

Watkins-Lewis, Karen et al. "Relationships among Sense of Community, Science Self-Efficacy, and Science Identity for Female Meyerhoff Scholars: Implications for Pathways to Broadening the Workforce in STEM." *Journal of Women and Minorities in Science and Engineering*. DOI: 10.1615/JWomenMinorScienEng.2022038088

<https://doi.org/10.1615/JWomenMinorScienEng.2022038088>

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RELATIONSHIPS AMONG SENSE OF COMMUNITY, SCIENCE SELF-EFFICACY, AND SCIENCE IDENTITY FOR FEMALE MEYERHOFF SCHOLARS: IMPLICATIONS FOR PATHWAYS TO BROADENING THE WORKFORCE IN STEM

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Women remain underrepresented in STEM fields, even with the plethora of programs to increase diversity. Understanding the undergraduate experience for female students of color majoring in STEM is critical for determining effective strategies for retention and smooth career pathways. Using data from 96, (predominantly) African-American female and Latina students in the Meyerhoff Scholars Program at the University of Maryland, Baltimore County, this study quantitatively examined the relationships among sense of community, science self-efficacy, and science identity. Mediation models were run on all female STEM majors in the dataset. There was a positive and significant indirect effect of sense of program community on science identity via science self-efficacy. The results of this study enhance our understanding of how female Meyerhoff students with a strong sense of program community thrive in STEM. It adds support to previous studies of the positive impact that student-focused programs that address multiple areas of students of color needs and challenges have on psychosocial variables important to

student success. This study provides further insight into the critical work of retaining female undergraduate students of color in STEM programs and ensuring their success along the pathway to a STEM career.

Keywords: Females, African-American Females, Latina students, students of color, STEM community

1. INTRODUCTION

With the many environmental and social challenges worldwide, innovative discoveries in the Science, Technology, Engineering, and Mathematics (STEM) workforce have profound implications for advancements that affect individual wellbeing, economic growth, national security, and global influence. Meeting these challenges and developing solutions requires a strong STEM workforce. The vast majority of positions in STEM fields must be filled by highly skilled, career-oriented professionals with a bachelor's or higher-level degree. Recognizing the importance of sustaining a viable pool of individuals with skill sets in STEM, the United States (U.S.) has taken deliberate steps towards determining the state of its workforce and effective ways to broaden participation in STEM among all U.S. groups (Chen, 2013; National Academy of Sciences et al., 2010; National Science Board, 2019).

Two trends in the labor market have emerged in STEM: workforce demand and job stability. The demand for scientists and engineers has grown at a steady rate for more than half a century (Branigan, 1975; Carnevale et al., 2011; Sargent, 2017). The need is due in large part to the integral role that STEM professionals play in supporting a wide variety of professional sectors (e.g., business, education, and government) to meet industry goals (National Science Board, 2018). In addition, there is a high demand for individuals with STEM knowledge and skills to work in non-STEM professions (Carnevale et al., 2011). Also, science and engineering

jobs are in high demand and resilient even in the face of tumultuous economic times, such as the Great Recession of 2008 and the high unemployment rate that resulted from COVID-19 in 2020 (Kochhar, 2020). Along with demand, STEM careers can provide a comfortable and secure source of income. STEM professionals and those with STEM degrees working in non-STEM fields often garner higher salaries than those in non-STEM careers. Over half of STEM workers with a bachelor's degree (56%) and a master's degree (52%) make more than the average worker with each respective degree in other fields. Also, even though women and people of color are paid less than Whites in STEM, the pay gap is smaller in STEM occupations than other fields (Carnevale et al., 2011).

Given this demand and the economic attractiveness of STEM careers, the number of science and engineering (S&E) professionals has grown at an average annual rate of 3% over the last six decades (National Science Board, 2018). Yet, questions about the adequacy of the U.S. STEM workforce raises concerns about supply keeping pace with demand. The potential shortfall of professional talent in engineering is of particular concern to private industry and government alike, due to the importance of the profession for advances in science and technology (Lapedus, 2019; Sargent, 2017). Thus, the United States has compelling reasons to broaden its talent base in both science and engineering among all its citizens.

There are clear advantages to diversifying participation in S&E (Committee on Equal Opportunities in Science and Engineering, 2014; Matthews, 2020). Women and people of color in S&E have made meaningful contributions to advancing economic prosperity, national security, and personal wellbeing in the United States (Hicks, 2017; Shetterly, 2016). Yet even with demands for a larger workforce, many women of color remain underrepresented in S&E, in part because they are not retained in the educational pathway required for participation. While

there have been gains in representation among women in STEM, recent reports on diversity suggest that White women are largely responsible for closing the gender gap (Alfred et al., 2019). In addition, the proximal parity may be primarily due to a concentration of degrees completed in the biological and social sciences (Sax et al., 2018).

