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An Exploratory Analysis of Cultural Capital Among Black Engineering Students at Minority Serving Institutions

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Dr. Jerrod A. Henderson ("Dr. J") is an Assistant Professor in the William A. Brookshire Department of Chemical and Biomolecular Engineering in the Cullen College of Engineering at the University of Houston (UH).

He began his higher education pursuits at Morehouse College and North Carolina Agricultural & Technical State University where he earned degrees in both Chemistry and Chemical Engineering as a part of the Atlanta University Center's Dual Degree in Engineering Program. While in college he was a Ronald E. McNair Scholar which afforded him the opportunity to intern at NASA Langley. He also earned distinction as a Phi Beta Kappa member and an American Chemical Society Scholar. Dr. Henderson completed his Ph.D. in Chemical & Biomolecular Engineering at the University of Illinois at Urbana-Champaign. During his time as a graduate student, he was a NASA Harriet G. Jenkins Graduate Fellow.

Dr. Henderson has dedicated his career to increasing the number of students who are on pathways to pursue STEM careers. He believes that exposing students to STEM early will have a lasting impact on their lives and academic pursuits. He is the co-founder of the St. Elmo Brady STEM Academy (SEBA). SEBA is an educational intervention aimed at exposing underrepresented fourth and fifth-grade students and their families to hands-on STEM experiences.

Henderson's research interests are in engineering identity development among Black men and engineering student success. He was most recently recognized by INSIGHT Into Diversity Magazine as an Inspiring STEM Leader, the University of Illinois at Urbana-Champaign with the College of Liberal Arts & Sciences (LAS) Outstanding Young Alumni Award, and Career Communications Group with a Black Engineer of the Year Award for college-level promotion of engineering education.

Cheery Chukwukelu, University of Houston
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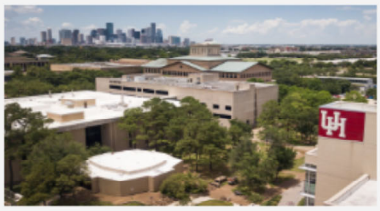

UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING

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Introduction: Blinded for review

Overview

- Positionality
- Background
- Purpose
- Research Question
- Theoretical Framework
- Methods
- Findings and Discussion
- Limitations
- Recommendations
- Conclusions

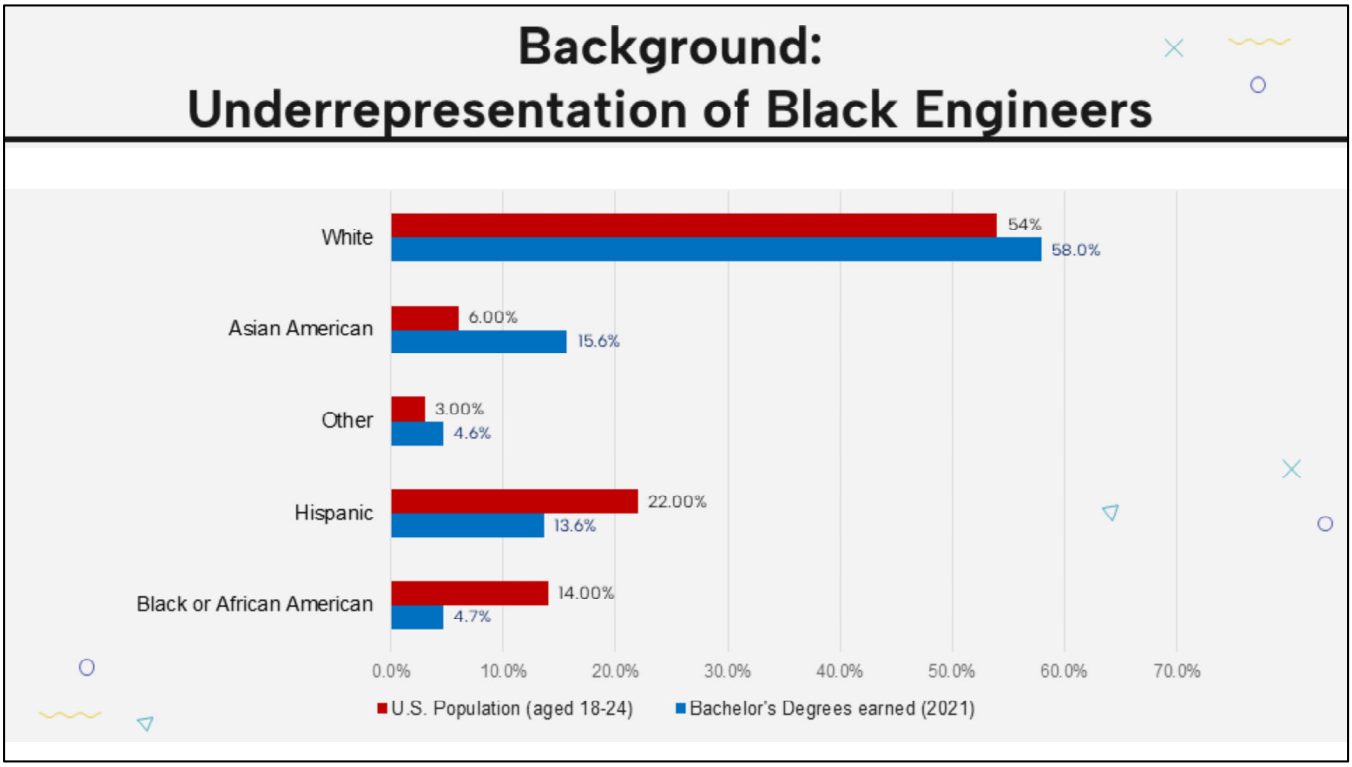
Here is an overview of what I will discuss today. First, I will start with Positionality. I will go explain the general background and the purpose of our research. I will state the research question, explain our theoretical framework and highlight our methods of data collection and analysis. Then, I will explain and discuss our findings as well as limitations to the study. Recommendations including our Implications for Practice and Research will be highlighted and then I will conclude.

Positionality

(presenting author)

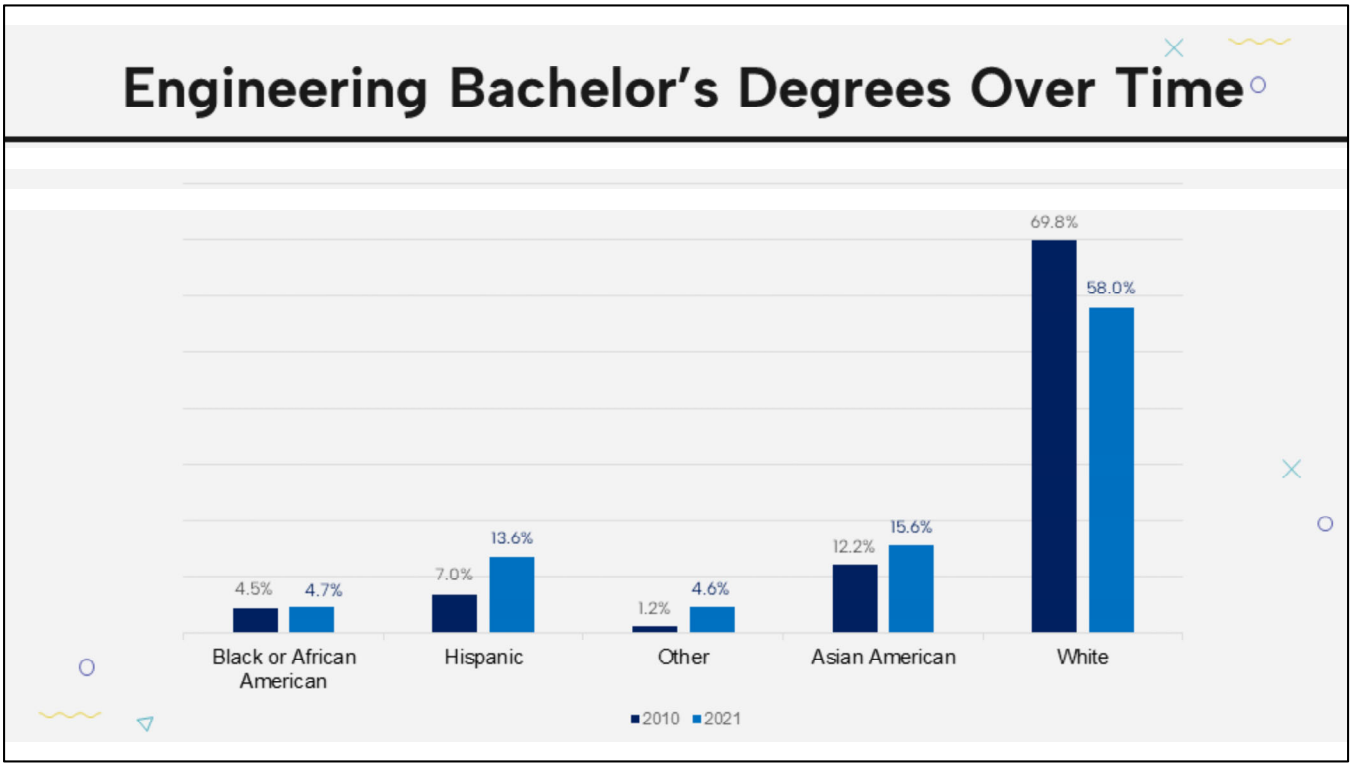
- Black female chemical engineering undergraduate student
- Beginner qualitative researcher
- Belief in & advocate for equity and inclusion
  - Personal life
  - Research methods

As a Black female chemical engineering student, I can understand and empathize with the participants as I am also going through my own unique undergraduate engineering experience. I am an undergraduate student. Consequently, I am a beginner in qualitative research. I also lean into my experiences as an undergraduate when building rapport with undergraduate research participants. Further, I also believe in equity and inclusion of marginalized groups in engineering and engineering education. I practice this in the types of methods that I use in research and the theoretical frameworks that I use when attempting to understand the experiences of historically marginalized individuals.

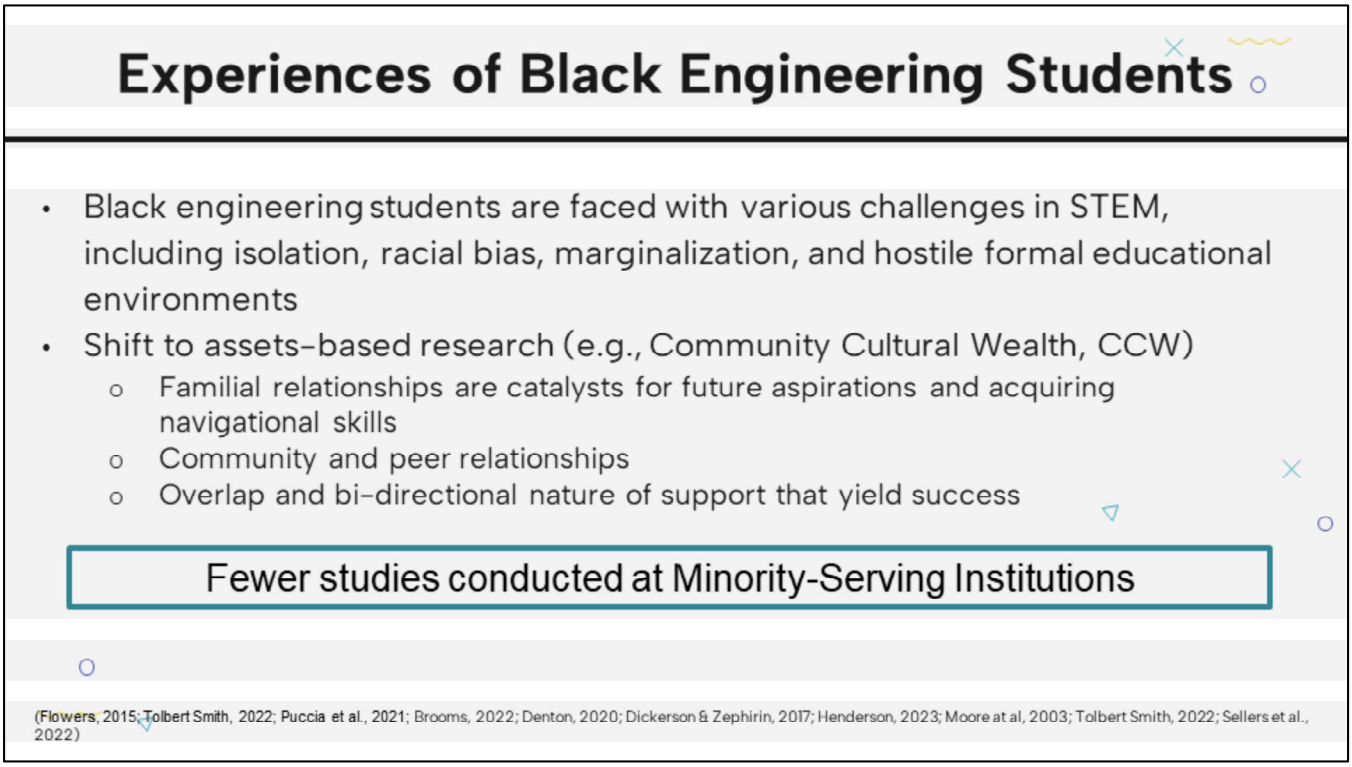


- As the graphic shows, Black students earned 4.7% of Bachelor's degrees in engineering in 2022.

