2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #40099

Engineering While Black: Exploring the Experiences of Black University of Florida Undergraduate Engineering Students Using Photovoice

Dennis R. Parnell Jr., University of Florida

Dennis Parnell Jr. is a Ph.D. student in the Department of Engineering Education at the University of Florida. His research focuses on understanding and improving underrepresented student retention and persistence in engineering. For his doctoral research, Dennis is leveraging emerging learning technologies to broaden participation in engineering by exposing students to semiconductor fabrication processes. Much of his work involves designing and assessing interventions for extra- and co-curricular activities for students throughout the educational ecosystem. He is also a member of the ASEE CDEI Spotlight Team. Dennis holds a B.S. in mechanical engineering from The University of Alabama and a M.S. in mechanical engineering from the University of Florida.

Jabari Wilson, University of Florida
Dr. Karen Theodora Hicklin
Dr. Jeremy A. Magruder Waisome, University of Florida

Dr. Jeremy A. Magruder Waisome is an Assistant Professor in the Engineering Education Department at the University of Florida (UF). Her research focuses on self-efficacy and critical mentoring. She is passionate about broadening participation in engineering, leveraging evidence-based approaches to improve the engineering education environment.

Engineering While Black: Exploring the Experiences of Black University of Florida Undergraduate Engineering Students Using Photovoice

Abstract

Black engineering students attending a predominantly white institution (PWI) must often navigate unwelcoming and hostile environments on their journey to degree attainment. Despite encountering such adverse circumstances, these students persist to graduation, albeit at lower rates than their white counterparts. Addressing this discrepancy is a critical factor in improving diversity in the workforce. This work aims to explore Black engineering students' experiences using a community-based participatory research (CBPR) strategy called photovoice, which is commonly practiced in public health. Photovoice is a qualitative research approach that involves the collection and analysis of data through the lens of each participant. To date, few scholars have applied this narrative approach to understanding Black students' experiences in the context of engineering education and practice.

This study explored how the current racial climate in the United States impacts the experiences of Black undergraduate engineering students. The outcome of the photovoice experience was two-fold: 1) To capture each participant's lived experience, leveraging each photo as a visual demonstration, to bring their words to life; 2) To connect an accompanying narrative describing each lived experience, thus, expressing the world as they see and experience it. Through photography, reflection, and critical dialogue, five undergraduate students at a large southeastern PWI shared their stories and agreed on actionable measures to improve Black engineering students' experiences at their university. During semi-structured interviews, participants described the images they captured related to the research prompts. Using an inductive approach, we conducted a reflexive thematic analysis, and six themes emerged related to the students' experiences: (1) finding comfort, (2) building community, (3) fitting in, (4) experiencing frustration, (5) overcoming imposter syndrome, and (6) valuing mentorship. Participants collectively discussed their images and related experiences in a final group session. Steps to address emergent themes were also identified and presented to the Associate Dean for Student Affairs, along with a plan to showcase their work.

I. Introduction

The discrepancy between the number of Black students who complete a college degree compared to their white peers has been of national concern for many years [1], [2]. In engineering, this problem persists and has been exacerbated in the last decade by stagnant growth in awarded degrees for Black students [2], [3]. Factors contributing to this educational gap may result from institutional racism in an institution's policies, values, and norms [4]. For example, students who do not feel they belong because of racial stereotyping or a lack of institutional support in combatting racism might have a more challenging time in college [5], [6]. In addition, students may find it especially troubling to excel during times of racial injustices and intolerance, which can be particularly problematic for Black students [7].

In the aftermath of George Floyd's murder, the University of Florida (UF) created a $400,000 Racial Justice Research Fund "to support research and scholarship that will inform understanding of the Black experience, racial justice, diversity, equity, and inclusion on campus and beyond." [8]. Realizing the lack of space for Black engineering students at the university to discuss the impact of the current racial climate in the U.S. on their college experience, the third and fourth authors of this work submitted a research proposal to the university's advancing racial justice solicitation [9]. This project aimed to provide information to staff, faculty, and administrators on ways to improve the experiences of Black engineering students on campus.

Black engineering students' experiences at UF have not been studied at length. While the institution has focused on implementing general measures to address the needs of all Black students, it could benefit from collaborating with its Black engineering students to identify better approaches to supporting them throughout their undergraduate studies. One way to achieve this goal is through an action research methodology called community-based participatory research (CBPR). This strategy is a practical approach for involving the study population as active participants in all phases of research. The CBPR principles include but are not limited to (i) building on the strengths and resources of the community, (ii) achieving a balance between research and action that both benefit science and the community, (iii) disseminating knowledge gained from the CBPR project to community stakeholders, and (iv) ensuring a long-term commitment by stakeholders to enact change [10].

Photovoice is a CBPR method in which participants are asked to capture photos of moments focused on a particular theme (e.g., racism, racial injustice, mentoring, isolation) [11]. Each participant brings their image(s) and a description to an individual or small group setting, where they discuss each image and its meaning. At the end of the process, participants develop an action plan to address their concerns about the study's topic and disseminate the photographs to community stakeholders [12]. Photovoice has been widely used in public health [13], but it is becoming a popular research strategy in engineering [14]–[17].

The objective of this pilot study was to explore the experiences of Black undergraduate engineering students using photovoice. The research questions guiding this work were:

1) What does it mean to be a Black student at the University of Florida?
2) What does it mean to be a Black engineering student?
3) What does it mean to be a Black person in society?

By requiring participants to use photovoice to answer these questions, we sought to uncover actionable steps to improve conditions for Black students pursuing engineering bachelor's degrees at the university. The photovoice process allowed these students to share their journey and explore ways to improve not only their experiences but also the experiences of future generations of students. This methodology empowers and gives a voice to the students who assume active roles in determining ways the university can better support the Black engineering population.

II. Method

We used a reflexive thematic analysis to understand the experiences of Black engineering undergraduate students engaged in this photovoice project. Given the exploratory nature of this study, the researchers decided against applying a theoretical framework to the investigation.

A. Location

This study occurred during the spring 2022 semester at UF, a large, public PWI in the southeastern United States. Of the over 40,000 students enrolled at the institution in the fall 2021 semester, only 5.36% identified as Black/African American, while 51.73% identified as white [18].

