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# DISRUPTIONS TO THE “MODELED MINORITY” IN ENGINEERING: WHY DO SOME ASIAN AMERICAN STUDENTS LEAVE ENGINEERING?

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## ABSTRACT

Asian American students are the largest non-White racial group in US undergraduate engineering, but they are often labeled as the "model minority." This stereotype confines them to STEM majors, limiting their access to diversity, equity, and inclusion (DEI) programs. Little attention has been given to why some Asian American students leave engineering. To address this gap, a pilot study using semi-structured interviews aims to explore the reasons behind their decision to leave the field or change their major. The study seeks to contribute to engineering education scholarship by promoting more inclusive learning environments for Asian American students and providing recommendations for better support from faculty, administrators, and staff.

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## 1 INTRODUCTION

Asian American students are the largest non-White racial group in US undergraduate engineering, though they are still considered members of a unique minority population - the “model minority.” However, scholars in Asian American studies

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continue to disrupt the norms placed on Asian American students. And with the stereotypes of Asians as geeks and doctors, Asian American students are typically boxed into STEM-oriented majors, thus further forcing Asian American students to take on the “modeled minority” stereotype. Here, we use the term “modeled minority” as this stereotype is perpetuated by STEM. Unfortunately, traditional approaches to framing and justifying research concerning minority students based on concepts such as representation and retention might be challenged when examining the experiences of Asian American students in engineering. Even if we are able to solve the problem of representation, we argue that it may not completely remove racial inequity against Asian American students from engineering education (Trytten et al. 2009). Despite being “overrepresented,” Asian American students in engineering (and Asian American students in general) in the United States are still facing racial discriminations, stereotypes, microaggressions, and other forms of systematic anti-Asian racism. To a large extent, the model minority myth and the overrepresentation concern challenging Asian American engineering students has limited their access to DEI programs.

Traditional DEI-focused studies in engineering education often focus on how to retain minority students especially those from Hispanic and African American backgrounds in engineering. Arguably, excluding Asian American students from retention research in engineering might assume either: (1) there is no retention issue among Asian American engineering students (again derived from the overrepresentation assumption); or (2) the traditional retention framing is not effective in serving the DEI needs of Asian American students.

Nevertheless, contrary to stereotypes around the model minority, our anecdotal evidence suggests that Asian American students (at least some of them) *do leave engineering*. Given the two assumptions articulated in the last paragraph, these students are not usually or necessarily included in most DEI programs, despite that a major goal of these programs is to retain minority students in engineering. We argue that one overlooked and yet critical aspect of DEI research in engineering is why some Asian American students leave engineering. While there have been limited studies in both engineering education and the social sciences regarding Asian American student experiences in engineering, even less attention has been brought to why some Asian American students leave engineering.

This pilot study aims to explore the paths some Asian American students took in deciding to leave either the field of engineering or engineering as a major. Semi-structured interviews are utilized to capture and center students’ experiences as first-hand accounts as to why these students leave engineering. This paper concludes with recommendations for engineering education and faculty, administrators, and staff for better supporting Asian American students during their journeys in engineering. This paper will contribute to the scholarship in engineering education that explores the diverse experiences of Asian American students in US engineering and more authentic approaches to the creation of inclusive learning environments for students from all backgrounds.

## **2 LITERATURE REVIEW**

### **2.1 Asian American Students in Engineering Education**

Based on previous scoping reviews, there has been a significant scarcity of empirical research regarding the experiences of Asian American students in US engineering education, both within the engineering literature and the social sciences literature. In the scoping review of the engineering literature, only three papers that empirically investigated Asian American students in engineering or STEM programs. A similar scoping review of the social sciences literature found only 14 papers, of which two were included in the previously mentioned literature review. Of the existing literature about Asian American engineering students in the US, there are two major areas of focus: (1) how Asian American students enter the STEM pipeline; and (2) the lived experiences of Asian American students during their time in engineering education.

