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Black Males in Pursuit of Advanced Engineering Degrees

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Dr. Jerrod A. Henderson ("Dr. J") is an Instructional Associate Professor in the Cullen College of Engineering at the University of Houston. He has dedicated his career to increasing the number of students who are in the pipeline to pursue STEM careers. He believes that exposing students to STEM early will have a lasting impact upon their lives and academic pursuits. He is a co-founder of the St. Elmo Brady STEM Academy (SEBA). SEBA is an educational intervention aimed at exposing underrepresented fourth and fifth grade students to hands-on, inquiry based STEM experiments and activities.

Henderson is a part of the William A. Brookshire Dept. of Chemical & Biomolecular Engineering and he was recently appointed by the Dean of the College as the Director of the Program for Mastery in Engineering Studies (PROMES), a program aimed at increasing engineering student achievement, engagement, and retention. His research interests are in engineering identity formation and persistence among underrepresented students, especially Black males. He was most recently recognized by INSIGHT Into Diversity Magazine as an Inspiring STEM Leader Award recipient. He was also recently awarded a Young Alumni Achievement Award from the University of Illinois' College of Liberal Arts & Sciences (2019); and the Science Spectrum Trailblazer Award, by career communications group as a part of the 34th Black Engineer of the Year STEM Conference (2020).

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Dr. Erik M. Hines is an associate professor in the Department of Educational Psychology and Learning Systems at the Florida State University as well as the coordinator of the Counselor Education Program and School Counseling Track. Dr. Hines prepares graduate students to be professional school counselors. Dr. Hines's research agenda centers around: (a) college and career readiness for Black males; (b) parental involvement and its impact on academic achievement for students of color; and (c) improving and increasing postsecondary opportunities for first generation, low-income, and students of color (particularly Black males). Additionally, his research interests include career exploration in the fields of Science, Technology, Engineering, and Mathematics (STEM) for students of color. Dr. Hines has secured research funding to study the college readiness and persistence of Black males to improve their academic and career outcomes. Further, Dr. Hines has worked on several grants aimed at increasing awareness of STEM careers for students of color and rural students. He has over 30 publications and secured over $1,000,000.00 in extramural and internal funding. His research has appeared in peer-reviewed journals, such as the Journal of Counseling and Development, Professional School Counseling, The High School Journal, and Urban Education. Equally important, Dr. Hines is an ACA Fellow and received the Al Dye award for co-editing the special issue, Group Work with African Americans Children and Adolescents published in the Journal for Specialist in Group Work. Dr. Hines received his Ph.D. from the University of Maryland, College Park in Counselor Education with a concentration in Urban School Counseling. Finally, he has worked as a counselor in various K-12 settings and for the Ronald E McNair Post-Baccalaureate Achievement Program.

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My name is Jared Davis and I am currently a junior mechanical engineering major at the University of Houston. For the past year, I have been conducting research in relation to increasing participation of Black males in graduate engineering programs. I enjoy this work very much and hope that it is helpful for many students like myself!

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My name is Tyron Slack and I am a doctoral student in the Combined Counseling Psychology and School Psychology program at Florida State University. I am from New Orleans, Louisiana. I received my B.A.

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Introduction

Producing graduates with science, technology, engineering, and mathematics (STEM) competencies remains a national concern/challenge [1]. Annually, less than half of the students who enter U.S. colleges intending to major in a STEM field persist [2]. The outlook is worse among underrepresented students (i.e., Black, Latinx, Native American, and women). For example, among engineering students, only 14.6% of bachelor's degrees were awarded to Latinx and Black students, and 20% to women in 2015 [3, 4]. In addition, the representation of Black males remains a challenge. Each year, about 64% of engineering bachelor's degrees are earned by White males, compared to only about 5% Black males [5]. The outlook is bleaker among those who obtain graduate degrees. Black males only account for 3% and 1.7% of STEM Master's and Doctoral Degrees, respectively [6].