B. Participants

As of the fall 2021 semester, this university's College of Engineering had over 9,800 students (including graduate students), with approximately 6% representing Black/African American undergraduate students [3]. The study's original recruitment goal was to have at least 20 sophomore or senior engineering students. This target included four photovoice groups (one group of Black male sophomores, one group of Black female sophomores, one group of Black male seniors, and one group of Black female seniors) with five to eight students in each group. Individuals were to be compensated $15.00 per attended session, for up to $75.00 if all sessions were completed. Individuals were recruited via email, physical flyers, and word of mouth. The $75.00 gift card incentive was included in advertisements to make full participation in the study more appealing.

Approximately ten students initially expressed interest in participating in the project and attended the interest session. However, only five individuals could participate fully due to scheduling conflicts and significant unresponsiveness. While the number of participants in this work was small, five is a reasonable number of participants for photovoice studies [16], [19]–[22]. Table I provides the participant demographic information.

TABLE I
Participant Demographic Information.

Pseudonym	Classification	Gender	Major
Kyle	Senior	Male	Electrical Engineering
Max	Senior	Female	Electrical Engineering
Khadijah	Junior	Female	Electrical Engineering
Overton	Sophomore	Male	Computer Science
Régine	Sophomore	Female	Chemical Engineering

Four facilitators led the individual activities. Three of these facilitators were Black men in graduate school, two of whom are the first and second authors of this work, and engineering graduate

students with no previous photovoice experience. The other Black male facilitator and the fourth facilitator, a Black woman, had prior experience conducting photovoice interviews.

C. Activities

According to the original plan, the study was to have five two-hour sessions. The first session was intended to be an informational meeting where students would become familiar with the photovoice process. Three of the remaining sessions would be focus group discussions where the participants could talk about the experiences depicted in their photographs. The students would be grouped based on gender and classification as described above, and each session would cover one of the study's research questions. The final session would be a closing session where students would determine actionable steps to address the issues brought up in the focus groups.

Since the recruitment efforts didn't yield the desired number of participants, the research plan was modified. The introduction session remained unchanged, but the three focus group discussions were replaced with an individual interview with each student. The closing session would now be a focus group with all students discussing the topics from their interviews and identifying ways the institution could better support Black engineering students. The final study plan included three sessions, and students were compensated $25.00 per session, keeping the total compensation for participating at $75.00.

Two facilitators conducted each interview. Facilitator training consisted of a two-hour Zoom meeting in which experienced photovoice facilitators walked new ones through the process of completing an interview. The main points covered in training included, the questions facilitators should ask, lessons learned from prior activities, background information on photovoice, and the purpose of this study. At the end of the study, the facilitators were compensated for their time.

D. Introductory Session

The first session was an informational meeting where students learned about the project's goals, completed training in camera use, filled out consent forms, and could ask questions. The session began with an icebreaker that asked everyone in attendance to state their names, hometown, major, and a current event that had their attention. Breakdowns of desirable norms for group meetings, a summary of what photovoice is, and participation expectations were discussed. Critical guidelines were also given for ethical considerations of photographing others, including requiring consent forms for featured individuals.

E. Individual Interviews

Teams of two facilitators conducted the individual participant interviews. The interview protocol was loosely based on the SHOWED method, which consists of six questions: 1) What do you **S**ee here? 2) What is really **H**appening here? 3) How does this relate to **O**ur lives? 4) **W**hy does this concern, situation, strength exist? 5) How can we become **E**mpowered through our new understanding? 6) What can we **D**o? [11]. The primary facilitator was responsible for asking questions and leading the discussion. The secondary facilitator took notes and passed along

questions to the primary interviewer to ensure the conversation stayed relevant to the research goals. Sessions varied from less than 45 minutes to just over two hours.

F. Focus Group Discussion

The final session was a focus group. This meeting was not intended to reveal new themes but to help identify actionable items. Participants shared their photos and a synopsis of their experience with the group. They commented on each other's input, with the initial discussion being self-guided by the group rather than guided by facilitators. After individuals were familiar with each other's photographs, the facilitators directed the discussion to include conversations on how the university could attempt to solve the problems contributing to the negative aspects of Black students' experiences. Because photovoice is an action research method that requires dissemination to key stakeholders, the students agreed to present the results to the College of Engineering's Associate Dean of Student Affairs. The participants also discussed how they should display their work to the broader university community. Finally, students were thanked for their time and participation, then given specifics on how compensation would be distributed.

G. Data Analysis

After the individual interviews, audio files from the Zoom recordings were transcribed using the Rev.com transcription service. The photovoice component of this study was used to facilitate discussions about the participants' experiences. However, the images participants captured are not included in this work as this study focuses on the reflections derived from the photographs. The resulting transcripts were analyzed using a reflexive thematic analysis to identify common themes among the participants. Thematic analysis is a detailed method for identifying, analyzing, organizing, describing, and reporting themes found in qualitative data [23]. One popular approach to thematic analysis is the reflexive method. It involves an iterative coding process to develop themes that the researcher uses to interpret the data and (potentially) provide a voice to marginalized or seldom represented groups [24]. Because a particular theory or epistemology doesn't guide it, thematic analysis is a flexible approach that can be used for various studies [23].

There are six steps to performing a reflexive thematic analysis: 1) familiarize yourself with the data, 2) generate initial codes, 3) search for themes, 4) review themes, 5) define and name themes, and 6) report findings [23]. Since the coding process is inherently subjective, it produces themes grounded in the researcher's beliefs, feelings, and experiences as they relate to the topic [25]. Therefore, it is imperative for researchers who undertake this type of analysis to consider how these aspects of their identity can impact the theme generation and employ techniques that can increase general confidence in the research findings. Nowell et al. [26] recommend several methods that researchers can implement to establish trustworthiness in each of the six phases of the analysis. Table II outlines the reflexive thematic analysis process with descriptions of each step and strategies for establishing trustworthiness.

