Exploring the Relationship between Faculty Mentor Engagement and African American STEM Persistence

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Exploring the Relationship between Faculty Mentor Engagement and African American STEM persistence

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Abstract: This quantitative study explored factors associated with the persistence rates of African American students that aspired to major in STEM and ultimately completed undergraduate degrees in STEM. The primary data source for this study came from the Cooperative Institutional Research Program's 2009 *The Freshman Survey* (TFS) and 2013 *College Senior Survey* (CSS). The sample included 379 African American students that indicated, on TFS, that they intended to declare STEM as their major. The findings revealed that African American undergraduates were significantly more likely to persist in STEM majors when they have increased levels of faculty mentor engagement. Findings demonstrate a need for institutions to consider implementing curricula that encompasses factors that contribute to meaningful faculty engagement to help create more inclusive academic environments for African American students in STEM.

Keywords: STEM culture; underrepresented racially minoritized students; race; faculty pedagogy; campus climate; student experience; faculty engagement

African American students graduate at significantly lower rates than their racial/ethnic counterparts in science, technology, engineering, and mathematics (STEM) (Chang, Sharkness, Hurtado, & Newman, 2014). Students from all racial/ethnic groups do not persist in STEM (The National Academies of Science, Engineering and Mathematics, 2016); however, there is a disproportionate amount of African American students that leave their programs compared to their peers (Lancaster & Xu, 2017). Higher education stakeholders continue to seek solutions that address the disparity with an aim to achieve parity in degree completion. Underrepresented minoritized students express interest in STEM at the same rates as their counterparts, yet leave their degree programs at scientifically higher rates than their peers (NASEM, 2016; Hurtado et al., 2009; Eagan et al., 2011; Soldner, Rowan-Kenyon, Inkelas, Garvey & J. C., & Robbins, C., 2012). The shortage of African American STEM professionals has significant implications on challenges facing our nation and workforce demands. PCAST reports that the US must produce a significant amount of STEM college graduates in order for the US to, "retain its historical preeminence in science and technology" (2012, pp. i).

Addressing STEM degree completion disparities is a complex undertaking that requires a nuanced approach. More African American (AA) students are attending college than in previous years; yet are not completing their STEM programs at the same rates as White and Asian students (NASEM, 2016). Between 1990 and 2013, AA college enrollment into undergraduate programs increased by five percent (NCES, 2016). While the increase of enrollment into postsecondary education is promising, AA students still continue to attrit from their STEM degree programs at higher rates than all other racial /ethnic student populations (Estrada et al., 2016). Lundberg and Schriner (2004) explored the quality and frequency of faculty-student interactions and found that, "African American students experience more differential treatment by faculty in academic settings than did Caucasian, Hispanic, or Asian students. The lower expectations held of AA students were conveyed by such behaviors as ignoring their participation, treating them stereotypically, and expressing impatience with their responses" (pg. 562). AA students have reported that ineffectual formal relationships with faculty, unpredictable class offerings, and a lack of academic preparation were reasons why they experienced challenges persevering in STEM (Lancaster & Xu, 2017).

Understanding what facilitates STEM degree completion helps to strengthen interventions created by researchers and practitioners that are focused on decreasing disparities. Research indicates that faculty/student relationships affect student satisfaction with college (Guiffrida, 2005). However, the types of interactions students have with their instructors is key to understanding whether those interactions will prove to be beneficial or less than useful to students. This paper is focused on examining the relationship between faculty mentor engagement on AA STEM persistence.

Key factors that influence the impact of AA student outcomes

A diversified STEM workforce is necessary since minoritized (MS) STEM professionals are more likely to examine problems faced by their communities than non-minoritized (NMS) scientists (Hurtado et al., 2008). The term "minoritized students" recognizes that students that are deemed "minority" are not inherently so, they are embedded in systems that are unjust, inequitable, and are consequently placed in the margins. Historically, pervasive literature has used the term underrepresented minority students to describe students, for example, who identify as Hispanic or AA; however, educational scholars have recently taken issue with the term "minority" as it fails to address the actions that render students minorities (Stewart, 2013). "Although Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives represent 30% of the employed U.S. population, they are 23% of the STEM workforce due to underrepresentation of these groups among STEM workers with a bachelor's degree or higher" (National Science Board, National Science Foundation, 2021, pg. 7).Of the AA students that entered STEM degree programs in 2004, only 13.4 percent completed their degrees within four years and 18.4 percent completed their degrees within five years (Higher Education Research Institute, 2010). Comparatively, in 2004, White students had a four-year STEM degree completion rate of 24.5 percent and a five-year completion rate 33 percent (Rohrbaugh & Corces, 2011). There are factors that have been shown to positively influence underrepresented students: precollege characteristics, STEM environment, sense of belonging, undergraduate research, faculty mentors, and faculty mentors in undergraduate research programs (URPs).