The first area focuses on how Asian American students enter the STEM pipeline. One quantitative study found that individualistic student choice rather than parental influence were strong predictors for Asian American students to choose STEM over liberal arts and business majors (Lowinger and Song 2017). Lowinger and Song (2017) defined parental influenced variables such as parental education, parents' savings, parenting style, and level of involvement in their children's schooling while student variables included advanced placement and college preparation programs, subject preparation, extracurricular activity engagement, and student test scores. Another quantitative study examined the pathways to STEM majors for Asian American students and found that entrance to STEM varied among different Asian American ethnic subgroups, thus disrupting the model minority myth (MMM) (Kang et al. 2021). For instance, Filipino students were less likely to choose STEM majors compared to other Asian subgroups of students and Indian/Sri Lankan student choose STEM majors more than any other subgroup. Pang (2023) focused on how Asian American female college students, mostly STEM majors, decided to choose their major and the factors that influenced their agency in deciding their major such as family influence, personal expectations, and gendered expectations.

The second area centers on the lived experiences of Asian American engineering students in the US, throughout their time in engineering education. One quantitative study, centered on Asian American engineering students in the University of California system, found variations between classroom engagement and GPA across different sub-ethnic groups (Ing and Victorino 2016). One mixed-methods study focused on Asian American engineering students found that these students continued to experience racist stereotypes but also projected these stereotypes onto other Asian American students (Trytten, Lowe, and Walden 2012). Another study focused on examining the stereotypes Asian American students endure during college found that students indicated the stereotypes of the MMM and expectations to excel in math and science devalued the work they did to get where they were (Museus and Park 2015). In a phenomenological study, researchers looked at how Asian students navigated the social and psychological impacts of the MMM in their STEM education which backed up claims in disrupting the MMM (McGee et al.

2017). One paper summarizes the (lack of) literature and research on APIDA and Southeast Asian and Pacific Islander American (SEAPIA) students in STEM, specifically focusing on the importance of students' interactions with faculty which feed into factors of retention and persistence (Eleno-Orama and Ross 2019).

## 2.2 Minority Students Leaving Engineering

Historically, a major concern for engineering education research is how to sustain the engineering workforce pipeline. Researchers and policymakers in engineering education have explored ways to retain students, especially those from underserved cultural backgrounds in the engineering profession. To better study how to retain minority students in engineering, some scholars have studied the factors that may potentially cause them to *leave engineering*.

Hughes (2018) found that factors such as participation in undergraduate research, STEM identity, having a parent employed in STEM, and high school GPAs and SAT scores can potentially predict the retention of sexual minority STEM students. Watson and Froyd (2013) discuss how the leaky pipeline diagram, popularized to showcase how students leave STEM, indicates that engineering systems are geared to “plug” rather than renew the culture of engineering. Park et al. (2020) found that Black and Latina women were more likely to leave STEM due to racial and ethnic discrimination from their STEM professors. Hall et al. (2015) determined that strong predictors for retention in engineering included high school GPA, SAT math scores, and Assessment and Learning in Knowledge Spaces (ALEKS, a placement test measuring calculus readiness).

In summary, the existing literature in engineering education has yet problematized the experiences of Asian American students. More specifically, the literature on minority students leaving engineering has not considered Asian American students. Therefore, the major research question for this exploratory study is: ***What are the factors that may potentially lead some Asian American students to leave engineering?***

## 3 METHODS

### 3.1 Study Setting and Participants

For this pilot study, qualitative methods were utilized to understand the narratives and experiences of the students. This study was approved by the University's Institutional Review Board for human subjects research (IRB approval number 23-461). Student participants were from a public Asian American, Native American, and Pacific Islander-serving institution (AANAPISI) located in the Southern region of the United States. This institution was chosen because as it holds AANAPISI status, indicating that at least 10% of the total undergraduate student population is of APIDA descent. In order to be considered for the study, students had to have started in the College of Engineering and transferred out of engineering prior to their undergraduate graduation.

If the student agreed to participate, a one-on-one semi-structured interview was conducted virtually, lasting 30 to 45 minutes. Semi-structured interviews allow for the student to share their lived experiences through open-ended responses to closed questions. The lead author conducted and audio-recorded the interviews, which were then transcribed. In the first stage of data cleaning, all personal information was de-identified. With the de-identified transcripts, the researchers on this project coded the interviews according to themes that organically emerged from the student interviews.

Rigor and trustworthiness were considered for this qualitative research study (Lincoln and Guba 1985). Credibility emerged throughout the pilot study from the positionality of the researchers, the iterative nature of the interview questions, and frequent debriefing sessions between the researchers regarding the interview transcripts.

### 3.2 Positionality Statements

The first author is a biracial Asian and white woman graduate student whose research focuses on Asian American and multiracial engineering students. The second author is an Asian man from China who was educated in both China and the United States. His research focuses on global engineering, engineering ethics, and ethics of AI and robotics.

