

## **Improving the Experiences and Retention of Black Students in STEM Education**

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# Improving the Experiences and Retention of Black Students in STEM Education

## Introduction

Traditionally, Predominantly White Institutions (PWIs) have welcomed a homogenous body of students with similar socio-economic, academic, and racial/ethnic backgrounds. Institutional policies have prevented access and full participation of minoritized students leading to lower retention and graduation. This has spillover effects into the workforce where there is an imbalance in the representation of minority groups. As shown in a recent report from the Pew Research Center, Blacks and Hispanics make 27% of all employees but only 17% of the STEM workforce [1].

Despite this history, for the past few decades universities and colleges have seen an increase in students coming from historically marginalized communities including Black students [2], [3], [4]. This new generation of students have experienced challenges that their predecessors did not. They suffered negative impacts from an unwelcoming campus climate, the curricula and policies set by most universities and colleges [5]. This negatively impacts a student's college experience including academic performance, graduation rate, grade point average, and persistence in completing degrees [6].

The curricula and policies affect students' outcomes. For instance, introductory classes in calculus and chemistry serve as gatekeepers for students who want to major in STEM fields [7]. Black students disproportionately fail these courses more than their White counterparts. For example, at this institution, about 40% of Black students did not earn a passing grade in their first semester compared to 7% for their White classmates. Understanding the factors contributing to this failure rate is important for diversifying STEM education since Black students who failed these classes tend to not pursue STEM degrees as compared to their White peers. Furthermore, even if a Black student stays four years and graduates, they face significant challenges that their White counterparts do not.

Other challenges that affect Black students' outcomes are feeling of isolation and discomfort with campus climate. For example, *My Experience Survey* at UC Berkeley in 2019 revealed that many underrepresented groups felt marginalized and excluded leading to a lack of sense of belonging [8].

The murder of George Floyd on May 25, 2020, compelled many PWIs to, finally, take actions on how to improve support for minoritized students, including Black students. Issues these institutions explored included: 1) the sense of pressure felt by community members of color to locate or establish safe spaces where they can experience a sense of belonging. For example, by making the campus and library spaces that are flooded with photography, statues, and portraits depicting mostly White males more inclusive for Black students [9]; 2) awareness of microaggressions by developing workshops to improve awareness of microaggressions on campus [10]; and 3) the struggles that diverse students face in maintaining positive mental health and staying motivated by developing strategies to increase their wellbeing [11].

This research distinguishes itself by taking a holistic approach to understanding the Black student experience. First, the team utilized a mixed-method research design that incorporated both qualitative and quantitative methods. Second, and more importantly, the team moved beyond engaging Black students and alums as research “subjects” and engaged with them to first identify obstacles that impede their success, then elaborate strategies that help increase their sense of belonging. This research study aimed to identify factors that would address the negative experiences faced by the increasing number of Black students at this PWI. To achieve this goal, this paper seeks to answer the following question: What are the challenges and problems encountered by Black students on campus?

This study revealed two primary outcomes: 1) Black students face difficulties with adjusting to academic and campus life and 2) they feel excluded from the campus community. This paper documents the main challenges that hinder Black students’ experiences on campus and identifies remedial interventions to increase their sense of belonging.

## **Research Methodology**

This research is part of a multi-year effort to understand and improve the experiences of Black students. A three-step research process began with in-depth interviews and focus groups with a sample of Black alumni and current students. Findings from these interactions were used to develop a survey that identifies stakeholder-driven interventions that could improve the campus climate for Black students. In summary, the research process comprised of the following:

