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Cultural Capital: A Contributing Factor in the Success of High Achieving, Low Income Engineering Students

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Abstract

Due to the continued lack of diversity in engineering and the limited research on socioeconomic status, the objective of this project was to understand how high-achieving, low-income engineering students utilized cultural capital to carve successful academic pathways. This study used a qualitative inductive approach to address the research question: *how did high-achieving low-income engineering students use cultural capital to succeed academically during COVID-19*? Results showed that participants utilized social, navigational, and aspirational capital to succeed during the pandemic. The results expand understanding of this sample of students and their resolve to succeed academically using cultural capital.

Keywords: cultural capital, engineering, low-income

Cultural Capital: A Contributing Factor in the Success of High Achieving, Low Income Engineering Students

One of the most significant concerns in the field of engineering is the lack of diversity. In the last six decades, a considerable body of research has drawn attention to the disparate number of professionals and students who represent historically underrepresented racial, ethnic and gender groups. In 2021, Georgetown University Center on Education and Workforce reported that 81% of the engineering workforce was White or Asian, 3% were Black or Latino women, and 84% were men (Carnevale et al.). During the decade between 2009-2019, the number of engineering degrees awarded to Latinx folks increased by 13% and by 3% for African American folks. However, both groups are underrepresented in the engineering workforce (Carnevale et al., 2021; National Science Board, 2022). Though the number of women engineers has increased from 5.8% to 14% over the last twenty years, the fact remains that the number of women engineers is drastically lower than their male counterparts (American Society of Mechanical Engineers, 2012).

Diversifying the future engineering workforce is critical for the future growth of the nation. In 2015, The President's Council of Advisors in Science and Technology (PCAST) called the lack of diversity across all STEM fields a national imperative given the exigent role of science and technology in the nation's economic stability, national security, and global influence (Chen, 2013). As the current workforce approaches retirement age, the need to fill open positions will be even greater. Moreover, census projections indicate significant growth among racial and ethnic minorities populations which will create another potential pool of future engineers (US Census Bureau, 2021). Arguments that support diversity in engineering have been focused on race, ethnicity, and gender. However, much less is known about socioeconomic diversity in

engineering. Hence, the emphasis of this study will be high achieving, low-income engineering students.

Literature Review

Low-Income College Students

Recent data show that a mere 8.1% of students enrolled in undergraduate engineering programs come from low-income families (NCES, 2016; Major et. al, 2018). Furthermore, students from low-income backgrounds have higher attrition rates than their White and Asian counterparts in STEM programs (Chen, 2013; Griffith, 2010; Hoxby & Avery, 2012). The relative absence of low-income students enrolled in engineering programs has systemic effects. Since engineering degrees typically lead to higher salaries, the underrepresentation of low-income students impedes future earning potential that engineering degrees offer, thereby perpetuating income inequality for decades to come (Major et. al, 2018; Wait & McDonald, 2019). Scholars from multiple disciplines agree that the shortage of women, Latinx, and African Americans in engineering is an irrefutable crisis in academia.

While they may often face additional barriers to successfully accessing meaningful college pathways, low-income college students can be determined and resilient in creating success for themselves. Low-income college students experience increased self-worth and success when they engage with pre-college mentors (Hurd et al., 2018), college faculty, and peers (Holcombe & Kezar, 2020). Regularly scheduled meetings with mentors, faculty, and peers can help these students to build deeper relationships that support their successful navigation of college (Spindel Bassett, 2021). The cultural capital that these students build can lead to increased ability to successfully navigate engineering pathways (Ruiz Alvarado et al., 2020).

However, low-income college students often struggle to ask for help due to perceived negative reactions and internalized views of help (Spindel Bassett, 2021). Low-income college students are more likely to experience impostor syndrome and decreased self-worth when engaged in cross-socioeconomic friendships (Jury et al., 2019; MacInnis et al., 2019). Underrepresented college students need intentional social and structural support systems to increase success in academic pathways (Ong et al., 2020). Thus, institutions that utilize knowledge of the community cultural wealth framework (Samuelson & Litzler, 2016) to construct programs may be able to increase the navigational capital and overall success in engineering pathways for diverse low-income students (Kezar et al., 2020; Ruiz Alvarado et al., 2020).