## 4 RESULTS

For this pilot study, two students were interviewed about their experiences in engineering. Their backgrounds are shared in the table below (Table 4.0). It is worth highlighting here that this paper is an exploratory study and it does not aim to draw any systematic findings across the sample. It is unlikely that insights from the two interviews will reach any kind of saturation for any typical qualitative study.

**NOTE:** Our major goal of this paper is two-folded. On the one hand, since there is no existing work on Asian American students leaving engineering, we are eager to get some very preliminary sense about the experience of these “less typical” students. On the other hand, analysis of the two interviews will help us further refine our interview protocol and develop a more comprehensive code book as we are interviewing more participants.

**Table 4.0 Demographic Information of Student Interviewees**

| Interviewee Pseudonym | Year           | Starting Major                  | Graduating Major         | Ethnicity | First Generation |
|-----------------------|----------------|---------------------------------|--------------------------|-----------|------------------|
| Sarah                 | Junior (Third) | Architecture → Computer Science | Cybersecurity (Business) | Chinese   | Yes              |
| Rebecca               | Senior (Fifth) | Computer Engineering            | Food Sciences            | Filipina  | No               |

#### **4.1 The Lack of Care and Sympathy in the Classroom**

Both Sarah and Rebecca shared that a major reason causing them to leave engineering was the lack of care, empathy, and teaching effectiveness among some engineering faculty in the classroom, especially those who were teaching mathematics subjects. They indicated that their mathematics courses were the tipping point for them in engineering. To a large extent, the lack of care and empathy in the everyday teaching of these faculty further help to reinforce some problematic and yet dominant engineering ideologies such as meritocracy.

For instance, Sarah's introductory calculus instructor made no attempt to connect with students which included not responding to students' emails. Even when Sarah had a question, her professor had no interest in helping her and instead the ways the professor spoke made students feel that they were stupid. Rebecca's multivariable calculus course left a similar bad taste. Rebecca recalled a moment when her professor made the course inhabitable: "my teacher literally was like, 'hey, you failed this test,' in front of the entire class." It is worth noting that both professors were international faculty and both Sarah and Rebecca considered that the cultural backgrounds may have contributed to some culturally insensitive practices in the classroom such as humiliating Sarah and other students, not being sensitive to diverse learning habits among students, and sharing aloud Rebecca's grade.

#### **4.2 The Competitive Culture: Engineering as a Rat Race**

According to Rebecca, a major cultural dimension of engineering that disengaged her from further pursuing her learning in engineering is the *competition culture* of engineering. Rebecca called the competition aspect of engineering a "rat race." Despite that she enjoyed the problem-solving spirit of engineering, she felt concerned about the overly competitive process of becoming an engineer. As noticed by Rebecca,

I feel like it's [STEM] almost oversaturated, and it's just so competitive. It's kind of like a rate race right now. There are just so many people in engineering who want to do the same things, and they're all usually great people. But the issue is, in the end, they're all kind of your competition, which just sucks, because a lot of times it doesn't help when you want to build relationships with those people.

As indicated in the quotation above, in fact, the competition culture can be further worsened by the lack of diverse ideas in engineering. In addition, there can be consequences resulting from the competition culture. For instance, competition will make engineers unable to build relationships with their colleagues. In general, Rebecca's impression with the competitive culture in engineering is that it is so difficult to "break through." Rebecca later found the food science program she transferred to included more diverse topics and ideas.

#### **4.3 Engineering Is Not for Everyone**

Both Sarah and Rebecca shared their experiences interacting with their peers, advisors, and family members when they were considering leaving engineering for

other majors. These different stakeholders in engineering students' ecological system all indicated that it is totally fine to leave engineering simply because *engineering is not for everyone*.

When Sarah consulted with a friend in her calculus class that she planned to leave engineering, her friend was trying to comfort and said, "yeah, I get it. It's like some majors are not for everyone, and it's okay." More broadly, Sarah reflected on her experience discussing the relationship between gender and engineering and realized that engineering is still a male dominant field. As Sarah pointed out,

But I do feel like there is still very much a male dominant field and they're kind of like, the males, they still kind of have that superiority complex, be like, "oh yeah, a woman can't do the field thing." Because I've heard from other friends, some of the guys do that because they're like, "Oh, I'm going to take over this whole project. You don't have to do anything."

