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Lived Experiences of African American Engineering Students at a PWI Through the Lens of Navigational Capital

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Introduction

There are significant disparities between the conferring of science, technology, engineering, and mathematics (STEM) bachelor's degrees to minoritized groups at four-year predominantly White institutions (PWIs) and the number of STEM faculty that represent minoritized groups [1], [2]. The Morrill Act of 1862 established engineering as a major at institutions currently known as PWIs. From the very conception of the engineering collegiate culture in 1862, minoritized groups have been ostracized and unwelcomed. Engineering as a major was not created with Communities of Color in mind. Studies have shown that a diverse engineering faculty contributes to improving access and success of diverse students [3]. Considering this, it is important to address the effects of the lack of minority faculty representation on student success at PWIs. This pilot study will begin to identify the ways in which African American students may arrive at success in engineering programs at PWIs where the minority faculty ranges from 0-10%. We define success as the matriculation from undergraduate to graduate programs.

Literature Review

Research has highlighted the experience of minoritized students in spaces with few minoritized faculty [4]. There has also been a consistent push for increasing minority representation at PWIs, yet studies show that as of 2019, the number of African American faculty at PWIs has increased by only 2.3% in the last 20 years [5]. Researchers have been studying the experience of the minority student from a critical race standpoint to highlight the lived experience of minority students in engineering programs at PWIs [6] and how they feel like "outsiders within" [7]. Research has highlighted multiple ways that students arrive at success in these institutional spaces created without them in mind. For example, Samuelson presents the belief that navigational capital is an existing asset that African American and Hispanic students use to maneuver their way to success. He provides examples of conditions or constraints faced by students of color including isolation, perceptions of racism, low expectations from faculty or peers, and few faculty members or peers of color to serve as role models and mentors [8]. The relationship between faculty and student is critical to the overall retention and persistence of engineering students [3].

Navigational capital has been applied in educational contexts to study its use among minoritized groups, and specifically in engineering education to study the persistence of students of color [6], [9]. Research on navigational capital often focuses on how participants acquire resources from others [9]. There is a limited focus on the experience of the student as the individual agent exercising their own navigational capital [9]. This study will draw from the framework of navigational capital and adapt it to study the success of two African American students in engineering. Integrating knowledge from the navigational capital framework and its existing applications in engineering education, we seek to lay the foundation for the exclusive use of navigational capital to analyze the experiences of minoritized groups in engineering. We seek to begin to fill the gap in research by drawing on the participants' accounts of their stories to identify the experiences that can be mapped to navigational capital.

Stories have the potential to broaden our understanding of phenomena. No two stories are ever the same. Critical race theory (CRT) supports the necessity of storytelling to understand how individuals experience life. CRT places importance on counter-storytelling and values the stories of marginalized groups in their own voices. These stories can be used to illuminate and explore lived experiences of racial oppression while capturing experiences that have been unaccounted for, dismissed, or obliterated in dominant narratives within education [10], [11]. Chimamanda Ngozi Adichie speaks on the dangers of relying on just a single story [12]. She

posits that although a group of people may share identities and goals, it is important to understand the nuances that exist within those groups by highlighting their stories [12]. To highlight these stories, we consider the presence of intersectionality in the identities of our participants. CRT framework brings into focus the ways in which race, class, and gender differently shape the experiences of students, and also differently affect the tools that enable them to succeed [11]. Intersectionality can be defined as overlapping traits or interests that attribute to isolated experiences [13]. Intersectionality lends to the understanding of individuals that experience overlapping oppressions [14]. Often the current conventional systems in place are not privy to the ways in which multiple identities compound themselves and create obstacles for the individuals at the center of those identities. Intersectionality provides a space of enlightenment by placing identity within a macrolevel analysis that connects the individual experience to a person's membership in social groups within larger, interlocking systems of advantage and success [14].

Theoretical Framework

The framework used for this study was derived from community cultural wealth (CCW). CCW takes an anti-deficit stance on the experiences of individuals from minoritized groups. It takes a critical approach to highlight the capital groups have based on their culture. Within CCW, there are six capital classifications: aspirational, familial, social, navigational, resistant, and linguistic [6, Fig. 4]. Each of these classifications contributes to the cultural wealth held by different communities. We have chosen to observe the uses of navigational capital among African American students in engineering. Navigational capital highlights the ways in which minoritized groups maneuver their way to success in environments not created with them in mind [6]. These environments include but are not limited to social institutions.