To *familiarize ourselves with the data*, the authors spent a month reading through each transcript multiple times and correcting any mistakes the transcription service made. Using reflexive journals, we kept notes on the data and documented thoughts about potential codes. These ideas were discussed during weekly meetings and served as the basis for the initial coding. In *generating*

initial codes, coding reliability was established using the test-retest and independent coder methods. The test-retest process involves one person coding the same data twice without looking at the results. Unlike the test-retest procedure, a second person must review the data set for the independent coder process. For this study, two people analyzed each transcript (independent coder) twice (test-retest).

TABLE II

Steps to Performing a Reflexive Thematic Analysis and Methods for Establishing Trustworthiness. Adapted from [23], [26].

Analysis Step	**Description**	**Trustworthiness Methods**
1. Familiarize yourself with the data	- Repeatedly read through data - Transcribe data - Note any coding ideas	- Store data in an organized archive - Create a reflexive journal - Keep notes on each meeting
2. Generate initial codes	- Systematically analyze data - Identify repeated patterns in data - Collate data for each code	- Team debriefing - Utilize coding framework - Keep notes on initial codes
3. Search for themes	- Sort codes into potential themes - Form sub-themes - Identify significance of themes	- Researcher triangulation - Connect themes via diagrams - Note relationships or hierarchies
4. Review themes	- Refine candidate themes - Review extracts for each theme - Determine if themes fit data set	- Vet themes and sub-themes - Check reference accuracy of themes - Keep notes of review process
5. Define and name themes	- Analyze themes - Identify “story” themes tell - Clearly define and name themes	- Review and discuss themes - Ensure group consensus on themes - Document theme terminology
6. Report findings	- Prove prevalence of themes - Choose vivid data extracts - Tell “story” of data	- Make assumptions explicit - Describe coding process in detail - Provide substantial context

The test-retest method was performed via inductive (open) coding - a strategy by which the researcher creates codes based on whatever important information catches their attention [27]. During the first pass of the transcript, we assigned codes to data samples. This process was repeated for the secondary analysis, and data segments with similar codes between the two tests were highlighted. These highlighted extracts were collated by code and stored in a Microsoft spreadsheet (Excel) where the two analyses for each participant were combined. We began the *search for themes* phase of the analysis with a focused coding activity. Focused coding involves two main steps: 1) narrow the list of codes found during open coding and merge related ones, and 2) define the final list of codes and use them to recode the entire data set [27]. This procedure was performed in Excel using the codes related to the highlighted extracts from the previous step. After completing the focused coding, the authors organized the codes by potential theme and discussed the significance of each theme to the "story" we wanted to tell with the data.

For the *review themes* step, the authors met to refine and review the candidate themes. Following the two-fold review process outlined by Braun and Clarke [23], we first analyzed the excerpts to determine if they fit their related themes. Once the themes were reconfigured to describe the associated data segments accurately, the authors proceeded to the second review phase. This stage included discussing how well the themes represent the entire data set. As part of the *define and name themes* process, the authors met to achieve consensus on the names and definitions of the themes. The *reported findings* from this analysis will be discussed in a subsequent section.

III. Positionality

All authors of this work are Black people who have earned bachelor's degrees in a STEM discipline. The first author is a Black male who majored in engineering at a large, public, southeastern PWI like the one in this study. The second author also identifies as a Black male, attended the same undergraduate institution as the first author, and majored in engineering. Author three is a Black woman who earned a bachelor's degree in mathematics from a southern HBCU. While her undergraduate experience differed from the other authors', she received a Ph.D. in engineering from a large, public PWI. Lastly, author four identifies as a Black woman and received her engineering degrees from the same institution the study participants attend. We believe our shared identities with the participants allowed us to understand their experiences better. We acknowledge our potential biases given the proximity to the students in this work. To minimize any external influences, we followed a regimented protocol during the study design and data collection processes to ensure the trustworthiness and credibility of our findings.

IV. Individual Interview Findings

From our thematic analysis of the individual interviews, we identified six themes: 1) finding comfort; 2) building community; 3) fitting in; 4) experiencing frustration; 5) overcoming imposter syndrome; and 6) valuing mentorship. Selected excerpts are presented in this section. Figure 1 provides a visual representation of the frequency of each theme identified from the analysis of each participant's interview transcript.

