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Institutional Barriers to Black and Latino Male Collegians' Success in Engineering and Related STEM Fields

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Dr. Michael Steven Williams' research broadly focuses on equity and diversity, the social psychological development of students, and institutional diversity in American postsecondary education. Specifically, he centers his inquiry on two aspects of higher education: (a) the student, particularly graduate (e.g., masters, doctoral, professional) student socialization and mentoring and (b) the institution, with a focus on specialized institutions such as historically Black colleges and universities (HBCUs).

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Abstract

Diverse people and perspectives are needed to spur innovation and tackle societal problems. A wealth of untapped intellectual and economic potential exists among historically underrepresented racial/ethnic groups – including Blacks and Latinos – who have not had equitable access to engineering and related STEM fields. For Blacks and Latinos who are accepted into engineering and related STEM fields, they face a number of barriers to their success which lead to low retention and graduation rates. In historically male-dominated fields such as engineering and related STEM disciplines, Black and Latino men have remained underrepresented at the student and faculty ranks. To uncover and tackle the "institutional barriers" that men of color face, nearly 50 interviews with Black and Latino collegians were analyzed to better understand the mechanisms that prevent them from maximizing their potential for success in engineering and related STEM fields. Interviews revealed that students must overcome institutional obstacles such as: (a) inadequate academic advising, (b) poor quality teaching, (c) limited course offerings, and (d) insufficient financial aid. This paper includes recommendations that are helpful to faculty, staff and administrators who are interested in increasing the number of Black and Latino male graduates in engineering and related STEM fields.

Introduction

By 2022, the United States will need approximately 1 million more professionals in science, technology, engineering and mathematics (STEM) fields (U.S. Department of Education, 2016). STEM occupations are critical to the U.S. economy, global competitiveness, and national security. To fill the anticipated number of U.S. STEM jobs, colleges and universities need to enroll, retain and graduate more STEM majors. A wealth of unused ability exists among racial and ethnic groups – including Blacks and Hispanics – who have been historically underrepresented in STEM fields like engineering. Targeted research, policies and practices are needed to create a larger and more diverse STEM workforce.

U.S. institutions of higher education continue to enroll, retain and graduate both Black and Latino students at much lower rates than their proportion of the overall U.S. population (National Science Foundation, 2014; U.S. Census Bureau, 2014a; U.S. Census Bureau, 2014b. STEM fields like engineering continue to rank among the lowest disciplines for their proportion of Blacks and Latinos (National Science Foundation, 2014). Although men continue to be overrepresented among U.S. engineering bachelor's degree recipients, while earning over 80% of engineering diplomas, Black and Latino men continue to be underrepresented (National Science Foundation, 2014). Black and Latino men represent approximately 6% and 9% of the U.S. population but only about 3% and 7% of engineering bachelor's degree recipients (National Science Foundation, 2014; U.S. Census Bureau, 2014a; U.S. Census Bureau, 2014b). More

attention must be paid to increasing the number of Black and Latino men who graduate in engineering.

Negative statistics and cultural stereotypes regarding Black and Latino men inaccurately suggest that men of color are inherently less likely to succeed in academically rigorous fields such as engineering (Hodge, Burden, Robinson & Bennett, 2008). Black and Latino male engineering students do find ways to successfully overcome institutional systems of inequality and racism (Harper, 2010; Long & Henderson, 2017; Moore, Madison-Colmore & Smith, 2003). As other institutional barriers are identified and dismantled, many more Black and Latino men will have opportunities to succeed in engineering. This study seeks to highlight some of the institutional barriers that prevent Black and Latino men from maximizing their potential for success in engineering and related STEM fields.