CCW comes from a critical race theory standpoint. It is built on the understanding that racism does exist and is integrated into the very fabric of our American society [6]. The history of communities of color not being considered when the culture of the nation was being established sets the stage for the unique experiences of and challenges faced by individuals from minoritized groups. Navigational capital allows researchers to look at those experiences and challenges. There is an existing understanding that communities of color experience stereotype threat, racism, microaggression, and other stressful events that can put a strain on their journey to success [7]. Rather than focus on these stressful events as markers of possible failure, we look at the ways students overcome these stressful events and achieve success. We use navigational capital to identify the individual agency that African American students have within the institutional constraints of their engineering departments.

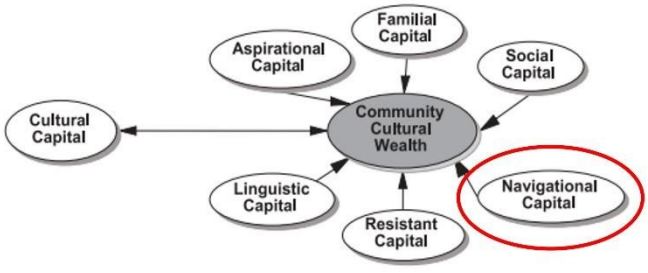

Fig. 1. The theoretical framework of community cultural wealth by [6] was used as the basis for this study design and analysis.

Methods

A. Interview Participant Recruitment

Participants were chosen from a student population at a single institution (a land grant PWI in the southeastern United States) in an engineering department that has no African American or Black faculty members. Participant selection was bounded by the participants' academic success, which we defined for this study as completing an undergraduate engineering degree and entering a graduate engineering degree program in the same engineering department. We wanted to only focus on students that are retained in their majors. For this pilot study, two participants were selected. This small number speaks to the unique intersectionality of the participants of this study. The participants had to be Black or African American and retained in their major from undergraduate to graduate. The PWI/LGU in this study has a total Black or African American student enrollment of about 6% with about 2.6% full-time Black/African American female graduate student enrollment and unreported Black or African American male enrollment. This number does not account for specific statistics within engineering majors nor whether students matriculated from the same university or degree program. Nevertheless, African American men continue to have markedly lower attainment than African American women and White students of both sexes [15]. If we have small numbers of Black or African American male and female students matriculating into graduate programs in their major, it is our duty as researchers to gain expertise in methods that allow them to learn from small numbers of participants [16].

B. Data Collection

Participants were sent IRB-approved documentation via email with an overview of the study and their roles in the study. Pseudonyms were selected by the participants at the end of their interviews. Sage identifies as an African American woman and has a mixed racial background. Frank identifies as an African American male. Both students interchange "Black" and "African American" when they are referring to themselves. The interviews were conducted via Zoom and transcribed first by Zoom analytics. Transcriptions were finalized and data was cleaned in conjunction with the first pass of coding. This cleaning process deidentified the data to maintain the protection of the participants.

C. Protocol

The interview protocol was adapted from a related study about student motivation, identity, and sense of belonging in engineering. Questions about navigational capital were added to the protocol to tailor it to the research purpose. The interview protocol had four sections: the student's story and indicators of success; engineering identity; navigational capital; and future-oriented motivation. These four sections provided context for participants to share how they arrived at success as defined in this pilot study.

Sample interview questions include:

Story/Indicators of Success:

- When were you first aware of graduate school, or getting a Ph.D.?
- When did you discover the engineering Ph.D. program at LGU?

Navigational Capital:

- Have you faced any difficulties or barriers in this journey?

- What roles have [name of program] played on your journey through [major] engineering?

The goal of the protocol was to reveal the story of the participants in such a way that highlighted the unique paths taken to achieve success.

D. Qualitative Methods

The qualitative analysis was carried out with closed coding, drawing from the framework of navigational capital, to identify skills used by the participants as they maneuver their way to success in an engineering program at a PWI. The first pass was descriptive coding to become familiar with the data and define descriptors of the participants' stories and experiences. This was followed by in vivo coding to highlight the ways the participants identified their experiences, connections, resources, and involvement that shaped their undergraduate careers. This process was coupled with the creation of a graphic representation of the phenomena of navigational capital among the participants. The excerpts coded through the in vivo coding were extracted to an Excel spreadsheet to map out the emergence of navigational capital for Sage and Frank.