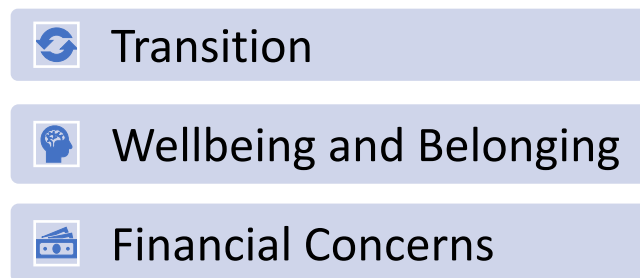
1. **Individual interviews and focus groups:** Qualitative data were collected from interviews and focus groups with Black alumni and current students.
  - a. In late October and November 2021, the research team conducted open-ended and unstructured interviews with 15 Black alumni from various STEM fields who graduated from the institution between 2009 and 2021 to gain insights into their experiences and reflections. Conducting interviews first helped gather data to explore more specific topics in the focus group sessions. The sample is representative of Black students across gender and race/ethnicity.
2. **Survey:** The qualitative data was used to develop a survey specifically to better understand the experiences of Black students at the institution.
  - a. The survey questions were structured around the key themes and issues that emerged from the interviews and focus groups with Black alumni and students. The survey asked questions to understand the experience of students in relation to their level of preparation for their STEM courses, programming that support their transition, support services received during their adjustment to academics and campus life, experiences with academics, racism, and discrimination, as well as questions about their sense of belonging and connection to the community. The team tested the survey with a small group of Black students to ensure that the questions were clear and easy to understand.
  - b. The survey was made available online in March 2022 and provided multiple reminders to encourage participation and increase response rates. Over 115

students from a total of over 330 students completed the online survey yielding a response rate of more than 35%.

- c. The institutional review Board's (IRB) committee of the institution approved the research and all of the participants consented to the IRB rules.
3. **Interventions and strategy forward:** The results from the data informed the development of interventions to improve the campus climate for Black students. The results of the interventions will be reported in another paper.

## Results

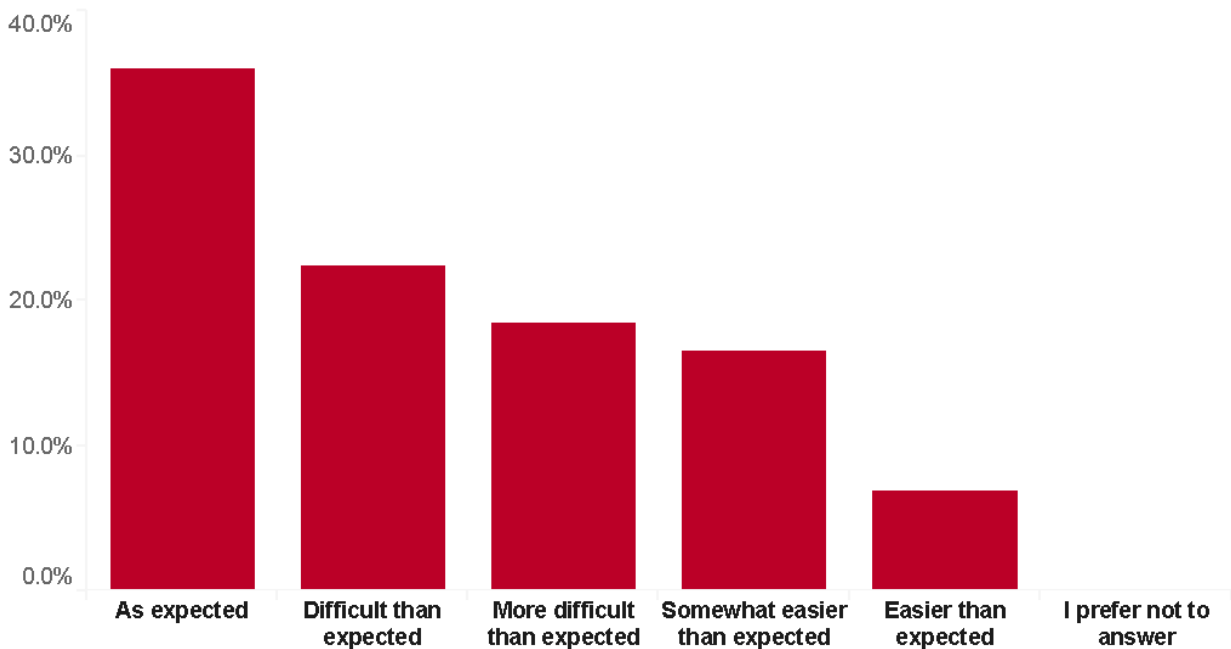
The analysis of the interviews and focus group discussions conducted with Black alumni led to three (3) major themes to describe their experiences during their time as students at the institution. These themes summarized in Figure 1 were further explored through surveys with current students to assess the prevalence and persistence of those issues. We summarize here the main findings by theme.