A considerable amount of scholarship has looked at the power of interventions as a means to increase the representation of underrepresented students (including Black males) in engineering such as undergraduate research experiences, active learning in the classroom, and living and learning communities [7]- [9], [2]. While these post-secondary interventions have shown to be effective, the representation of Black males in all segments of the engineering pipeline is still a challenge. Leading scholars have elucidated the experiences of Black males once they enter graduate engineering programs and what is essential for them to be successful [10], [11]. However, there remains a dearth of literature that has sought to uncover and understand the factors that influence Black male engineers to pursue engineering graduate degrees, and further use their perspectives for more informed intervention design.

In this work in progress paper, the findings that are presented are a part of an ongoing NSF funded project to understand how to get more Black male engineers to pursue advanced degrees in engineering and go into the engineering professoriate. Of the research questions that are a part of the ongoing work: 1) What factors influenced Black males to pursue graduate degrees in engineering? 2) What assets/strengths do Black males possess who persist or plan to continue in engineering beyond undergraduate studies? Only research question 1 will be explored in this paper. This manuscript provides a brief review of the literature and overview of the study's methodology. Findings are then presented by themes. The paper concludes with a discussion and recommendations that might further impact the decisions of Black males to pursue advanced degrees in engineering.

Literature Review

To demonstrate the trends in Black male participation in engineering, it is necessary to understand the national trends of Black students overall. According to the National Action Council for Minorities in Engineering, Inc. [12], of the 286,000 Black students who enrolled in a 2-or 4-year college or university in 2010, just five percent enrolled in engineering programs. That figure rose by more than two percentage points by 2012, with 7.5 % of all Black freshmen

entering 2-and 4-year colleges and universities intending to major in some engineering program [13].

When disaggregated by gender, trends on Black male participation in engineering majors are alarming for retention and degree completion. To illustrate, data from 2012 indicated that Black freshmen males possessed greater intentions to major in engineering (13.2%) than Black freshmen females (3.2%) [13]. Yet, despite Black males having higher intentions to major in engineering programs, attainment trends show Black males earn fewer engineering degrees than Black women. In 2006, 14.3% of Black males and 2.3% of Black females intended to pursue an engineering degree [13]. In 2010, bachelor's degree completion in engineering for Black men was 4.8% and 7.6% for Black women, respectively [12]. This means roughly 10% of Black males who intended to pursue engineering do not earn an engineering degree within four years. These alarming figures suggest Black males, who are more likely to pursue engineering majors than their female counterparts, are leaving engineering programs at alarming rates.

Black male participation in graduate engineering programs remains critically low. NACME (2012) [12] reported that between 2009 and 2010, Black graduates represented 3.5 percent of engineering master's degrees (n=1,385), and 2 percent (n=163) of all engineering doctorates. These figures decreased between 2010 and 2015. According to degree conferral data presented by Yoder [14], of the 57,433 master's degrees in engineering awarded in 2015, Black males accounted for 929 or 1.6% and 112 or 1% of the 11,702 engineering doctorates conferred.

The present-day representation of Black male engineers in the workforce not only affects Black males looking to start or continue their careers, but it also affects Black males in pursuit of engineering degrees. The disproportionate number of Black male engineers, combined with projected increases in Black student enrollment of 22% by 2025 [15], situates institutions and employers in positions to educate, train, retain more Black males in engineering. This is particularly noteworthy because a growing body of research suggests that minoritized students could benefit from having the leadership and mentorship of their own race/ethnicity [16] which could have a profound effect on employee recruitment, productivity and retention.

Practitioners, policymakers, and other leaders in education have claimed that having faculty and senior administrators whose identity is associated with an underrepresented or minoritized group are uniquely positioned to improve the performance of minority students directly and/or indirectly, by serving as role models, mentors, advocates, or cultural translators for those students [16]. We can extend this claim to other fields, especially engineering. In attempts to broaden participation in engineering, large research-intensive universities typically have created specific programs for women and people of color with the mission to increase the number of underrepresented students enrolling at the university [17]. Effective programs like the Meyerhoff Scholars Program at the University of Maryland, Baltimore County, and the federally-funded McNair Scholars Program have enhanced the number of Black students who pursue science, technology, engineering, and mathematics since the late 1980s.