High-Achieving, Low-Income College Students

Most of the current literature on the experiences and needs of low-income college students has not specifically focused on high-achieving, low-income students, though they were inadvertently included (Ruiz Alvarado et al., 2020; Wilson, 2016). This group of students tend to graduate at lower rates and attend less selective colleges, while also being more likely to experience shame, lack of academic and social integration, and financial stress (Ruiz Alvarado et al., 2020; Wilson, 2016). In a more recent study on high-achieving, low-income college freshmen, students perceived a lack of social fit, uncaring professors, and a lack of support (Wilson, 2019). In other words, these students are experiencing challenges in building cultural capital in college, which has an impact on their ability to successfully matriculate into and navigate through engineering academic pathways (Ruiz Alvarado et al., 2020).

While students in one study named study habits, self-esteem, finances, and the above factors as challenges to their education, they also described a determined resolve to complete

their goals (Wilson, 2019). However, the researcher noted that these challenges in attending college also led to decreased confidence and increased uncertainty about college. Another researcher concluded that high-achieving, low-income college students were successful and resilient in college when they had the support of family, mentors, and teachers (Hebert, 2018). In other words, high-achieving, low-income college students are successful when they have the opportunity to utilize cultural capital to navigate college matriculation (Samuelson & Litzler, 2016).

Theoretical Framework

In this study, we sought to understand how high achieving, low-income students utilized community cultural capital to successfully access academic pathways to engineering majors during the COVID-19 global pandemic. The theoretical framework of community cultural wealth (Ruiz Alvarado et al., 2020; Samuelson & Litzler, 2016) informed the research design and thematic analysis of the data. This framework takes an asset-based understanding of marginalized groups and looks to understand the systemic barriers to their success, rather than perceived deficits. Specifically, six types of capital can build on each other to pave the way for success for many marginalized populations, though this theory was initially based on communities of color (Yosso, 2005). Aspirational, navigational, social, linguistic, familial, and resistant capital are not considered to be mutually exclusive and help researchers to understand how some students from marginalized backgrounds have overcome systemic barriers to their success.

Previous studies utilizing this framework have identified the need for navigational capital, or the ability to maneuver social institutions, among marginalized populations (Mobley & Brawner, 2019; Ruiz Alvarado et al., 2020). However, the studies that we located were

focused on using this framework to understand the experiences of Black and Hispanic students. Because low-income college students have faced their own challenges to economic mobility and success historically, we believe that the community cultural wealth framework (Yosso, 2005) can aid us in building an understanding of this population's strengths and resources. For instance, low-income college students may not already be equipped with navigational capital typically given by parents but can gain this support from other natural mentors, or nonparental adult mentors that exist in a student's pre-college social networks (Hurd et al., 2018). Thus, our seminar design has the potential to increase cultural wealth for low-income college students through peer group support, professional networking, and intentional mentoring.

Methods

In this qualitative study, we chose to take a basic inductive approach (Thomas, 2006) to allow the voices of students to surface through the data. We did not form hypotheses prior to conducting the research. Taking an exploratory perspective, we developed meaning and themes based on the data itself, as the analysis developed. The codes produced in this research deepen our understanding of the values expressed by students when discussing the cultural capital, they utilized to successfully access and matriculate into engineering pathways.

Study Site & Participants

This study took place at a medium-sized southeastern university in the United States. In 2018, funding from the National Science Foundation (NSF) Scholarships in Science, Technology, Engineering, and Math (S-STEM) Program led to the development of a scholarship program for high-achieving, low-income students admitted to any of the five engineering programs offered. The S-STEM program was created to increase the number of under-represented students in STEM (NSB, 2022). Our S-STEM scholarship program provides a wrap-

around cohort experience that includes student support, mentoring, specialized advising, and $40,000 of individual scholarship funding for four years. A purposeful sample of fifteen undergraduate engineering students who were recipients of the S-STEM scholarship program, and thus, participants in the S-STEM seminar were the focus of this study. The sample included five women and ten men who were undergraduate students in civil engineering, computer engineering, electrical engineering, electrical engineering technology, mechanical engineering, and mechanical engineering technology. Participant demographics are shown in table 1.