*Figure 1: Main Themes from Interviews and focus groups*

### Transition

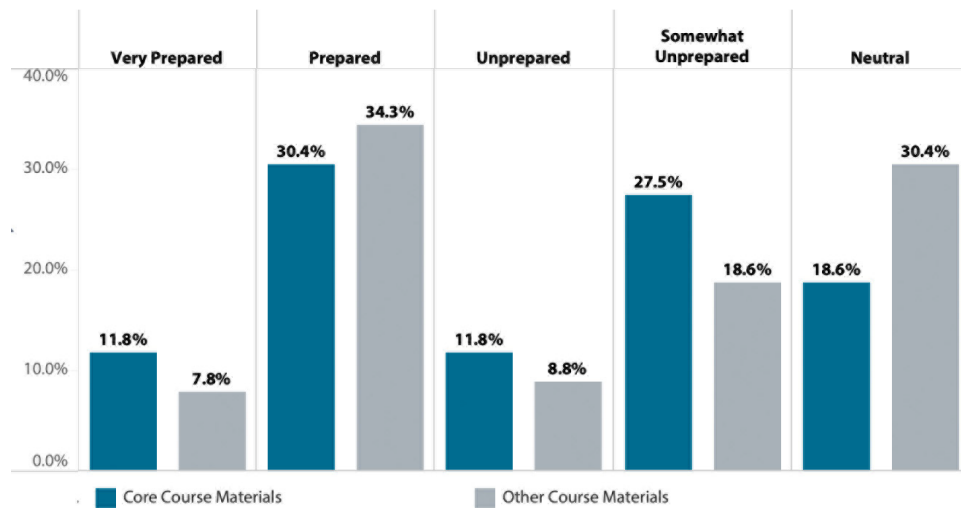
Black alumni and current students described the challenges that they encountered when transitioning to the institution during their first year. These challenges include a lack of preparedness for STEM introductory courses and difficult access to campus resources. In general, more than 40% of current students from the survey rated their transition as either difficult or more difficult than expected (See Figure 2).



**Figure 2: Transition**

***Pre-college preparation***

When asked about their level of preparation at the start of their first-year classes, many Black students felt less prepared for their core courses. About 39% of study participants responded that they felt unprepared for their core course as compared to only 27% for other courses (See Figure 3). Core courses including introductory STEM courses (math, physics, chemistry, and programming) are gatekeepers for students who want to major in STEM fields.



**Figure 3: Level of preparation for first-year classes**

Black students who tend to come from high school with no or limited access to advanced courses to prepare them for these courses are at a disadvantage. One male student explained: *“Coming from an underfunded high school I felt extremely underprepared for this school courses and structure with little to know resources for help”*. Similarly, another student expressed how difficult it was to keep up with their coursework: *“I think my school didn't teach a lot of the assumed knowledge that physics and calculus assume you have been introduced to, so it was much harder catching up to where the other students already were...”*

### ***Other transition challenges***

Other factors that affect student academic transition include 1) technological literacy, 2) familiarity with doing homework outside of the classroom, and 3) fast pacing seven-week curriculum that makes it difficult for students to catch up with their peers when they already come with a gap in preparation and pre-requisite for courses. A student reported the following about technological literacy.

*“I felt that I was way behind my peers during my first semester in terms of technological literacy”*. (Anonymous student)

Technology is important for STEM education and students who do not have the technological skills required to succeed in their classes are at a huge disadvantage as compared to their peers.

The fast-pacing curriculum is uneasy for any student who is not used to this system. However, when a student comes with other challenges, it becomes more difficult to succeed without any support.