A closer examination across disciplines in STEM shows a persistent pattern of long-standing differences in the participation of women of color in engineering, computer science, mathematics, and statistics (National Science Board, 2019). Between 2008 and 2018, the pursuit of bachelor degrees by women of color was far lower in non-organic fields, such as physics and engineering and higher in psychology, social sciences, and biological and agricultural sciences (National Center for Science and Engineering Statistics, 2021). In 2018, African-American female students earned 1.14% of all bachelor degrees in engineering and 3.13% in Earth and physical sciences. Similarly, Latina students earned 2.85% in engineering and 4.83% in Earth and physical sciences (National Center for Science and Engineering Statistics, 2021).

For decades, the United States has launched a variety of initiatives aimed at increasing interest in STEM among females and students of color. Educators, policymakers, and faculty members in favor of diversity have presented reams of data to support carefully crafted arguments about the importance of diversity and educational equity in STEM. Some gains have been made, especially among the number of Latinx students applying to engineering programs (American Society for Engineering Education, 2021). Yet meaningful and sustainable change remains elusive as underrepresentation persists.

Part of the challenge in increasing the number of women and persons of color in STEM degree programs is in identifying social factors that undermine change. Programs fail to eradicate the systemic and subtle forms of racism and sexism that tend to impose feelings of isolation and

exclusion among females and students of color (Baber, 2015; Espinosa, 2011; Pawley, 2019; Rincón et al., 2020; Ro and Loya, 2015; Villa et al., 2016). Many initiatives focus on the individual or target specific populations, such as Latinx or African-American students. When STEM students leave school, or transfer to non-STEM programs, reasons all too often center on the individual student instead of flaws in the educational system (Baber, 2015). Scholars focused on diversity in STEM suggest that systematic change must be paramount, and include effective diversity and inclusion initiatives embedded in all facets of STEM education programs, starting with faculty development (Atadero et al., 2018; Ro and Loya, 2015).

Others argue for a more critical pedagogical approach in STEM education, particularly in science and engineering programs, that recognizes that these disciplines do not occur in a vacuum and are not inherently neutral or unbiased (Baber, 2015; Pawley, 2019). As with any human endeavor, people come to science and engineering with personal biases and preconceptions. Thus, the technologies and new understandings that emerge from research on these fields can have broader social, political, and environmental implications. Efforts to attract and retain women of color in science and engineering must make connections at the educational level between the curriculum and current socio-environmental issues (Espinosa, 2011; Villa et al., 2016).

In addition to looking at the overall culture of an institution, understanding the undergraduate experience of women of color for those majoring in STEM is critical for determining effective strategies for retention and talent development. To this end, a fair amount of research has been devoted towards identifying factors associated with successful recruitment and retention of women and students of color in STEM majors. However, fewer studies employ quantitative methods to investigate these phenomena, or place emphasis on a target population

that intersects gender and race/ethnicity. The purpose of this study was to investigate the relationship between sense of program community and two forms of science based self-concepts, science identity and science efficacy, among a sample of female students pursuing degrees in STEM. Science based self-concepts in general are a person's self-perception as, or potential to become a scientist.

Bronfenbrenner's Bioecological theory of human development serves as the framework for this examination (Bronfenbrenner and Morris, 2006). The Bioecological model emphasizes the role that a series of ecological systems play in shaping the human experience at all stages of life, including during emerging adulthood (Arnett and Tanner, 2006). Of particular relevance to this study are interactive processes that occur in the mesosystem. Within the context of a learning community, the mesosystem is composed of interrelationships between the individual and a combination of microsystems, or socializing agents (e.g., a community of instructors and peers) that are considered to be vital to the learning experience. It is argued that an enhanced sense of community is important in the development of the science identity of budding scientists with science self-efficacy or belief in one's capacity to do science as a mediator variable in the process. Studies centered on social phenomena associated with STEM success have identified links between science self-efficacy, research experience, and science identity (Robnett et al., 2015; Syed et al., 2019). The current study expands on this literature by investigating the relationship between self-efficacy, science identity, and sense of community among female students of color.

2. REVIEW OF THE LITERATURE

2.1 Programmatic Initiatives that Broaden Diversity in STEM

Since the 1960s, there has been a push to increase diversity in STEM through programming within the formal education system (Branigan, 1975; National Research Council, 2010, 2014). In 1976, the Office of Opportunities in Science of the American Association for the Advancement of Science (AAAS) compiled a directory of 355 programs created to increase the involvement of people of color in the sciences that were in existence from 1960–1975 (Mahaley Malcom et al., 1976). Many programs were also still being developed then. Problems emerged, however, with communication and coordination between programs. An inventory was developed to facilitate sharing of best practices and to avoid duplication of effort, given the limited resources. The researchers used a broad definition of the sciences, including: “the physical and biological sciences, engineering and technical fields, health sciences, agriculture, science education and counseling, and some social sciences such as anthropology, psychology and geography” (Mahaley Malcom et al., 1976, p. 1). About 60% of the 355 programs focused on engineering and health sciences, and overall, most programs targeted African Americans, since “only about 12% of the projects did not have Black student involvement” (Mahaley Malcom et al., 1976, p. 7). Program components included curriculum changes, faculty development, institutional programs at minority-serving institutions in partnership with industry and professional organizations, and special programs at majority-White institutions, such as tutoring and mentoring programs.