Literature Review

Limited research exist surrounding barriers faced by Black and Latino male students, especially in STEM fields. Equity advocates have addressed unjust barriers that many Black and Latino males encounter prior to college such as public school resegregation and mass incarceration (Alexander, 2012; Tatum, 1997). In college, admissions policies can negatively affect Black and Latino male enrollment numbers (Long & Mejia, 2016; May & Chubin, 2003). Some scholars have uncovered the academic and social barriers faced by Black and Latino male collegians in engineering and related STEM fields (Strayhorn, Long, Kitchen, Williams, & Stentz, 2013). Still, little is known about the institutional barriers that Black and Latino males must overcome in college.

Students of Color in STEM

Collectively, studies surrounding the experiences of students of color in STEM fields often conclude that racial disparities in academic outcomes (for example, degree attainment in STEM) are the result of individual student differences before and during the collegiate experience, rather than institutional factors that inform student success. Extant literature on the experiences of students of color in STEM fields is replete with studies that utilize demographic (e.g., race/ethnicity, gender) and pre-college (e.g., academic preparation) variables as predictors of academic outcomes in college (Moses et al., 2011; Palmer, Maramba, & Dancy, 2001; Smyth & McArdle, 2004; Strayhorn, 2015). Additionally, studies of students' experiences in college often utilize individual academic (e.g., course grades, grade point average), sociocognitive, and non-cognitive indicators (e.g., self-efficacy, sense of belonging, psychological cost) as explanatory variables underlying individual student differences in academic and social outcomes in STEM (Perez, Cromley, & Kaplan, 2013). However, the focus in empirical literature on demographic, pre-college, and individual (e.g., academic, social, sociocognitive) variables contribute to an incomplete narrative of the experiences of students of color in STEM broadly and engineering specifically. More research is needed on the institutional barriers that students of color must overcome in STEM.

Institutional Factors and Student Success

There is some empirical evidence that institutional policies and practices inform students' ability to transition to, and succeed in, collegiate educational environments. These institutional factors inform students' experiences and decision-making long before students arrive to college and continue once they matriculate. Research suggests admissions policies shape the institutions students choose to pursue and the institutions they ultimately attend (May & Chubin, 2003; Moses, 2001). Similarly, the type and amount of financial aid granted to students may inform the institutions they choose to attend as well as the majors they pursue after matriculation (Kim, 2004; Stater, 2011). Notably, Stater's (2011) study found that higher net costs of attendance decreased the probability that students would choose a major in STEM.

Additionally, after matriculation, a host of institutional factors may support, or impede, student success in STEM. For example, research indicates that institutional practices, such as career and academic advising, play a critical role in facilitating retention, persistence, and degree attainment in college (Pascarella & Terenzini, 2005). A number of studies have demonstrated that students' perceptions of, and experiences with, academic advising may directly or indirectly inform their satisfaction with college, academic performance (e.g., grade-point average), and departure decisions in college (Metzner, 1989; Young-Jones, Burt, Dixon & Hawthorne, 2013).

Finally, just as institutional practices (e.g., academic and career advising) inform student success, so too do policies that govern students' social behaviors and academic decision-making. For example, a host of scholars cover the structure of typical engineering programs as a potential barrier to student success. Chen (2013) cite the rigidity of course sequences in engineering as a factor that informs students' academic decision-making about course taking and individual departure from STEM disciplines or college altogether. Others cite negative experiences with unsupportive "gatekeeper" courses in engineering, wherein students perceive faculty as designedly unsupportive and coursework as deliberately overwhelming, as a possible explanation for attrition in engineering (Chen, 2013; Suresh, 2006).

All of these studies suggest institutional factors play a critical role in individual student success in college broadly, and STEM specifically. Still, there is some evidence that students across racial/ethnic and gender backgrounds do not experience these institutional policies and practices similarly. Specifically, Black and Latino student success may be differently informed by institutional factors before and during their college experience that may further explain persistent gaps in enrollment and student success (Kim, 2004; Museus & Ravello, 2010; Perna, 2006). For example, whereas some posit that unsupportive faculty in "gatekeeper" courses may lead students to depart college altogether (Chen, 2013; Suresh, 2006), others suggest that supportive connections with faculty, though often scarce and infrequent, may be particularly fruitful ways to support retention and success in college broadly, and engineering specifically (Museus & Ravello, 2010; Dika, Pando, Tempest, & Allen, 2017).