*“I never really studied or had to spend time outside of the class to do homework etc. So transitioning to such a fast pace and unforgiving curriculum was a wake up call for me.”* (Male student)

### ***Support services***

There is a number of academic resources including academic programs and services (e.g.: First Year Experience program, tutoring services, writing center) and other student support services (e.g.: library resources, health services, housing services dining services, fitness center) to contribute to student success. It is important to understand why these resources have not been able to support these Black students in their transition.

### ***Participation in a First Year Experience Program***

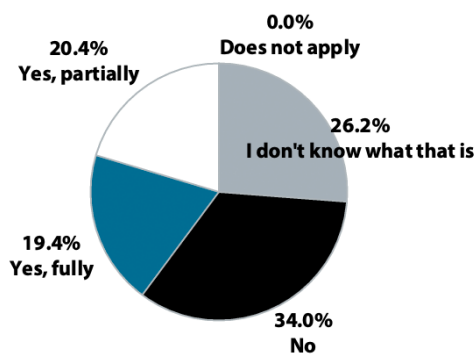
The institution offers a first-year experience program in which faculty and peer advisors help students adapt to campus life and learn about campus resources. However, results suggest that Black students do not fully participate in this program. About 60% of the survey participants did not attend the First Year experience program (Figure 4). Academic advisors in the program guide first-year students through the institutional resources and the courses they need to take to succeed

during their first semester and beyond. They also help them choose the courses they need in their first year to complete their degree requirements. Through the program, first-year students get introduced to campus social events and work with peer advisors (residential advisor (RA) and community advisor (CA) to learn about one another and build a strong community life in their dorms and on campus. Black students did not attend the first-year experience program because 1) they might not know the value of the program, 2) some of them have already attended a pre-orientation program that prepares underrepresented students in STEM to navigate college but that does not offer academic advising or 3) they do not know about the program. A student stated the following about the program:

“I just remember having meetings with the RA and people on my floor”.

*(Female student)*

The low participation of Black students in the First Year Experience program is alarming because the academic and social support services offered can ease student transitions and reduce the gap in students’ level of preparedness for college and STEM majors.



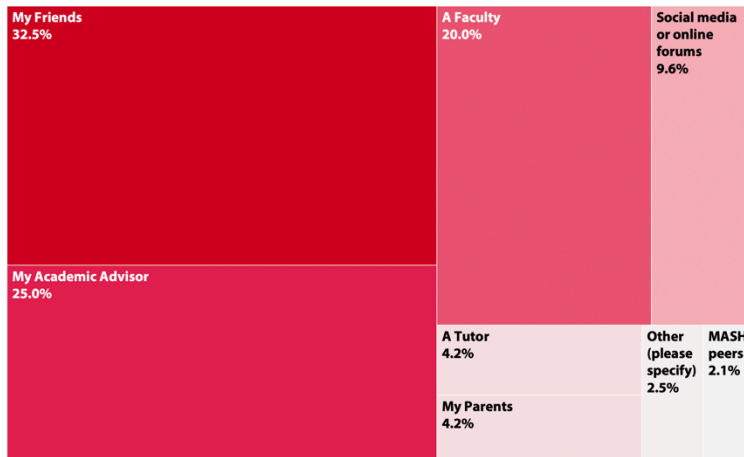
**Figure 4: Have you attended the First Year Experience program?**

### *Use of tutoring services*

Tutoring services are critical for first-year students who need academic support to pass their gateway courses. On campus, the Academic Resource Center offers review sessions to students for math, science, and computer science courses. These sessions are critical for student success. The stated goal of the sessions is to help students make the transition between high school learning patterns and the necessary habits and skills needed for college work.