Precollege Characteristics

Precollege characteristics, such as the amount of science and mathematics courses taken in high school or parental academic achievement, have a positive correlation with STEM persistence (NASEM, 2016; Dai & Cromley, 2014). Yet, mathematics, both how it is taught, and the availability of courses in high school, is a potential barrier for STEM aspirants. The National Academies of Science, Engineering, and Mathematics (2016) found that, "25 percent of the students who take calculus 1 at a research university receive a D or F or withdraw from the course, and another 23 percent receive a C" (pg. 64). How students experience mathematic curricula largely influences whether they see themselves as being able to successfully complete their academic programs.

STEM Environment

An environmental influence on the academic outcomes of students in STEM concerns the culture of the institution; and how it may or may not promulgate diversity and inclusion. Culture, as defined by the National Academies of Sciences, Engineering, and Medicine (2016) ,is "…shared patterns of norms, behaviors, and values of STEM disciplines that manifest themselves in the way courses are taught and the classroom is experienced" (pg. 60). The National Academies of Science, Engineering and Mathematics (2016) found that institutional cultures that are unwelcoming and hostile contribute to both isolation and withdrawal for students. One contributor to an unwelcoming STEM culture is stereotype threat. Stereotype threat is a burden students feel when they perceive they may be viewed in congruence with group stereotypes (Hurtado et al., 2009; NASEM, 2016). Moreover, "Stereotype threat is conceived as a state of psychological discomfort that is thought to arise when individuals are confronted with an evaluative situation, in which one's group is associated with a negative stereotype" (Appel & Kronberger, 2012, pg. 610). It has been shown in some studies to be an even more powerful predictor than academic preparation on whether MS students will persist in their STEM degree programs (Ben-Zeev et al., 2017). While science culture has been widely reported as unwelcoming to students of color, STEM academic environments may potentially be tempered by the presence of faculty members who show they genuinely care about the academic outcomes of students (Guiffrida, 2005).

The types of support MS receive while in college often determines whether they will persist in their academic programs (Chang et al., 2014). MS students report that their postsecondary classroom environment often does not provide a healthy learning atmosphere (National Academies of Science, Engineering, and Medicine, 2016). Negative racial experiences often make AA students feel marginalized because of the unwanted, and unwarranted, feedback on their perceived social and cultural locations (Espinosa, 2011).

Sense of Belonging

AA students must feel a sense of belonging in their classrooms, and part of the science culture as a whole, in order to persist in their STEM degree programs (Hurtado et al., 2007; Schlossberg, 1989). On top of interpersonal challenges that are apparent in the science culture, structures in place perpetuate an atmosphere that may be perceived as being more concerned with "weeding students out of STEM majors" than working to support and retain them once admitted (Espinosa, 2011, pg. 214; Hurtado et al., 2008). Whether students experience their academic setting as one that supports their potential in STEM, influences their disposition as STEM aspirants, and informs how they address obstacles and barriers when they present themselves (National Academies of Science, Engineering, and Medicine, 2016). "Academic climates that emphasize learning, mastery, and improvement in math and science, rather than inherent ability can promote both performance and persistence in those subjects through positive effects on students' self-beliefs" (NASEM, 2016, pg. 67). Meaningful faculty mentor engagement could perhaps help to mitigate an unwelcoming science climate.