Findings

Navigational capital can be defined by resilience, academic invulnerability, and skills [6], [8]. These three concepts come together to denote the journey of an individual as they achieve success in an environment not created with them in mind. The results showed that the participants tapped into their navigational capital when they used experiences, connections, involvement, and resources to be resilient, academically invulnerable, and skillful. In other words, they learned from experiences (theirs or others), capitalized on their connections, positioned themselves through involvement, and used their resources to achieve success in their engineering program. We describe each of these factors and how the participants connected them to demonstrate resilience, academic invulnerability, or skills.

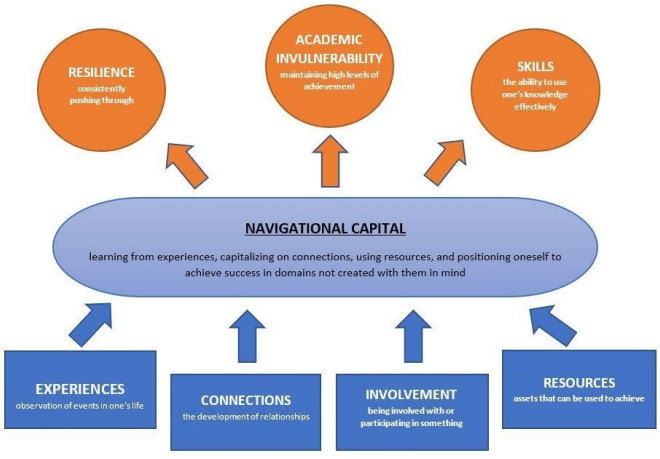

Fig. 2. Relationships between aspects of navigational capital based on data analysis of participant interviews.

1) Experiences: When participants described using experiences as part of their navigational capital, they tapped into experiences of their own or of someone else. The participants learned from those experiences for subsequent functioning.

"I've been a mentor for Minority Engineering Program (MEP) for about or I was a mentor for MEP for about two years um. And I participated in that summer research experience before I got to college, so that was a big big big big big part of you know my being comfortable with the LGU atmosphere…" – Frank

Frank's **experiences** helped him maneuver the demographic makeup of his PWI. His **experiences** in MEP and in the summer research experience set him up to build community and to be able to lean on this community during his undergraduate tenure. He developed the **skill** necessary to be comfortable at the university. As an African American male, he found that his surroundings were a significant contributor to his level of comfort. He mentioned that *"…I surround myself with a lot of Black people, because it was what made you say I, I was comfortable…"* Frank's **skill** of being able to establish community is a marker of his use of navigational capital. His previous **experiences** helped him to realize that to navigate his PWI, he needed to feel comfortable.

"Half of my family was like Black. I had a lot of experience kind of like seeing what people are like from you know those two very different cultures. And I feel like that's kind of helped me with like trying to connect with people…" – Sage

Sage comes from a blended family (African American and White) and identifies as African American. Sage drew from the **experiences** she had with her blended family to enhance her subsequent functioning. Sage's experiences helped her to understand the cultures of Black and White people. She was able to turn that into a **skill** to connect with others at her PWI. The point at which Sage took her familial **experiences** to use as a **skill** to maneuver her way to success at a PWI was an example of her navigational capital. Sage connected mostly with faculty, all of whom were not from minoritized populations, so her experience with White culture was key in developing relationships with faculty members that would later contribute to her acceptance into the Ph.D. program.

2) *Connections*: When participants used connections to exercise their navigational capital, they thought about their network. Their connections stemmed from different relationships they had built with peers, professors, staff, and other affiliated entities. Participants took those connections and began to use the relationships they had built over years to contribute to their resilience, to help them achieve academic invulnerability, and to develop skills.

"It took me a minute to build those relationships and it definitely paid off in terms of you know, like having reliable study partners, having reliable people who knew like whatever I didn't understand they did, whatever they didn't understand I did you know, so it was a mutual agreement, we can we can actually help each other…" - Frank

Frank capitalized on his **connections** to develop **academic invulnerability**. Frank was able to build his **connections** by making meaningful relationships with his classmates. His intentionality can be seen in his account of why he built those relationships. Frank knew the importance of having reliable people to be there for him when he encountered a topic he did not understand. He cultivated an environment between himself and the classmates he made relationships with such that he could not fail. He set himself up to achieve academic invulnerability in his classes by building connections with his classmates thereby exhibiting individual agency in his journey to success at his PWI.