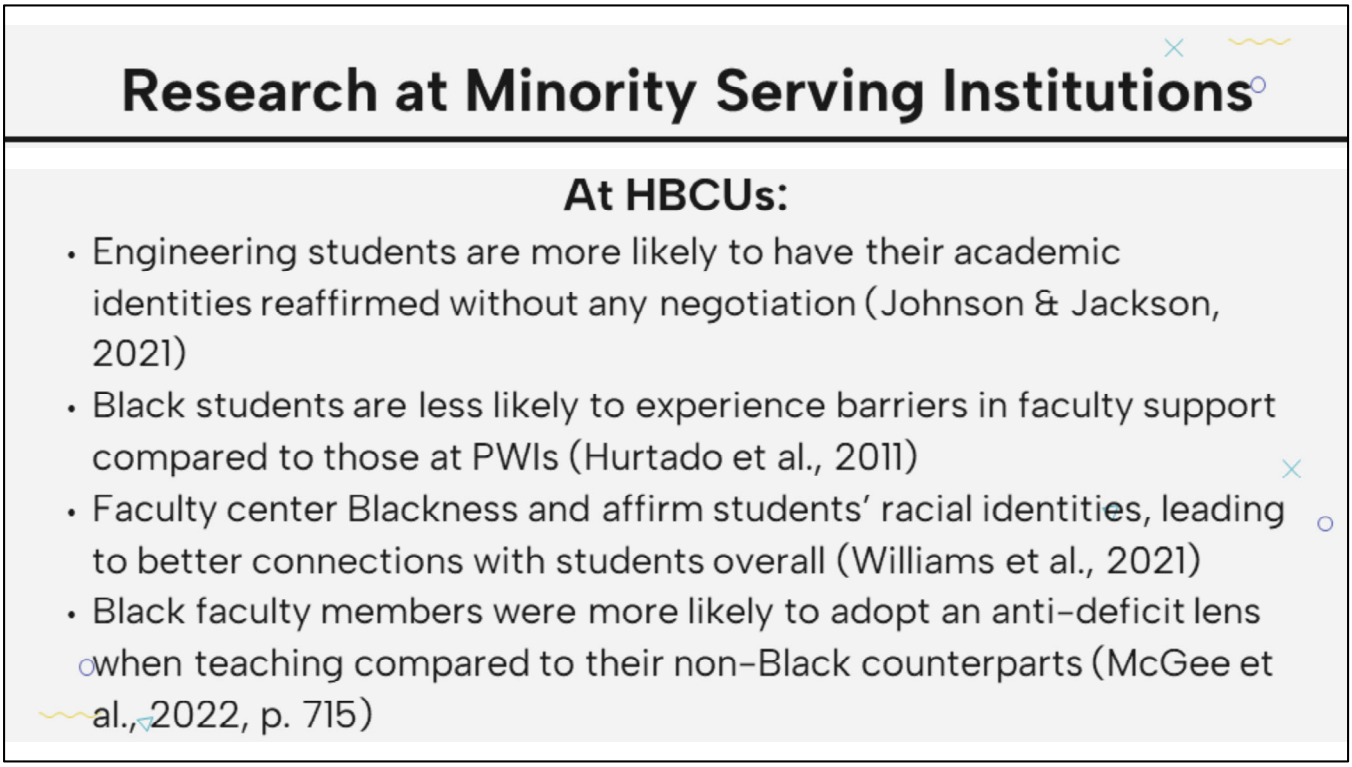
- Black engineering students in undergraduate programs earn about 4.7% of engineering bachelor's degrees annually – least represented compared to counterparts (NSF, 2023).



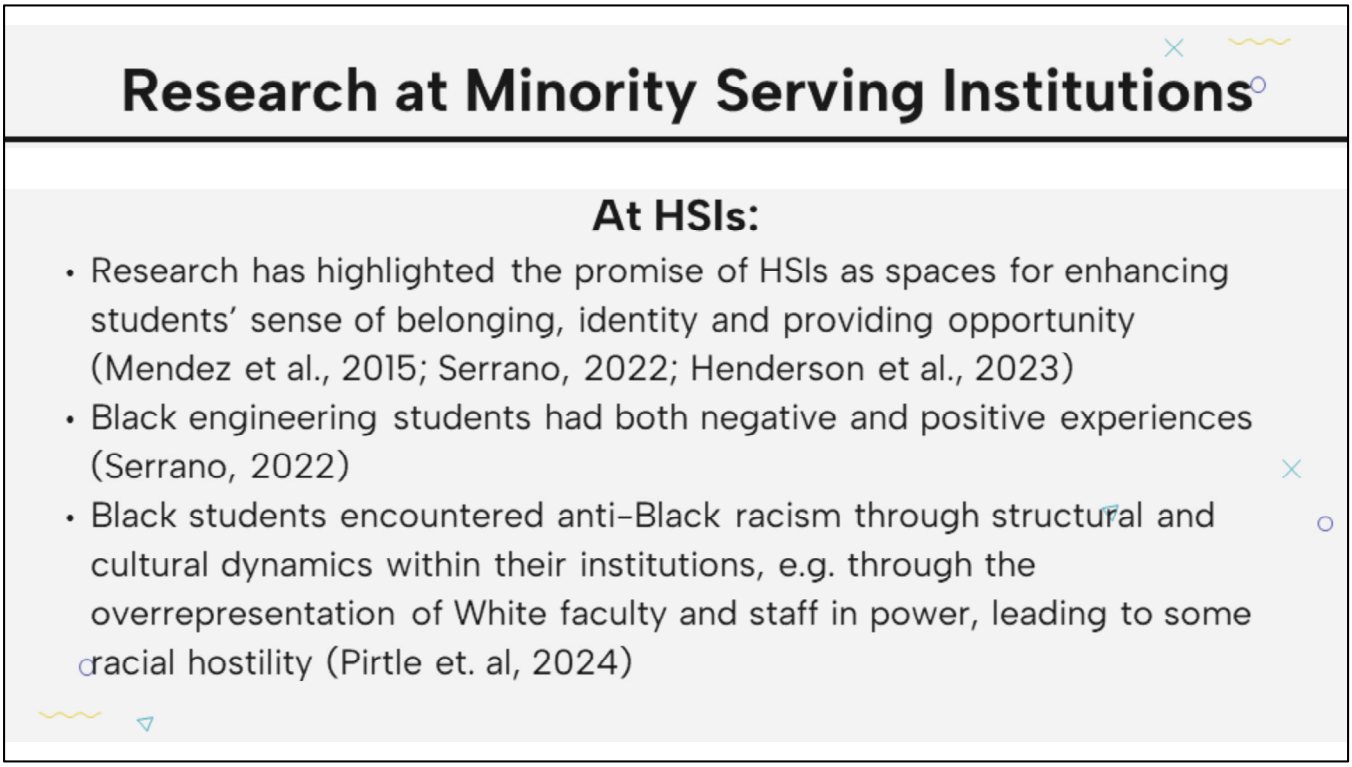
- Further, this graph shows the growth of engineering bachelor's degrees among different races/ethnicities. While the number of Hispanic and Asian American engineering degrees increased between 2010 and 2021, the number of Black engineering degrees remained relatively stagnant.



- On the topic of Black students' representation in STEM and engineering specifically, I discovered several literature sources that approached understanding Black student experience from deficit (or what they lacked)
- Starting around 2005, there were more calls for and a shift to more assets-based research. Such that the onus for lack of representation of Black students in engineering is not solely placed on the students or blame them for lacking something. Instead, we look at systemic challenges.
- Black engineering students are faced with various challenges in STEM, including isolation, racial bias, marginalization, and hostile formal educational environments
- When researchers used more assets-based frameworks such as Yosso's CCW, they started to uncover more in the literature such as:
    - Black students possess tools and experiences that allow them to thrive in high educational institutions.
    - Researchers have found that parents are instrumental in building social capital by connecting their children to various college resources and relationships and equipping them with the skills to seek out these social networks.
    - Community and social networks can come in the form of mentee-mentor relationships, student organizations like NSBE, student-faculty relationships, and general class relationships with their peers. These relationships are crucial in the development and support of Black students persisting in engineering
    - Literature also showed that the types of support that Black students is multifaceted
        - The types of support overlap and they are bi-directional.
- I also determined that there were fewer studies conducted at Minority-Serving Institutions… this is significant because… (next slide)



- Research at PWIs vs Minority Serving Institutions (MSIs): HBCUs and HSIs produce a significant portion of Black students who have been underrepresented in engineering. Given the dearth of literature highlighting Black engineering students at these MSIs compared to PWIs, there is a gap in applicability of such findings for minoritized students at MSIs.
- At HBCUs, some researchers (Johnson & Jackson, 2024) have found that Black students may experience an extension of a familial unit at HBCUs. Compared to PWIs, those HBCUs can be hubs for strengthening Black students' academic identities without negotiation. Their identities were affirmed, and this led to their success. We talked a little bit about faculty relationships at MSIs.
- Faculty center Blackness and affirm students' racial identities, leading to better connections with students overall (Williams et al., 2021)
- Black faculty members were more likely to adopt an anti-deficit lens when teaching compared to their non-Black counterparts (McGee et al., 2022, p. 715)



Interestingly

- Research has highlighted the promise of HSIs as spaces for enhancing students' sense of belonging, identity and providing opportunity (Mendez et al., 2015; Serrano, 2022; Henderson et al., 2023)
- Black engineering students had both negative and positive experiences (Serrano, 2022)
- Black students encountered anti-Black racism through structural and cultural dynamics within their institutions, e.g. through the overrepresentation of White faculty and staff in power, leading to some racial hostility (Pirtle et. al, 2024)
- This points to an interesting uncovering that might need to be explored further.

Purpose of the Study

We explored how Black engineering undergraduate students at Historically Black Colleges and Universities and Hispanic-serving institutions cultivate and use their **cultural capital**.

We explored how Black engineering undergraduate students at Historically Black Colleges and Universities and Hispanic-serving institutions cultivate and use their **cultural capital**.