A few of the programs from the inventory have endured, along with other, newer initiatives that take a similar approach to increasing degree completion in STEM among students of color. While the number of students interested in STEM fields has increased, attrition from STEM degree programs continues to be a challenge. Examining longitudinal data from a variety of four-year institutions, Griffith (2010) found that women and people of color had lower than

average persistence rates in STEM majors than their male and White counterparts, particularly if they had negative experiences during their first two years. According to a report that used U.S. student data for 2003 - 2009, about 28% of students in bachelor's programs intended to major in a STEM field at some point, but 48% of these students either switched to a non-STEM major or left school without completing their degree (Chen, 2013). This same study found that a larger percentage of females than males (32.4% vs. 25.5%) switched to a non-STEM major, and at 36.0%, Blacks had the highest rate of switching to a non-STEM major of any race/ethnicity (Chen, 2013).

Various factors contribute to success in attracting and retaining women and people of color in STEM majors. A growing number of programs incorporate a “summer bridge” experience with the goal of transitioning students from high school to the rigors of the STEM curriculum in college (Ashley et al., 2017). Summer bridge STEM programs help by offering math and science courses outside of a normal course load. Students also have an opportunity to meet fellow STEM majors, build friendships, and adjust to campus life before the start of the first semester (Johnson, 2016). Many programs offer peer tutoring, which provides benefits to both parties--tutees feel less intimidated and tutors solidify their knowledge in the subject matter (Cromley et al., 2016; Doerschuk et al., 2016). Research and internship opportunities also support retention. These experiences allow students of color to develop their science identity, apply theory, set professional goals, and foster science self-efficacy (Hernandez et al., 2013). For women, working to improve society or serve the greater good through their research experience improves the likelihood of engaging and persisting in their respective STEM majors (Espinosa, 2011; Tsui, 2010; Villa et al., 2016). Many programs provide access to campus and professional mentors, a known factor associated with increasing retention rates, particularly when mentors are

of the same race/ethnicity and gender as their mentees (Doerschuk et al., 2016; Hill et al., 2010; Tsui, 2010). For many Latina students, family is very important, but sometimes there is a disconnect between their university ties/interests and family ties/interests, particularly for first-generation students. Finding ways to incorporate families in recruitment and orientation strategies, including providing materials in Spanish, and offering programs that showcase student research, where families are invited to campus, can help parents and other family members better support their children throughout working towards their degree (Carpi et al., 2013; Peralta et al., 2013; Rodriguez et al., 2021). Another approach, scholarships and stipends, provide financial support and help to reduce the chance of premature departure from school (Lam et al., 1997; Newman, 2016).

Several programs have noted success in supporting minority students on a pathway to careers in STEM. Research on the first five years of the University of Akron's Increasing Diversity in Engineering Academics program (IDEA) found that the number of African-American students increased from 38 to 78. Retention also rose from 31% to 74% from 1990 to 1994 (Lam et al., 1997). Lamar University started the Students Advancing through Involvement in Research Program (STAIRSTEP) in 2009, which focuses on increasing participation and retention of first-generation, low-income and students of color in five STEM disciplines: chemistry, computer science, geology/earth and space sciences, mathematics, and physics (Doerschuk et al., 2016). Before the start of the program, "...the 6-year retention rate for the five STEM disciplines averaged only 22%" (Doerschuk et al., 2016, p. 684). An analysis of data from the program from January 2009 through August 2014 showed that "...89.58% of participants stayed in their majors (86 of 89 participants) and 86.66% of program participants either went on

to STEM graduate programs or employment in a STEM field” (Doerschuk et al., 2016, p. 690). Both the IDEAs program and STAIRSTEP are still in existence.

2.2 The Meyerhoff Scholars Program

One of the most successful programs to increase the numbers of women and students of color in STEM fields is the Meyerhoff Scholars Program at the University of Maryland Baltimore County (Maton et al., 2009, 2016). The MSP is a scholarship program that cultivates peer support among undergraduate students interested in pursuing a PhD in STEM. In addition to financial support, the MSP promotes group study and provides tutoring, academic advising, personal counseling from staff, mentoring and support, organized social activities, faculty involvement, interactions with UMBC administrators, and professional development. Since 1988, annual groups of students or “cohorts” have begun the MSP with a 6-week summer bridge program. During the school year, cohorts receive advising, faculty and staff mentoring, peer support, research experience, and attend seminars and field trips meant to enhance the skills needed for retention, degree completion, and graduate school success. Meyerhoff Scholars are five times more likely to pursue STEM PhD and MD/PhD degrees post-college than their equally high-achieving peers who declined to participate (Maton et al., 2012, 2016). The MSP has been successfully adapted at other Predominantly White Institutions (PWIs), including Penn State University and the University of North Carolina at Chapel Hill (Sto. Domingo et al., 2019).