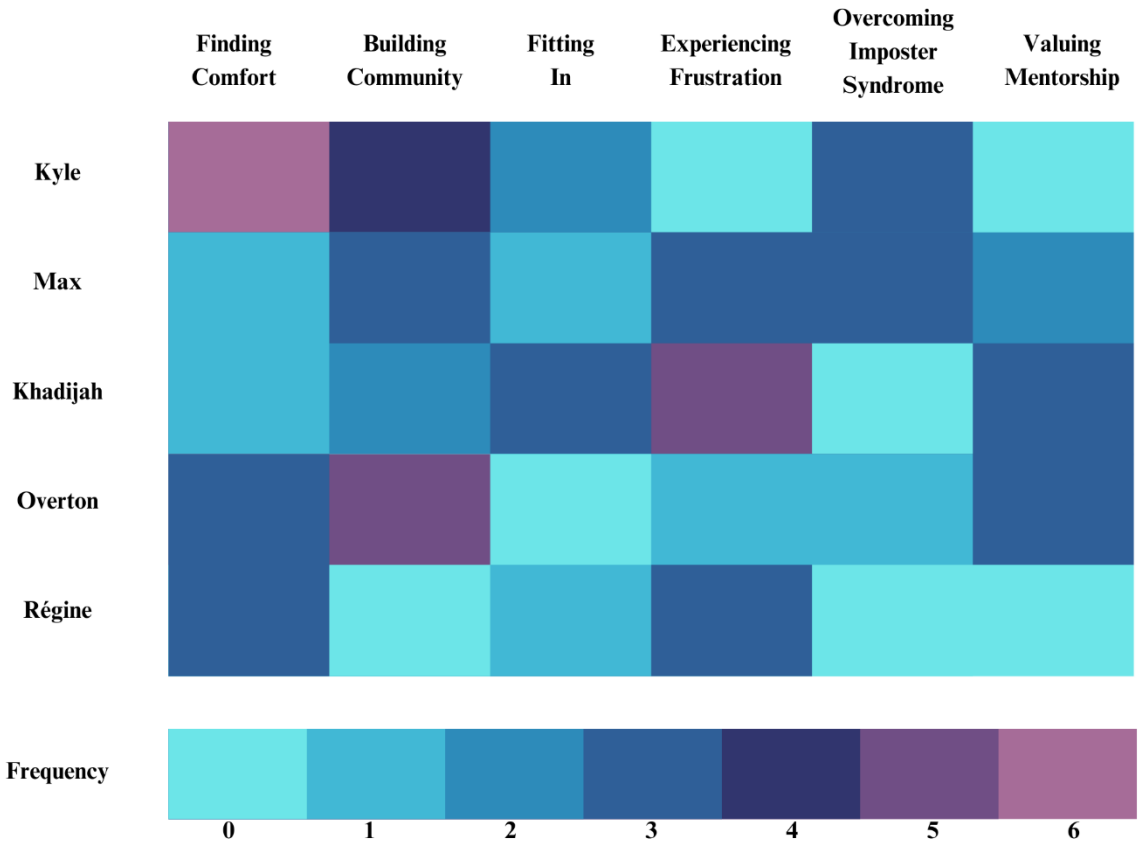

Fig. 1. Frequency of themes by participant.

A. Finding Comfort

Several participants alluded to their sense of belonging as Black engineering students by describing how comfortable they felt being their authentic selves in a particular environment. This comfort stemmed from the presence (or lack thereof) of people that looked like them and shared similar experiences. Students identified physical spaces intended to facilitate the gathering of Black students as significant elements in cultivating their feeling of comfort. Overton highlighted the importance of physical spaces, such as the Black Enrichment Center (BEC), in facilitating genuine social interactions that allow him to be comfortable on campus.

> …the BEC is somewhere either to do schoolwork or socialize with people. It's definitely a really nice get away from just being at school all day. Because, I don't see people like me very often. And so when I do get the chance to, it's really nice when I get to be in a space like this....It definitely makes me feel more connected to the community....it is a good space just to get schoolwork done in general or any work or extracurriculars that you have. In terms of the social aspect of it, for me, I don't have any fear or I don't know how I could put it. I'm just able to open up and express and be myself in the space. So, I can talk about my experiences or I can talk about how my day has been and a lot of these people can relate to whatever I'm going through. So that's what is the really nice thing about going here.

For Overton, the BEC is a place where he can exist with those who relate to his experience of being a Black student at a PWI. He is thankful that this space allows him and his peers to be comfortable at an institution where they usually are not. Similarly, Kyle appreciates the dedicated spaces for Black students to gather as they offer environments where he feels a stronger sense of belonging than other places on campus.

> I guess because in my experience, I think space is important for me because I guess for me personally, it's very easy for me to feel like I don't belong. With any group that I'm in, I'm always trying to feel like, okay, the people that I'm around, they actually want me to be there. You know what I mean? I feel like that's why space is important for me because I know that space was created for me to be there. In the back of my head, there isn't that voice that's like, "Ha-ha. You're the only Black person right here right now. They're probably all thinking about you right now. They're probably like, oh you don't even want to... They don't want you around right now." But when I feel like when I'm in these spaces, I don't even think like that. I'm just thinking, okay, I'm with my people right now. Or I'm like, I'm uncomfortable so there isn't that voice in the back of my head that's just making me on guard. You know what I mean? I can just be what I want.

Kyle feels comforted knowing he can enter the space authentically and belong. He finds solace now that the voice in his head that usually emphasizes he is alone is silenced. Despite Kyle and Overton feeling comfortable being themselves in workspaces intended for Black students, Régine expressed that she could not achieve the same level of comfort in her Black Living Learning Community. Her frustration is evident in the following excerpt, where she describes her experience as a minority within a space advertised for people that look like her:

> I'm not going to lie. Sometimes when I'm walking, it's kind of depressing, walking through the hallways. Most times I don't even want to be there, or if I'm staying in my room, or I leave to go to the library or stuff, it feels draining walking back through those hallways. And I can't even explain why. It's just how I feel walking through them...I live in [residence hall]. I already said that, but it's supposed to be the Black Living Learning Community. On my floor of 60 students, 60 girls, four of us are Black in the Black Living Learning Community....And most times I don't even feel comfortable going in there when they're all packed in there, every day, bringing students from other halls or wherever they live by the one space I'm supposed to feel comfortable, just walking. I don't even feel comfortable walking most of the times.

The discomfort Régine feels in this environment directly results from the lack of Black people in a space where they are supposed to be heavily represented. Unfortunately, being uncomfortable is often necessary to succeed as a Black engineering student at a PWI. Khadijah speaks to the silver lining in this situation here:

> … it's beautiful being the first one, or doing something that's different, I think there's beauty in that, but I also think it can be scary, like she was saying. It's hard because you

> don't... There's such thing as familiarity bias, so if everyone looks like you, it's easier to ask for help, it's easier to feel comfortable, but if no one looks like you, then you're kind of in an uncomfortable position all the time. So, there's beauty in it because when you're uncomfortable, there's growth, but it's a little bit scary, and it's hard sometimes.

She recognizes the importance of actively and intentionally stepping out of your comfort zone but acknowledges that it is not an easy undertaking. Max shared this sentiment and described being empowered by NSBE to deal with being uncomfortable as a Black engineering student:

> And honestly, NSBE really did help me grow out my shell in Boston. And just having that support system made me feel comfortable and confident enough to be able to ask for help and do that. Because they're always telling you, "Talk to your TAs, go to office hours. Talk to your professors." Building those relationships will just only help you be more successful. And so, hearing that all the time makes you think, "Maybe I just try it out."

Other participants alluded to being uncomfortable as one of the few Black students in a space. But Max extended that to a classroom context, where that reality prevented her from feeling comfortable asking for help.