The United States' inability to achieve science, technology, engineering, and mathematics (STEM) workforce diversity goals has long been attributed to the failure of the academic "pipeline" to maintain a steady flow of underrepresented minority (URM) students [3]. These

trends suggest institutions are doing an inadequate job to recruit, support, and retain more minorities in engineering. Hence, without effective interventions for URMs workforce diversity trends will not change significantly over the next decade.

Theoretical Framework

The Cultural Capital Theory (CCT) emphasizes how social mobility can be impacted by the presence or absence of social capital [18], [19]. Social status or position is acquired through possessing several forms of capital, usually attained through education, family, and social context [18]. Embodied, objectified, and institutional are the three forms of cultural capital. Embodied cultural capital consists of the abilities, attitudes, language, cultural norms transmitted through various social contexts such as community, family, and school. Objectified cultural capital refers to material and physical possessions such as boats, cars, homes, and jewelry. Institutionalized cultural capital revolves around an individual having a credential or qualification such as a certification, degree, or diploma to signify some authority, career, competency, or social status. Black males may acquire cultural capital through family, social context, and educational credentials to reach a certain status or position [19]. Also, cultural capital theory incorporates the tenets of habitus and field. Habitus occurs as a result of the skills and habits an individual requires through life experiences [18]. Field refers to various careers and vocations such as education, technology, and religion that have a set of rules, practices, norms, and types of capital needed to advance or lobby for a position [18]. Cultural Capital Theory was used to understand participant assets, strengths and tools that contributed to their ability to persist in advance degree attainment.

Methodology

Participants were recruited from attendees at the 2019 spring NSBE National Conference. Prior to the conference, an email blast was sent to conference attendees to solicit participation in the study. Participants completed an online demographic form used to gather information on their personal and professional backgrounds. Of the 30 or so who initially responded to the call, fifteen arranged an interview during the conference.

Semi-structured interviews were used to elucidate the experiences of study participants. Example interview questions include: What was your main reason for pursuing an advanced degree? When did you decide an advanced degree in engineering was the path for you? What were the experiences during your undergraduate career that influenced you to pursue an advanced degree?

All interviews were recorded and transcribed. Each participant was given a pseudonym (which are also used in the findings section).

Data Analysis

For this study, an interpretive phenomenological (IPA) approach was used as this is a qualitative inquiry to discover the lived experiences of several individuals (i.e., Black Males) experiencing a phenomenon (e.g., graduate students in engineering, Black males with advanced degrees) [20], [21]. This method is iterative and ongoing. Two members of the research team independently

reviewed transcripts. Portions of transcript text that gave insights into experiences of participants were identified as examples of coding. After reviewing 5 transcripts to establish coding independently, these team members had a "calibration meeting" to discuss emerging codes and align their definitions of these codes. Researchers then continue independent reviews. Codes were scrutinized using constant comparisons. If codes could not be distinguished from one another, they were reanalyzed and assigned a more appropriate label and definition [22], [23] and like codes were combined into categories (axial coding). Another member of the research team (who did not participate in the original data analysis) served as an external auditor. This research team member created a table of superordinate themes composed of all the emergent themes [24]. Finally, data was discussed and prepared for dissemination.

Findings

Participants for this project included fifteen Black male engineers who are currently in graduate school or who had attained an advanced degree (M.S. or Ph.D.) in engineering. The average age of study participants was 33.3 years old. The youngest participant was 24 and the oldest was 57. 60% of the participants were in doctoral programs, 13.3% were in Master's Degree programs while 26.7% were working in the engineering workforce. 38% of participants were first-generation college students with 69% growing up in a two-parent household and 31% growing up in a single-mother home. 46.2% attended a Historically Black College and University (HBCU) for their undergraduate degree, and 80% attended a PWI for their graduate degree.

