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Board 114: Amplifying Resilience and Becoming Critical Advocates: Three Black Engineering Students' Experiences in a Multi-Institutional Summer Camp Collaboration

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Amplifying Resilience and Becoming Critical Advocates:
Three Black Engineering Students' Experiences in a Multi-Institutional Summer Camp Collaboration

Abstract

This qualitative case study examined three Black undergraduate engineering students' experiences in the context of a collaborative grant project of two institutions—a Predominantly White Institution (PWI) and a Historically Black College/University (HBCU). Grounded in African American Male Theory (AAMT), our research team examined the three students' experiences in the context of the interconnected environmental systems (microsystem, mesosystem, exosystemic, macrosystem, chronosystem). Thematic and cross-case analysis revealed the importance of mesosystem and macrosystem, such as multi-layered and culturally relevant mentoring and support, in amplifying the participants' resilience and personal and professional development. The three participants' community-serving mindset and authentic reciprocity with high school students prompted them to become reflective and critical advocates of the program's original intent. As a result, they played a pivotal role in fulfilling the ultimate goal of institutional collaboration—diversifying the STEM workforce.

Introduction

Diversity is widely recognized as a pivotal factor for innovation and ground-breaking transformation in scientific research [1]. As a result, the National Science Foundation (NSF) and other federal funding agencies have long supported the creation of diverse research project teams to enact a significant change in scientific knowledge and positively impact society. Beyond the rhetoric of research productivity, facilitating diversity in engineering programs and professions would help raise individuals' ethical awareness and commitment to engineering ethics. Previous studies confirm that individuals from diverse life experiences and cultural backgrounds offer varied perspectives and help create a fertile ground for deeper reflections and perspective changes [2]. Students of color tend to be more aware of ethics and moral principles based on their lived experiences with social prejudices and inequity (Thoman et al., 2015). Therefore, they will likely develop a strong ethical stance that challenges the observed social injustice [3].

Despite the large number of federal grant programs that require the inclusion of a minority-serving institution (MSI) as one of the key collaborators in large, multi-institutional grant proposals, very few studies have examined the complex relationships between PWIs and MSIs working for their shared goals of scientific research and other programmatic implementation. Furthermore, it is unknown how their collaboration space and related activities function as an affirming and supportive space for historically marginalized students attending the MSIs.

This qualitative case study examined three Black undergraduate engineering students' experiences in the context of a collaborative grant project of two institutions—a PWI and an HBCU. Based on the African American Male Theory (AAMT) [4], our research team examined the three students' experiences in the context of the interconnected environmental systems (microsystem, mesosystem, exosystemic, macrosystem, chronosystem). Highlighting the

concepts of "resilience," "resistance," and "pursuit of social justice" in AAMT, the authors explored the three students' multiple-layered social and professional identities as emerging Black male engineering professionals.

Theoretical framework

This study is grounded in Bush and Bush's African American Male Theory [4], which provides an effective analytic framework to understand the unique facets of Black males' experiences situated in various educational, academic, and community contexts. Like other critical, social justice-oriented social theories, such as Black feminist theory [5] [6] and LatCrit [7] [8], AAMT was proposed to illuminate, disentangle, and advocate for the experiences of Black males, a historically marginalized group of individuals in American society. As a result, AAMT pays close attention to the intersectionality embedded in Black males' experiences grounded in the institutional culture, policies, and program structure.

AAMT is comprised of the six fundamental tenets: 1) ecological systems approach, 2) uniqueness of being male and of African descent, 3) continuity and continuation of African culture, 4) resilience and resistance of African American males, 5) impact of race and racism coupled with classism and sexism, and 6) pursuing social justice as a focus and purpose for African American men [4]. Figure 1 illustrates the conceptualization of African American Male Theory.