B. Building Community

The participants mentioned the importance of community as Black engineering students. In-person interactions on campus offer students the chance to build community. Unfortunately, the COVID-19 pandemic eliminated many opportunities for in-person events and proved a significant barrier to finding community on campus. Regarding her experience, Khadijah remarked:

> So, before COVID, which was just my freshman year, I would say everything was very inclusive and fun, maybe because I was on campus more. So, I just felt like there was a lot more people who could potentially help me. In my mind I was like, okay, I'm just a freshman, so I still went to career showcase even though no one's going to hire a freshman, but I still show up. But I got to see a lot of people who kind of looked like me, who had similar experiences, and I got to talk to them which was kind of cool. So, it made me feel like, okay, this is great. This is totally feasible. I'm here, people have similar struggles, so I can definitely just ask them for help and move forward to the next step. Then post COVID, or while in COVID I was like, okay, so what happens now. So, you just kind of take it day by day while in COVID. But then post COVID, I think it was hard, trying to integrate back into society, even though I'm an extrovert, I was already comfortable with being home and being by myself.

She highlights that building community was easier before the pandemic than during, partially due to the in-person events where she could interact with and be supported by other Black students. Likewise, Kyle identified his limited exposure to the Black community on campus as another barrier to finding community:

> And then to answer your other question, is it easy or hard to find these spaces? I'm honestly not sure. Just because I feel like it depends on where you surround yourself because I came in through [first-year program] so I was already around a lot of Black people. Wherever they went, I just followed them. But I can imagine that someone who came in, a Black person who comes in, who maybe they didn't come in through [first-year program], maybe they just have a bunch of non-Black people around them, they're not very familiar with the Black community and spaces. I feel like it could be hard for them because they're just not privy to it. They just don't know about it. I feel like once you know about it, it's easy because then the connections are there, but if you don't have those connections, to begin with, then yeah, it can be hard.

He credits a first-year university-wide program with immersing him in the Black student community, which made him privy to information concerning how to develop meaningful relationships while at the university. Max, a Black woman, mentioned an additional obstacle to finding community is the lack of other Black women engineering students:

> There's not really any Black female engineers unfortunately. There's I know some younger ones in electrical and I'm friends with them, but I don't have as many classes with them. So, I don't really see them and interact with them as much. So, there's that community. But then there's also the other community of a lot of my friends are women. And so that's really encouraging, just having women in engineering, women in electrical engineering, because it's already far and few in between.

While disappointed, Max realizes the importance of community to her success as an engineering student. Instead, she found additional support from other women in engineering who did not identify as Black.

C. Fitting In

Even within the Black community, students can face issues with fitting in. Students who don't fit the preconceived notion of what a Black person *should* be can have trouble being accepted for being themselves. For Khadijah, this problem manifests as people questioning her Blackness:

> And then you find yourself and there's like, swirl of just cliques, one club, the next club, the next club. And they have all these requirements that they, although they don't say, they don't say you must be this kind of Black person or you must have these kind of experiences, they make you feel like maybe you're just not Black enough, or maybe you don't look Black enough. So, then you find yourself just lost in a pitch Black of, you're trying to find people who look like you, you're trying to find your Blackness. You find yourself just in a pitch-Black moment of trying to find, like damn, am I even Black enough to fit into where I'm supposed to be, or where am I supposed to be. Because you have this frat, this sorority,

> this club, that club, and then you're just like sitting there by yourself trying to figure it out mentally.

Khadijah's identity as a Black-Hispanic woman subjects her to scrutiny from both ethnic communities:

> … even though I'm there, whether it's a Hispanic thing or a fully Black thing, in both places I'm still questioned. If I don't act a specific way as a Hispanic or speak enough Spanish, then I'm not a good Hispanic. And then if I don't have a certain experience or have my hair a certain kind of way or look a certain kind of way, then I'm not really Black, because no one's ever asked, no one's assumed, oh, you're just Black. Everyone's always assumed that I'm mixed or this or that, blah, blah, blah. So, without it being directly said, to most people the question of my Blackness is always there. So, it's like, okay, so what makes me Black to you…

These quotes from Khadijah reflect how others' perceptions of her Blackness have molded her experience as a Black student. Max echoes this sentiment:

> And so, I feel like I didn't fit the typical Black mold that [the Black Student Union] I guess had in mind and I just didn't really feel welcome there. So that's really why I really fell in love with NSBE because I could tell them about like, "Oh my gosh, I love like doing all these things." And I feel like they were like, "Okay, that's actually kind of cool. That's dope, Max, that you do like these different activities that you enjoy and hobbies." And so, that kind of transition between me, freshman year, not knowing what she was doing, to finding a group of community of students who look and like things that I like and look like me and are also passionate about engineering was really important to me.

It is unrealistic to expect Black students to measure up to an artificial standard of Blackness. Unfortunately, this pressure extends to the engineering community and can manifest as a burden for Black students to prove they are the "right" type of student because it allows them to fit in. This reality is illuminated in the following quote from Kyle:

> Because I feel like when I'm usually the only one, I don't get taken as seriously. I feel like I have to do more to show that I can hang with them. You know what I mean? I feel like when I'm not in those spaces, I'm always feeling I have to go either above and beyond or to just hang out, not hang out, hang behind, and things like that. I don't feel like I'm really actively participating how I want to.

As a Black engineering student, Kyle acknowledged that when he is the only Black student in a space, he needs to prove that he fits in, affecting his ability to be fully present. Régine communicated this experience in her remarks about working on group projects:

> So, it's the same for me, but not only proving it to myself, but to others. I find myself in group projects where, I guess, people play into stereotypes of the work ethic that I'd be able to provide in groups like that. So, I feel like I have to go to the extra mile to prove to people that I deserve to be here in this class. It hasn't been the case in most gen ed courses, but as it gets closer to the major classes, I see that happening. So, I feel like I have to go to the extra mile to prove to people that I deserve to be here in this class. It hasn't been the case in most gen ed courses, but as it gets closer to the major classes, I see that happening.

Both participants underscored the problem of fitting in for Black engineering students – feeling that they must prove to others that they deserve to be in these spaces.