Again, as this is a work in progress, only research question one "What factors influenced Black males to pursue graduate degrees in engineering?" will be explored here. Researchers found that the factors that played a role in advanced degree pursuit and attainment align nicely with Cultural Capital Theory. All participants experienced some or all three forms of cultural capital through their graduate school experiences. In particular, many of the participants benefited from the objectified and embodied capital they acquired or possessed as demonstrated in the Findings section.

Two major themes emerged as motivating factors for participants pursuing advanced degrees in engineering- the benefits of pursuing an advanced degree and the influence of social supports (e.g. family, peers, etc.).

The participants in this study saw the benefits of attaining an advanced degree and were motivated to achieve this goal. Most often, the benefits aligned with embodied and objectified cultural capital. For example, Carlos stated

> "… so I stopped and thought in order to sustain a good business, I have to do research in order to have a good competitive advantage. Well who knows how to do research better than the PhD? If I have to do research anyway and do that level of innovation anyway, I might as well get a degree."

While other participants mentioned that earning an advanced degree provided the benefit of having access to the maximum amount of future opportunities. One participant, Jared said,

> “So I think, one of the main reasons that I'm pursuing an advanced degree in engineering is because I want options in the future. I want to be able to flow in and out of industry or academia.”

While another study participant, Michael frames it as such

> “what I was told by my mom and my grandma and everyone that there's gonna come a time where your bachelor's degree will be as about as good as a high school degree…. That pushed me to want to at least get my master's degree, which I did get.”

Most often participants cited a desire for self-fulfillment/desire to learn more as their motivation for pursuing an advanced degree. This personifies embodied cultural capital. For example, Ben said that his next step would be pursuing graduate school:

> “A graduate degree felt like the natural next step and progression both for my advancement, getting more knowledge and just pursuing my goals of being a technical person, a scientist and inventor or so on and so forth.”

Moreover, Edward believed he needed more information and skills to apply theory to practice:

> “The knowledge I have is not enough for me to do any kind of research that can find application to real life. So I thought going for a graduate program will be a very good platform for me to gain and apply this knowledge.”

Similarly, Nathan stated,

> “I felt like pursuing an advanced degree allowed me to kind of expand upon that knowledge that I learned and how can I apply this to real-world applications.”

Though not many, not all participants spoke of an idealistic quest for more knowledge as their motivation for pursuing an advanced degree in engineering. For example, some participants talked about the earning potential of obtaining an advanced degree. Their direct quotes are below:

> “I knew immediately that I had to get one [an advanced degree] because my mom mentioned that if you wanted to get some six-figure income in industry, you need a master’s degree” – Erick

Nathan very quickly stated,

> "Oh, well, alongside making a little bit more money, I would say I really wanted to get into research.”

Another participant talked about obtaining an advanced degree in order to help others.

> "…I thought I will be a faculty member… to help young people or people like myself…" – Carlos

A second theme emerged in this work in progress, the influence of social networks, such as family, professors, mentors and peers. For example, Jared decided to pursue an advanced degree because he met several professors through a program designed to assist Black men in preparing for graduate school and received coaching to make his decision in pursuing another engineering degree beyond the doctorate:

> "When I joined the scholar's house... it was a pretty pivotal point, I would say. That's where I got to meet some great individual professors. And, they kind of opened my options up to research and I spent a summer interning at Oak Ridge National Laboratory. And I saw that research was, was a more than viable option, but something that I could physically see myself doing and I could be successful. And so after that, after that experience and then further talking to individuals like, like Dr. Hines… it was, it really helped the push to solidify the, this is possible for me. And that's when I further made my decision to continue."