The MSP began with all male scholars in 1988 but started to recruit and accept female students the next year. Between 1989 and 2018, it admitted 707 women. From those who entered in 1989 through 2015 ($N = 631$), 601 or 95% have graduated with STEM bachelor degrees and 397 or 63% have matriculated in advanced STEM degrees, including medicine (Maton and Sto. Domingo, 2020).

Research on the MSP has found that, consistent with program theory, students who benefit broadly from the wide array of program elements also develop greater levels of research self-efficacy and science identity, two critical variables that have been found to be linked to academic success in STEM (Maton et al., 2016). This finding supports the view that the multifaceted, comprehensive nature of the MSP, which addresses multiple areas of minority student need and challenge, all while enhancing the sense of program community, explains its high levels of success over time. Students who perceive greater benefit from the varied elements, as a whole, appear to be those who develop the psychological attributes and personal competencies inherent to success as a scientist (Maton et al., 2016).

Several factors affect persistence in STEM at the undergraduate and graduate degree levels for students of color, including GPA, mentorship, research experience, academic and social integration, and research self-efficacy (Alston et al., 2017; Carpi et al., 2017; Estrada et al., 2018; Foltz et al., 2014; Wladis et al., 2015). Three key psychosocial areas of influence on STEM retention are the constructs of interest for the current study: sense of community, science self-efficacy, and science identity.

2.3 Sense of Community

McMillan and Chavis (1986) describe a sense of community as “a feeling that members matter to one another and to the group, and a shared faith that members’ needs will be met through their commitment to be together” (p. 9). An element of sense of community, membership, is described as a feeling of belonging to or being a part of an entity (McMillan & Chavis, 1986). There is also the feeling that an individual has a right to belong because of her or his investment in the community. The idea that some people belong and others do not indicates that there is a division between members and non-members (McMillan and Chavis, 1986).

The sense of belonging to a scientific community can have a profound impact on a student's social integration, academic success, and persistence in the major (Carlone and Johnson, 2007; Massi et al., 2012; Summers and Hrabowski, 2006). In some cases, community membership can take on an exclusive form when acceptance and support are limited to those who have demographic characteristics in common with those who define its principles (Seymour and Hewitt, 1997). Specifically, exclusion has been shown to work against female and student of color persistence in majors dominated by White males, especially in rigorous academic programs (Mills et al., 2010).

In an academic setting, students of color, who are accepted into membership on the broader level (i.e., acceptance into the academic program), must feel valued at the community or microsystem level (faculty and classmates) and feel that their academic and social needs will be met without discrimination. Students of color who are otherwise isolated can face feelings of rejection that result in a cascade of emotional and cognitive consequences. The adverse psychological effects place excluded students at risk for diminished satisfaction within the engineering major and fuel desires to leave (Amelink and Creamer, 2010; Trent et al., 2021; Webber et al., 2021). Extant literature links low numbers of participation among women and students of color with a decrease in self-confidence and self-efficacy (Arthur and Guy, 2020). Research has yet to fully explore the extent to which an inclusive community may interject resilience as a protective factor.

Findings on academic achievement and persistence in STEM consistently illustrate the importance of community support and inclusion in increasing female student persistence in particular (Banda and Flowers, 2017; Casad et al., 2018; Maton et al., 2009; Mondisa and McComb, 2015; Rincón et al., 2020). Female students who leave engineering and other STEM

majors report an absence of social connectedness with their peers and instructors and feelings of unwelcomeness in the classroom or living space (Berger, 2001; Cabrera et al., 2012). The resulting frustration leads to low self-confidence in their abilities to maneuver the “complexities of the systems in their home department or institution” (Brown et al., 2020, p. 10). Participation in comprehensive STEM programs and learning communities have been shown to protect against social barriers which, in turn, have a positive effect on the academic experience and degree completion rates for women and students of color (Carrino and Gerace, 2016; Dagley et al., 2016; Kezar and Holcombe, 2018; Solanki et al., 2019; Villa et al., 2016; Walton et al., 2014).

In addition, literature on community and student retention in STEM suggests that community experiences have a meaningful effect on science self-efficacy. Fencil and Scheel (2005) found significant correlations between confidence changes related to physics self-efficacy and course climate, including the “supportiveness of classmates and instructors, and the instructor’s responsiveness and accessibility to students” (p. 21). Marra et al. (2009) assert that the self-efficacy of minority students in engineering at predominantly White institutions benefits from curricular and extracurricular programs that address feelings of inclusion in the learning community. Research conducted by Vogt et al. (2007) on female student success in engineering links positive outcomes in self-efficacy to “integrative” strategies in the classroom that focus on community-based interactions with instructors (e.g., taking an interest in and sharing experiences with students and/or providing students with opportunities in the field). Beason (2018) found that high achieving students of color in STEM who reported a stronger sense of community also experienced higher research self-efficacy and science identity by the end of their first year in college. Our research aimed to expand investigations on efficacy and retention by examining the

role that science self-efficacy plays in the relationship between sense of community and science identity.