"faculty who I really like build those strong relationships with I don't know if I could say I built super strong relationships with everyone else. But we definitely had like this understanding that like you know I am here to learn and they knew that" – Sage

Sage made it a point to build relationships with her department faculty throughout her undergraduate tenure. This decision to invest in her faculty relationships set Sage up for success. As mentioned, because Sage was able to get to know her faculty members, they had an understanding that she was there to learn. They acknowledged her zeal for knowledge, and this showed in their interactions. Sage also noted in her interview that she would often have conversations with her faculty regarding points missed, *"if I got a 98 in the test I'm still coming to your office and asked why [I] miss[ed] those two points."* The relationships built with her faculty can be identified as **connections**. By ensuring that her faculty could see her passion for learning, Sage secured her ability to maintain high levels of achievement in class which contributes directly to her **academic invulnerability**. Sage's decision to intentionally build her relationships with her faculty fed into her navigational capital. The point at which she used these relationships to show her passion for learning and reveal her perseverant character is considered a marker of her navigational capital at use.

3) Involvement: When participants used their involvement to exercise their navigational capital, they strategically positioned themselves into different organizations within their communities. They identified with these communities by race, gender, major, interests, etc. The participants then used this involvement to be resilient, achieve academic invulnerability, and develop skills.

"I was trying to get involved to make sure that my voice was being heard, because if anybody else ain't gonna speak about it, I will …" – Frank

As a member of a minoritized group, Frank was well aware of the struggles of not being heard. There were individuals at his PWI from the same cultural background as those that historically stifled the voices of African American peoples. He knew the importance of his voice being heard and was able to position himself to achieve that through **involvement**. Despite the silencing culture of White to Black individuals, Frank found a way to persist and have his voice heard. This shows how Frank was able to use his involvement to become **resilient** at his PWI, which was how he maneuvered his way to success. He developed **skills** at making sure that his views were heard and that he was seen. This eventually led to recognition from faculty, which was important to his success as an accepted PhD student.

"…and Department Mentoring Program (DMP) and Department Government (DG) and all these engineering organizations. I feel like it kind of helps tie me into the department…so I feel like being involved in that kind of stuff helped me to just be in the Department Building (DB) more and have my voice heard…" – Sage

Department Mentoring Program and Department Government are two engineering organizations within Sage's engineering department. Sage's **involvement** in these organizations helped her position herself within her department and create ties that set the stage for her voice to be heard. Considering Sage's racial and gender positionality as a Black African American female at a PWI, the ability to be heard and to have safe spaces to voice her concerns and opinions contributed to her ability to push through adversity by way of communication. Sage

acknowledged the importance of having a voice as a significant reason she chose to continue her education at her PWI, "…or *do I stay somewhere that kind of needs more voices from students of color*". Her **involvement** in DMP and DG fed into her navigational capital. She used this **involvement** to navigate her way to success by ensuring she had the space to be **resilient** within her department.

4) Resources: When participants described using resources to exercise their navigational capital, they considered all that has been offered to them or shown to them throughout their engineering student experience. They referred to the availability of these resources and oftentimes would jump at any opportunity to use said resources.

> *"so I finished my first semester didn't do too hot um and I realized, you know hey I gotta figure this out, you know i'm started, you know going to university tutoring sessions and whatnot" – Frank*

Frank was aware that to achieve in his courses, he needed to try something different. He leaned on the **resource** of tutoring available to him at his university. His decision to use his **resources** to perform better in his courses fed into his navigational capital. Frank made mention of the disparity between the background knowledge he entered the engineering program with and that of his fellow classmates, *"that's another thing my high school wasn't the best high school, you know we didn't have every AP class available to man…. I hadn't been taught how to think critically… I never seen engineering fluff you know… a lot of people around me did right. They knew how to think critically…remember thinking…do I have the wrong textbook do I have a different textbook".* Frank understood his position and knew that to bridge the divide, he would need to take matters into his own hands. Choosing to use the tutoring resources helped Frank attain higher levels of achievement thereby securing his **academic invulnerability**.

> *"Like having the resource of the co-op office and that experience and just internships also like the research internships which are a little bit more departmental were definitely very beneficial to me throughout undergrad" – Sage*

Sage identifies the **resources** that were beneficial to her throughout undergrad. Although she had internship and research experiences, she does not identify a specific resource for these opportunities. It is important to note, however, that she identifies the internships as a resource and connects them to her academic success.