Gleaning from and learning from MSIs may help produce more Black Engineers.

Research Question

How do Black engineering students build, support, and use their cultural capital at HBCUs and HSIs?

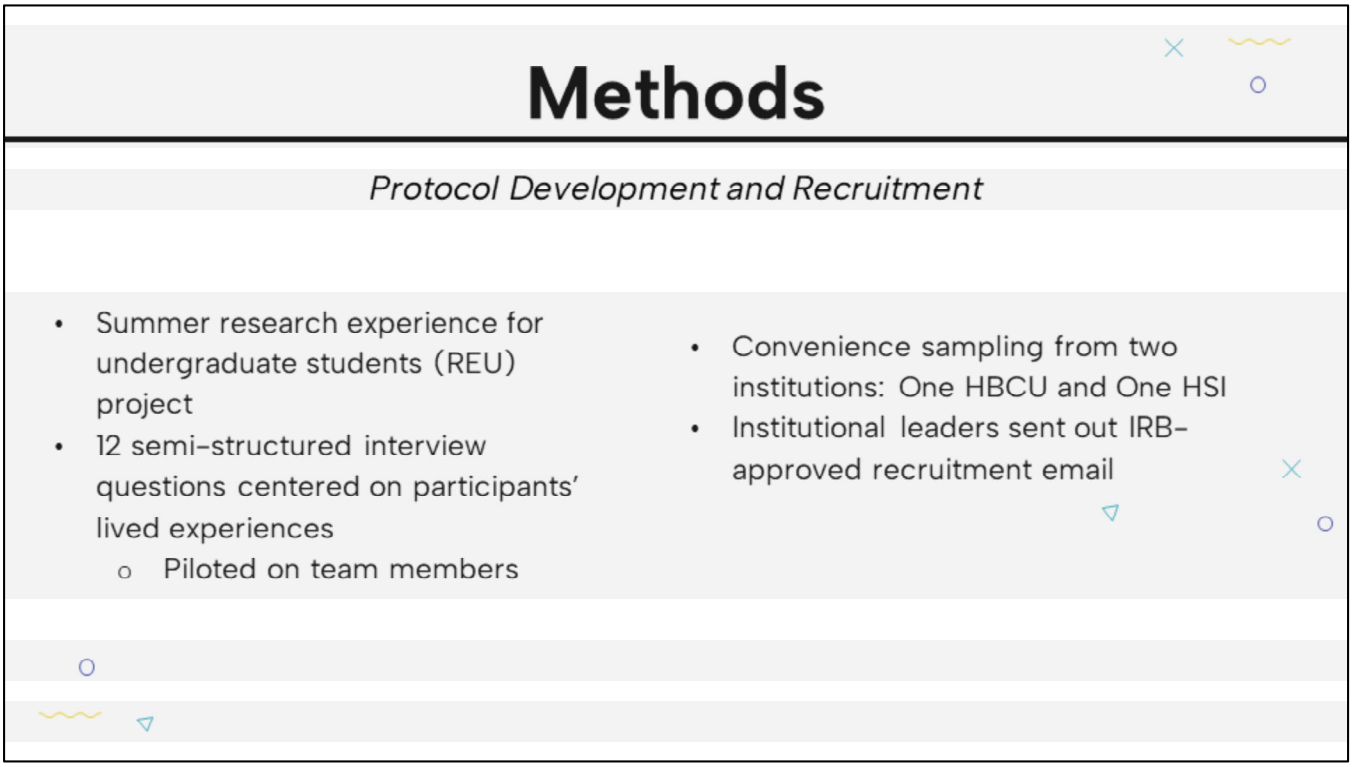
Theoretical Framework

Community Cultural Wealth (CCW)

Capital	Definition
Aspirational	The ability of students to build, maintain, and pursue their goals for the future while overcoming challenges
Linguistic	Communication, social, and language skills that students possess
Familial	Familial and communal relationships maintained by students that contributed to their cultural identities
Navigational	The ability of students to effectively seek and utilize school resources
Social	Peer, faculty, and other relationships that students form at school that directly influence their academic careers
Resistant	Knowledge and skills students possess to counter inequality

(Yosso, 2005)

- Community Cultural Wealth (CCW) is a particularly helpful framework for understanding the experiences of our participants. Developed by Tara J. Yosso, it highlights the cultural assets of students of color, which allow them to persist through systemic barriers that may hinder their degree completion.
- Students draw on six different types of capital, aspirational, social, familial, navigational, resistant, and linguistic capital. Here are some definitions so better explain what these mean.
- For example, Social capital might be cultivated in a student organization like NSBE. Resistant capital might include some kind of stereotype management taught by family over the years.
- Further, CCW also helped focus our attention on external barriers rather than on how to "fix" students (McGee, 2020; McGee et al., 2022). The system must be fixed rather than the students.

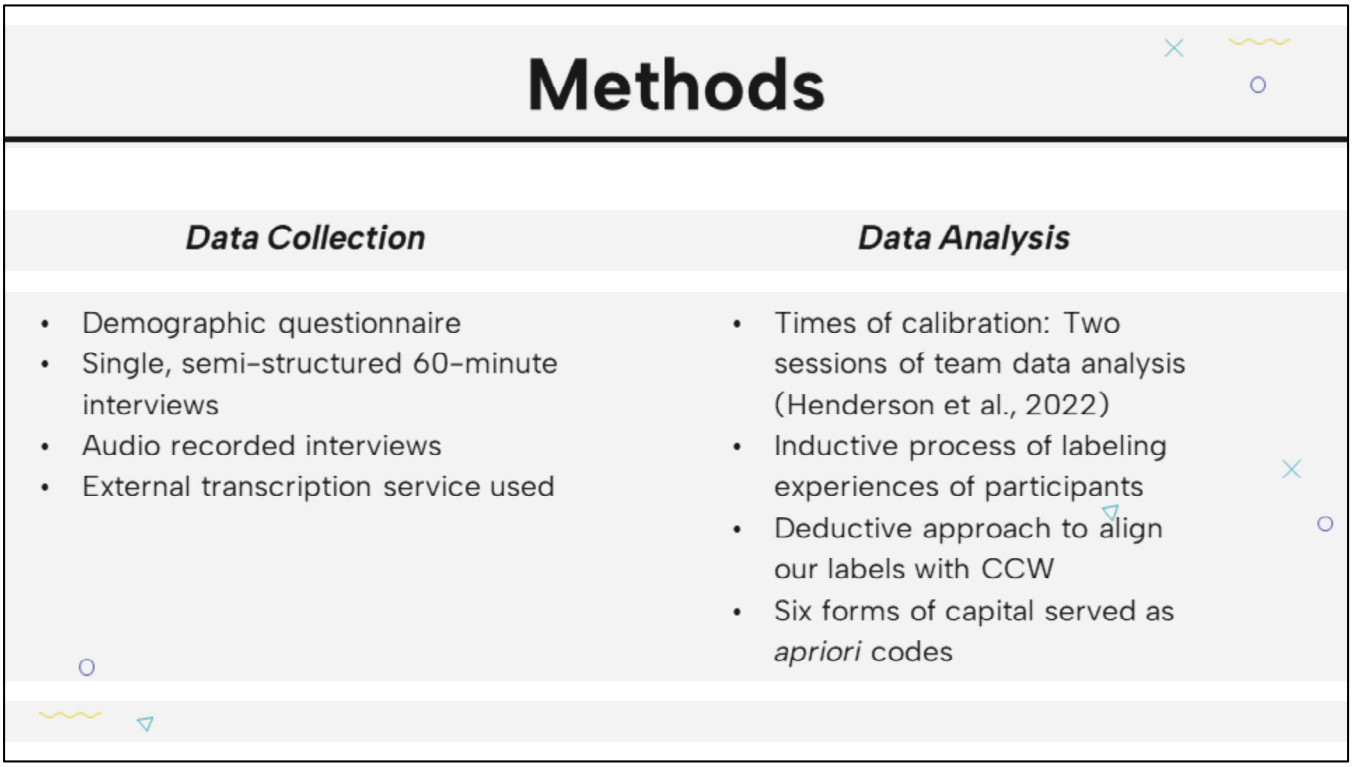


- We developed the interview protocol within our research group. Before conducting interviews, research team members not involved in the study provided feedback on the protocol. Specifically, undergraduate engineering students and education faculty provided suggestions for improving clarity and reducing the protocol length to accommodate a 60-minute interview schedule. The final protocol included 12 questions centered on participants' lived experiences.
- Some leading questions were:
    - What are the biggest barriers or challenges you've experienced as an engineering major?
    - What positive experience have you encountered in your engineering major?
    - Please tell me about your engineering journey and why you decided to major in engineering.
- We recruited from two universities that we had a relationship with, and administrators that we knew would share our recruitment email quickly since this project was during the summer. We were hoping that participants would respond quickly.

Participants & Selected Demographics

Pseudonym	Gender	Institution Type	Engineering Major (Year)	Year in Major	Race/ Ethnicity	First Generation College students
Cam	Male	HSI	Mechanical Engineering	Second	African American	Yes
Alex	Male	HSI	Chemical Engineering	Third	Sudanese – Black	Yes
Abbas	Male	HSI	Chemical Engineering	Third	East African	No
August	Male	HBCU	Chemical Engineering	Second	African American	No
Bea	Female	HBCU	Civil Engineering	Third	African American	No

- Recruitment yielded 5 participants
- Here we describe some of their demographics.
    - There are 4 males and 1 female student
    - Three of the participants are HSI students and two were HBCU students.



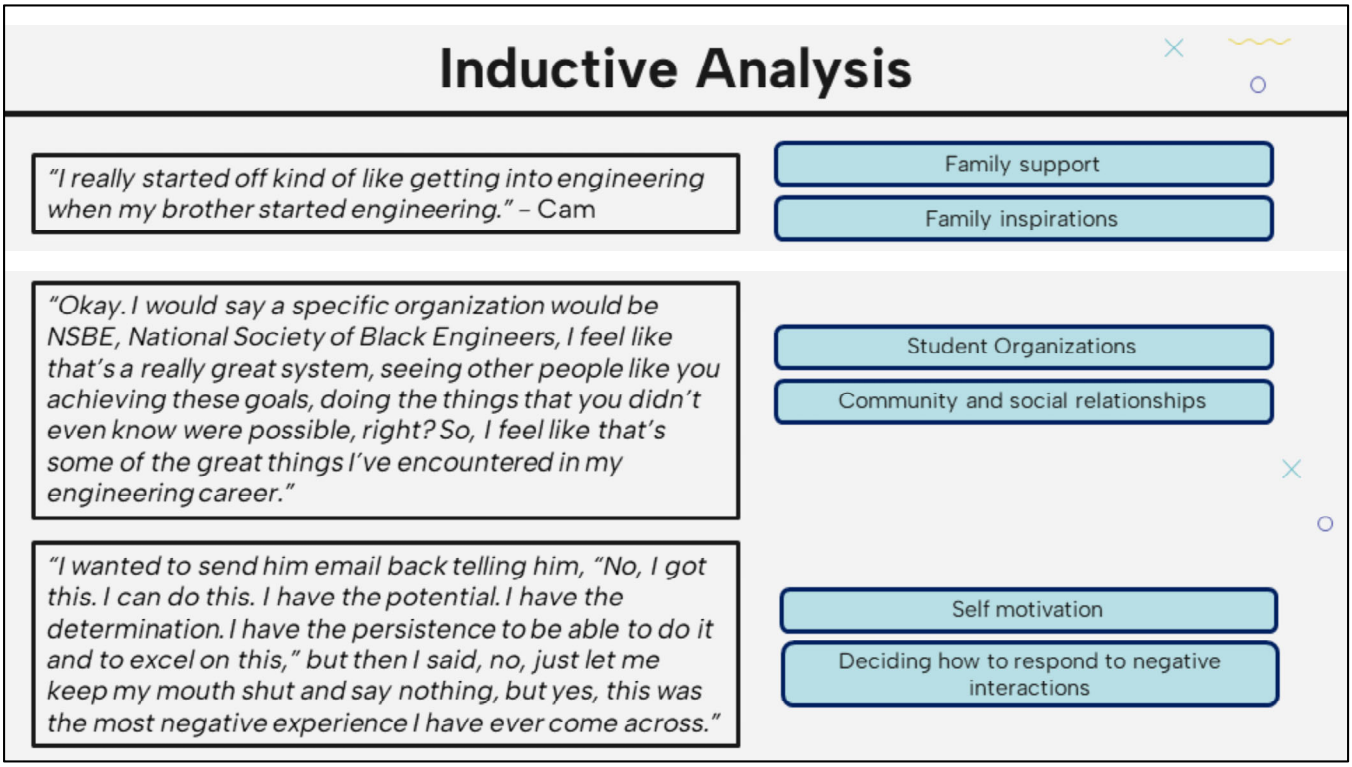
●*Data Analysis*

- Teamwork! : Two sessions of team data analysis led by author 1. Times of calibration were team sessions that helped curb authors' bias and influences on the data analysis by bringing in other team members of the lab to weigh in on transcript analysis and interpretations.
    - For the team sessions, five of the lab members were given one transcript to look through and code inductively. When we arrived at the session, we discussed our different ideas and themes we assigned to participant's experiences. Many of the themes were similarly defined. After that, author 1 (I) took the remaining transcripts and aimed to match what had already been done with the first transcript.