Institutional Factors and Students of Color

Taken together, the literature on student success is clear that institutional factors are important antecedents for student academic and social outcomes. Still, Bensimon and Bishop (2012) argued that in order to address racial disparities in student outcomes, student success must be reframed as an institutional responsibility requiring race-conscious institutional policies and practices. Indeed, across the literature on institutional factors that inform student success, a consistent recommendation is for institutional practitioners (e.g., academic advisers, professors, admissions professionals) to consider specific, demographic-conscious interventions for improving student outcomes (e.g., Bensimon & Bishop, 2012; Young-Jones et al., 2013). The present study will help to fill our current gap in knowledge involving Black and Latino males in engineering and related STEM fields. In this study, we investigate how Black and Latino males in engineering experience institutional policies and practices, and the role these factors play in supporting, or impeding, their success in engineering.

Purpose

The purpose of this story was to categorize and critically examine the educational experiences of Black and Latino males in engineering and related STEM fields. Particular attention was given to the "institutional barriers" that prevent Black and Latino men from maximizing their potential for success in engineering and related STEM fields.

Method

This study is part of a larger, longitudinal study titled, *Investigating the Critical Junctures: Strategies that Broaden Minority Participation in STEM Fields*, funded by the National Science Foundation (NSF). As such, the study focused on Black and Latino men in engineering and related STEM fields. While the larger study consists of both quantitative and qualitative components, this report is based on interview data only.

Participants. To understand the institutional barriers faced by Black and Latino men in engineering and related STEM fields, "information rich" participants were selected using a purposeful sampling approach. According to qualitative texts, "information rich" participants are those who meet our sampling criteria, have experiences that align with the phenomenon under investigation (i.e. they identify as Black or Latino in STEM), and have a capacity to talk about their experiences in some detail. Specifically, all participants shared several important characteristics. First, only undergraduates were recruited as participants to eliminate any unforeseen variability in experiences between undergraduate and graduate students. Second, all participants had declared a major in engineering or a subfield (e.g., mechanical), as defined by the National Science Foundation (NSF).

Participants were recruited using a variety of strategies including electronic announcements, college listservs, Black and Latino fraternities, as well as the National Society of Black

Engineers (NSBE). Willing participants were contacted via telephone or email by the researcher(s) to confirm their participation, review informed consent information, and schedule a day and time for interviews. This approach yielded 27 Black and 22 Latino male collegians majoring in engineering and related STEM fields, whose ages ranged from 18 to 24 years. The sample included a range of subfields, hailed from diverse family environments (i.e., single-parent, guardian-led, both parents), and 70% were in-state residents. All of the participants are referred to by their self-selected pseudonyms.

Data Collection and Analysis. The primary methods for data collection were semi-structured one-on-one and group interviews. Interviews were conducted in a private room, centrally located on campus, by the researchers. Each interview lasted 90 to 120 minutes. All interviews were digitally recorded and subsequently transcribed by a professional.

Prior to analysis, transcript data were organized and stored in NVivo®, a qualitative data analysis software. Data analysis proceeded in several stages using the constant comparison method by reducing a preliminary set of codes into larger themes through an iterative process of reading, categorizing, and comparing categories/codes both within and across transcripts. Several strategies were employed to establish credibility: member checking (i.e., asking a participant to review his transcript for accuracy and completeness), triangulation of data sources (e.g., interviews, demographic questionnaire), and peer debriefing (i.e., researchers talked with colleagues regularly for the purpose of exploring implicit aspects of the study).