Figure 1: African American Male Theory [4]
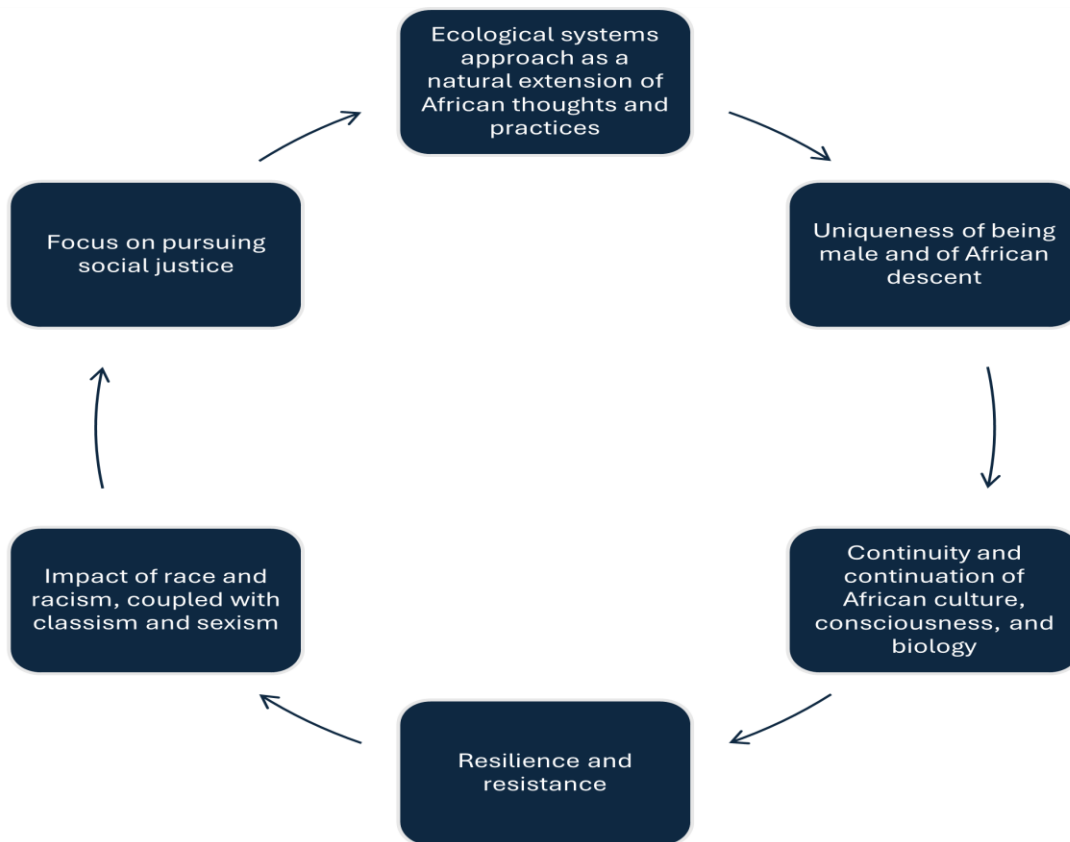
These six tenets of African American Male Theory [4] offer an asset-based conceptual tool to understand the experiences and sense-making of African American males and, therefore, challenge the current scholarly literature and public perceptions reflecting implicit bias against African American boys and men. The ecological systems approach, the first tenet, considers the symbiotic and bi-directional relationship between African American males and "other beings, matter, concepts, and phenomena (p. 8)" [4]. The theory also highlights African American males' unique position, being male and of African descent, which calls for specialized and distinctive pedagogical approaches. Continuity and continuation of African culture, consciousness, and biology present the idea that African American men's and boys' education should be anchored in the deeply connected traditions of Africa. Resilience and resistance highlight their inherent desires for self-determination. The impact of race and racism, coupled with classism and sexism, explain the complex power dynamics inherent in the experiences of African American males, as well as their nuanced position within and across multiple social groups with varied degrees of marginalization and privileges. Focus on pursuing social justice explains African American men's determination to advance social justice through various means, including cultural and community engagement.

The AAMT is relevant to understanding the experiences and sense-making of this study's three participants, African American male engineering students enrolled in a historically black university. For example, the ecological systems tenet provides the lens to analyze participants' relationships with their professors/mentors and other collaborating RAs/TAs throughout the summer program and beyond. The uniqueness of being male and of African descent and the continuity and continuation of African cultural tenets allow for analysis of their relationship-building and teaching practices rooted within African culture. The other three tenets, race and racism, resilience and resistance, and pursuit of social justice, allow for a deeper analysis of how participants use their resilience and navigate in a world in which they are subjected to racial and class bias. These tenets help elucidate the process of how they ultimately exercise their power to advance a social justice goal in the space in which they found themselves as active change agents.