Our findings show that Black students do not utilize these services fully. Only 2.1% and 4.2 % of respondents respectively list Math and Science Help (MASH) and other tutoring services as resources they rely upon when having an academic question (See Figure 5). In focus groups, the students explained that they do not seek help from these academic support services because they feel a lack of sense of belonging when there. Students reported that White peer tutors would often diminish them by making them feel like they lack knowledge on very basic questions. As a result, some Black students reported that MASH and other tutoring services are not designed for them. A student explained:

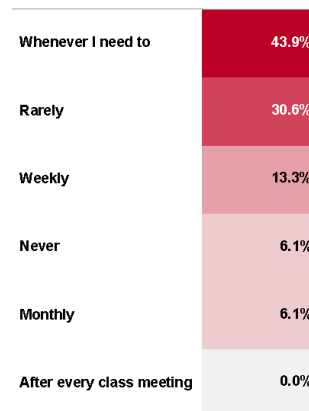
*“I don't really use academic services I've never received great help there; I've used ARC once or twice the writing center is nice though”. (Female student)*



**Figure 5: Academic Support**

### **Faculty support**

Interactions with faculty allow students to engage with the course material and learn better. When asked how often students visit their faculty outside of the classroom, 44% of students responded that they attend office hours whenever they need to. (See Figure 6).



**Figure 6: Participation in faculty office hours**

However, another 37% of students either never or rarely meet with their faculty during office hours, outside of the classroom (See Figure 6). One student reported:

*“I feel like all the computer science classes at this school are too big to really get any sort of connection with faculty. It could also be my fear of them that leads to that missing link. I really enjoy my interactions with other faculty though, specifically those in social sciences and humanities. They have lots of empathy and really seem to care about their students”. (Anonymous student)*



### *Other academic support services*

Black students do not always get the academic support they need to succeed in their classes despite the range of resources the institution offers. Students relied more on their friends than any formal academic support including academic advising, MASH, and other tutoring services. As presented in Figure 5, 32.5% of the participants turn to their friends to get academic support before their academic advisor and faculty.

### *Awareness of campus support services*

A successful navigation of support services can indeed ease student transition. However, not all resources are equally accessible to the students. Only 66% of Black student participants reported that they feel either comfortable or very comfortable navigating campus resources including library resources, health services, dining services, fitness center, etc. (See Figure 7)

Comfortable	39.8%
Very comfortable	26.2%
Somewhat comfortable	15.5%
Neutral	13.6%
Does not apply	2.9%
Not comfortable	1.9%

**Figure 7: Navigating campus resources**

Students do not necessarily know what resources are available on campus. For example, some students described how challenging it was to successfully complete assignments for their first-year courses that required textbooks. An alum stated:

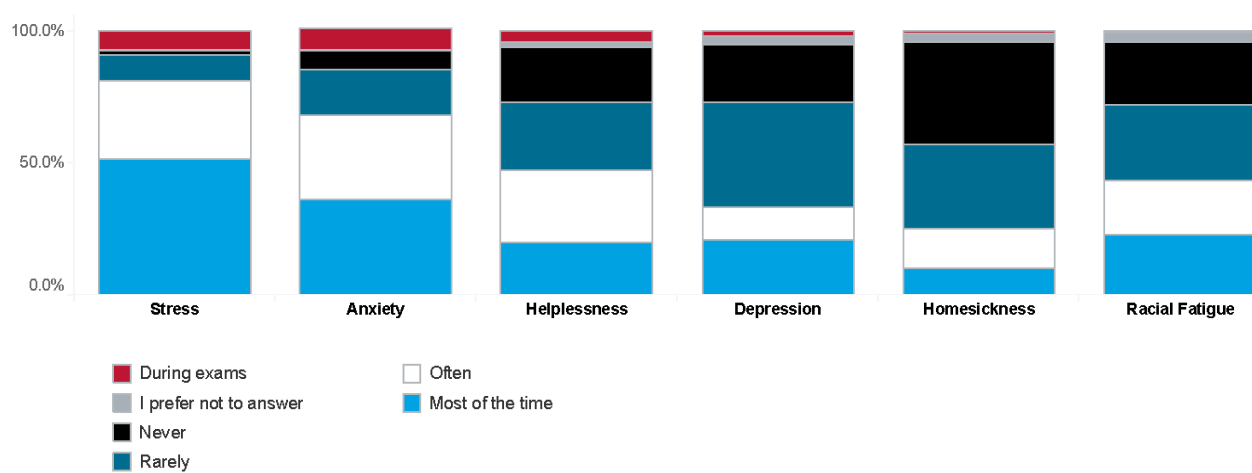
*“I didn’t know textbooks were available in the library until I was a sophomore”.* (Female alum)