Findings

When investigating institutional barriers that Black and Latino male students face in engineering and related STEM fields, four major themes emerged involving: (a) inadequate academic advising, (b) poor quality teaching, (c) limited course offerings, and (d) insufficient financial aid. A Latino male and recent microbiology graduate named Miguel mentioned how he wished he "could take advantage of certain things" but he did not receive adequate academic advising, high quality teaching or sufficient financial assistance. Students like Michael, a Black male senior electrical engineering major, described how "you have to work so much harder [than peers from privileged backgrounds] to do well [in engineering] but I think the reward is so much greater." By "the reward," Michael expresses gratification about participating in professional and social organizations, obtaining his engineering degree as well as receiving a job offer.

Although Michael displays gratitude about his prospects for success after overcoming obstacles such as inadequate academic advising and limited course offerings, many Black and Latino male STEM students develop mental, emotional and physical "battle scars" while overcoming institutional barriers to their success. For example, a Black male and senior aerospace engineering major named Charles notes how he overcame inadequate academic advising, limited course offerings in his major, and insufficient financial aid. He says he experienced a "lack of sleep, [and] just kind of dealing with a little bit of depression… I was forgetting to eat a lot of times…I just wasn't in a great mood." Due to limited course offerings and insufficient financial

aid, Charles also states "it was constantly you know Monday through Sunday almost 24/7 just going through from the time I wake up to the time I go to sleep just aero work whether it was assignments or studying." Fortunately, Charles is also a very optimistic and resilient person. He says, "I'm a person that believes that God put me there for a reason so I'm here for a reason and I made it through so I'm happy."

Inadequate academic advising

Several Black and Latino male students expressed disappointment with the academic advising they received. The participants mentioned how poor academic advising negatively affected their course loads and ability to succeed each term. Students recalled advisors who did not know much about the courses they were taking, were not readily available or did not seem to care about developing a relationship with them. For example, Charles describes the nature of relationships with academic advisors in his major:

> My academic advisor she was not very helpful in a sense – she wasn't an engineering major, she didn't have an engineering background so she could only kind of go off [what] students somewhat told her about classes. **So, as far as her advising me, I don't think she did a great job because she would allow me to sign up for classes that I wasn't necessarily, I wouldn't say prepared for, but didn't have the requirements.** So, like my junior year I wanted to take all my technical electives early so she would put me in advanced aerodynamics before I took my preliminary aerodynamics class or I would be taking them at the same time. She was just like oh well if you want I can put you in there, granted I did well but she could have set me up – well you know I think you should take this class she never really kind of offered that so with her it was more so me having to take everything with a grain of salt. It wasn't a great relationship, it was mediocre.

Like Charles, a Black male and senior electrical engineering major named Derrick says that it was hard for him to find an advisor who possessed the knowledge he needed:

> Going through courses **one [challenge] was just [getting] advice because there are certain times for, you weren't sure whether to drop a class** and basically the professor will tell you 'you're not really good at this' so the question is how do I deal with major challenges?

Similar to Charles and Derrick, Miguel discusses how he was unable to receive the support he needed from his academic advisor:

> I disliked my academic advisor that I had. There was a guy that I went to because I had to for my scholarship program but **I saw no genuine interests in wanting to help me** so I went because I had to and then after I didn't have to anymore because I think I only had to go for like the first year of my scholarship, I didn't go anymore.

Although Derrick did not seem to have strong relationships with an advisor he does mention how knowing more than one advisor was necessary for him to get the help he needed with some classes:

> So if its scheduling for a class **I try to find the right advisor to talk to because sometimes they have the ability to place you into a class but they just won't** so you gotta go mention that they need to put you into a class maybe it's a struggle in the homework.

Unlike the above students, Michael had a much more positive experience with his academic advisor. However, he still highlights another frustration involving academic advisors. Michael talks about the limited time advisors had to interact with students and develop a personal relationship with them:

> I needed to go to the advisors in the engineering department and for the most part they were pretty helpful but **I didn't really gain a close relationship with them because our time was always limited**. Always just have my appointment and speak with them just about the major or whatnot and they are seeing so many students it was just really hard to get a good relationship with them.