Literature review

Over the past three decades, the issue of educating Black male students in engineering and other STEM disciplines has emerged as an important research topic [9]. It has drawn significant attention from a broad spectrum of stakeholders, including policymakers, university leaders, and individual researchers. Engineering educators and researchers have explored the unique experiences of this historically marginalized group of students and identified the major factors that shape their challenges, coping mechanisms, and, most importantly, the completion of engineering degrees and career advancement.

The lack of representation of African American men in engineering programs and the profession at large is well-documented. The proportion of Black male students in engineering programs has remained low [10]. Their retention and graduation rates are also lower than those of their counterparts (ASEE). Prior studies identified several factors contributing to these dismal statistics, such as persistent socio-economic disparities, inaccessibility to quality K-12 education,

and the dearth of proper role models [11]. The underrepresentation of Black males is a persistent issue plaguing not only undergraduate programs but also the engineering profession as a whole, including those in faculty positions [10] [12].

Many studies investigated the factors positively correlated with their academic persistence and success to find a solution to the phenomenon of Black males' underrepresentation in engineering mentioned above. Research indicates that establishing an inclusive culture in the program environment that allows for adequate academic and social support networking is crucial to their success [11] [12] [13] [14]. Not surprisingly, various forms of mentoring, such as faculty mentoring and peer mentoring, are found to generate a positive "vibe," facilitating their sense of belonging and self-confidence in engineering [9] [15] [16]. Furthermore, researchers recommended that educators should develop culturally relevant STEM curricula and pedagogy to eliminate long-standing cultural and socioeconomic barriers and proactively invite young Black students to STEM pipelines [17].

It is noteworthy that African American male engineering students have a unique position in society due to their intersecting identities, some visible (e.g., race and gender) and others invisible (SES, sexuality, disability). While the engineering field is considered a male domain, which implies Black male students' privileged gender status, their intersectionality invites a deeper level of complexity into their experiences. As a result, they face distinct challenges that set them apart from other student groups in engineering, such as white men or black women [18]. Therefore, exploring their experiences and perspectives through an adequate theoretical lens and culturally relevant method is crucial for a holistic and deeper understanding of this unique group of students in higher education.

Methods

Study contexts

This study stemmed from the larger mixed-methods program evaluation that included multiple surveys, interviews, and document data. The purpose of the program evaluation was to assess the overall impact of STEM enrichment summer camps on participating high school students and collaborating schoolteachers, all recruited from rural areas in two southern states. The summer enrichment program consisted of three weekly summer camps. Each camp lasted for four or five days. Since the program's primary goal was to provide a high-quality STEM enrichment opportunity for students living in rural areas of the two rural states, all three camps were held at local school sites. The camp curriculum was developed and implemented by a joint team of six faculty members from two institutions, one PWI and one HBCU (2 PWI and 4 HBCU faculty members). Eight graduate or undergraduate students were hired as teaching assistants (TA) and led sessions on their assigned topics with some hands-on activities. Three HBCU undergraduate engineering students worked most closely with high school campers as they covered more than 70% of the summer camp topics and activities. The three HBCU teaching assistants also led one of the two field trips, an HBCU campus tour that introduced college life to all high school students in each camp. The larger program evaluation indicated the summer camps were a great success, as evidenced by many statistically significant differences in high school campers' pre-

and post-camp learning outcome measures. Multiple qualitative data that were collected and triangulated across high school students, collaborating teachers, faculty/staff members, and involved university students (e.g., teaching assistants) confirmed a similar pattern pointing to the synergetic collaboration and significant contributions to the professional development of key stakeholders, especially the three HBCU students reported in this paper [19].

Collaborative participatory case study

After the successful implementation of the 2023 summer camp program and witnessing the three HBCU undergraduate TAs' profound and distinctive professional development throughout the program, the authors formed a collaborative research team to gain a deeper and more encompassing understanding of the three Black undergraduate students' experiences and professional development unfolded during the summer camp.