2.4 Science Self-Efficacy

Science self-efficacy refers to a person's subjective evaluation of their ability to perform well in a particular domain (Schlegel et al., 2019). Students' beliefs about their abilities in STEM-related classes are important to consider as these beliefs might influence their persistence and retention in STEM fields. Qualitative studies illustrate how science efficacy and identity begin to erode when students perform poorly or think it necessary to work harder than their peers in STEM (Aschbacher et al., 2010; Margolis et al., 2000). The students then feel that a STEM major or career is not for them. Unequal access to support structures, such as mentors or positive advising experiences, as well as previous opportunities to engage in STEM activities can also lead to differences in the levels of self-efficacy that students possess (Aschbacher et al., 2010; Margolis et al., 2000). Having a sense of community and support can allow students to develop a higher science self-efficacy (Garriott et al., 2019).

An increasing number of quantitative studies have examined the relationship between a variety of factors associated with STEM achievement and retention, including science self-efficacy, science identity, and sense of belonging (Robinson et al., 2018; Robnett et al., 2015; Starr, 2018; Syed et al., 2019; White et al., 2019). A two-year study by Robnett et al. (2015) on the undergraduate research experience found a positive relationship between students' engagement in research, science self-efficacy and science identity. Syed et al. (2019) found that STEM support systems that offer opportunities for research, mentoring, and interactions with scientists bolster higher levels of self-efficacy. In turn, students felt a greater sense of belonging in STEM fields and had a stronger commitment to pursuing a STEM career.

Other empirical studies utilize mediation models that differ from the current study. White et al. (2019) use a mixed method approach to explore how science efficacy mediates the relationships between science identity, science achievement, racial identity and science achievement. Starr's model (2018) examined how science identity mediates the relationship between science stereotypes and STEM motivational variables such as self-efficacy. Still, quantitative studies on the relationship between self-efficacy and science identity remain scant. The current study helps fill that gap.

2.5 Science Identity

Social identity and multiple identity theories posit that a person's identity is dynamic and not static (Brodsky and Marx, 2001). Additionally, according to social identity theory, identity is an individual and social construct (Stets and Burke, 2000). These individual and social constructions work in tandem to form both an individual and group-based identity. Thus, context is important, as aspects of a person's identity may be influenced by his or her surroundings and the group of which one is part.

Rodriguez et al. (2019) describe science identity in terms of being recognized by others, and one's self as a "science person." Science identity is a measure of an individual's recognition, performance, and competence in STEM. Science identity is found to be positively associated with student academic success in STEM and persistence in their major (Adedokun et al., 2013; Carlone and Johnson, 2007; Chang et al., 2011; Rodriguez et al., 2021; Syed et al., 2019). White et al. (2019) found that scientific identity is an important driver of science achievement among African-American students attending historically Black colleges and universities and argue for the importance of promoting science identity, particularly as they

move into majority-white spaces during internships, research experiences, and/or upon graduation.

Both White women and women of color are found to have low science identity when compared to their male peers (Hazari et al., 2013). Reasons include the perpetuation of White male scientist stereotypes reinforced by low diversity among mentors. Such stereotypes of scientists affect whether or not students believe they can succeed in STEM (Schinske et al., 2015). Ceglie (2011) postulates that the development of science identity among women of color is influenced by the lack of representation of women of color in STEM, in addition to perceptions of what a scientist should look like. The author further found that the challenge of creating networks with professors, as well as the competitive, rather than collaborative nature of STEM environments were an obstacle for nurturing a science identity. This body of work suggests that the overrepresentation of White males may result in a belief by women of color that there is no place for them in STEM. Moreover, Malone and Barabino (2009) described the experience of being the only woman of color in a STEM setting as a major contributor to difficulties in cultivating a science identity. Such experiences contribute to diminished STEM participation of women of color and a decrease in science-based self-concept.

Given these social barriers and the overrepresentation of White men in STEM, it is important for students of color and women to have strong science identity beliefs as it may serve as a source of motivation to persist and excel in science fields (Robinson et al., 2019). According to the expectancy-value theory, students who value science as part of their identity are more likely to persist amid challenging science-related tasks and will still choose science as their field of study. Indeed, when students of color enter college, they are often faced with many barriers compared to White students, which in turn may influence their weak or tenuous science identity

(Aschbacher et al., 2010). Thus, it is important to identify protective factors for female students of color interested in pursuing STEM majors. For example, Robinson et al. (2019) reported that students who have strong science self-efficacy and a strong sense of community alongside an enhanced science identity are also more likely to persist and succeed in the sciences. This finding suggests that factors such as community belongingness and students' beliefs about their abilities can influence their identity as a scientist and, subsequently, their retention in STEM majors. This points to the central importance of science identity in enhancing representation and success of women in general and women of color in particular in STEM. It also underscores the need for greater understanding of the factors that contribute to enhanced science identity, such as a sense of community and science self-efficacy. The current study adds to the literature on science identity by investigating how STEM program communities on college campuses influence students' science self-efficacy, which in turn strengthens their science identity.