D. Experiencing Frustration

Repeatedly feeling you must prove to others that you belong can be frustrating. The participants alluded to several frustrations associated with being Black engineering students. One source of frustration is the reality of the age-old adage "you have to work twice as hard to get half as far" that many Black people in the U.S. have heeded. Max stated:

> I definitely agree with everyone's point too. The whole working twice is hard, is so prevalent. I feel like people just kind of put this image of how Black people are in general; we don't work hard, we're lazy, and all these stereotypes, and so when we come here and prove that we work, and they're like, "oh", they're usually shocked, which is kind of upsetting, but it's just... it is true, you have to work two times harder just to be on the same playing field, which is kind of frustrating sometimes because it's like, why does the color of my skin define my work ethic or my ability to be great or be successful? So yeah, it's just frustrating sometimes having that bias even before you just walk in a room... immediately.

Régine shared a similar annoyance with the unfair expectation that Black people need to work twice as hard:

> But most times, Black students trying to achieve the same things as their White counterpart have to try twice as hard to get the resources that they have. And putting a lot more effort to be viewed as someone that's capable. So, in group projects and stuff, this has always happened, especially since I'm an engineering student. Most of the students I'm going to be in group projects with are going to be White males. And they sometimes just jump over what you're saying. This is at [university], this is just a student. But I guess as society, I guess, the way they view Black people as not being able to achieve these types of things.

These two excerpts emphasize a duality in the participants' experiences as Black engineering students: non-Black people stereotype them as lazy, yet the Black community expects them to work twice as hard to overcome this stereotype. These expectations can undoubtedly trigger frustration in Black engineering students, which can impact their undergraduate experiences.

Several students described dealing with frustration in their interviews, including Overton, who mentioned the low number of Black students in the College of Engineering as a root cause:

> But it is not specifically at [university] because I've actually talked to a couple of friends and they run into the same issue, where there's like... It seems like it's disproportionate in the number of Black students actually in engineering.

Similarly, Régine's frustration stemmed from the lack of Black students even within co- and extra-curricular programming marketed to underrepresented minorities:

> So, they kind of present these programs as helping underrepresented kids. But when you look into it, a majority of them aren't underrepresented minorities in the first place. You wonder why they've said it forth in the first place. It doesn't make any sense. ... It's not significantly different from any other class you'd be taking or any other program you'd be in. You're still the minority in this group that they said is full of minorities.

While Overton and Régine are frustrated with a lack of other Black students, Khadijah's frustration arose from her experience as a Black engineering student not being understood by her family. Khadijah explained:

> It definitely, I think for me it was like, it's the fact that when you have an accomplishment, whether it's small or big in engineering, you don't have anyone at home to tell it to without an explanation. They don't understand, but they want to, and they're happy for you, but in the core of it, they don't understand.

These three participants experienced frustration with circumstances outside their control. Unfortunately, an inability to change these circumstances requires them to normalize it as part of their experience as Black engineering students.

E. Overcoming Imposter Syndrome

Another part of the student experience that our participants communicated in the interviews was dealing with imposter syndrome. Kyle and Max referenced it as an obstacle they navigate as engineering students at a PWI. Kyle detailed his internal struggle with this in his interview:

> It's internally because it looks like physically, the accomplishments are there. You pass the classes, you're doing well, but for some reason on the inside, it's just a mental battle of actually trying to correlate your accomplishments with how things actually are...

He expanded on this idea in the following quote:

> I think that's the biggest reason why I have an imposter syndrome because I look at myself and I have all the skills and to put all these things together, but then I still compare myself

> to other people. And I watch what they're doing and I'm like, dang, I'm not doing that. So obviously, I'm not good enough to be like them. It's focusing too much on the factors around me instead of focusing on what I actually can do.

For Kyle, comparing himself to others was a primary trigger for his imposter syndrome. On the other hand, Max commented on the double-edged nature of battling imposter syndrome:

> It's definitely hard, but it's good and bad. And it's hard because it's just like you look around the room and you're like, "Dang." You don't see anyone who really looks like you. Maybe one or two, but it's far and few in between. And it's really almost discouraging, because it's- ... almost discouraging, because it's like, am I really meant to be here, when you don't see anyone else look like you, pretty much all your peers are white men usually? And so it's kind of hard to find that drive to keep going when it's only you in there, but also it's kind of really awesome at the same time because you are that trailblazer. You are kind of inspiring others or being that inspiration to others to continue engineering or to even think of doing engineering, which I think is really important just to have representation for that so we can increase the number of Black engineers.

The lack of Black engineering students at the university stirred up feelings of inadequacy in Max. However, she realized that this disparity allowed her to be a role model for the younger Black engineering students at the university.

F. Valuing Mentorship

Students reported that mentorship was integral to their experience as Black engineering students. Mentorship from older students provided them with advice on navigating life as undergraduate students at a PWI. Max spoke about the benefits of having access to near-peer mentors through NSBE:

> And so, we just talked to a bunch of the older, old heads is what we call them, students who were able to guide me and help me secure my first internship actually. Definitely, just having that group of people just supporting me and being able to help me, that's how you do this, that's how you do that, definitely helped me a long way.

She felt the support and guidance of her peers, which helped motivate her throughout her studies. Later, Max talks about NSBE offering her a channel to connect with and learn from other Black women in engineering:

> NSBE kind of leading the right direction was definitely something that shaped me, as one, being a female, because we had our little NSBE ladies chat. And so that was nice because we got to do like brunches and we would just talk about girl talk. And so it's nice to have that because it's like, Okay, where do I get my hair done for this?" Or like, I can't really talk about that with like non-Black people. So that was kind of nice having the group of women to just kind of relate to just everyday Black girl struggles.

Like Max, Khadijah described an appreciation for NSBE in providing opportunities to connect with other students willing to provide mentorship. She talked about one instance here:

> ... I had to get a different computer to run specific programs. And I just asked in a NSBE chat and someone actually helped me go through all these different computers, the processors, the space, the storage.... Then eventually that same person helped me with my coding homework, and then I helped them with their Spanish homework. And it was just you build this relationship that's based on we have similar struggles, like you need help with something and I need help with something. We can help each other.

Khadijah was receptive to the mentorship, and her role in this situation evolved into a mutually beneficial partnership. Like Khadijah, Overton recognized the value of mentorship:

> I think the biggest thing my mentor told me was, "You see everything that I'm doing for you, you got to do the same for somebody else." And so, giving back is probably... That's the thing that closes the loop. I think the biggest thing with my mentee is I just want to see her be successful and go even further than me, but the biggest thing I want her to do is get a mentee and then see what it's like from the mentor perspective and just uplift somebody else to that same, more or better.