The research team intentionally adopted a collaborative, participatory case study approach to ensure the high quality and trustworthiness of this case study based on a small number of participants. This collaborative case study was led by three faculty members with diverse disciplinary and professional backgrounds. Their varied expertise and relationships with the three student participants helped draw a balanced and holistic understanding of the participants. This case study is also participatory research that upholds the reciprocity and authentic voices of study participants as the central guidelines in research. The three student participants in this study served as co-researchers, actively engaging in dialogues with the first author (the primary investigator) and their two mentors in the research process. A typical case study splits the roles of the researchers and participants, limiting the involvement of the participants in the later stages of research, such as data analysis and writing. However, this collaborative, participatory case study invited participants as co-researchers and actively sought their involvement throughout the research process so that the final outcomes are not just "about" them but "with and by themselves."

The primary source of data for this collaborative, participatory case study is a series of narratives generated by three student participants/co-researchers. The three participants generated multiple narratives through two individual interviews and post-camp reflective writing. All interviews were virtual, and the length of the interviews ranged from 24 to 52 minutes. Two faculty researchers also completed their individual interviews, and their data were used to provide contextual information about the summer camp program environment and the three student researchers' roles during the program period.

All interviews were transcribed verbatim and checked by the interviewers for accuracy. The research team followed the general guidelines of thematic analysis, starting with careful reading and re-reading of all interview transcripts [20] [21]. The lead investigator developed an initial set of descriptive codes to capture the critical points made by the participants. She used NVivo, a qualitative data analysis program, to ensure a consistent and systemic coding process and generated several distinctive patterns and preliminary themes. These preliminary themes and their evidence were shared with the two faculty researchers and three student researchers/participants. Based on other team members' feedback, the initial themes and related

codes were revised and refined. Therefore, the data analysis was a collaborative and reiterative process by the entire research team of six individuals with diverse professional/disciplinary backgrounds and racial/ethnic and cultural identities.

The research team consisted of six members, three faculty members, and three undergraduate engineering students who were also participants in this case study research. The lead researcher is an Asian American woman who served as an external program evaluator for the summer camp program. The second researcher is a Caucasian male affiliated with the PWI. He was the PI of the entire grant project and led the enrichment program throughout the summer. The third researcher is an African American woman, a faculty member in the HBCU's engineering program. The three student researchers are African American undergraduate engineering students from the HBCU, who worked as Teaching Assistants during the summer program. The three faculty/staff researchers worked and traveled with the three student co-researchers/participants throughout the summer program period and had many opportunities to witness their professional development during that time.

Findings

Thematic and cross-case analysis revealed the importance of mesosystem and macrosystem, such as multi-layered and culturally relevant mentoring and support, in amplifying the participants' resilience and personal and professional development. Their community-serving mindset and authentic reciprocity with the high school students they served prompted them to become reflective and critical advocates of the program's original intent. As a result, they played a pivotal role in identifying and filling in the critical void unnoticed—and hard to address--by PWI members.

Multiple layers of support system: Extended family and homey HBCU

All three participants shared that they have a strong, multi-layered support system that allowed them to build a growth-oriented mindset, overcome challenges, make the right choices, and overcome some unavoidable challenges in their lives. They have strong support from their family, which encompasses not only their parents but also their grandparents, who sparked their intellectual curiosity, and an uncle who inspired and modeled responsible manhood during their critical developmental period. Leon fondly recollected the time with his grandparents who allowed him to dissemble their old telephone and sparked his interest in machines and technology. Mark's mother was a strong advocate of her son's academic aptitude and proactively searched for various enrichment opportunities to support his intellectual development. Familial support is not limited to the participants' intellectual development. They also had someone who stayed close to and walked with them throughout many important milestones in their lives. Calvin described the influence of his uncle, who played a pivotal role in his development as a young Black man in the South. After naming his uncle as the most influential person in his early days, he described the way his uncle supported the development of his manhood.

> It was when I started working with him, we were, we would build fences. Well, I would go, even before then, he taught me how to cut grass. And there was a significance behind that because cutting grass, it takes, especially in summertime, it's hot. The air quality is

really thick. Sometimes it's humid and you'll be out there. Depending on how large the yard is, you'll be out there for hours. So just pushing yourself to get the job done and doing it correctly and thoroughly. That was the first step that I took with him to experience manhood. Cause I mean, a man could take hits in life and it's not about how hard you can get hit, it's about how hard you can get hit. And even if you fall down, you have to get back up. I mean, you can't bat a thousand in life. And that's something that I learned throughout working with him. Cutting grass was the start. Building fences, and then even building houses, parts of houses, fixing cars, and being right by women as well. That was another big milestone that I've had passed across.