Two participants spoke about the importance of faculty in motivating them to pursue advanced degrees. Michael credited his undergraduate professor for his motivation for pursuing an advanced degree. Michael stated,

> "…the biggest influence to get me into Grad school was that faculty member, my mentor. Okay. Who, you know, paraded the opportunities available from Grad School."

Another participant said,

> "I had a really awesome faculty member who also came from really humble beginnings and he was an awesome motivation for going to pursue the PhD"- Ali

Similarly, family played a significant role in the participants' quest to pursue an advanced degree in engineering. Researchers have documented how parents/family play a significant role in their child's college going process [25]-[27]. The authors equally emphasize that family influence is as important in choosing to pursue graduate school. Kape mentioned his sister as a motivation as well as being in a position to mentor her which pushed him to pursue an advanced degree. Kape said,

> "…it was probably my sister and she's like my protégé. And she started getting a masters in nursing. So we were like going, who's gonna finish first?"

Nathan's wife encouraged him to pursue an advanced degree as she said,

> "…hey look, you should go forward to great opportunities. So I decided to do it and never looked back since then. It was a great experience. Great professors and yeah, that's pretty much it."

Alex reflected on who had a role in directing him toward the engineering field and mentioned his mother:

> "It was maybe, her, pushing me to do something else [other than her profession], you know, turned me more toward engineering."

Another participant said it like this

> "... they [my family] don't truly understand what I go through as a PhD, but they're always there to like encourage me, push me and be like, you got it. You got yourself this far. You'll, get through. And whether you make it through or you don't, we still love you."

Discussion and Recommendations

So far in this project, participants spoke about the benefits of attaining an advanced degree in engineering. More opportunities for career advancement, becoming an entrepreneur, being competitive in the job market, and seeking more knowledge were some of the reasons these Black men attended graduate school. Elka et al. [28]examined the need for a master's degree and suggested some individuals needed advanced degrees to get entry-level job positions, advancement, and higher wages. Conversely, Elka et al. [28] noted that an advanced degree does not necessarily translate into increased pay. As stated earlier, some of our participants were interested in more knowledge and research, which would benefit them in their future aspirations.

Research has shown that undergraduate research programs are more likely to increase interest in attaining graduate degrees, particularly in STEM [29]. The authors propose engineering faculty and programs recruit Black males as early as the undergraduate level to engage in research and have formal/informal discussion about pursuing an advanced degree. The aforementioned objectified capital can serve as a passport for cultivating interest and preparation for graduate schools.

As seen in other work, the support from friends, family, mentors, and faculty is crucial to the decision-making process and persistence of Black males in pursuit of advanced degrees. Specifically, the role of the family provided motivation, support, and encouragement. Further, parental influence has been cited as an important indicator in their child attending college [19], [25]-[27], [30], [31]. The authors of this article suggest the role of parents and family play are significant in Black males pursuing an advanced degree and persisting toward attaining it. This type of embodied capital shows how families believed in the participants' ability to attain an advanced degree and knew that this type of institutionalized capital (i.e., advanced degree attainment) is beneficial for their career and life aspirations. Graduate schools or engineering graduate programs should consider incorporating a parent/family component. This component can operationalize as a website with resources, an on-campus office with dedicated staff, or part of a new admission orientation. Faculty and staff can relay the importance of students connecting with their families or significant others in their lives, especially when Black males encounter obstacles or stress during their tenure in their engineering programs. Also, engineering faculty

and staff can direct Black males to the university counseling center to work with a counselor on how Black men can best communicate with their families about the graduate school process.