Undergraduate Research

Undergraduate research programs (URPs) have been found to positively influence MS student STEM persistence, and they typically have faculty mentors that, in addition to giving students guidance on research projects, provide them with "access to professional networks, new sources of information, and broader access to institutional resources" (Eagan et al., 2013, pg. 689). Additionally, URPs increase one-on-one interaction between faculty and students, which bolsters their educational experience (Hurtado et al., 2009). Researchers have reported that URPs are positively related to the strength of one's science identity (Hurtado et al., 2008; Eagan et al., 2013), the culture of the institution (Rodgers & Summers, 2008), and mitigates stereotype threat (Hurtado et al., 2008). Further, they are positively correlated with underrepresented minoritized student STEM persistence. While URPs help to mitigate MS STEM attrition, there are not many studies that focus specifically on whether faculty mentor engagement is positively correlated to AA STEM persistence. Towards that end, strategies that cater to a wider population of students is necessary to addressing STEM degree completion disparities. Exploring the relationship between the two could enhance interventions aimed at increasing AA STEM persistence.

Faculty Mentors

Faculty members strongly influence the decision of MS students to remain in their academic programs (Eagan, Sharkness, Hurtado, Mosqueda, & Chang, 2011; Gasiewski, Eagan, Garcia, Hurtado, & Chang, 2012). McCoy, Luedke, Winkle-Wagner (2017) found "for undergraduate students, and Students of Color in particular, mentoring has been evidenced to improve students' transition to higher education, retention, GPA, self-efficacy, graduate student training, career selection, and socialization to academic and professional roles" (pg. 658). Given the importance of faculty engagement on AA STEM persistence, this study defines mentoring as a series of behaviors that seek to encourage students, and bolster who they are as STEM professionals, both inside and outside of the classroom.

Faculty mentor engagement spans beyond simple interactions between faculty members and AA students in STEM, which is the impetus for this study. To identify faculty engagement behaviors that positively influence AA STEM degree completion. The mentoring experience encompasses students receiving advice about their academics, critique on their work, and graduate school or career preparation. The underlying key to faculty mentor engagement is a genuine concern about the successful academic or professional outcomes of AA students in STEM which may span beyond what is typically outlined in job descriptions (Guiffrida, 2005).

Faculty Mentors in URPs

URPs are positively correlated with MS STEM persistence due to faculty interactions, mentoring opportunities (Jones, Barlow, & Villarejo, 2010; Eagan et al., 2013), and academic support (Hurtado et al., 2009). Moreover, MS science identity is also noted as being strengthened by URPs (Hurtado et al., 2009). While URPs vary across institutions, a fundamental component of all URPs are engagement with faculty. Faculty mentors are found to positively contribute to MS STEM persistence; however, research illuminates that faculty are least likely to communicate with students by way of URPs (Kuh & Hu, 2001). This finding is particularly concerning since URPs are found to be positively correlated with STEM persistence for MS students. If engagement with faculty mentors is positively related to AA STEM persistence, then colleges and universities could further support AA students in STEM, outside of URPs, by utilizing the information presented in this study.

Theoretical and Conceptual Framework

The research question guiding this study is: *What is the relationship between faculty mentor engagement and African American student STEM persistence?* The Input, Environment, Output model (IEO) was used to emphasize the importance of examining the campus environment and more specifically policies, practices, and procedures that either positively or negatively affect the academic performance of AA students in STEM (Astin, 1970; Pascarella & Terenzini, 2005). An example of this is placing "gatekeeper" classes in the first two years of STEM education and not focusing on faculty diversity and inclusive pedagogy simultaneously - contributes to whether AA students will persist in STEM (Hurtado et al., 2009). Schlossberg's (1989) marginality and mattering framework expands the IEO model by amplifying the experiences of students in the unexamined margins. Given that environment has some bearing on the decision of AA students to continue in their programs of study, understanding components of mattering helps to contextualize the issue.

The role of self-perception on academic outcomes is also significant (Dai & Cromley, 2014; Eagan et al., 2013). For example, despite what may be perceived as an unwelcoming science culture, there are AA students in STEM that persist in their degree programs. Using Harper's asset-based lens to guide the approach to this study helped inform researchers about educational interventions that have been proven to work. The anti-deficit model put forth by Shaun Harper (2010), encourages researchers to discuss AA STEM persistence from a positive perspective, as opposed to focusing on what is perceived as not working. We used a strength-based lens for this study, in part, by exploring the faculty interaction construct which provide faculty and students with specific academic ways of being that positively influence AA STEM persistence. Other conceptual models that inform the variables used for this study are marginality and mattering, and social and cultural capital, which examine factors associated with both campus climate and access to information to advance in the science profession. Moreover, faculty members are positioned to augment the social capital of AA STEM aspirants, and when they genuinely show that they care about the wellbeing of AA students it positively influences whether they will persist (Guiffrida, 2005).