3. AUTHOR POSITIONALITY & PROTECTION OF VULNERABLE POPULATIONS

3.1 Author Positionality

Our involvement in this area of research, as well as our approach to the current study, were greatly informed by our individual intersecting identities and diverse academic experiences, ranging from graduate students to professors, librarian, and research scientists. Indeed, our multiple intersecting identities highlight power, privilege, and oppression and how these constructs may differ for each of us, as well as for the communities that we study. Thus, we acknowledge our positionality.

Karen Watkins-Lewis is an African-American, first-generation college educated, cisgender woman with degrees in engineering and research psychology. These intersecting characteristics have uniquely positioned her to experience firsthand the multitude of challenges

faced by minorities who attempt persistence and leadership in STEM. Her background in engineering and research both lend themselves to work in advancing participation in engineering in a way that is informed, sensitive, objective, and goal oriented.

As a cisgender man of Asian background, Mariano R. Sto. Domingo's research on education and community for more than 20 years has always included ethnicity and gender as major contexts for how people understand and structure their lives, and how they are seen and treated by others. This also translates to his community-based initiatives, giving opportunities to girls and women to claim space and time that otherwise they would not have a chance to claim in the context of patriarchal conditions.

Rupsha Singh is a cisgender, immigrant woman of Asian background. She has first-hand experience with and has witnessed racial and gender biases in academic settings and understands the impact it has on one's confidence in the ability to perform well in academia. As such, her research has focused on psychosocial factors that promote success among women and underrepresented students.

Nicole A. Telfer is a Black, cisgender woman from the Caribbean. Her research has always been centered on the theory of intersectionality and on giving a voice to those who are multiply-marginalized in intersectional locations, like she has been. Thus, the current research study is a reflection of her own social identities and values. Her positionality in relation to the current study and the participant group is that she identifies as a member of the Black community who supports and understands the Black educational experience on college campuses.

Eileen G. Harrington is a White, middle-class, cisgender woman, who has personally experienced gender bias during her educational and professional career in the sciences and has witnessed subtle and overt gender and racial discrimination against others with whom she

studied and worked. Much of her past work as an educator and her research has focused on increasing the representation of women and minorities in STEM fields, including finding practical ways to support all females along the entire STEM pathway.

Rukiya Wideman Moraga is an African American, first-generation university educated cisgender woman who has a passion for understanding the factors that contribute to the academic achievement of racial/ethnic minority students. She is particularly interested in researching strategies to increase the number of underrepresented racial/ethnic minority students in STEM programs from the baccalaureate through the professoriate.

As a White, middle-class, cisgender man, Kenneth I. Maton has not personally experienced racial bias during his educational and professional career in academia. Rather, he has benefitted from the privilege of his identity in ways major and minor. He has sought to address the problem of racism and representation in our educational system by focusing his research over the past 30 years on evaluation of STEM programs that seek to enhance the academic success of undergraduate and graduate students of color.

3.2 Protection of Vulnerable Populations

To protect confidentiality of all participants in the current study, all data is stored in password-protected files at the lab of Dr. Kenneth Maton at the UMBC Department of Psychology. A crosswalk file is kept in a secured online storage system that requires passwords to access. Only the Research Director and research staff have access to the crosswalk file and other records. Research staff who are allowed access to the database is limited to those who work in an on- campus building with laboratories and rooms that have a security system in place. All printed data or reports are kept in an alarm-secured and locked research lab. If information learned from this study is published or included in a report, participants cannot be readily

identified by name, position, gender or ethnicity. All participants are requested to sign IRB-approved consent forms, with parents of minors (17 years old and under) required to provide agreement for their children's participation.

4. METHODS

4.1 Research Participants.

The study sample comprises 96 female students of color in entering Meyerhoff cohorts 24 (fall, 2012) through 29 (fall, 2017). A large majority are African American/Black ($n = 87$, 90.6%), and Latinas comprise the rest of the sample ($n = 9$, 9.4%). Among the participants, 32 (33.3%) are biology majors, 26 are engineering majors (27.1%), 22 are biochemistry and molecular biology majors (22.9%) and the rest are majoring in other STEM fields. The engineering majors include concentrations in mechanical, chemical and computer engineering, while other majors include computer science, bioinformatics and computational biology, chemistry, and physics.

Table 1: Demographics of study participants and descriptives for study variables (N=96)

Variables	Categories	n	%
Race/Ethnicity	<i>Black</i>	87	90.6%
	<i>Latina</i>	9	9.4%

Major	<i>Biology</i>	32	33.3%
	<i>Engineering</i>	26	27.1%
	<i>Biochemistry and Molecular Biology</i>	22	22.9%
	<i>Bioinformatics and Computational Biology</i>	5	5.2%
	<i>Computer Science</i>	4	4.2%
	<i>Chemistry</i>	4	4.2%
	<i>Physics</i>	1	1.9%
	<i>Individualized Studies - Science</i>	2	3.8%

4.2 Procedure

The scales measuring sense of community, science self-efficacy, and science identity were administered, as part of a larger survey, at the end of every academic year. For this study, we used sense of community at the end of the first year and science self-efficacy and science identity scores at the end of the second year. Demographic and background variables (i.e., gender, race/ethnicity, major) were obtained from Meyerhoff office records. All students (and if under 18, their parents) completed consent forms when they applied to the Meyerhoff program.