Table 1.
Demographics of focus group participants

Major	Race	Gender
Civil Engineering	Hispanic/Black/White	M
Civil Engineering	White	F
Civil Engineering	White	M
Computer Engineering	Not disclosed	F
Electrical Engineering	Black	F
Electrical Engineering	Not disclosed	M
Electrical Engineering	Not disclosed	M
Electrical Engineering	Not disclosed	M
Electrical Engineering Technology	Black	F
Mechanical Engineering	Hispanic & White	M
Mechanical Engineering	White	M
Mechanical Engineering	Black	M
Mechanical Engineering	White	M
Mechanical Engineering Technology	Hispanic	M
University College	Black	F

In the first year of the S-STEM program, the scholars participated in a weekly seminar, led by the graduate research assistant, an advanced doctoral student in the college of education. While the seminar experience was patterned after other successful S-STEM programs at Appalachian State University (Tashakkori et al., 2018) and University of Wisconsin at Milwaukee (Reisel et al., 2012), we modified our offerings based on scholar feedback. Tailored to the developmental needs of traditional college students, our programming is designed to create a cohort experience, develop the scholars' independent problem-solving skills, and build their confidence as future engineers.

Data Collection

Given the small sample size, we conducted three, online focus groups. Focus groups are used widely in qualitative research and are beneficial for cultivating participant interactions and free expression of multiple perspectives (Henneck et al., 2019; Jenkinson et al., 2019; Mertens, 2020). Being synergistic in nature, focus groups can create a safe environment for participants and the focus group moderator to engage with one another. Using focus groups as an evaluative tool, we also collected ideas to improve the mentoring component of the scholarship program. A graduate research assistant conducted three, 1.5-hour focus group sessions during the Fall 2020 semester using Zoom for video and audio recording. There were five participants in each focus group. After each focus group, the audio was transcribed using an external transcription service.

Analysis

To understand our data, we used a two-phase approach for data analysis. In phase one, all focus group transcripts were reviewed for accuracy of transcription. Then, using methods coined by Strauss and Corbin (1990), we read all transcripts line by line, studying fragments of the data and labeling them with open codes. During the second phase, we developed axial codes from the

open codes. Continual contrasting and comparison of open codes led to the development of analytical themes, sub-themes, and conceptual linkages between the participants' responses (Thomas, 2006). Memos were also created to summarize themes and to identify analytical connections throughout the data. Since the analytical process is iterative (Charmaz, 2014) open codes, axial codes, and themes were refined and reconceptualized at multiple stages of the analytic process. Throughout the coding process, memos were created for reflections and thoughts about the focus group interviews.

Trustworthiness

Several steps were taken to ensure rigor and the trustworthiness of our study. We used the tenets of credibility espoused by Lincoln and Guba (1989). Member checking between the research team occurred by sharing the open and axial codes with the entire team. This step allowed for discussion of the coding and thematic analysis. Furthermore, memos and spreadsheets were created by the two main researchers to create a trail for the processes that we used and to ensure that, if necessary, our study could be replicated by other qualitative researchers.

Reflexivity

As researchers, it is important to practice reflexivity in identifying, announcing, and bracketing our biases and assumptions about the nature of our research, including our positionalities and relationship to the data and study participants (Smith & Luke, 2021). As a doctoral research assistant, I have a strong belief in education and social justice, a strong passion for supporting low-income college students and other underrepresented groups, and a personal understanding of the significance of building cultural wealth in the successful navigation of higher education. I bracketed my biases through ongoing conversations with other members of

the research team and through the creation of memos during the research process. It is important to note that I am not the same doctoral research assistant mentioned in the study design and seminar facilitation section.

Findings

Our findings indicate three overall themes, with sub-themes: (a) social capital (mentoring & peer support), (b) navigational capital (mentoring & resourcefulness), and aspirational capital (problem-solving abilities) were forms of cultural capital utilized by low-income engineering students to successfully navigate undergraduate engineering pathways during COVID-19. Our sub-themes were fitted into the community cultural wealth framework (Yosso, 2005) to conceptualize the various forms of capital that participants were utilizing to matriculate through their engineering journeys. In the following sections, we will discuss each theme and utilize participant quotes to illustrate salience and offer detailed meaning of the themes.