Drawing on these theories we establish a conceptual framework that hypothesized that because majoring in STEM can be isolating for all students, and AA students in particular, that faculty mentor engagement may lead to higher STEM persistence. Faculty mentors are the mechanism by which social and cultural capital are passed along to AA STEM students, which work to demystify what it means to be a scientist and subsequently strengthens their science identity and self-efficacy (Chang et al., 2014). As noted, college and university campus environments may be perceived as unwelcoming to AA STEM aspirants. There is a need to explore additional strategies that will support a wider population of students in STEM. First-time full-time AA students in STEM at predominantly White institutions are the focus population.

Methods

Data Source

The primary data for this study came from the Higher Education Research Institute (HERI) at the University of California, Los Angeles. HERI houses the Cooperative Institutional Research Program (CIRP) which facilitates surveys around the country to understand the experiences of students in postsecondary education. The surveys are longitudinal in nature. The Freshmen Survey (TFS) is administered to freshmen students their first year and the College Senior Survey (CSS) is administered, to the same students, their senior year. The TFS and CSS enables the examination as to whether AA students in STEM are more likely to persist in their academic programs when they engage in meaningful faculty mentor interactions. Persistence in this analysis is defined as AA students that indicate their interest in STEM on the TFS and selected a STEM major on the CSS. Students that expressed a pure interest to major in STEM, and then switched majors outside of STEM, were identified as students that did not persist in their STEM degree program.

Cooperative Institutional Research Program's TFS and CSS Survey

The CIRP survey is operationally used to: (a) to collect data from students at different institutions around the country simultaneously, and (b) to collect data longitudinally to measure change (Astin, 1972). The survey is given when students are accepted into postsecondary education as freshmen, TFS, and then a follow-up survey is distributed four years later in their senior year, CSS. The institutions that participate in the CIRP survey are representative of two-year and four-year institutions that self-select participation and pay to access the survey instruments and associated reports (Astin, 1972). The study participants are STEM aspirants, AA, at postsecondary institutions. TFS and CSS survey questions that focus on campus climate, faculty interactions, and how students navigate their academics are used in this study. The CSS provides longitudinal data on the impact of the college environment on the academic performance of STEM AA students (Franke, Ruiz, Sharnkess, DeAngelo, & Prior, 2010; Higher Education Research Institute, 2016).

Variables / Constructs

The faculty mentor construct used for this analysis consists of thirteen distinct ways of being that may help to inform the way classes are conduced, and the creation of meaningful mentoring relationships, for AA students in STEM. The faculty mentor engagement construct is comprised of responses to CIRP questions that ask about whether faculty:

- Provide encouragement to pursue graduate/professional study,
- Provide an opportunity to work on a research project,
- Give advice and guidance about their educational program,
- Provide emotional support and encouragement; provide a letter of recommendation,
- Give honest feedback about the students' skills and abilities,
- Help improve student study skills; give feedback on the students' academic work (outside of grades),
- Are intellectual challenging and stimulating; provide an opportunity to discuss coursework outside of class,

- Help students achieve their professional goals; provide an opportunity to apply classroom learning to "real-life" issues, and
- Give students an opportunity to publish.

As noted, the study research question is "What is the relationship between faculty mentor engagement and African American student STEM persistence?" Each variable associated with the research question and how they are operationalized for each statistical test is explained. The faculty mentor engagement construct variable was created by HERI using Exploratory Factor Analysis which involved thirteen different questions from the survey. Additionally, three categories of high, medium, and low were created for each construct and students were assigned their category based on the rescaling of their scores. Scores of 0.5 standard deviations above the mean or higher are coded into the "high" category; scores within 0.5 standard deviations of the mean are coded into the "medium" category; and scores of 0.5 standard deviations below the mean or lower are coded into the "low" category (Frankie, Ruiz, Sharkness, DeAngelo & Pryor, 2010, pg. 13). Therefore, faculty mentoring engagement was used as continuous and dichotomous variables to answer the research question in this study.