Rebecca's experience with that engineering is not for everyone came from a more institutional approach. When discussing her experience with the process of switching majors, she cited the university's involvement:

He [academic advisor] was a transitional advisor, specifically an advisor for people who are changing out of majors...I didn't know [they had transitional advisors] either until I got an email saying, "Hey, you're not doing great in engineering" and I was like, "Okay."

Thus, Rebecca was flagged by the College of Engineering on low performance, which led to the process of her leaving engineering.

#### **4.4 Goals More Fundamental to Engineering**

While analyzing the two interviews, we also realized that there are factors or "goals" more fundamental to engineering that in fact motivated both Sarah and Rebecca to leave engineering. These factors or goals shaped the ways they perceived engineering and what other non-engineering degrees they switched to. For instance, as a first generation college student, Sarah (and her family members as well) cared more about whether she could graduate on time and find a well-paid job. When consulting with her family members, Sarah found her family members supportive of her leaving engineering, despite that her family members "don't really care...as long as [she] is getting a degree that it's going to help [her] be able to make enough money." Therefore, Sarah ended up transferring to the cybersecurity major in the business school that was perceived to be less challenging but equally employable and profitable as engineering.

In comparison, Rebecca really enjoyed cooking, life, and family relationships. She was able to do a lot of cooking for the family during the COVID which used to be done by her grandmother, thus shifting her interests towards Food Sciences.

## **5 DISCUSSION**

In contrast to the existing literature that focuses on either how Hispanic and Black students leave engineering and the factors that may lead to their departure, this



paper presented some preliminary findings on the factors that caused Asian American students to leave engineering. Unlike the traditional model minority myth, some Asian American students did find themselves challenged by engineering cultures. First, for the two Asian American students in particular, some preliminary evidence showed that the lack of care, sympathy, and teaching effectiveness in courses with difficult, math-intensive concepts was a major reason for them to leave engineering. Second, the competitive environment of engineering disengaged students from meaningfully participating in engineering. The innovative, hands-on aspects of engineering did attract students but were later neutralized by the “competitive reality” of engineering which further caused mental health issues and the lack of diversity and creativity. Third, in addition to the formal engineering curriculum, institutional cultures such as the ways in which the university communicated to students about their performance and interactions between students and their peers and advisors may also affect students' determination to pursue engineering. Lastly, students all have different motivations to pursue engineering and therefore if their goals are not met they could potentially leave engineering. Future engineering education needs to help students navigate how their personal values are aligned with professional goals in engineering education.

These interviews unpacked the nuanced experiences and expectations of Asian American students to navigate the space of engineering. For future research, the intersections of various identities should be understood in order for better equity of all students in engineering and the lasting effects of COVID on students' academic performance. Perhaps the most important implication for research, generally and in engineering, is to disaggregate data on Asian Americans broadly in engineering, as subgroups of Asian Americans experience engineering differently. This is salient especially in thinking about policy and practical changes that could affect Asian American students in engineering.

As much of the literature in engineering makes the false assumption that all Asian Americans experience engineering the same, continuing to disaggregate Asian American data could help provide the needed resources for students. Another way that this research could help future generations of Asian American engineering students is by encouraging more funding towards programs that support Asian American cultural development. This could be seen through support for Asian cultural centers, living learning communities, or support for Asian and Asian American Studies at the university level.

## **5.1 Limitations**

As our study is exploratory in nature, it is important to note some of its limitations. First, our two participants are female students. While we will try to diversify our student population as we continue this project, we want to note that there could be a gendered phenomena of those who chose to leave engineering. As Sarah indicated, the male dominated environment of engineering may be a reason why Asian American women may feel compelled to leave engineering (Castro and Collins

2019). In other words, we need to explore whether Asian American women are more likely to leave engineering than Asian American men. Second, part of our objectives for this study is to explore the feasibility of this project, including the interview protocol by experimenting with two participants. Doing so can help us further refine the interview protocol which will be included in our future research. Third, while we had hoped to find and include metrics to help strengthen our arguments, there have been no systematic data regarding this as retention is not a concept often found popular in studying Asian American students in engineering. Unfortunately, Asian Americans are considered, at least in the US context, a homogeneous group and therefore are considered overrepresented. Therefore, there has not been specific metric on this topic, but we hope that future engineering education researchers will consider this and include this population in future research on retention in engineering.

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