Since Michael did not have a close relationship with his engineering academic advisors, he sought out support from same-race staff members on campus. He mentioned how same-race staff members were able to answer questions "on what classes to take and to serve as resources [when he] needed help with –financial aid or just advice in general." Michael also describes his level of comfort with a same-race staff member because he "could talk with her on a lot of stuff that [he] couldn't talk to with the regular advisors at the regular engineering office." He certainly highlights the benefit of having quality relationships instead of a large quantity of relationships.

The above excerpts from Michael, Miguel, Charles and Derrick provide depth into how individual Black and Latino men believe they could benefit from improved academic advising. Previous work has focused on poor academic advising at the K-12 level which decreases the likelihood that some Latino men are prepared to even apply to college (Long & Mejia, 2016). Scholars have also shown how supportive relationships help Black males succeed in college (Strayhorn, 2008). It is important for academic advisors as well as other university faculty and staff to develop strong bonds with men of color and to provide them with the guidance they need in engineering and related STEM fields.

Limited course offerings

Black and Latino male participants did not only mention the institutional barriers they faced when seeking academic advising, but they also noted the limited course offerings that were available to them. Charles illustrates how he could have easily fallen behind in his major and graduated a year later due to limited course offerings:

> I would just say the whole major itself is pretty challenging but I would say junior year was the most challenging because the aero engineering there is only four or five professors and **they only offer that class that quarter or that semester so if don't take it then or if you drop it you have to wait an entire year to take that class over again and all of those classes stem off one another so if you drop one class you weren't eligible to go to some of the other classes** so junior year I had four to five aero classes per quarter that you couldn't drop you could split it.

Michael discusses academic challenges he dealt with due to the limited number of weeks available during the quarter system:

> I had to take calculus first time here so **learning derivatives and all that stuff on a quarter system was a bit difficult**. I started out in pre-algebra here but I worked my way up and got to calculus and all the differential equations so I think it would have been good to have some background around that so I would at least know what to expect but having to learn that for the first time and then do well in it was definitely a challenge.

Charles and Michael encountered different problems with course limitations. Both the frequency with which courses were offered and the length of a course proved to be problematic for them. When courses are offered with limited frequency, students who lack prior exposure to some academic content or those who have to repeat a course suffer serious setbacks to graduating within four years. Indeed, lengthening time to degree has been identified as a serious threat to student retention to graduation in the United States and beyond (Aina, Baici, & Casalone, 2011; Herzog, 2006). As quotes in the next section indicate, the type of instruction students receive in courses can also positively or negatively affect their success.

Poor quality teaching

Carlos, a Latino male and senior math major, comments about the lecture-based teaching approach of his classes and he compares them to a more hands-on style that he was exposed to in his home country:

> **We just go lecture, lecture, lecture, work, lecture, and that's it.** Back in [the Caribbean country where I was born and raised] we had practice classes, but that is not the style here....We have like from Monday to Wednesday we have lectures, and Thursday and Friday we just go to the class, and with the same class we with a TA and we solve exercises. Like all the assignments, you're supposed to do the assignments and come with your own results to the classes, so the class goes smooth. But the idea is that you go there and you start solving the problems in the board, so everyone can see and you share the discussion, and that was pretty good. **There is a difference just going, giving lectures, and giving you theory, there is a difference between that and actually applying that theory to solve problems**, so this practice class is how to solve the

> problems using what you have learned in the lecture. So pretty useful here we don't have it so we actually do it on our own.

Jose, a Latino male biology major also complains about being limited to professors who lecture:

> Well at least for this quarter it's just like, well lecture **it's just lecture**.