This study applies the CIRP definition of STEM which is comparable to National Science Foundations approved STEM fields (National Science Foundation, 2017). The majors that are considered STEM for this study are: biology, biochemistry or biophysics, botany, environmental science, marine (life) science, microbiology or bacteriology, zoology, other biological science accounting, aeronautical or astronautical engineering, civil engineering, chemical engineering, computing engineering, electrical or electronic engineering, mechanical engineering, other engineering, astronomy, atmospheric science (incl. meteorology), chemistry, earth science, marine science (incl. oceanography), mathematics, physics, statistics and other physical science.

Table 1- Research Question, Theory, and Operationalization of the Variable

Research Question	Controlled Variables	Independent Variable	Dependent Variable
What is the relationship between faculty mentor engagement and African American student STEM persistence?	Model 1: None Model 2: Student Characteristics, Institutional Constitution, and Institutional Type	Faculty Mentor Engagement	AA STEM persistence

As noted in Table 1, the research question explores the relationship between faculty mentor engagement and AA STEM student persistence. Each regression analysis consists of different combinations of control variables that account for factors that may influence the relationship between faculty mentor engagement and STEM persistence. In Table 2 we include faculty mentor engagement as the independent variable and AA STEM persistence as the dependent variable. In the second model, we control for student characteristics and institution type.

Research Design

We will primarily answer the research question by employing linear probability models and logit regressions. Both statistical tests will be used to investigate whether the raw outputs demonstrate the same direction and significance for the outcome associated with each statistical analysis. Although the dichotomous nature of the outcomes of interest makes logit regressions the most appropriate statistical model, we focus the discussion of the results on the linear probability models because their interpretation as changes in the probability of the outcome are more intuitive to interpret than the logit coefficients. However, we note whether the two approaches differ in direction or significance.

The logit model takes the form:

$$\mathrm{Log}\left[\frac{p}{1-p}\right] = b_0+b_1X_1+b_2X_2+\ldots+b_nX_n$$

The linear probability model takes the form:

$$Y = b_0+b_1X_1+b_2X_2+\ldots+b_nX_n+\varepsilon$$

Where Y is the dependent variable of interest and X is the independent variable of interest and X_2 - X_n are control variables as described in Table 1. The tables displayed in the findings section reflect non-standardized coefficients of each statistical test. For non-standardized coefficients that are statistically significant, the level of the significance may be viewed via the level indicator at the base of each linear probability model statistical table.

Power Analysis

A power analysis was conducted to determine a minimum meaningful effect size for the analysis. The alpha level used to conduct the power analysis was .05, and the number of predictors for this study is one for the research question. The predictors for the research questions is: faculty mentor engagement. The power analysis revealed that with a power of .80 and one predictor, the sample must be about 150 students. The effect size for the population of students examined in this study is ≈ .053. The sample size for this study is 379 AA STEM students.

Limitations

TFS captures the intended majors of AA newly admitted students at PWIs, and not the majors they actually declared. The implications of capturing the desired majors of participants, and not their actual declared majors, are that the results do not reflect the actual majors of all of the survey participants. While the results accurately reflect the relationships between the independent and dependent variables, there as some students that may have actually majored in non-STEM areas of study. The use of the intended majors of STEM degree aspirants is in direct alignment with similar research in the field on MS STEM persistence (Chang et al., 2014; Eagan et al., 2013).

AA students that began their postsecondary education at two-year colleges and transferred into STEM programs at PWIs were not included in the sample population used for this study. Data could not be obtained from students that completed the TFS, but did not complete the CSS during their senior year. Understanding whether those students remained in STEM, switched out of their programs, or left the university, helps to provide researchers with a more comprehensive understanding of why AA students attrit from STEM degree programs. Further, the data does not include whether faculty mentors were in STEM, or the specific proportion of diversity of STEM faculty at PWIs. This has implications on understanding who the faculty members are that mentor AA students in STEM, and whether the faculty that exude those characteristics are STEM faculty at PWIs. The extent to which the findings can be applied to AA students in STEM is limited since the population does not include AA students that are not first-time, full-time, AA STEM aspirants. Moreover, students that transferred between 4-year institutions were also not included in this analysis.

Results

This study sought to answer the overarching question of whether faculty mentor engagement positively influences the academic outcomes of AA STEM aspirants. The data used for this study were collected, and managed, by CIRP at the University of California, Los Angeles via TFS and the CSS. When results are deemed "positively correlated" that means that the test was statistically significant in the positive direction.