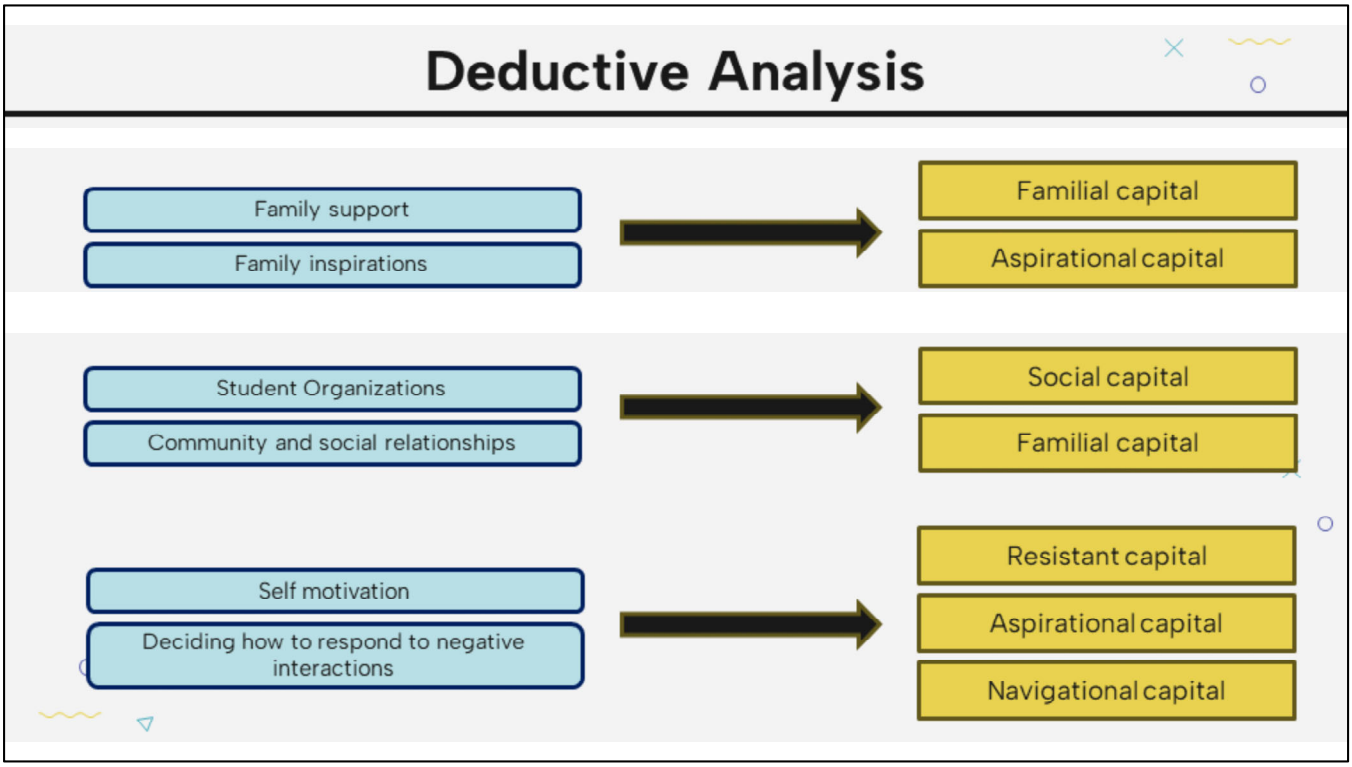
- Inductive process of labeling experiences of participants. Some of the labels used for the transcripts included: Family Support, Early conflicting interests, Isolation, Student organizations, Math skills, etc.

- Deductive approach to align our labels with CCW: Using these labels, we were able to identify where some of the participants experiences fell in terms of the cultural capital, and which forms of capital would have been used to overcome certain challenges that they faced.

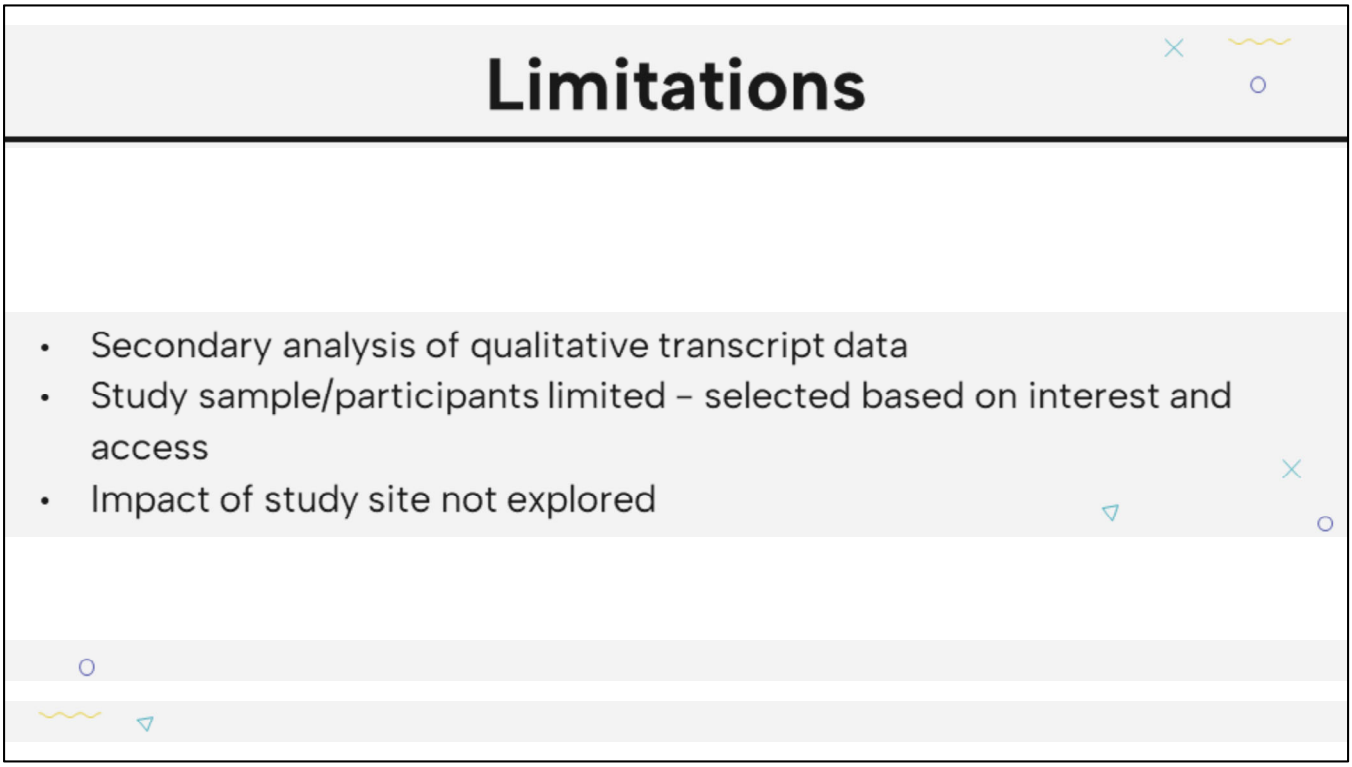
- Six forms of capital served as *a priori* codes



- Here is a look into how I analyzed the data!
- During an individual session, codes were assigned to quotes inductively. We analyzed the quotes individually and decided what the participants attempted to describe with their experiences. Some of the categories included Embracing challenges, self-motivation, Family relationships, Early love of Math and Science, etc.
- Here we highlight three quotes and some fitting labels that describe what the participant is experiencing.



- During team sessions, we analyzed the labels created for the different quotes and assigned codes to them. We coded based on labels, and also, went back to the actual quotes to recognize if more cultural capital could be attached to an experience they described.
- This is an iterative process.
- In some cases, I had to go back to transcripts and revisit assigned codes and their descriptions.



- First, we conducted the qualitative interview virtually, which may have limited rapport building. We attempted to mitigate this limitation by beginning the interview with introductory conversations to build rapport with participants. Since interview audio files were destroyed after transcription and some time had passed between data collection and analysis, there is a possibility of a loss of some of the essence of participants' experiences that may have been observed through their audio files.

- Study sample/participants limited - selected based on interest and access: While we identify specific differences between participants in HSIs and HBCUs, we acknowledge that participants from only two institutions responded. These participants were selected based on interest and access.

- Impact of study site not explored: During the interviews, we did not explore about how attending an HBCU or HIS directly impacted participants' experiences as engineering students.