Another strong support system is their university and engineering program where they found abundant support from faculty and peers. They described their experiences as "absolutely phenomenal" and "great." They acknowledged that they had "been able to learn a lot of things, improve on skills that I've learned, and I've met some great teachers and students, as well who's been really helping me to grow and figure out what I want to do with my career specifically." While all acknowledged the academic demand in their engineering program posed a challenge, they equivocally highlighted the benefits of HBCU's class structure and faculty's individual attention and support for their academic and professional development. Leon called it "the home feeling" when comparing his possible PWI experience and his current one.

> I would feel if I went to a PWI, my experience would've been, uh, maybe even the complete opposite. The thing I like about HBCU is the home feeling. It's like you're not gonna get those connections with your teacher at those PWIs with the classrooms that are just huge. During the class here at an HBCU, the teacher asks, are there any questions? And they'll really can call you out by name and you get that connection. And even outside of class or when you come to their office hours, they're readily available. And I feel like there's more of a personal connection here at HBCUs that lacks at PWIs.

The three participants also described their strong sense of belonging and connection with their peers and listed their collaborative peer relationships as one of the major benefits of being a student on an HBCU campus. They reported communal and collaborative culture permeated throughout the campus and beyond. Mark expressed the same positive sentiment as Leon and added that the homey feeling is not limited to the campus, but extended to the professional world through alumni.

> There are a lot of great benefits that come with being at Alabama A&M, an HBCU. Of course, that's what we love about HBCUs, a kind of connection when it comes down to, even beyond Alabama A&M University. When you speak, and you say that you attended an HBCU, you meet fellow HBCU alum. It's kind of just feels like home. Like it feels like, you know, you have that same connection. It's like, oh, you attended this school! And it's like you get more of a family and homey field. The benefits that come from it are kind of great. They're not even kind of great. They ARE GREAT.

Remembering the past and leading a great example: Persistence, resilience, and leadership

The three participants showed a deep understanding of their unique position as young Black men in today's American society, especially in the engineering field that lacks representation. Calvin described the pressure he experienced during his summer internship at a local company, where he was the only Black man in the room, even given the responsibility to lead a discussion on diversity. Still, he did not lose his composure and inner fortitude.

> It is very different when you're the only black man in a room full of white men. The pressure is different, especially when the topic of a meeting is on racial disparities, a meeting that you have to lead. To grow from that I have to remember that diamonds are formed from various amounts of heat and pressure.

Leon expressed his keen awareness of the historical lineage and struggles that permitted him and other Black male students to be where they are now. He remembered "the people [who] fought for me" and made "their sacrifices." Leon himself is determined to remember the past and play a significant role in the historical struggle.

> I would say most definitely being a black male in the STEM, in the STEM field. It definitely does come with that you're tapping into that fortitude that's been installed with you. Because growing up as a black male, especially in the South, I'm aware of what my past and my ancestors have done to get me, for me to be able to even go to a college and pursue it. So I really understand that the sacrifices that were made. And also for others, like most black males, some of them are first generation college students. So that comes with this chip that you have to realize that there's a cause beyond just you. There are people who you rely on, who rely on you,. You have to really, it just helps when you understand that, okay, people fought for me to get here, and I don't wanna go mess that up, and I wanna really give this my all to show them that their sacrifices were worth it.

Mark, as a first-generation college student, clearly understood his position and responsibility to set up a good example that would inspire his younger siblings and relatives in his entire extended family. He explained his determination.

> I'm the oldest of all of my siblings, for my cousins as well when it comes to family, friends. I have a lot of younger kids that I've always grown up with and watch [them] grow up and inspired in a way. No matter what I do, they're gonna be watching [me] basically. So once they saw me graduate high school, they knew that they had to graduate high school. Once they see that I went to a college on scholarship, they knew that they see that it's possible. ….They're gonna follow right behind me and be able to do what they need to do to make sure that that's accomplishable for them as well. … So [I] gotta make sure that I'm leading a great example.