Social Capital (Mentoring & Peer Support)

Our first emergent theme, social capital, further validates the importance of building relationships that are resources in a student's success, as previously conceptualized by the community cultural wealth framework (Yosso, 2005). Social capital describes the people and community resources that students may use as a support in accessing or succeeding in an institution or academic pathway (Samuelson & Litzler, 2016). This can range from community organizations that support students in preparing their financial aid applications to social contacts that students are able to access for homework help. Our participants described utilizing various mentoring sources available to them to overcome challenges and depending on peer support to make it through difficult moments. The participants seemed to particularly benefit from and

value connections with mentors or peers that had shared experiences, such as navigating higher education as a Black engineer.

One participant asserted the importance of connecting with their peers whether that be for building their own social skills, working with teams in class, or creating networks for future resourcing. When asked what skills they needed to access the engineering pathway, they stated,

> "Um, social skills or teamwork. Uh, that's obviously important in almost anything these days. Um, those two are the main ones and those are the ones I definitely practice the most in high school. Aside from that, um, going, going back to social skills, just the ability to [inaudible] that characteristic would be, but just being able to make connections easily is a very important thing. And it goes to networking of course, but just being able to be a people's person."

Another participant described how meaningful it was for them to connect with other persons with shared identities, noting a felt sense of support and collective success. When asked about how they were succeeding so far in their academic program, this participant stated,

> "So that's what I like about meeting other black engineers. It's like, we're all if you're succeeding, I'm succeeding. I'm like we studied for a test together. I had never done something like an actual study session that I felt was actually helpful. That was the first time. Um, you know, if we have questions on homework, we can, we can ask each other that type of stuff."

This quote highlights the importance of not only building powerful social capital networks that offer resources for academic success, but also of connecting with others who share intersectional cultural identities and experiences.

Navigational Capital (Mentoring & Resourcefulness)

Our second finding, navigational capital, illustrates the need for low-income students to learn how to navigate complex administrative systems and locate faculty, staff, and institutional resources that can assist them in doing such. Our participants discussed pre-college opportunities that they had which afforded them early access to and knowledge of engineering pathways. This type of access and early exposure to engineering can give them an advantage when they matriculate into their engineering department. Specifically, professional interactions, or mentoring, and a student's resourcefulness, can have a meaningful impact on their academic performance and overall college experience.

When asked about the experiences that shaped their expectations about majoring in engineering, participants described developing an awareness of what it meant to become a professional engineer through interactions with industry professionals. Some participants recalled a wealth of experiences while others noted the lack of experiences with engineering prior to college. However, those that described a lack of experiences typically also gave examples of brief informal encounters that were meaningful as well. For instance, one participant noted:

> "Uh, prior to UNC Charlotte, it would probably be, um, meeting other professional engineers through robotics, uh, I had met a couple of them. I remember I met a software engineer who is going to mentor the team, but due to COVID, uh, things got a little shaky there, so I never really got to work a lot with them, but I did get to meet him. He sent me a little bit of his, um, coding. Um, that's pretty much about it. I didn't really talk to a lot of engineers prior to UNC Charlotte."

Of course, this participant has illustrated the extra challenges that our scholars experienced during the COVID-19 global pandemic. During this time, most interactions were held online, leading to feelings of burn out around online meetings which also represented an extra barrier to building navigational capital.

Pre-college experiences were particularly powerful for our group of participants, though the results around college experiences could certainly be impacted by the challenges of the pandemic and strictly online communications. One participant listed several opportunities that they had to engage in STEM prior to college. They stated,

> "Uh competitive, uh, interaction I've had through STEM. Um, yes. Uh, so it's, since, uh, in, um, elementary school, I've, uh, always had the interactions before working with, uh, like things that are related to STEM, like producing projects that are, uh, related to, um, building circuits and building robots and, uh, data, uh, that was, uh, greatly improve the, in my high school years when, uh, during the sophomore year I, uh, started, I joined the tech cop and, uh, started, uh, the robotics team with a couple of my friends. And we got together and built a robot and found out about this competition, uh, was the students, uh, technologies, uh, associated and, uh, using, uh, vex, robotics parts. Uh, we built robots and, uh, based on the criteria of the competition, we bent and competed with them every year until long, uh, senior years. And, uh, that was the first real, like real world, uh, especially."