Findings

- Relationships as the Bedrock for Success
- Intersections of Cultural Capital in Overcoming Engineering Challenges

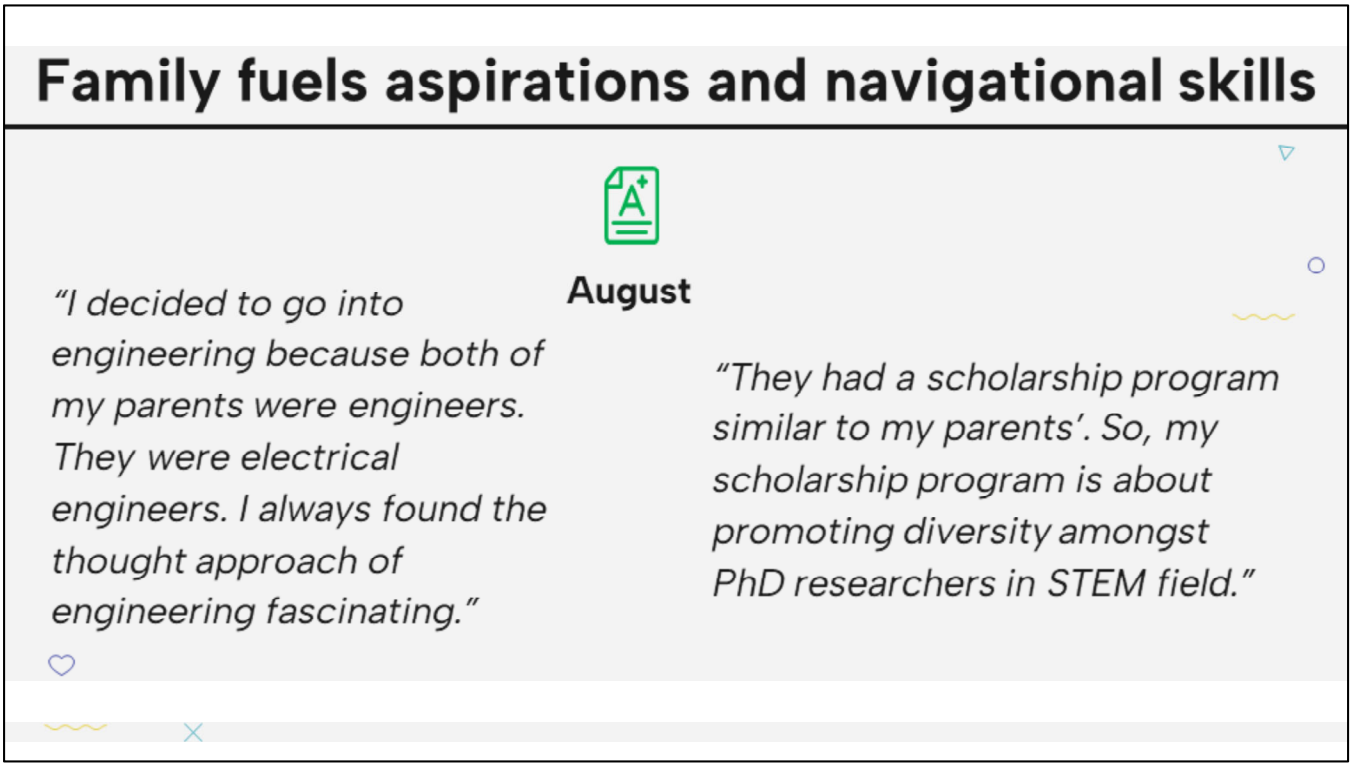
Two themes emerged from our findings:

- Relationships as the Bedrock for Success
- Intersections of Cultural Capital in Overcoming Engineering Challenges

Relationships as the Bedrock for Success

Relationships with parents, peers, pre-college teachers and siblings act as sources for different forms of capital.

Familial capital can manifest itself in various ways for students. Interestingly, most of our participants were often inspired by family members with careers or engineering experiences. Early exposure to engineering inspired students to move forward with their degrees regardless of the challenges that they may have faced. For example, Cam discussed how his brother inspired him to consider an engineering career, even when he had prior contrasting interests in basketball. *See quote*



Familial capital was not just instrumental in informing their initial interests in engineering but also sustained them in their journey while channeling their aspirational capital. For example, August said, "I decided to go into engineering because both of my parents were engineers. They were electrical engineers. I always found the thought approach of engineering fascinating." Also, when there was a familial connection to engineering, some students found they could navigate their majors more easily.

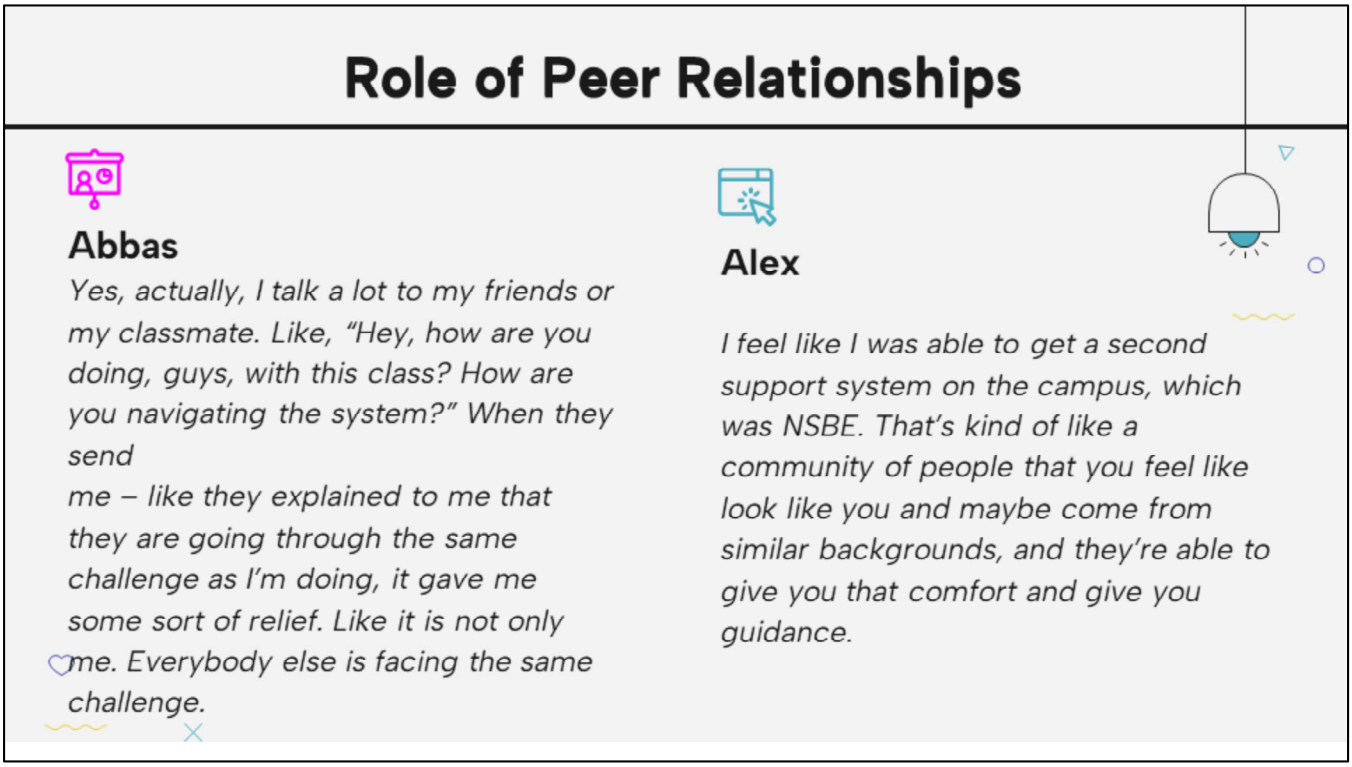
Family fuels aspirations and navigational skills

Bea

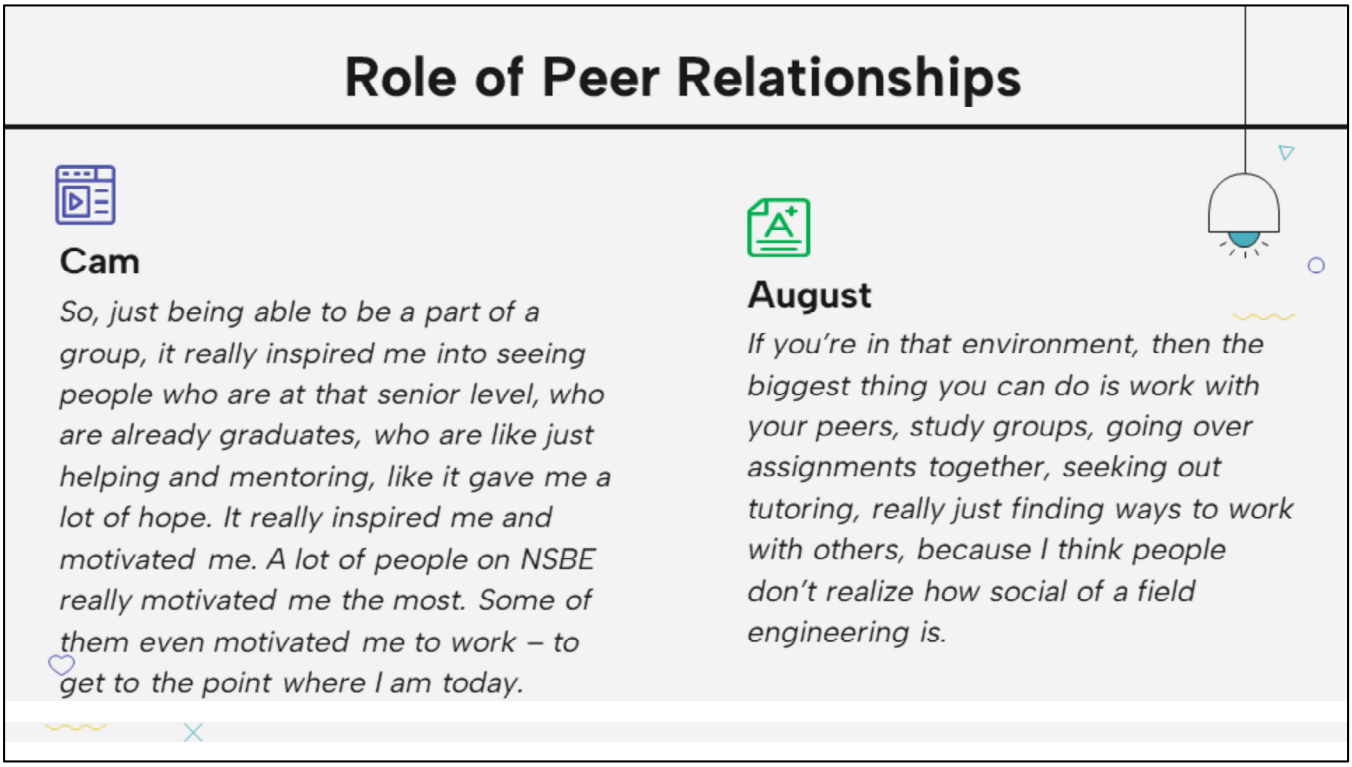
"Nobody else in my family ever majored in STEM. Nobody else is an engineer. It's pretty much just me paving the way"

"When she moved me to another district, she encouraged me to join this program called Project Lead The Way, where they had a class. Another district, because I'm originally from Ohio. So, they're really big on the STEM initiative there. So, after I joined that class and I learned the possibilities are very endless for engineering, I think I just kind of fell in love with it, because I've always had a creative mind."

- Participants who did not have engineers in their families also benefited from familial capital. For example, Bea mentioned there were no engineers in her inner circle, however, that motivated her to maybe become the first one in her family.
- A simple push from her mother helped to instill aspirational capital. The results of this push included learning about the possibilities for engineering and eventually, falling in love with it.
- This push also led Bea to college, where she began meeting professionals who "looked like her." While not an early childhood encounter, meeting Black engineers who got to the finish line was a subtle nudge to keep going. Bea felt like she had to get to that finish as she needed to "pave the way" for others who might want to follow in her footsteps. She exhibits that her familial capital sowed the seeds of her aspirational capital.



- For other students who did not mention familial capital, they highlighted that social relationships were a big contributor to their success, as well as highlighted how important it is to initiate and sustain relationships to be successful. For example, Abbas, who is an international student, emphasized that his peers helped him in navigating the institution.
- We are highlighting how social capital can fuel aspirations and navigational skills as well.
- Peers played a critical role in enhancing participants' navigational capital, particularly by offering guidance on maneuvering through their institutions and engineering majors. Every participant responded with some instance of how important their social connections were in mitigating imposter syndrome and their feelings of isolation. Three participants mentioned NSBE, noting how it provided them with an additional layer of support on campus.



- Cam's social capital influenced his aspirational and navigational capital. He spoke further about how isolation can negatively impact student engineering studies and asserted that developing a support system in school is important for being successful in engineering.