4.3 Measures

Sense of Community. Twelve items from the original Sense of Community Index (Chavis et al., 2008) were used to measure sense of community in the Meyerhoff program at the end of the first year. The original scale was developed based on McMillan and Chavis' (1986) theory of psychological sense of belonging. The adapted scale includes the subset of items most relevant to an academic community context, and item stems were changed to focus on the Meyerhoff program context. Sample items include: "I expect to be a part of the program for a long time" and "I can trust people in the program." Response options were 1: *Strongly disagree* to 5: *Strongly agree*. Scale scores were calculated by taking the mean of all items completed.

Reliability of the original measure has been found to be high (Chavis et al., 2008), as was the case for the adapted scale with the current sample (Cronbach alpha = 0.80).

Science Self-Efficacy. Fourteen items were used to measure science self-efficacy in year 2. The items were from the Scientific Self-Efficacy Scale (Chemers et al., 2010) that assesses students' confidence in their ability to function as a scientist. Sample items include student confidence to "use technical science skills," "generate a research question," and "use scientific literature and/or reports to guide research and develop theories." Response options were 1: *Not at all confident* to 5: *Absolutely confident*. Scale scores were calculated by taking the mean of all items completed. Previous studies reported high reliability (Chemers et al., 2010; Estrada et al., 2011). The Cronbach's alpha for the current sample was 0.94.

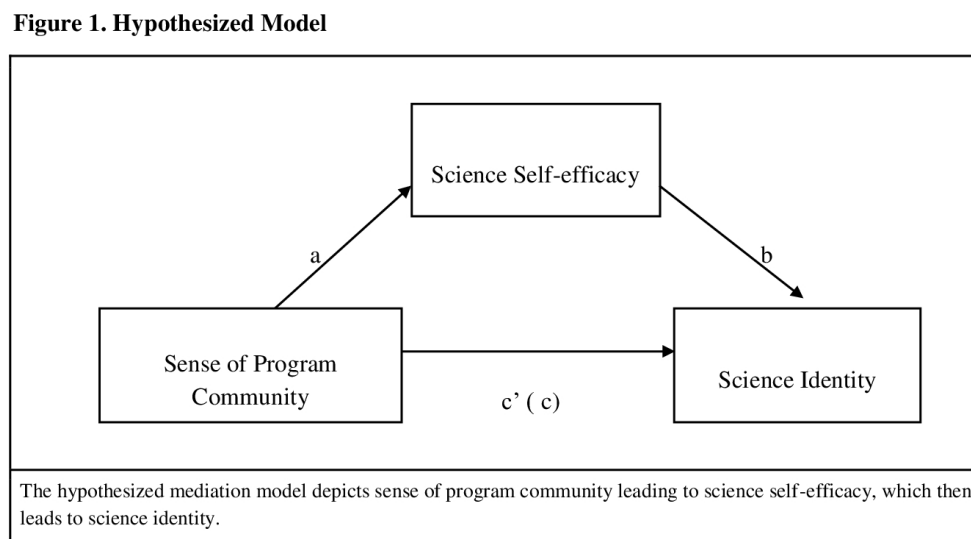
Science Identity. The five items from the Scientific Identity Scale (Chemers et al., 2010) were used asking students to assess the extent to which students view themselves as a scientist. Sample items include "(I) have come to think of myself as a scientist," "I have a strong sense of belonging to the community of scientists," and "feel like I belong in the field of science." Response options were 1: *Strongly disagree* to 5: *Strongly agree*. Scale scores were calculated by taking the mean of all items completed. Prior studies reported high reliability (Chemers et al., 2010; Estrada et al., 2011). The Cronbach's alpha for the current sample was 0.83.

4.4 Data Analysis

To test mediational or indirect effects, this analysis used the SPSS PROCESS macro developed by Hayes (2018). The simple mediation analysis uses a series of three Ordinary Least Squares (OLS) regression analyses (Hayes and Rockwood, 2020). A mediation effect involves a third variable or mediator (M: Science Self-Efficacy) serving to "go between" an exogenous variable (X: Sense of Program Community) and a criterion variable (Y: Science Identity)

creating an indirect effect. The letters a, b, c and c' on the hypothesized mediation model on Figure 1 represent the coefficients for the effect of sense of program community on science self-efficacy (a), the effect of science self-efficacy on science identity (b), the total effect of sense of program community on science identity (c), and the direct effect of sense of program community on science identity (c'). We hypothesized that for female students of color, sense of community would have an indirect effect on science identity via science self-efficacy. The analysis will determine if this indirect path exists. That is, the benefits of a sense of belonging in STEM scholars programs are predicted to enhance students' identification with science by increasing their science self-efficacy.