Discussion and Conclusion

The students spoke explicitly about their PWI culture in their engineering department. They did not expect to have role models in their major that looked like them and went into their undergraduate experience with the understanding that they will be the distinct minority in their classes. Understanding this, they did not make notable mention of the way a lack of minority faculty affected their success. They identified ways they maneuvered around this fact through involvement, experiences, and connections. When explicitly asked if having minority faculty would have made a difference, Sage and Frank had different responses:

> *"There's a certain amount of ideas and like ways of thinking that you know your upbringing and identities and who you are you won't ever understand someone; its*

perspective completely and I do feel like there are some limitations that we have, or I have. With having no one like, not a single you know we have people of color in our department, but not a single Black faculty member who you know, has an experience similar to a minority." – Sage

"I wouldn't know honestly um something that I've thought about since graduating you know from undergrad, I thought a lot about what my undergraduate experience could have been had I attended a HBCU." – Frank

The institutional support for individuals from minoritized groups differs across different institutions and types of institutions. Some universities may have engineering-specific student support programs, while others may aim to provide support to all minoritized students regardless of major. The important factor to highlight is the accessibility of these programs and subsequent recognition of them as resources by minoritized students. At the PWI in this study, Frank identified his involvement in an MEP and how beneficial this experience was to his success. Sage speaks about the same program, stating that she "missed the ball somehow" because she wasn't aware of the program and therefore could not participate. This shows how although programs may be in place at different PWIs, their reach to students and students' awareness of them needs to be re-evaluated.

The participants, much like many other minoritized students at PWIs, were cognizant of the racial makeup of their university when they applied. Upon acceptance, they took on the challenge of being a racial minority in exchange for a credible degree they know will be held in higher regard compared to other engineering programs. Frank noted, *"When people hear LGU, not even just in the state but all around the United States like people hear LGU and know that there is a certain level of respect behind your degree."* This exchange reflects the necessity of knowing how to tap into navigational capital. Minoritized students enter PWIs with the goal of arriving at success. As noted in this study, the way that minoritized students arrive at success is not one-size-fits-all. Sage and Frank arrived at the output constructs (resilience, academic invulnerability, skills) using the same input constructs (connections, involvement, resources, experiences). Even still, the manners in which their navigational capital manifests itself was not always the same. It is necessary to present stories that reveal different paths to success to shed light on student experiences and to find purpose in their differences. Stories can be used to empower and to humanize [12]. It is our duty as researchers to ensure that we recognize and continue to bring forth these different stories of minoritized students in engineering.

In this study, success is defined as the matriculation from undergraduate to graduate studies. Research shows that African American students struggle with feeling like the "outsider within" in graduate programs [7] and that the engineering culture can persist from undergraduate to graduate programs. Students at PWIs can benefit from understanding their own navigational capital to help them identify the qualities and competencies they require to successfully navigate educational institutions by exposing their capacity to maintain high levels of achievement, their connections to networks that facilitate navigation, and their ability to draw from experiences to enhance resilience [8]. Sage and Frank majored in the same engineering discipline, finished their undergraduate degrees in four years, and matriculated to the graduate program at the same institution, yet still had significantly different experiences. There is power in those differences.

Limitations & Future Work

One of the limitations of this pilot study is the small sample size. Although this pilot study presents rich, focused data to build on, we look forward to including more voices from African American students in engineering at PWIs as we expand beyond this pilot study. Also, these findings are not necessarily limited to Black and African American students at PWIs; future studies could expand on our findings to explore other minoritized populations at institutions that were not designed with them in mind.

A second limitation of this study is the fact that the results are preliminary and call for further study that aims to explore the cultures cultivated in different engineering programs at PWIs and how African American students navigate them. We plan to collect and analyze further data to identify how students use their navigational capital to achieve this aim.

Finally, this study looks at the broader view of the participants' experiences and maps those experiences to navigational capital. Because the protocol was adapted from a previously established protocol about students' experience in engineering, the amount of data from the interview focused on navigational capital is limited. For example, we did not specifically probe for participants' experiences with respect to resources and might have found more insight had we asked more specific questions on this point. We plan to develop the protocol further to specifically focus on aspects of navigational capital that were revealed in this pilot study. To identify other aspects of student experiences that are not reflected in the navigational capital framework, we will also use open coding in future analyses.

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