Roughly, 75.5 percent of students in the dataset attended four-year colleges and 24.5 percent attended schools characterized as universities. In this study, there are two postsecondary institutional types: liberal arts colleges and research universities. Universities have multiple "schools" (e.g., education, liberal ats, science, etc.), whereas, a college has one school (usually liberal arts). 91 percent of the schools represented in this study were private while the remaining 9 percent were public. 63% of the students identified as female and 36% as male. Of the majors of students tht persisted in STEM, the following were most prevalent: Biology (18.09 percent), Chemistry (6.03 percent), and Psychology (29.65 percent). 24% of the sample for this study did not persist in STEM.

Table 1 - AA Students that Persisted in STEM

Major	Percent of Sample
Psychology	29.65
Biology (general)	18.09
Chemistry	6.03
Computer Science	6.03
Other Biological Science	4.52
Civil Engineering	4.02
Biochemistry or Biophysics	3.02
Mathematics	3.02
Computer Engineering	2.51
Environmental Science	2.51
Physics	2.51
Architecture or Urban Planning	2.01
Data Processing or Computer Program	2.01
Electrical or Electronic Engineering	2.01
Mechanical Engineering	2.01
Medicine, Dentistry, Veterinarian	2.01
Chemical Engineering	1.51
Earth Science	1.51

Industrial Engineering	1.01
Other Engineering	1.01
Aeronautical or Astronautical Engineering	0.5
Marine Science (incl. Oceanography)	0.5
Microbiology or Bacteriology	0.5
Other Physical Science	0.5
Other Technical	0.5

Note: AA Students that indicated they were STEM majors on ***both*** *the TFS and CSS*

Table 2 presents a list of variables used to illustrate the percentage breakdown across AA students that did, and did not, persist in their STEM degree programs. As shown in Table 3 AA students that persisted in STEM had higher levels of faculty mentor engagement. Interestingly, faculty mentor engagement and habits of mind equally contributed to AA STEM persistence with 50.36 and 55.34 percent, respectively, of students persisting. State what's observed in this table. Income levels stand out to me. High School Avg. GPA stands out. Father/Mother college degree. Faculty diversity had little impact on persistence.

Responses to the survey. Higher levels of engagement (constructs of behaviors).

Table 2- Average Scores of AA Students across variables

AA Student Population	Persisted in STEM	Did not Persist in STEM
Faculty Mentor Engagement	50.36	49.15
High School Avg. GPA A or A+	30.8	22.3
High School Avg. GPA B	15.2	17.6
High School Avg. GPA C	.5	1.4
Father College Degree	40.8	42.2
Mother College Degree	46.9	36
First Generation College Student	20.7	19
Income Between $0-24,999	23.2	20.9
Income Between $25,000-49,999	22.6	21
Income Between $50,000-74,999	14.7	17.4
Income Between $150,000-250,000	9.1	6.9

**Average score in each category*

Research Question: What is the relationship between faculty mentor engagement and African American student STEM persistence?

Table 3 displays a linear probability analysis with STEM persistence as the dependent variable and faculty interaction as the primary independent variable. We examined the extent to which the relationship between the faculty mentor engagement and AA STEM persistence changed with the addition of other variables to observe the extent of the relationship with faculty mentor engagement and AA STEM persistence. Model 1 did not have any control variables because we were only interested in exploring the correlation between faculty interaction and STEM persistence. In this simple model, there is a positive correlation between STEM persistence and faculty mentor engagement. In Table 3, faculty mentor engagement continued to reflect a positive relationship with AA STEM persistence even with the addition of student characteristics, which included academic preparation, parental academic achievement, first-year generation status, and institution type. However, the relationship between faculty mentor engagement and STEM persistence weakens to the point of non-significance with the addition of annual family income. This may be a consequence of having a small sample size and adding multiple variables into the model.

As shown in Table 3,while the relationship between faculty mentor engagement and STEM persistence weakens with the addition of the control variables, the relationship is still marginally significant. The raw output magnitude of the faculty interaction coefficient did not change much when student characteristics, institutional context, and faculty diversity were added in Models 2,3, and 4.