The three participants shared many stories testifying to their resilience and persistence in the face of many personal and academic challenges, some of which were even beyond their control. However, they kept a growth mindset while dealing with those challenges, endured times of uncertainty and turbulence, and maintained hope and faith. They depended on their intellectual

astute and bicultural adaptability and utilized pragmatic and creative problem-solving skills and other soft skills, which are often considered as lacking among typical engineering students. Most importantly, they showed an unwavering commitment to their engineering career and professional success. For example, Calvin admitted that he had a hard time in his life, yet he stayed firm and focused: "I didn't let this stop me or steer me away from the main objective, which was to succeed and excel in my field." His advice for other Black high school students pursuing an engineering career reflected the same sentiment. He said:

> My experience, I mean, my advice would be to always stay vigilant, hold steadfast, because I mean, it does get rough a little, a little bit. At some point in time, you will be faced with challenges. But don't let that stop you from being the best that you can be. Always come on time, and be persistent. Be persistent, come on time, and be in tip-top shape for the material that you have to execute.

Mark highlighted the importance of taking time, having patience, and not being afraid of messing up. He considered making mistakes a natural part of his academic and professional journey. Responding to a question about how he managed difficult course contents and academic demands, he replied:

> Just time and, and patience. Just being able to know that I have enough time to figure it out and giving myself the patience and the grace to be able to do it. And not being afraid to mess up or trial and error. You know, being able to look at the problem, just like I may not be able to figure it out the first time. But it is okay because I know it doesn't work now, or I know that this doesn't work anymore, so I can't use this one…. You gave yourself time, grace, and patience to where you were able to figure it out eventually by yourself.

"Even without blood": Commitment, connection, and authentic reciprocity

One of the most important and clear findings from our study was the three participants' immediate and natural embodiment of constructivist teaching approaches manifested in their work with high school campers throughout the summer camp period. When they were given the task of modifying or transforming the STEM topics and initial curriculum provided by their professors, the three students instantly took a student-centered perspective to develop something relevant and enjoyable for middle and high school students. They prioritized the middle/high school campers first and welcomed the—sometimes highly time-consuming--tasks of creating and constantly revising their assigned camp topics and instructional approaches to meet the young learners' needs. Their sincere interest in and commitment to campers' STEM learning was evident throughout the three summer camps and clearly articulated in their reflective accounts later. Calvin described his extensive curriculum revision effort to modify and tweak the given materials considering campers' ages and their learning style preference.

> I also modified the slides to where I could, or I wrote my own script to kind of tweak the whole base of everything. So it could be very understandable and comprehended by the high school students. Because I know that once you get into higher education things may be abbreviated or they may have different meanings than what a high school student can

understand. So I basically had to simplify what I knew and give it to, teach it to the high school students. So that was something that I did. And with wind tunnels… I kind of, freestyled everything together because I knew they would understand it. Cause that's kind of how I learned. I don't just learn from a regular lecture, like a traditional lecture. That's, it's boring. And these are high school kids, and they are kids still… they like fun. I still like fun. So I was, I would want them to have fun learning.

The three participants' immediate development of a sense of connection and ethical obligation was noteworthy as almost all the summer camp participants were not Black students. However, their communal cultural dispositions, empathy and sensitivity toward younger students in need of academic enrichment opportunities, and proactive leadership disposition naturally transform them to become advocates of the campers. Mark, who considers himself a trailblazer in his extended family, envisioned his role in the summer camp the same way. He explained that his role in the summer camp was not much different from what he does for his own siblings and younger cousins. He paid attention to schoolteachers' conversations that informed him of the campers' lack of access to STEM learning resources and support at the remote rural schools. He acknowledged his position to be a model and to inspire young students at resource-stricken rural schools, which goes beyond his own family boundaries. Despite the racial, ethnic, and cultural differences between the summer camp participants and himself, Mark clearly stated:

> Even without blood, you know, even with those younger students that we were teaching at that school. You know, we were teaching with them because they didn't have the resources or the outreach or even the family members. When I was talking to the teachers, they were like, 'yeah, some of these students don't even know about college or they didn't even know anything about engineering, or is that something that's possible?' But we opened up their eyes for that. And that's just the biggest impact. You never know who you're gonna impact or you never know who actually needs to see that's something that's accomplishable and something they can do. So just letting it be known and just remember that I am that example.