He adopted a "pay-it-forward" attitude and sought opportunities to mentor other students to ensure they received the same level of support he had as a Black engineering student.

V. Focus Group Findings

The focus group discussion provided space for students to share their photographs with each other. Participants discussed each theme identified in the individual interviews and determined desired outcomes of this study. As the discussions progressed, participants transformed the desired results into actionable steps the university could implement to improve Black engineering student experiences. These steps fell into two categories: solutions to problems and suggestions for improvements.

A. Solutions to Problems

Several themes from the analysis related to problems the students associated with their experiences as Black engineering students. As a group, the participants agreed that the following means address their struggles with **fitting in**, **frustration**, and **imposter syndrome**:

- *Create events highlighting Black culture and student accomplishments* - The students desired increased representation and visibility of other Black students on campus. Being around people that can relate to their experiences cultivates an environment where they can fit in. This suggestion would affect not only Black engineering students but the Black student body.

- *Create safe spaces where Black students can talk to each other about their experiences* - Spaces for Black students currently exist on campus yet the participants expressed a need for a dedicated space where they could speak freely about their experiences. In the focus group, students hesitated to share their frustrations in the current spaces on campus because these venues are not designated for non-judgmental and vulnerable discussions. An atmosphere where these conversations are encouraged can alleviate student frustrations because they can connect with other students who can validate their feelings.

- *Create a smaller career fair event specifically for Black students* - The participants acknowledged that comparing themselves to other students was the primary source of their imposter syndrome. The student career fair was referenced as one event where they struggled to overcome feelings of self-doubt. External pressures were compounded by being surrounded by students and employers who mostly did not look like them. A smaller career fair designed for Black students was lauded as a vessel for overcoming imposter syndrome because it would allow them to be more comfortable in the space, thereby improving their confidence.

B. Suggestions for Improvements

In the focus group, students discussed university programming as a critical element to their success as Black engineering students. While they seemed mostly satisfied with their experiences, the participants collectively agreed they could benefit from better-structured programming. The students' suggestions for improvement included activities that would enhance their **comfort**, **community**, and **mentorship**.

- *Host a student panel for incoming first-year and transfer students* - The participants reflected on their first year at the university and recalled their difficulties as they acclimated to undergraduate life. During these reflections, an idea emerged for the university to host a panel where upperclassmen could pass on advice. Students noted that these interactions could make first-year students more comfortable and ease their transition into college.

- *Increase representation of Black students in programming for underrepresented minorities* - Students mentioned their search for community within programs designed for underrepresented minorities. While participating in these programs, they noticed a lack of Black students. Their solution to this disparity involved asking the university administration to encourage more participation from Black students.

- *Match students with mentors upon enrollment* - Most students referenced mentoring relationships as essential to their success in engineering. Participants described these relationships as informal. They voiced that their mentoring experiences could be enhanced by more formal mentoring programs offered through the university. Specifically, they suggested a program where first-year students are paired with an older mentor in their major to guide them throughout their degree program.

These actionable steps were communicated to the College of Engineering's Associate Dean for Student Affairs and the broader university community. He was receptive to these suggestions and open to including students in future discussions regarding implementing these measures.

VI. Implications

Through this work, the photovoice approach was applied within the context of a large, southeastern university. These results, though context-specific, provide a snapshot of the experiences of five Black engineering undergraduate students. While the scope was limited due to recruitment issues, this work has provided much-needed insight into life as a Black engineering student at a PWI. Further research in this area is encouraged within the engineering education domain to capture additional ways to address these students' challenges. Researchers can apply photovoice to other universities and demographics to elicit actionable steps to support groups of interest.

At UF, Black engineering students identified solutions to problems and suggestions for improving current institutional efforts. This information offers prospective methods to help Black students combat institutional barriers to success. However, additional work would allow the education community to address the structural issues Black engineering students face in higher education across the United States.

VII. Conclusion and Future Work

We found six aspects of their college experience that most influenced Black undergraduate engineering students. The students faced challenges and gained opportunities related to finding comfort, building community, fitting in, experiencing frustration, overcoming imposter syndrome, and valuing mentorship. The results of this work included identifying actionable steps to disseminate to college administrators who can enact the changes necessary to improve Black engineering undergraduate student experiences, providing opportunities for these students to feel more included during their collegiate experience.

The actionable steps identified by the students provide a critique of the current campus culture and climate. Efforts to diversify undergraduate engineering programs at UF have not significantly impacted the enrollment and retention of Black engineering students. Future work should focus on understanding what factors contribute to low enrollment and addressing those issues in tandem with college administration. While mentorship was a theme and a desired actionable step that surfaced from these students' experiences, further understanding of how to effectively design and implement a formalized mentorship program to support Black engineering students is suggested before addressing that desired action.

This work sheds light on the perspectives of a handful of students at one university. Thus, future research should focus on understanding the experiences of Black engineering students at other types of universities (HBCUs, HSIs, and MSIs) and in different parts of the country. Contextualizing these experiences may offer a better understanding of the nuanced experiences Black engineering students encounter across the U.S. Future work includes implementing the

actionable steps and analyzing the images collected. The authors also plan to work with the participants to display their photographs in an art exhibit at the university.

VIII. References

[1] C. Libassi, "The Neglected College Race Gap: Racial Disparities Among College Completers," Center for American Progress, May 2018. Accessed: Oct. 14, 2022. [Online]. Available: https://www.americanprogress.org/article/neglected-college-race-gap-racial-disparities-among-college-completers/

[2] "Diversity and STEM: Women, Minorities, and Persons with Disabilities 2023," National Center for Science and Engineering Statistics (NCSES), Alexandria, VA: National Science Foundation, Special Report NSF 23-315, 2023. [Online]. Available: https://ncses.nsf.gov/wmpd

[3] American Society for Engineering Education, "Profiles of Engineering and Engineering Technology," Washington, D.C., 2021.

[4] E. O. McGee, "Interrogating Structural Racism in STEM Higher Education," *Educ. Res.*, vol. 49, no. 9, pp. 633–644, Dec. 2020, doi: 10.3102/0013189X20972718.