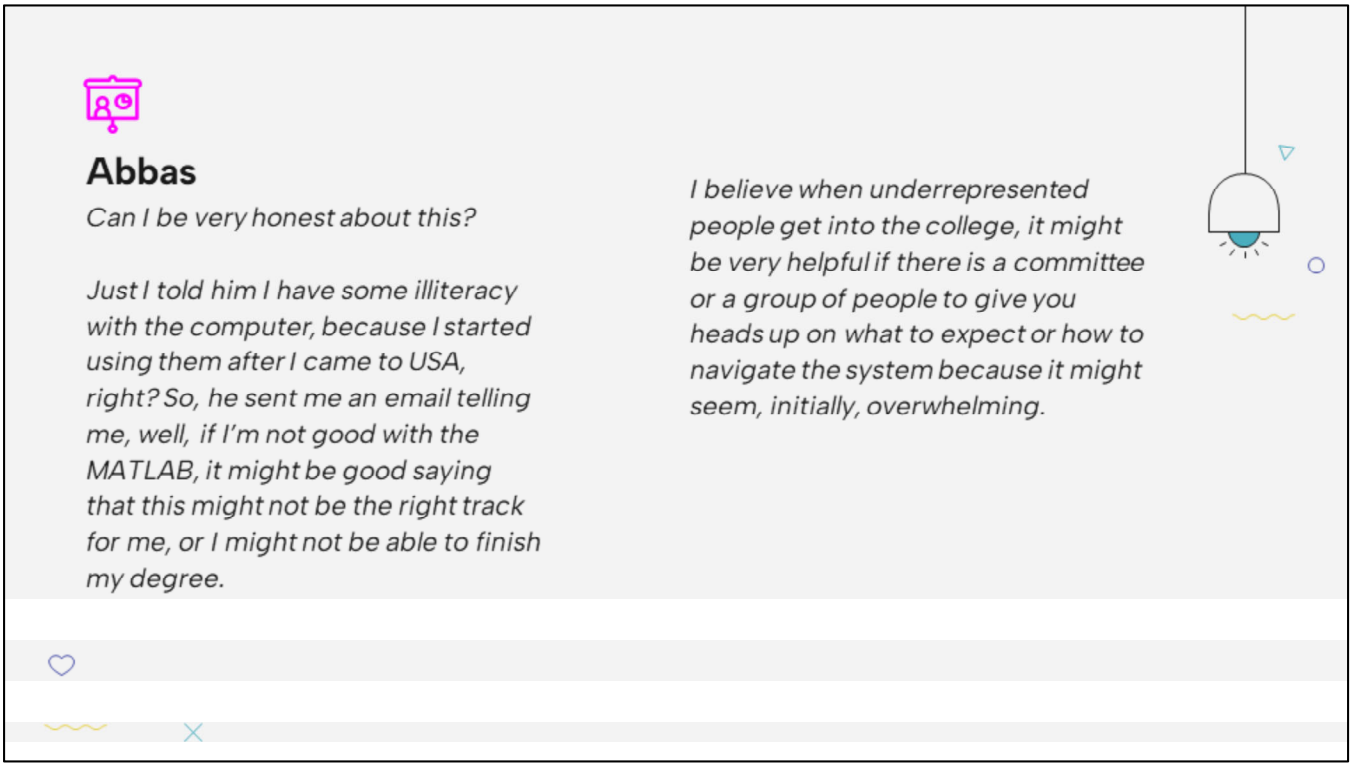
- August had similar views on isolation and laid emphasis on how collaborative engineering can be and ultimately advised that forming study groups is significant for academic success. These groups and relationships ultimately help engineering students feel more connected to their field, therefore influencing and supporting their aspirational capital.

Intersections of Cultural Capital in Overcoming Engineering Challenges

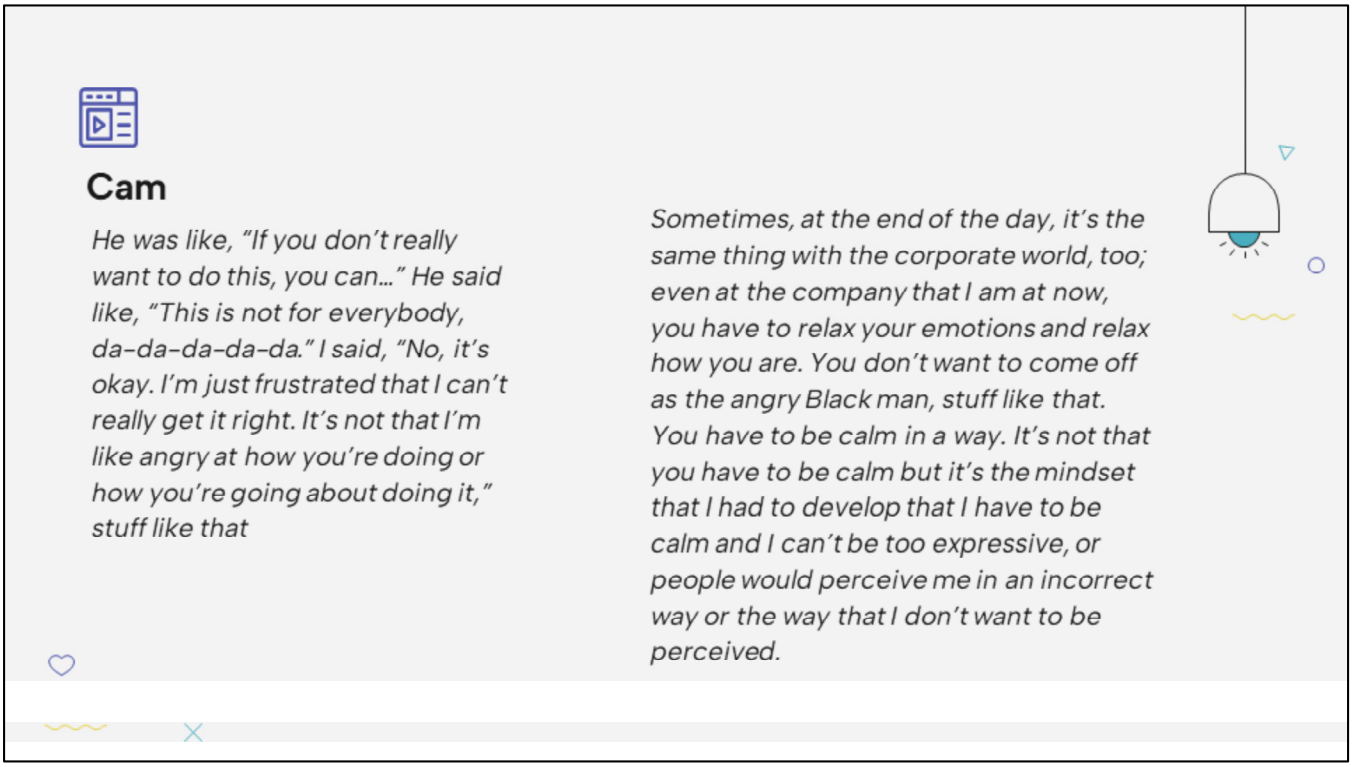
In examining the intersections of cultural capital, we highlight the challenges that pushed against participants' ambitions.

We found that their cultural capital enabled them to persist.

- These challenges caused them to drop courses and sometimes consider abandoning their majors entirely. With a combination of all or some of their cultural capital, they were able to persist and overcome hurdles.

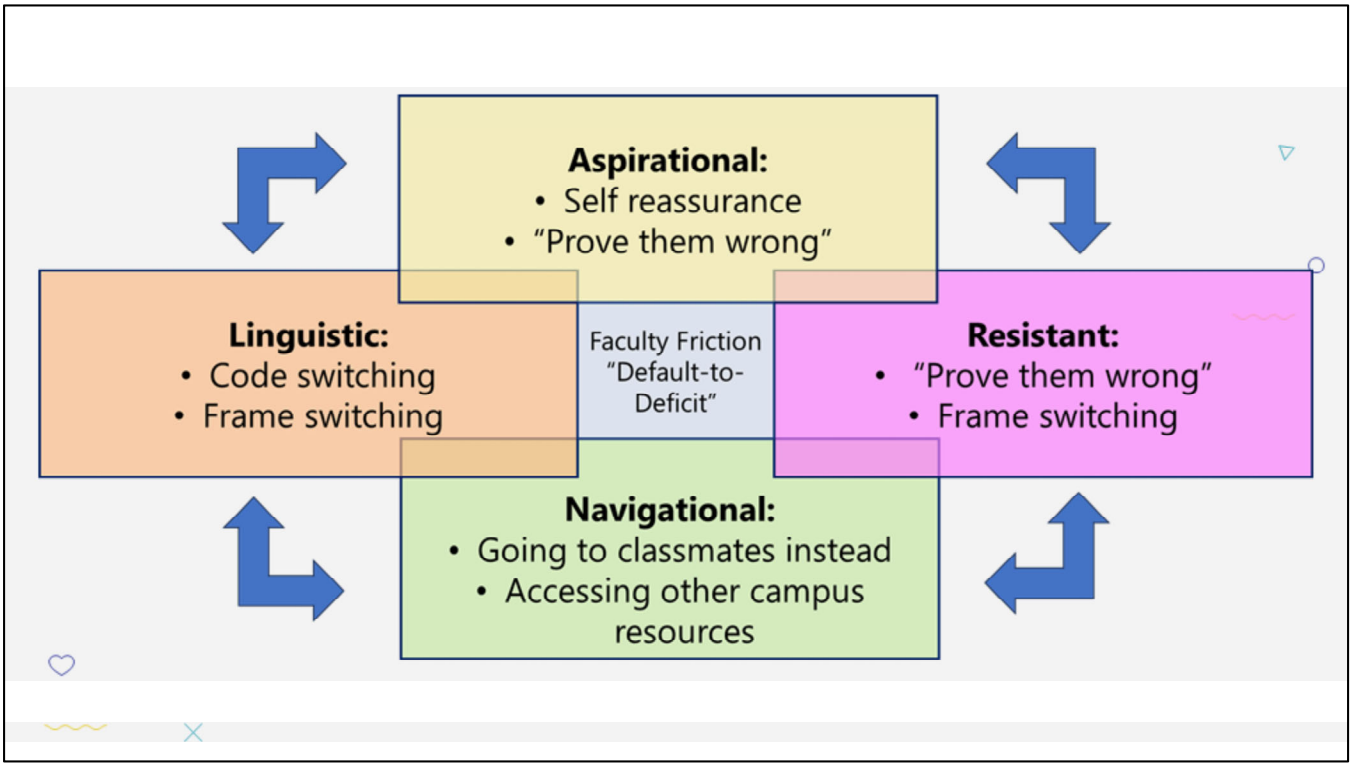


- Abbas was met by a professor who took a default-to-deficit approach to educating him at that moment, which caused him some turmoil.
- When the incident occurred, his aspirational capital was evident in the constant reassurance he gave himself amid this situation.
- His resistant capital was exemplified when he decided to avoid sending an email to defend himself against the professor. This is also an example of his resistant capital intersecting his navigational and linguistic capital.



- Cam seemingly experienced a default-to-deficit interaction with a professor as well.

- Cam's expression of frustration at his inability to understand dynamics course material was understandable as it is a core class for Mechanical Engineering majors. However, this expression of frustration was not received well by the professor during an office hours session.