For Leon, the summer camp experience offered an opportunity to see his "younger self," feel proud of himself and fall in love with engineering again. He experienced the overlap of the young campers and his younger self, which revitalized his engineering identity and commitment. Leon also noticed his own generative influence on other kids' motivation to advance to engineering. His experience was characterized by a sense of connection and reciprocity.

> It really, it really helped me, like, go back to see why I really like fell in love with it again. I fell in love with engineering again. Because once you start doing engineering, you get wrapped up in all of the hard work and it's like, man… But then once you see like your younger self and how much they wanted to get into it, you kind of can go back and be like, 'I can make, I can make that little guy proud." You know? And that really helped me just tap back into why I'm doing it all. And hopefully, make the want in other kids increase [and] want to get into STEM too.

Becoming critical advocates

The three participants' engagement throughout the summer camp period was deep and profound, which allowed them to observe and evaluate various aspects of the program's logistics and other individuals working with them. They were clearly aware of the purpose of the summer enrichment program—offering STEM enrichment opportunities to disadvantaged rural school students who, otherwise, would not have adequate exposure to STEM topics and career-related information. The three participants valued the program's goals and wanted it to become even better next year in fulfilling the goals.

The three participants equivocally highlighted the need for a more age-appropriate curriculum and activities. For them, an inadequate curriculum was more than a technical mistake. It was a lack of respect and compassion for learners. As a result, they criticized other TAs who showed little attention and adaptability to the needs of high school campers. Calvins raised a sharp criticism about another TA's lack of adaptability, calling it as "insult."

> We're teaching kids the basics of how rockets work and how they're made and what they do, and what their purpose is. In this day and age, a lot of kids, they don't study like how past students would do because of technology. Technology is taking over. So, you have to keep that in your mind. Well, I count this as an insult to intelligence. When you talk about material to kids who don't know what you're talking about, and then try to make yourself look smart off of that, I think that's very insulting to one's intelligence and especially kids. Because it could go over their head anytime. Somebody like me can see what you're doing. But I wasn't like that at all when I was a kid. We all were kids. We all used to be kids. I wouldn't want somebody treating… If I had a son or a daughter. I wouldn't want anybody treating my child that way because they, everybody has the opportunity to learn.

All three students pointed out the lack of diversity in school settings, especially African American students. Leo expressed his disappointment, noticing, "The ratio of African Americans wasn't what I thought it was." He hoped it would be addressed in the future. Calvin raised a similar point that even the most diverse school with a large number of Hispanic students had only "one black kid there." He explicitly added his recommendation that the summer program should reach out to more diverse and economically disadvantaged students to strengthen its original goals of diversifying the STEM workforce and social justice. He said:

> In the future, I would like to see more diversity in visiting these schools because, yeah, it's, it's, I would like, to me personally, if I were to do it again, I would like to visit other ethnic groups and teach them. Cause a lot of other ethnic groups that aren't white, don't know about engineering, they've probably never even heard about it.

While the lack of racial diversity identified by the three participants seems to be highly adequate and natural, this problem was ironically invisible from other team members' perspectives. The program's heavy focus on economically disadvantaged students in rural areas and a large proportion of Hispanic and female students in the campers' pool obscured this clear void and made it difficult for others, especially those leading the program, to discover it. The three

participants' critical and advocacy stances brought this point to the surface and helped the program move forward.

Discussions

The major findings of this collaborative, participatory case study confirm several key tenets of AAMT [4] and existing literature on Black engineering students. The three participants' early-year experiences illuminate both the persistent economic disparity plaguing the African American community in the South and the three students' remarkable resilience and persistence facilitated through the multiple layers of family and community support. The participants were keenly aware of their unique position in their family, engineering profession, and society at large. They exhibited a commitment to carrying the load of historical legacy by accepting the responsibility of pursuing social justice through their engineering careers. For them, their pursuit of engineering is not just an individual career aspiration but a way to serve their historically marginalized racial community. Furthermore, they naturally extended their ethical obligations and inspirational power to all young students they considered being deprived of quality STEM education in American society.