Miguel provides support to Carlos and Joel's statements about the prevalence of lecture-based classes:

> Most of the science classes that I had were very lecture [or] recitation days so you have big lecture hall, a lot of people, one professor –stuff stuff stuff is being taught and you're supposed to take it in and be able to regurgitate it down the road. And then recitation was to reinforce that intent or any questions. I found that the best way I was able to learn is obviously go to class but just read the book and essentially almost teach yourself the contents and try to answer your own questions and if there is something that you really don't understand that's where you go into a TA or tutor room or something like that... [my] BS [major] was more one sided – professor taught, we took it and we applied in a test but it was basically just saying it back and that's it. That was the idea, that was the concept of teaching which not my favorite but its undergrad so I accepted it as that and wanted to get good grades that's all.

Many evidence-based teaching approaches exist from active learning techniques to project-based learning to peer instruction. With the emergence of Engineering Education as an established research field and the existence of Centers for Teaching and Learning at many institutions of higher education, access to effective instructional practices should be plentiful. Still, many engineering and related STEM faculty rely heavily on less effective teaching approaches such as lecturing. Poor quality teaching can have serious consequences for Black and Latino males in engineering and related STEM fields and increase the probability of them having difficulty applying theory to practice (Strayhorn, Long, Kitchen, Williams, & Stentz, 2013).

Insufficient financial aid

Researchers have highlighted the importance of providing sufficient financial support to students of color, who may not possess the same wealth as more affluent peers (May & Chubin, 2003). Yet, participants mentioned how they did not have enough financial aid to take classes for more than four years or not work. For example, Miguel talks about having to pay for his own classes after four year:

> [I took] about three to four class every quarter. It's a pretty big load pretty standard every single quarter, **I was here for five years –actually about four and a half because last quarter I think I only took one class because I was out of my scholarship so I had to pay for it out of pocket**.

Charles had a similar issue to Miguel that limited his financial assistance to four years and substantially increased his course load for one year:

> A lot of people split their junior year but **I didn't have money to split junior year and go a fifth year**. I would've, junior year was the biggest challenge because I had to stack all of those aero classes on top of each other.

Miguel goes on to describe how financial obligations forced him to work during undergrad instead of getting recommended volunteer experience in his field:

> Once I determined that it was going to be my major I knew what classes I needed to take, I knew what courses I needed to pass and what grades I needed to get to graduate really – that was the plan. The only kind of confusion that I had which I am currently figuring out now is the route of medical school versus graduate school. That's the big decision as an undergrad I didn't make right away and after I graduated I worked for a couple of years, now I'm back deciding really what I want to do for the rest of my life. Someone that I probably should have done as an undergrad but **financially I didn't have the option of not working during undergrad and getting the experience and the preview –the hands on work of being in a lab or volunteering in a lab and things like that. I had to work throughout undergrad, I didn't have any other choice, I had a scholarship that paid for everything in school but had to work to pay my rent, my bills and things like that and my parents didn't save any money there wasn't any money to save for college so I knew that I had to work and I knew that those experiences probably would have helped but financially I wasn't able to take advantage of them.**

Miguel not only talks about having to work and missing out on professional volunteer opportunities, but he also conveys his feelings of resentment towards peers and the sacrifices he had to make in order to succeed:

> It was hard and I was jealous of people that didn't have to work during school, didn't have to work an average of 28 hours every week and also take classes and also be active in extracurricular activities. **I looked at students that didn't have to work and all they did was waste time or didn't go to class or something like that and I think it would have been nice to be able to be given the opportunity not to work but to volunteer to do an internship.** To me the idea of an unpaid internship coming from where I came from was the most ridiculous thing to even say, you're gonna do work without being paid, that's ridiculous and that's what I thought at the time because that's all I knew was you work you get paid that's what you do. I work very hard, I worked since I was 14. Now, I get the importance of doing internships, I get the importance of maybe sacrificing some financial gains for experience and this is something that I try to teach and really kind of trickle down to my younger siblings. I didn't have all the opportunities

> growing up and I knew that, I was comfortable with that –**I never had all of the opportunities financially to do what I wanted to do but I just made do with what I had** and it is what it is –that's just what you do. Work definitely made it a little bit tougher as an undergrad. I remember having class all day and going from my last class getting in my car and I already had my uniform and going straight to work and working till 11 o'clock at night, doing homework till very late, waking up go to class.