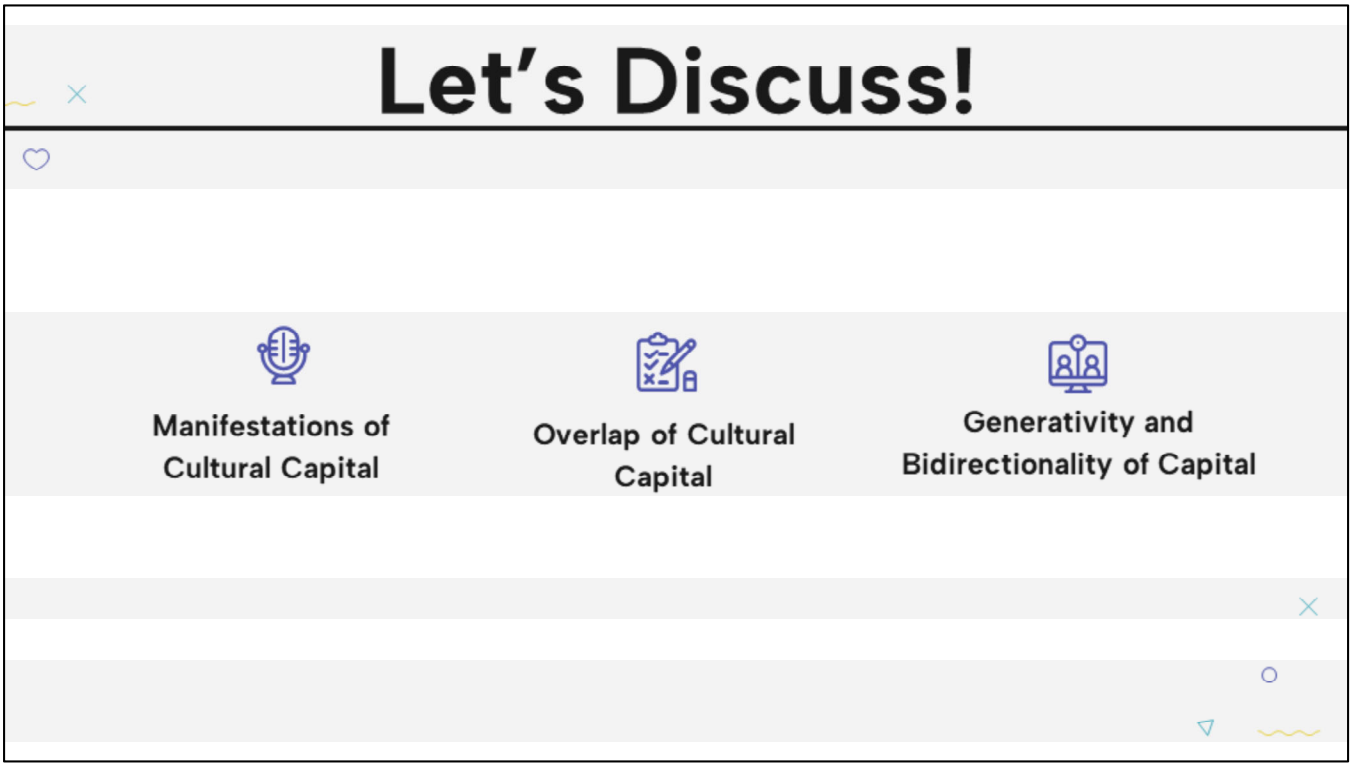
- When Cam and Abbas went through these experiences, they used aspirational, linguistic, navigational, and resistant capital to persist through and overcome the hurdle.

- Self-assurance was the first action they took both before and after they went through this. The ability to remind themselves that they could, in fact, do it and were still good students despite doubts by their professors.

- In doing so, they tried to understand where might the professors be speaking from. This is a form of frame switching, in which they approach the situation by trying to understand the cultural nuances they may be missing in such situations. This frame switch may be seen as an intersection between linguistic and resistant capital.

- By withdrawing (in Abbas's case) and looking for other resources that may help, we see a manifestation of his navigational capital.

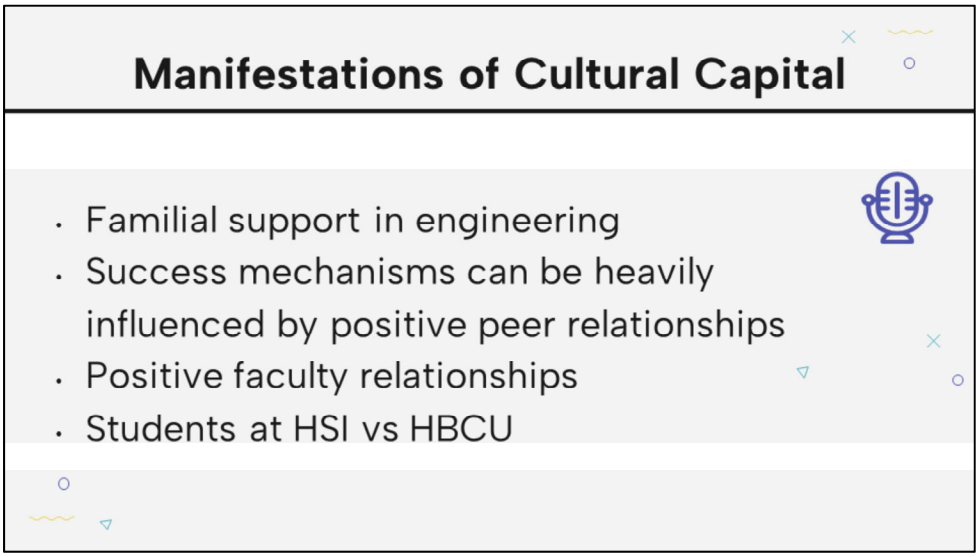
- **While HSIs are on the path to becoming more diverse in general, until faculty matches the racial composition of the student body, it is imperative that non-Black faculty adopt anti-deficit approaches to educating students of color.**



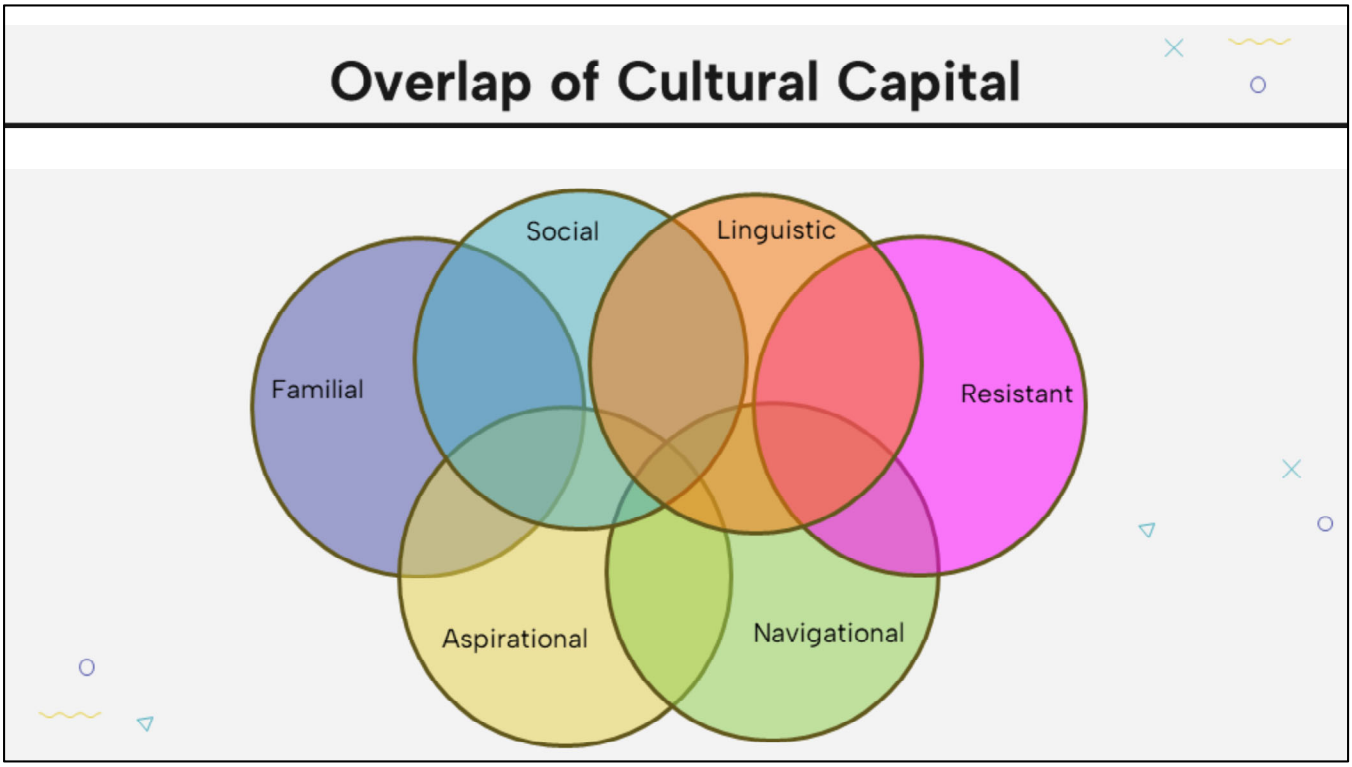
Manifestations of cultural capital: Students' capital enabled success and propelled them further in their engineering studies.

Overlap of cultural capital: The six types of capital were found to overlap given certain challenges that students experienced.

Generativity and bidirectionality: Students become sources of capital for their peers and in turn, have their cultural capital supported.



- Students' cultural wealth enabled them to overcome challenges and persist in engineering.
- Familial support in engineering: Family can serve as the first point of contact for aspirational and navigational capital. By early enrollment in STEM programs and emotional support, families lay the groundwork for cultivating students' aspirations for future engineering careers. Our findings further emphasize that parents are crucial sources of early encouragement in STEM.
- Students' success mechanisms relied on continued positive and influential peer support. All the students at HSIs mentioned peer support as necessary for combating these feelings. Participants in this study sought support from their peers both in class and through professional organizations such as NSBE and a gender-based mentoring program for Black males in engineering.
- Beyond peer support, faculty relationships were also crucial for students' success. Students who mentioned strong peer support also highlighted the positive impact of faculty on their engineering education. One HBCU student and one HSI student mentioned faculty relationships as an important contribution to their success in engineering. They emphasized that good support systems were important to prevent isolation as they successfully traversed their academic studies. Unique to this study, we saw the type of specific negative engineering faculty interactions Black students had with engineering faculty at HSIs and a nuanced look at how these students skillfully used their navigational, aspirational, linguistic, and resistance capital to overcome those challenges.
- Students at HSI vs. HBCU: Students at HSI vs HBCU: Three students at HSIs expressed that they had feelings of isolation and a lack of support within their institutions. Interestingly, only one of the HBCU participants, a female student, reported similar feelings of isolation, which may or may not have been influenced by her gender. The other HBCU students did not mention isolation but instead emphasized the importance of cultivating study groups and strong relationships with peers. One HBCU student even advised that students should be more inclined to join student organizations like NSBE. All of the HSI participants echoed this, viewing organizations like NSBE as safe spaces where they could connect with other Black engineering students. Some even described these groups as a 'family.' Regarding faculty support, two of the three HSI students shared experiences where they had to draw on their resistant capital, recognizing that certain challenges they faced might be tied to their race and/or background. These students also mentioned engaging in frame-switching or code-switching as a way to curb the situation and come out on top. However, one HBCU participant, a female chemical engineering student, also highlighted barriers to faculty support, noting that she received little to no assistance from her professors, which suggests that such challenges can persist even at HBCUs.



Further research that highlights the cultural capital of Black students has demonstrated that familial, navigational, and aspirational capital overlap (Tolbert Smith, 2022; Burt & Johnson, 2018). Based on more factors like gender and whether the student is international and/or first-generation, we observed that Black engineering students harness different combinations of capital to overcome challenges. When students face challenges, they typically lean into two or more kinds of capital to overcome or manage a potential challenge.