Table 3 - *OLS Models for Faculty Mentor Engagement and AA STEM Persistence*

Model	(1)	(2)	(3)	(4)
Faculty Mentor Engagement	.008**	.008*	.007*	.005*
	(.493)	(.003)	(.003)	(.004)
Female		-.079	-.078	-.057
		(.060)	(.060)	(.064)
High School Academic Avg. GPA A or A+		.086	.080	.055
		(.067)	(.067)	(.072)
High School Academic Avg. GPA B		-.015	-.009	-.006
		(.083)	(.083)	(.089)
High School Academic Avg. GPA C		-.211	-.214	-.313
		(.295)	(.294)	(.300)
Father Received College Degree		.059	.068	.106
		(.072)	(.072)	(.076)
Mother Received College Degree		.065	.058	.018
		(.067)	(.067)	(.072)
First Generation Stud		.050	.058	.028

		(.079)	(.079)	(.088)
Liberal Arts College		.054	.050	.028
		(.069)	(.069)	(.074)
Public		-.027	-.048	-.086
		(.123)	(.124)	(.130)
Faculty Diversity			.004	.004
			(.003)	(.003)
Income Between $0-24,999				.046
				(.094)
Income Between $25,000-49,999				.048
				(.086)
Income Between $50,000 – 74,999				-.152
				(.090)
Income between $150,000 – 249,999				.097
				(.125)
Adjusted R^2	.018	.012	.014	.001

Standard error of estimated coefficients are reported in parenthesis:*Significant at the 0.05 level, **Significant at the 0.01 level, ***Significant at the 0.001 level

Summary

This study focused on testing the relationships between: faculty mentor engagement and AA STEM persistence. The variables that provide the foundation for this study were born out of a comprehensive critical literature review that helped guide the selection of the theoretical and conceptual frameworks. Linear probability models, and logit regressions, were conducted to examine the relationships between the independent and dependent variables to ensure that the statistical outputs were similar with respect to the raw output magnitude and direction.

Based on the results from the linear probability and logit regressions, faculty mentor engagement has a positive correlation with AA STEM persistence $p < .05$. This finding indicates that AA students that are engaged in faculty mentorship have an increased chance of persisting in their degree programs compared to AA STEM aspirants that do not. This data is helpful for students and faculty either in or out of undergraduate research programs to enhance their work and interactions. For institutions that have URPs, examining the objectives of the faculty-student mentor engagement, reminiscent of the ones provided in this study, can ensure that the interactions they have are effective, and rooted in practices that have been tested in research to positively influence AA STEM persistence. For students and faculty that are at campuses that do not have URPs, this finding is helpful to guide the types of interactions that they have while being mindful that in order for the interactions to be useful they have to be meaningful. Our main finding is that AA students with more interaction with faculty have an increased likelihood to persist in their STEM degree programs.

Discussion

STEM degree completion requires that AA students navigate a complex web of internal and external factors that ultimately determine whether they will persist in their programs. It is incumbent upon higher education researchers, and practitioners, to consider the multilayered complexities of STEM persistence when creating interventions. Based on best practices in research about STEM persistence, higher education professionals have launched formal URPs to mitigate MS STEM degree departure. Undergraduate research programs usually consist of faculty interactions, research opportunities, and avenues for students to present their research findings (Hurtado et al., 2009). URPs are widely regarded as being able to strengthen MS science identity, self-efficacy, and sense of belonging which positively influences STEM degree completion (Hurtado et al., 2009). Additional intervention strategies are necessary to increase the rate of STEM degree completion for students from underrepresented communities, therefore, examining the relationship between faculty mentor engagement and AA STEM persistence could be useful to bolstering academic support for a wider population of students.

Interpretation of the Results

Our research question was developed to address a gap in the literature on AA STEM persistence, and to bolster support for AA students in STEM. Academic outcomes are clear and reflect that a disproportionate amount of AA students attrit from their STEM degree programs. We found that faculty mentor engagement is positively correlated with AA STEM persistence, further, students that were one standard deviation higher in faculty engagement were 3.2 percent more likely to persist in STEM than students that did not, when socioeconomic status was not included in the model. To be clear, faculty mentor engagement is positively related to STEM persistence, but this relationship, is at least in part, driven by annual income. It appears that students that reported a higher annual family income may be more likely to interact with faculty and persist in their STEM degree programs. This may be due to the sharing of social and cultural capital concerning navigating the academic space; however, more research is needed to confirm whether that is the case.