It is important to note that the three participants in this study exhibit a set of professional dispositions (e.g., relationship-building and communication skills, critical macro ethics) that are known to be lacking and hard to foster among typical engineering students. Previous studies indicated that engineering students gradually lose their interest in and commitment to larger societal issues and the critical role of the engineering profession. In contrast, women and students of color are more likely to respond to calls for diversity, equity, and justice as their life experiences have been complicated by social stereotypes, prejudices, and inequity to varied degrees [22]. Therefore, it is not surprising that the three African American engineering students approached their summer camp employment as an opportunity for social justice engagement and expressed their critical voice to enhance the diversity goal of the program.

We believe that this study's findings offer important insights and recommendations by situating the three Black students' experiences in the unique spatial context of PWI-HBCU's institutional collaboration supported by an external grant. The summer program's successful implementation and involved TA/RAs' palpable professional growth can be explained by several contextual factors. Most notably, the importance of team composition with individuals of diverse backgrounds should not be missed. The faculty and staff members on the diverse team modeled professional openness and mutual respect, as witnessed by all student participants, including the three Black undergraduate students. The project team also included a Black woman faculty member who traveled, worked closely with the three undergraduate students, and served as their advocate and mentor. The undergraduate students' positive experiences during the camp and sharing their authentic critical perspectives were possible as they perceived the space as safe and supportive. We believe that multi-institutional collaborations should acknowledge the unique cultural assets brought by the students of MSIs and HBCUs and strive to create a safe and, more importantly, generative space where those students can play an active role in driving the overall quality of the inter-institutional collaboration in light of diversity, equity, and social justice. This

type of institutional collaboration will fill the critical void that is hard to tackle by most PWIs and ultimately lead to creativity and innovation [1].

Limitations and future work

Despite its unique positioning and well-triangulated data from the larger program evaluation, this qualitative case study presents many limitations due to its temporal and spatial boundaries. The participants' experiences and other supporting data (e.g., high school campers' surveys and team members' observations) are all deeply grounded in the unique sociocultural contexts of the rural South. Even the three participants' personal and professional dispositions and self-conscious decisions were likely to have been shaped by the sociocultural contexts of the region as well. Therefore, the transferability of this study's findings may be limited for other Black students living and attending engineering schools in totally different sociocultural and regional contexts. Furthermore, it should be acknowledged that the three students' narrative data were socially constructed in their interactions with the project team's faculty and staff members. While the students all reported enjoying strong faculty support and positive summer camp experiences, social desirability might have influenced their accounts and interpretations. Considering their developmental stage, it could have been a challenge for them to engage in more critical conversations on race, especially with a person of a different racial and ethnic background.

Despite the abovementioned limitations, this study still offers some pragmatic recommendations for educational practitioners, policymakers, and institutions. Firstly, educators at all levels should acknowledge and value Black male students' unique cultural and dispositional assets and proactively develop innovative curricula and instructional strategies that can tap into their assets in STEM learning. For example, a social justice-oriented STEM curriculum can help enact Black male students' STEM career interests. A cooperative learning environment can help sustain their continuing pursuit of STEM learning when facing challenges on their academic path. This study also shows the importance of having a strong sense of community in multiple ways, such as cooperative peer culture within engineering programs, faculty support on campus, and alumni and other supportive connections that extend to the engineering professional society. Therefore, institutions should intentionally facilitate a supportive internal culture for Black male students and offer them rich opportunities to build and expand their professional network. The latter is vital to their continuing professional development and career advancement.

Conclusions

Multi-institutional collaborations provide a valuable opportunity for MSI and HBCU faculty and students by providing them access to research and career-related resources, training, and networking, otherwise unavailable. Policymakers can create this valuable space by supporting productive and synergetic cross-institutional collaborations between PWIs and MSIs/HBCUs. Not surprisingly, the quality of such PWI-MSI/HBCU collaboration depends on the shared goals and objectives, as well as mutual respect and egalitarian relationships established among the stakeholders from both institutions. In particular, it is a must to have a solid plan to understand, recognize, and capitalize on each institution's strengths, not only the intellectual merits but also the cultural assets brought by the members of the collaborating MSI/HBCUs. This should be one

of the major criteria against which the quality of multi-institutional collaboration that includes MSI/HBCUs should be evaluated. By doing so, this multi-institutional collaboration space can naturally become a live classroom where involved graduate and undergraduate students—the next generation of engineers and engineering researchers—witness the ethical and professional standards in practice and accept and emulate them as the norm in the profession.

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