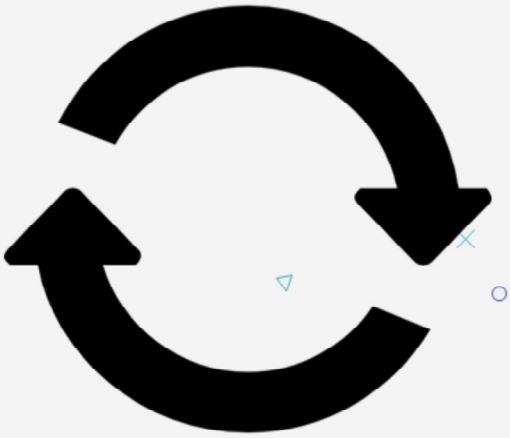
For example, we saw overlaps between familial, social, aspirational, and navigational capital, with one informing the other in several ways. In the cases where participants had negative encounters with professors, both displayed an intersection between their navigational and resistant capitals

Previous research has identified an overlap between familial and resistant capital (Hughes et al., 2006). However, in our study, we found no direct evidence of participants explicitly referencing their parents as sources of these values. Nonetheless, the way students navigated specific challenges suggests that they may have been socialized to resist in ways that align with key facets of familial-resistant capital overlap.

Black engineering students often demonstrate the ability to perceive and adapt to social cues that differ from those native to them. There is strategic use of their linguistic capital, a process known as "frame switching," which is especially pronounced among students attending Hispanic-Serving Institutions (HSIs). In this context, frame switching can be understood as an intersection of linguistic and resistant capital. Although HSIs are becoming more diverse, the faculty's racial composition still lags behind. Therefore, it is crucial for non-Black faculty to adopt anti-deficit approaches to effectively educate students of color.

Generativity and Bidirectionality of Capital

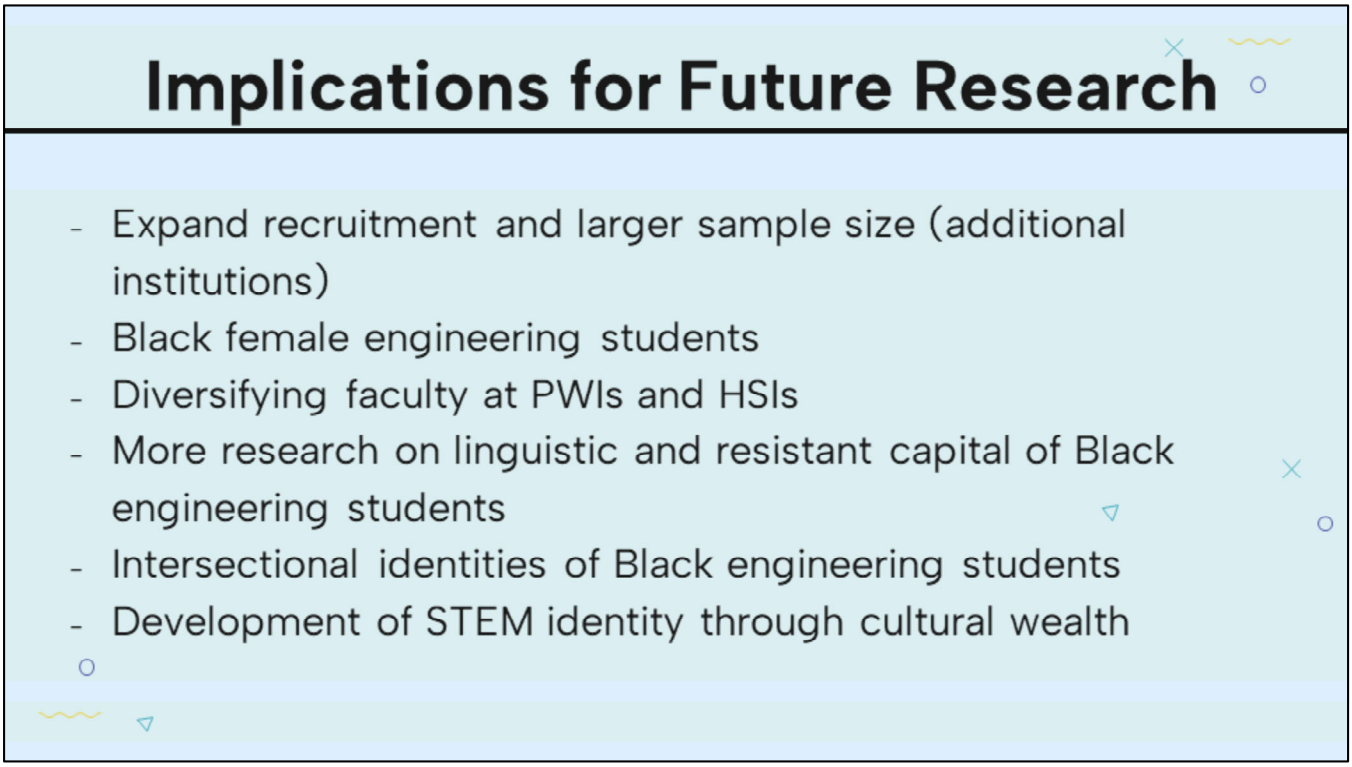
- Bi-directional nature of capital
- Mentee-Mentor relationships and Peer support
- Student Organizations



The bi-directional nature of capital is reflected in mentees harnessing and building their capital in the same way mentors may be supporting their own cultural wealth.

Previous studies (Tolbert Smith, 2022; Samuelson & Litzler, 2016) have recognized that a key motivator for students to persist in engineering is the idea that they may be able to help the future generation do better in engineering. This manifests in creation of mentor-mentee relationships and continued peer support. These relationships exhibit overlaps of social, aspirational, and navigational capital.

Student organizations like NSBE are great hubs for Black students to come together to help each other even when they have their own challenges. Three participants mentioned that NSBE was instrumental in their success stories. These hubs, or spaces, may be referred to as counter spaces in predominantly white settings. Our research suggests that such spaces exist at HSIs partly because experiences of Black engineering students as HSIs might mirror the experiences of their counterparts at PWIs.



- Black female engineering students: Carrying out this research, we found that Black female engineering students are understudied as a group. Even in our study, we were able to recruit only one female participant. More research highlighting Black women's persistence in engineering is needed in order to provide more insight into the overall Black student experience at various kinds of institutions. More research focusing on the forms of capital that Black women employ in higher institutions could broaden the knowledge in the field.

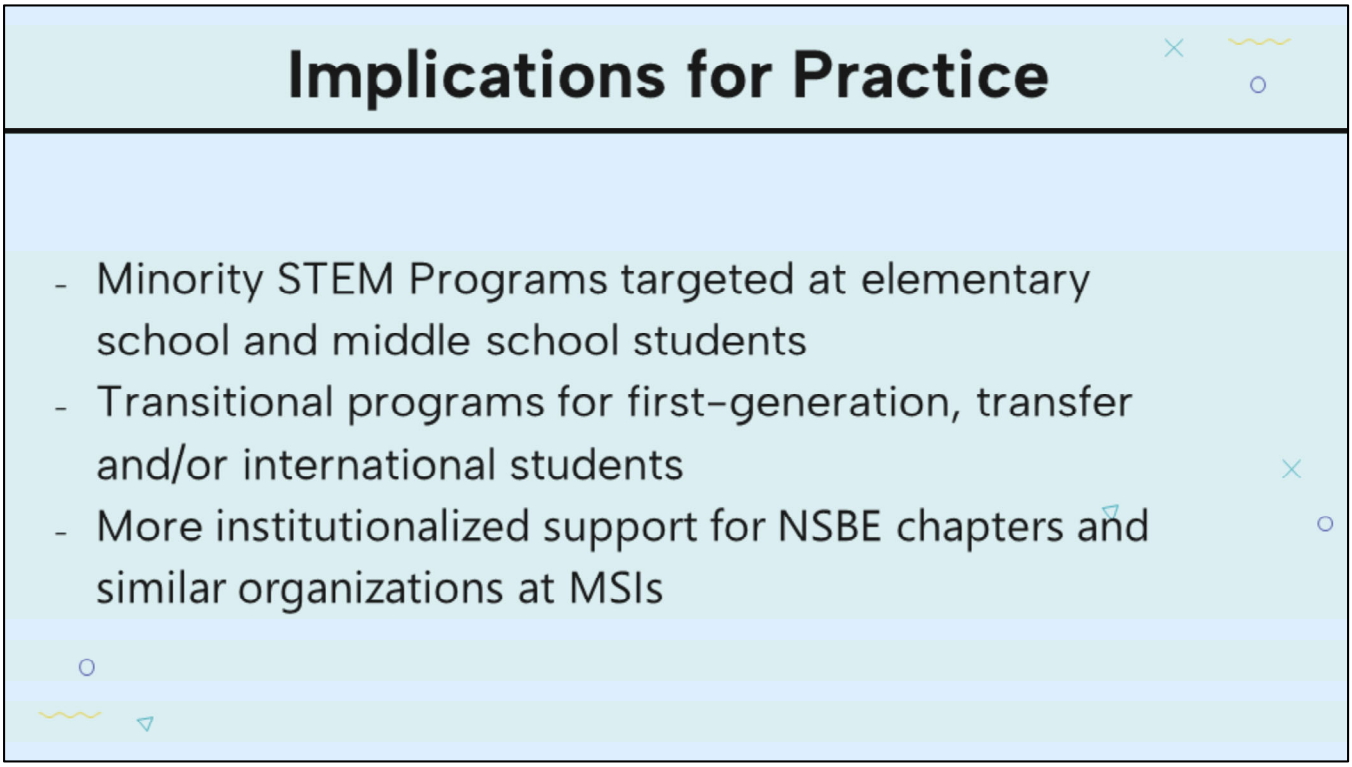
- Diversifying faculty at PWIs and HSIs: Various literature has highlighted the need for faculty diversity within different institutional contexts. While some have focused on this at PWIs, fewer have done so at MSIs. Work that focuses of faculty explicitly may advance the field.

- Linguistic and resistant capital: We saw a bit of overlap of linguistic and resistant capital per participants responses about dealing with challenges. While some research has gone into the overlap of familial, social, aspirational and navigational; linguistic and resistant capital overlap are understudied.

- Intersectionality: Black students are not a monolith, therefore more research into different groups of Black engineering students is important to capture the complete scope of the experiences of Black engineering students at higher educational institutions

- Development of STEM identity through cultural wealth: Black engineering students develop their cultural wealth over time. Further research may be conducted to analyze how their cultural wealth is sustained over time and how it

informs their engineering identities.



- Early STEM involvement: Many engineering students benefited heavily from STEM programs when they were in their formative years i.e. elementary, middle, and high school. These programs foster social connections in engineering and contribute to aspirations of becoming future engineers. These programs targeted towards K-12 students provide groundwork for developing cultural wealth and offer roadmaps for potential engineering success.

- Ease of transitions into higher educational institutions: With some of the participants being first-generation, transfer students and/or international students, we felt this study emphasized the need for transitional programs that help engineering students adjust to the rigor and expectations of a four-year university. Implementing these programs provides access to institutional resources and systemic support that supports and develops students' navigational capital, enabling them to gain access to resources often gatekept by word-of-mouth.

- More institutionalized support for NSBE chapters and similar organizations at MSIs is essential to student success.

Conclusion

- Steady growth of literature surrounding Black student experiences at MSIs
- Highlighting tools that Black engineering students possess that leads to their success at their MSIs
  - Relationships are the foundation for building and developing cultural capital
  - Intersections of cultural capital in overcoming challenges
- Cultural capital overlaps and is bidirectional
- Significant cultural changes at higher education institutions

In conclusion, there has been a steady growth of research surrounding Black student experiences at Minority Serving Institutions. We concluded that relationships are the foundations from which Black engineering students may build and cultivate their cultural capital. They may also use intersections of their cultural capital to overcome challenges. Their cultural capital overlaps and is bidirectional. Therefore, significant cultural changes must be made.

Thanks!

Any questions?

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