Students may need appropriate training in finding and using campus resources. One current student reported:

*“I didn’t really receive appropriate training to navigate campus resources”.*  
(Female student)

### **Wellbeing & Belonging**

In general, Black students reported that they experience stress, anxiety, and racial fatigue most of the time as shown in Figure 8. About 82% of students reported that they experience stress often or most of the time and 33% experience depression often or most of the time.

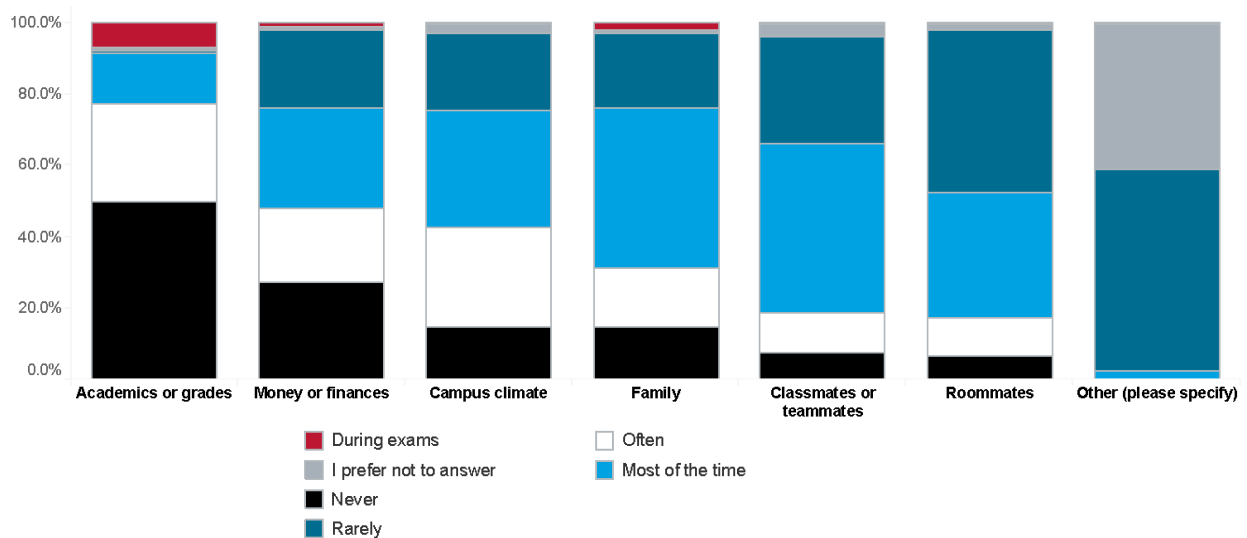


**Figure 8: Factors Affecting Students' Wellbeing**

When asked about factors that are sources of stress, many Black students described among other academics or grade, money or finance, **campus climate**, family, roommates, and **classmates or teammates** as factors affecting their wellbeing and sense of belonging.

**Campus climate and wellbeing**

According to the survey results in Figure 9, 42% of survey respondents identified campus climate as a source of stress for them either often or most of the time during their time at this institution.



**Figure 9: Sources of Student Stress**

For many students, the campus culture does not reflect the diversity that the university often advertises through brochures and online. Study participants feel like diversity “stopped at the pre-orientation program”. Once school started, many students expressed feelings of loneliness and being the “only Black student” in their classrooms or dorms. One female alum explained for example:

*"It's awkward sometimes being the only black women in spaces..." (Female alum)*

While the First Year Experience program introduces students to campus resources, it does not necessarily help students build and live in community. Students who participated in the program reported that they didn't feel connected to their roommates and floormates. One student reported:

*"The program really focused on getting to know the people on your floor and not anyone else. It was pretty clear to me that I was not going to be friends with most of them ..."* (Female student)

### **Classmates/teammates, microaggressions, and student wellbeing**

Most microaggressions Black students experienced come from the institution community, with 57% from non-Black peers and 10% from faculty (Figure 10).