This participant specifically described their pre-college experiences as real-world interactions, indicating their value to the student and the student's belief in the importance of early application experiences with STEM.

Aspirational Capital (Problem-Solving Abilities)

Our third theme, aspirational capital, illustrates the perception of our students that intrinsic motivation and self-reflection are necessary to tackle the curriculum and progress in the college of engineering. This is explained by the notion of aspiration capital within the community cultural wealth framework. Aspirational capital describes a person's inner characteristics, specifically their dreams for the future, as a powerful resource for perseverance despite real systemic barriers (Yosso, 2005). Within this theme, there was a sense of academic self-efficacy or a sense of confidence in one's own ability to succeed in engineering (Bandura, 1997; Schunk, 1991). Specifically, participants described problem-solving abilities as an important aspect of success in engineering. Problem solving abilities was referenced by the participants consistently when asked about how they had been successful or overcome challenges to their success in college so far. We conceptualized this as aspirational capital due to the connection students made between what it means to be an engineer, their personal strengths, and their aspirations as future engineers.

Starting with their identity as an engineer, one participant described personal qualities they felt they embodied. This participant stated,

> "So, as an engineer, I feel like my problem-solving abilities and my resourcefulness with what I have around me is probably my biggest advantage. Um, when it comes to like, if I get myself into a situation or if I, if I'm working on something, I can't figure it out. So, a lot of times, you know, I'm, I'm one of the first ones on the team or whatever is to look around and be like, hey, can you hand me that I can, I can do something with it."

While this participant specifically mentions problem solving and resourcefulness, we observed that they were also describing being a team player, taking initiative, and perseverance. These

were all qualities that they used to solve any problem that arose, because they believed in themselves and their career aspirations as an engineer.

In fact, another participant described the experience of navigating a system, asserting that the only option is to persevere, solve any issues that arise, and simply, get things done. This participant seems to illustrate the disempowered experience of navigating large institutional systems, while at the same time using the power of mindset to overcome challenges. They stated, "Sometimes I just, it's a system and it's just, no emotions got, gotta do it. Just keep on pushing and eventually it'll get easier." With this simple quote, we can understand both the perceived culture of engineering and education, as well as a personal narrative around what it takes to succeed in that culture. Meanwhile, another student talked about the culture of engineering through the particular skills needed for successful engineers. The participant states, "And to me, it's, it comes to me just so I think, um, that those are pretty good skills for engineering. I'm good at problem solving. I love to solve problems, whatever the issue is. I love solving it." While this quote indicates the relative confidence of this participant in engineering, it can also highlight a space where students might not see themselves as engineers. In other words, if students do not see themselves as adequate problem solvers, they may not be able to see themselves as future engineers.

Our overall findings for this study indicate that high-achieving, low-income college students in engineering utilize multiple forms of cultural capital to be successful in accessing the necessary resources to support their engineering pathways. Specifically, we found that students used forms of social capital, navigational capital, and aspirational capital to access and succeed in engineering. All this cultural capital accumulates to create cultural wealth for students which may help them to overcome systemic barriers to their success.

Significance

In this study, we aimed to gain a better understanding of the types of cultural capital that high-achieving, low-income students utilized to excel as engineering majors, despite the significant shift in teaching, learning, and institutional culture caused by the COVID-19 global pandemic. Our research findings could provide significant implications for the recruitment and retention of low-income college students, as well as for innovation in engineering education. Better understanding the experiences of low-income students in engineering may lead to the development of approaches that increase cultural capital for this group of students, allowing them the opportunity to overcome institutional obstacles and academic rigor of the engineering curriculum. Ultimately, a clearer understanding of the barriers that low-income college students face, and expansion of appropriate support programs could lead to increased diversity in engineering, increased economic mobility for underrepresented engineering students, and increased innovation in the field of engineering. Increasing diversity and innovation within engineering also supports the United States' need to maintain its position as a global leader in scientific and technological advancements. Our study adds to the growing body of literature on the needs of this group as they pursue their academic and professional goals to become future engineers.

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