups on campus, in engineering, and on the national level can help further interrogate issues regarding AAW and engineering education.

CONCLUSION

By exploring unique perspectives and experiences of AAW engineering students, this study demonstrates the importance of recognizing the unique identity experiences of AAW within college engineering programs. Intersectional identities were key for understanding the engineering identity experiences of AAW. These findings demonstrate that racism and sexism are not only present in larger society on campus but are also reflected in engineering settings for AAW engineering students. Considering that AAW engineering students have their own unique challenge and struggles due to their multiple marginalized identities, it is crucial for AAW students to have the space to be authentic and develop their engineering identities, without feeling compelled to conform. As a result of the findings, this study further suggests the need for engineering spaces not only to be inclusive of multiple identities and ways of being, but also suggests the need to dismantle larger systems of oppression that manifest themselves within engineering settings. Engineering must make changes to allow intersecting identities to flourish in engineering.

DATA ACCESSIBILITY STATEMENT

Given the original data collection permissions, sensitivity of the subject, and possible deductive disclosure, we have not made the data available to readers.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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