**Figure 10: Aggression by Non-Blacks**

Students report that they were often victims of racism in 1) classroom settings and 2) dormitories. They had challenges working on group projects and felt diminished and disrespected by their peers, which affected their contribution to group assignments and their grades. Students reported:

*"They underestimate me, question the quality of my work, some have been disrespectful/rude, and don't listen to my ideas or concerns"* (Female student).

*"One time in a lab I was working with two white boys and when it came time to write up the lab report one of them would always give me the writing option that had no brain power, and they did everything else"* (Female student).

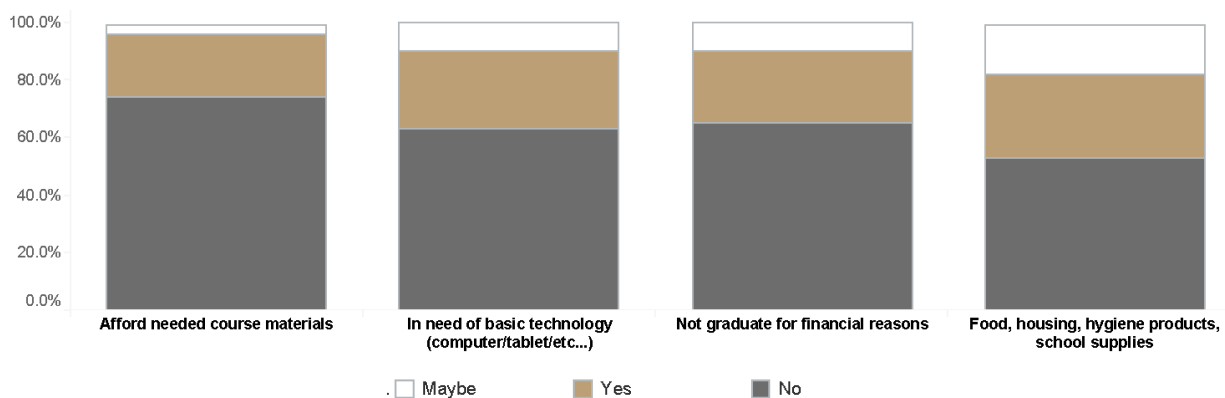
Students also reported bias in teamwork assignments within their group where they would be asked to complete less significant tasks or ignored. Consequently, students reported experiencing anxiety when working with non-Black peers on group projects because they feel stereotyped as "lazy". To avoid this stereotype, many Black students would work harder than expected even

when they do not feel well because they are not afforded the same level of grace and understanding as other non-Black students. Because Black students face racism and microaggressions in their housing and their classrooms, they expressed feelings of discomfort in the community that impacted their mental health and overall wellbeing. One student reported:

*“When I work with non-Black peers, it’s definitely stressful and I adopt some form of social anxiety. Because I don’t want to be stereotyped or be seen as the black kid that needs to be carried in a team, I push myself more to try and impress or meet expectations. This isn’t always bad, but it is definitely draining and sometimes makes me feel like I can’t make or have excuses when I naturally fail” (Male student).*

### Financial Concerns

Figure 11 shows how students often worry about their basic needs and not graduating on time due to financial constraints. About 55% of study participants had a job on or off campus, which conflicted with their need to make time for studying. Most students expressed concern about their finances and paying off student loans when they graduated.



**Figure 11: Financial Concerns: Meeting Basic Needs**

When asked about whether they ever needed to switch or drop a class because they could not afford to purchase the needed course materials, 24% of student respondents said “Yes,” suggesting that students might deviate from their intended majors for financial reasons.

About 87% of Black students in the study receive an average of \$32,882 in scholarships and/or grants from the institution a year. With this amount being less than half of the cost of attendance at the institution, many students work, take out student loans, or get help from their families to cover the remaining costs.