[5] E. Seymour and A.-B. Hunter, Eds., *Talking about Leaving Revisited: Persistence, Relocation, and Loss in Undergraduate STEM Education*. Cham: Springer International Publishing, 2019. doi: 10.1007/978-3-030-25304-2.

[6] E. O. McGee, "Devalued Black and Latino Racial Identities: A By-Product of STEM College Culture?," *Am. Educ. Res. J.*, vol. 53, no. 6, pp. 1626–1662, Dec. 2016, doi: 10.3102/0002831216676572.

[7] G. Anderson, "The Emotional Toll of Racism," *Inside Higher Ed*, Oct. 22, 2020. https://www.insidehighered.com/news/2020/10/23/racism-fuels-poor-mental-health-outcomes-black-students (accessed Dec. 08, 2022).

[8] J. Kays, "UF Racial Justice Research Fund established to support scholarship on the Black experience," Jul. 23, 2020. https://news.ufl.edu/2020/07/racial-justice-research-fund-release/

[9] UF Research and the UF Office of the Chief Diversity Officer, "2020 Call for Proposals: Advancing Racial Justice Through Inclusion, Diversity, Equity, and Access at the University of Florida." https://research.ufl.edu/wp-content/uploads/2020-RJcallFinal.pdf

[10] P. A. Holkup, T. Tripp-Reimer, E. M. Salois, and C. Weinert, "Community-based Participatory Research: An Approach to Intervention Research With a Native American Community," *Adv. Nurs. Sci.*, vol. 27, no. 3, pp. 162–175, Jul. 2004, doi: 10.1097/00012272-200407000-00002.

[11] K. Hergenrather, "Photovoice as Community-Based Participatory Research: A Qualitative Review," *Am. J. Health Behav.*, vol. 33, no. 6, 2009, doi: 10.5993/AJHB.33.6.6.

[12] C. C. Wang, "Photovoice: A Participatory Action Research Strategy Applied to Women's Health," *J. Womens Health*, vol. 8, no. 2, pp. 185–192, Mar. 1999, doi: 10.1089/jwh.1999.8.185.

[13] S. Lal, T. Jarus, and M. J. Suto, "A Scoping Review of the Photovoice Method: Implications for Occupational Therapy Research," *Can. J. Occup. Ther.*, vol. 79, no. 3, pp. 181–190, Jun. 2012, doi: 10.2182/cjot.2012.79.3.8.

[14] J. Wawire, J. Henderson, B. McGowan, and K. Schaefer, "Work-in-Progress: Balancing It All: Using Photovoice to Visualize Second-Year Engineering Student Experiences".

[15] J. G. Liang, R. Evans, and S. E. Kulesza, “We are thriving! Undergraduate women in engineering student project teams,” in *126th ASEE Annual Conference and Exposition: Charged Up for the Next 125 Years, ASEE 2019, June 15, 2019 - June 19, 2019*, in ASEE Annual Conference and Exposition, Conference Proceedings. Tampa, FL, United states: American Society for Engineering Education, 2019.
[16] L. Bosman, K. Chelberg, and N. Duval-Couetil, “Using Photovoice to Enhance Mentoring for Underrepresented Pre-Engineering Students”.
[17] S. Bork and J.-L. Mondisa, “Work in Progress: Using Photovoice to Examine the Mental Health Experiences of Engineering Graduate Students During COVID-19,” in *2021 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual Conference: ASEE Conferences, Jul. 2021, p. 36525. doi: 10.18260/1-2--36525.
[18] University of Florida Institutional Planning and Research, “Facts - UF Diversity Dashboard.” https://ir.aa.ufl.edu/facts/diversity/ (accessed Oct. 14, 2022).
[19] C. M. Killion and C. C. Wang, “Linking African American Mothers Across Life Stage and Station Through Photovoice,” *J. Health Care Poor Underserved*, vol. 11, no. 3, pp. 310–325, 2000, doi: 10.1353/hpu.2010.0816.
[20] M. Maratos, L. Huynh, J. Tan, J. Lui, and T. Jarus, “Picture This: Exploring the Lived Experience of High-Functioning Stroke Survivors Using Photovoice,” *Qual. Health Res.*, vol. 26, no. 8, pp. 1055–1066, Jul. 2016, doi: 10.1177/1049732316648114.
[21] C. R. Carnahan, “Photovoice: Engaging Children with Autism and their Teachers,” *Teach. Except. Child.*, vol. 39, no. 2, pp. 44–50, Nov. 2006, doi: 10.1177/004005990603900208.
[22] W. Hussey, “Slivers of the Journey: The Use of Photovoice and Storytelling to Examine Female to Male Transsexuals’ Experience of Health Care Access,” *J. Homosex.*, vol. 51, no. 1, pp. 129–158, Sep. 2006, doi: 10.1300/J082v51n01_07.
[23] V. Braun and V. Clarke, “Using thematic analysis in psychology,” *Qual. Res. Psychol.*, vol. 3, no. 2, pp. 77–101, Jan. 2006, doi: 10.1191/1478088706qp063oa.
[24] V. Braun, V. Clarke, N. Hayfield, and G. Terry, “Thematic Analysis,” in *Handbook of Research Methods in Health Social Sciences*, P. Liamputtong, Ed., Singapore: Springer Singapore, 2019, pp. 843–860. doi: 10.1007/978-981-10-5251-4_103.
[25] V. Braun and V. Clarke, “Can I use TA? Should I use TA? Should I *not* use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches,” *Couns. Psychother. Res.*, vol. 21, no. 1, pp. 37–47, Mar. 2021, doi: 10.1002/capr.12360.
[26] L. S. Nowell, J. M. Norris, D. E. White, and N. J. Moules, “Thematic Analysis: Striving to Meet the Trustworthiness Criteria,” *Int. J. Qual. Methods*, vol. 16, no. 1, p. 160940691773384, Dec. 2017, doi: 10.1177/1609406917733847.
[27] M. DeCarlo, *Scientific inquiry in social work*. Open Social Work Education, 2018. [Online]. Available: https://pressbooks.pub/scientificinquiryinsocialwork/