Mentorship is vital in the graduate school process for Black males. Several of the participants voiced how mentors (e.g., peer or supervisory) and advocates (i.e., champions) served as support networks for pursuing as well as navigating their programs as well as giving them the objectified capital (e.g., research opportunity, resilience, and social capital) needed to persist in their engineering programs. These mentors came in the form of advisors, faculty, and peers. Further, these mentors recognized the need to assist Black males in a way that demonstrated empathy, a level of cultural competence, and understanding. Researchers have noted [32], [33] noted how engineers returning to graduate school emphasized the significance of mentors in their decision making process to pursue an advanced degree. Also, mentorship is important to helping Black students persist in their major [19], [35]. Researchers on this team (under review) have emphasized five key strategies to consider when mentoring students of color: 1) Consider the impact of vicarious trauma, 2) Assist with the facilitation of peer and mentors 'squads', 3) Respect, honor, and celebrate students' culture, religion, and families, 4) Be vigilant of microaggressions and practice microvalidations, and 5) Develop mentoring competence. Conversely, Owens et al. [35] recommended Black men find mentors in their field of study for support around career aspirations as well as around the intersection of race, class, and gender. Since faculty advisors are often thought of as mentors they as well as other support staff should be trained on how to effectively engage students of diverse backgrounds (e.g. Black males). Training should emphasize how to help students navigate securing funding, improving their research writing and addressing negative racialized experiences. Mentorship and translate into objectified (higher wages) and institutionalized capital (Master's and/or Ph.D. degrees).

From the voices of Black male engineers we also learned that a key factor that impacted their interest in pursuing advanced degrees was the impact early exposure programs had on removing the mystery from the graduate school application processes and what graduate school entails. Participants cited programs such as Research Experience for Undergraduates and Summer Research Opportunity Programs as being crucial in their quest to attain an advanced degree in engineering. These types of programs equipped them with the institutionalized capital needed to actually pursue the degree. Perhaps more programs should be developed or current programs should do a better job at recruiting Black males.

Our work also points towards the need for more collaboration between organizations that already serve Black male engineers and colleges and universities. For example, the National Society of Black Engineers has a strong record of mentoring Black males and developing special interest groups. They might partner with institutions of higher education and NSF to create initiatives similar to the ADVANCE grant, which has had much success in increasing the representation and advancement of women in academic STEM careers.

Last, our work speaks to the intersectionality of identity and the lived experiences that Black male engineers face. One must be careful not to only analyze the experiences of Black males as race or gender only. Our study participants expressed that they were fathers, family members, scientists and engineers, student leaders, and community members.

Limitations

Several limitations exist in this research study. First, given the small number of participants and the methodology used in this research study, the findings are not generalizable to all Black men with advanced degrees in engineering. Second, the authors interviewed fewer Black men who were engineering faculty members to capture their experience as academics and former graduate students. Last, participants were recruited from one site as opposed to several sites such as universities and corporations. Multiple recruitment locations could have added to the rich data already collected by the authors. Also, the age-range of participants was pretty large, the experiences of participants may be impacted by when they attended graduate school. To overcome these limitations, this work has been expanded and an additional 30 participants have been recruited. Results will be disaggregated based upon as many factors as possible.

Conclusions

This work in progress highlighted themes that contributed to Black males choosing to pursue advanced degrees in engineering. These men had embodied, objectified, and institutionalized capital that assisted them in this process. More innovative and intentional interventions and programs are needed to improve the educational pipeline in order to increase the number of Black males earning advanced degrees in engineering. What this paper did not discuss was the experiences of Black men while pursuing advanced engineering degrees and the capital they used to persist. Which is a part of the larger study.

When thinking about the potential impact of this work, some suggestions for recruiting more Black men to pursue advanced degrees as well as support structures that should be in place while they pursue those degrees are listed below. These ideas were generated in conversations with interview participants.

Table 1. Supporting Black men in advanced engineering degree attainment

Strategy	Implications
Early Exposure Programs	Help debunk myths about graduate school; give Black males research experiences; recruitment tool to increase those in pipeline to earn advanced degrees.
Support structures in place for retention of students	Having support structures in place helps remove the burden from Black men from having to find their own networks or create those social supports while navigating graduate school.
Network of safe spaces	Creating a network of institutions, departments, and faculty who are supportive of Black men in pursuing their advanced degrees may help faculty mentors suggest places for Black men to pursue advanced degrees.

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