### Discussions

The purpose of this paper was 1) to identify the challenges and problems encountered by Black students on campus. Analysis of interviews, focus groups, and surveys with alumni and students show that an important number of Black students experienced a more difficult transition than they expected, leading them to perform poorly in their first two terms. These findings support

Black critical race theory that examines the “unequal and unjust distribution of power and resources along political, economic, racial, and gendered lines” [12]. Unequal distribution of resources creates gaps that prevent Black students’ successful integration into PWIs. These findings are consistent with previous studies that argue that these students must adjust to being college students while facing additional challenges related to racial campus climates [13], [14]. These findings are also consistent with institutional data that show that Black students are failing many of the courses they take in their first semester. Black students received a non-recorded (NR) or failing grade in more classes in their first semester than their non-Black peers. For example, in 2021, about 40% of Black students NRed one or more classes in their first semester compared to only 7% for non-Black counterparts.

Further analysis shows that, at this institution, from 2017 to 2021, students in their first semester failed the most their courses of Calculus II, Chemical Reactions, Calculus III, Calculus I, Introduction to Program Design, Calculus IV, General Physics Mechanics, and others. These core courses usually require a good level of pre-requisites or preparation that Black students either do not have access to or could not afford.

Because these core courses serve as gatekeepers, Black students who do not pass them are more likely to drop their STEM major for other alternatives. As the institution sets out to diversify its student body and contribute to the diversification of STEM fields, it is important to ensure that newly admitted Black students have a good start in their first semester.

Students also report issues related to their difficulties in navigating resources on campus. These challenges stem from 3 main issues: ignoring the existence of the resources, ignoring how to use them, or choosing not to use them for various reasons.

First, the students may not know about the existence or availability of the resources. Some students report not knowing the existence of resources such as the First Year Experience program, MASH and Tutoring services. This is due to a lack or an inefficient advertisement of these resources. Sometimes, these student resources are advertised during orientation programs and the low participation rates of Black students in these programs may compound their ignorance of the availability of the resources.

Second, some students may know of the existence of a resource but not exactly how they can use it or how the resource might be helpful in resolving their challenges. For example, many students knew of the existence of the library but did not know how they could use its resources. Working to support Black students' participation in programs such as the First Year Experience and more generally making sure resources the institution provides work equally for both Black and non-Black students would support Black student inclusion in our community.

Finally, some students might avoid using some support services because of issues related to microaggressions or lack of inclusivity. Knowing the existence of a resource and how to use it is not enough for Black students to fully benefit from using the resource if they do not feel a sense of belonging in the space where the resource is offered. Most Black students felt that the University was not as inclusive as it was advertised and lacked a sense of belonging. Many of them experienced microaggressions in their interactions with their peers and some faculty

members. Studies document the importance of sense of belonging to academic experiences of Black students particularly male college students (for example, Strayhorn et al. 2015) [15]. Supportive interactions with faculty are also important to Black men in college [16]. Students often engage with faculty because of their teaching style, the environment they create in the classroom, and their availability. A student who experienced an unintended microaggression from faculty for example, would stay away of this instructor's office hours, missing out on the opportunity to learn from interacting with them. Similarly, some students felt microaggressions in their interactions with their tutors during MASH and Tutoring sessions which discouraged them from seeking further help from these resources. Making these resources more diverse and more inclusive could improve participation from Black students.

## **Conclusion**

Black students admitted to this institution are talented. However, some of them come from disadvantaged backgrounds and do not have the privilege most non-Black students have. For example, access to high school with Advanced Placement (AP) credits, parents who have not been to college or who do not have skills and resources to support their students. Most PWIs are well equipped with resources to support students who are not fully prepared for STEM classes and those who do not feel included in our community. To address the challenges Black students experience, this study recommends understanding their needs first before addressing their entire experience. For this institution, findings suggest interventions that focus on a better transition to the institution, targeted academic support services, Diversity, Equity, and Inclusion training for all the members of our community to make the campus inclusive for Black students.

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