Recommendations to Theory

The theories that framed this study align well with the research findings. The postsecondary science culture is often characterized as unwelcoming, rigorous, and competitive which often leads to AA STEM students feeling marginalized in their programs (Cole & Espinoza, 2008; Espinosa, 2011; Hurtado et al., 2008; Hurtado et al., 2009; National Academies of Sciences, Engineering, and Mathematics, 2016). We hypothesized that students that engage in faculty mentor engagement would have higher levels of STEM persistence because faculty members play a key role in helping AA students in STEM navigate the science and engineering culture (Hurtado et al., 2009; Jones, Barlow, & Villarejo, 2010; McGee, 2016). Schlossberg (1989) posited that mattering consists of attention, importance, ego-extension, dependence, and appreciation. It appears that faculty members may enhance feelings of mattering (Hurtado et al., 2009) for AA students in STEM by: being there to answer questions (attention), giving them emotional support and encouragement (importance), inviting them to participate in undergraduate research programs (ego-extension), facilitating opportunities to publish (dependence), and celebrating academic outcomes (appreciation).

Recommendations to Practice

Faculty that provide AA STEM aspirants with encouragement to attend graduate school, provide research opportunities, give feedback on their work, provide students with emotional support, and give advice on how to navigate their program is positively correlated with AA STEM persistence. It is understandable that faculty may feel stretched thin due to their responsibilities with teaching, research, and service; however, thinking about how mentoring might be included in STEM curriculum for AA students could be one way to leverage time and resources to increase AA STEM persistence (Eagan et al., 2011).

Higher education leadership such as Chancellors, Provosts, and Academic Deans, play a critical role in fostering environments that consider the academic experience of all students. Their leadership in the space of diversity and inclusion will help to foster academic spaces that consider everyone, and each of their individual academic success, on their campuses. Further, offices that are housed in units on-campus such as admissions, graduate divisions, counseling / advising, multicultural centers, writing centers, or associated student centers should think about how the findings of this study might aid them in creating spaces on-campus that are inclusive of all students. Collecting data to ascertain who is receiving service, and who is not, could reveal important information about why some students may, or may not, feel welcome within their particular academic environments. Additionally, many of the items that make up the faculty mentor engagement construct could possibly be used to inform academic programming such as creating programs on campus that focus on providing resources to AA students.

Conclusion

There is a disparity in STEM degree completion between AA students and their racial / ethnic counterparts. STEM degree attainment happens by way of a complex pathway of barriers and opportunities that students must learn to negotiate in order to persist. Higher education stakeholders must consider the various layers associated with AA STEM degree completion when creating strategies that aim to support all students in their academic pursuits. The impetus for this study was to identify ways in which predominantly white institutions could further support AA students in STEM since, as noted in the earlier part of this study, they attrit from their program at higher levels than their peers. Consequently, the findings of this study are encouraging in that they help to inform scholars about strategies that could strengthen academic outcomes for students that have already expressed an interest in STEM. The results of this study revealed that faculty mentor engagement is positively related to AA STEM persistence.

The issue of STEM degree completion effects everyone. When students are wholly left out of any industry, albeit by internal or external factors, that poses significant concerns since innovation, scientific solutions, and technological advancement is necessary in order for the US to remain competitiveness in STEM on the national and international stage. STEM professionals must reflect the diverse needs of the country. AA STEM degree completion must be addressed in a layered and nuanced way to ensure that the culture of the institution is one of inclusivity for all students in STEM.

College faculty, staff, and administrators may use the findings in this study to ensure that their campus environments are inclusive, and that all students, regardless of their racial/ethnic backgrounds are able to thrive in STEM. In addition, understanding whether faculty mentor engagement contributes to AA STEM persistence will further inform higher education stakeholders about retention efforts that could strengthen support for a more diverse population of students in STEM. Seeing as though faculty mentor engagement is positively correlated with AA STEM persistence, researchers and practitioners may consider creating more opportunities to facilitate those interactions and also ensure that faculty are aware of, and incorporate, the items that make up the faculty mentor engagement construct to have a positive influence on AA STEM persistence.

Declarations

Availability of data and materials: The data that support the findings of this study are available from the UCLA Higher Educational Research Institute: CIRP Surveys 2009-2013 but restrictions apply to the availability of these data, which were used under the license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the UCLA Higher Education Research Institute.

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