Ultimately, some Black and Latino male students in engineering and related STEM fields find ways to successfully overcome institutional barriers like (a) inadequate academic advising, (b) poor quality of teaching, (c) limited course offerings, and (d) insufficient financial aid. Michael, says he "was able to 'weather the storm' to get there [to a point where he has a job after school and he's close to graduating]." He admits that it took "some luck and prayer." Unlike Michael, many Black and Latino men are unable to succeed due to the institutional barriers they face. If institutional barriers are eliminated then many more Black and Latino men can graduate from engineering and related STEM fields, in four to six years, with high GPAs and an abundance of post-graduate opportunities.

Recommendations and Conclusion

In conclusion, one-on-one interviews with Black and Latino male collegians in engineering and related STEM fields revealed institutional barriers to their success that university administrators, faculty and staff can work to remove. Four major themes emerged from this study involving: (a) inadequate academic advising, (b) poor quality teaching, (c) limited course offerings, and (d) insufficient financial aid. Future investigations might use intersectionality theory with Black and Latino males majoring in engineering and related STEM fields to challenge broad stereotypes that are placed on men of color. Future work can also use an anti-deficit perspective to further highlight the positive traits and strategies that Black and Latino men in STEM use to overcome institutional racism and systematic oppression.

In order to help Black and Latino men overcome institutional barriers to their success in engineering and related STEM fields, we offer the following recommendations to educators and practitioners:

- To address inadequate academic advising, engineering and related STEM administrators can:
    - Use targeted hiring practices to recruit more: a) Black and Latino academic advisors who can form positive relationships with men of color due to shared cultural experiences, as well as b) senior and graduate student academic advisors who can provide detailed curricular guidance after having taken engineering and related STEM courses
    - Add metrics to the tenure and promotion process for faculty mentoring of Black and Latino students so that more faculty help with academic advising in engineering and related STEM majors

    - Pair Black and Latino male students with mentors who are recent alumni of engineering and related STEM programs so alumni can also provide academic advising
    - Reduce advising loads for academic advisors and revise their evaluation structure to reward quality (e.g., student satisfaction, development of strong personal relationships with advisees) over quantity (i.e., the number of students advised)
- To address poor quality teaching, engineering and related STEM educators can:
    - Change engineering and STEM graduate programs so they have mandatory education classes involving pedagogy and experience teaching with a faculty member who has a record of high quality teaching
    - Add more metrics to the tenure and promotion process for faculty who receive professional training, secure grants and conduct research related to effective teaching in engineering and related STEM majors
    - On at least an annual basis, provide financial incentives and course releases so faculty members can use evidence-based strategies such as culturally relevant pedagogy to update curriculum in engineering and related STEM fields
- To address limited course offerings, engineering and related STEM programs can:
    - Consider offering more transparent and diverse options for students to transfer credit hours from other institutions like community colleges or online programs
    - Offer teaching certificates and financial incentives to recent alumni and qualified industry personnel who are capable of teaching high-demand courses
    - Provide financial incentives as well as new metrics to the promotion and tenure process to reward faculty who teach courses during the summer semester
    - Ensure that courses critical to program advancement (i.e., prerequisites and major required courses) are offered each semester
- To address insufficient financial aid, engineering and related STEM departments can:
    - Create endowments and scholarships for students from historically underrepresented racial/ethnic groups who have unmet financial needs
    - Develop increased partnerships with entrepreneurs and corporations who can offer paid positions to Black and Latino male collegians
    - Provide financial incentives for more students to work with faculty on research projects, curriculum updates, and outreach projects in engineering and related STEM fields
    - Replace work-study positions and non-STEM related jobs with less time-consuming and higher-paying positions that allow students to spend more time on coursework, student design teams and study abroad trips

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