Figure 1. Hypothesized Model



5. RESULTS

For the sample of female students of color from Cohorts 24 through 29 (see Table 2), the mean scores for the variables of interest are 3.10 for sense of community, 3.78 for science self-efficacy and 3.95 for science identity. The Bioecological model theorizes that social context, including community, has an impact on the development of individual characteristics such as self-efficacy and identity. The zero-order correlation table (Table 3) shows significant and positive relationships between sense of community and science self-efficacy ($r = 0.27, p = 0.05$) and between science self-efficacy and science identity ($r=0.59, p<0.001$), but non-significant correlation between sense of community and science identity ($r=0.17, p = 0.226$)

Table 2. Descriptives of study variables* (N = 96)

Variables	<i>M</i>	SD
Sense of Community	3.10	0.50
Science Self-efficacy	3.78	0.60
Science Identity	3.95	0.61

Range for all variables is 1-5.

Table 3. Zero-order correlations among mediation study variables (N = 96)

	Sense of Community	Science Self-Efficacy
Sense of Community	-	
Science Self-Efficacy	0.27*	-
Science Identity	0.17	0.59**

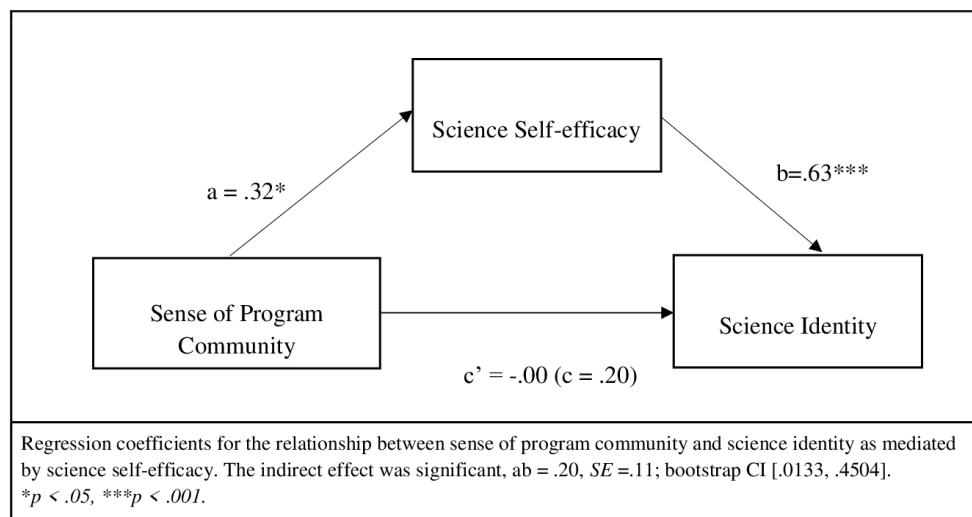
* $p=0.050$; ** $p<0.001$

Simple mediation analysis was used to test the model that science self-efficacy mediates the effect of sense of community in science identity. Results indicated (see Figure 2) that sense of community was positively related to science self-efficacy ($B = 0.32, SE = 0.16, 95\% CI [0.00, 0.64], p = 0.05$). Furthermore, science self-efficacy was positively and significantly related to

science identity ($B = 0.63$, $SE = 0.11$, 95% CI [0.40, 0.86], $p < 0.001$). Approximately 39.6% of the variance in science identity was accounted for by the predictors ($R^2 = 0.396$). The indirect effect was tested using a percentile bootstrap estimation approach with 10,000 samples (Shrout and Bolger, 2002), implemented with the PROCESS macro, Version 3.5 (Hayes, 2018). These results indicated that the indirect effect between sense of program community and science identity was significant, $B = 0.20$, $SE = 0.11$, 95% C.I. (0.0133 - 0.4504) supporting the mediational hypothesis. Neither the direct effect (c) nor the total effect (c') of sense of community on science identity is significant.

Figure 2. Test of indirect effect of sense of community on science identity for female students of color

Figure 2. Test of indirect effect of sense of community on science identity for female students of color



6. DISCUSSION

The results of the study enhance our understanding of how female Meyerhoff students of color thrive in STEM as a result of sense of program community. The findings related to indirect effects support the hypothesis that a significant consequence of participation in a supportive STEM community is enhancement of STEM students' science self-efficacy (Syed et al., 2019), which in turn enhances their science identity (Hurtado and Carter, 1997). The analysis indicated that the same is true for the indirect relationship of sense of community and science identity, i.e., science self-efficacy is a significant mediator. The findings are discussed below, along with limitations and directions for future research.

The findings of this study fit within the framework of Bronfenbrenner's Bioecological model (Bronfenbrenner and Morris, 2006), which emphasizes the role that the environment plays in shaping the human experience at all stages of life, including during emerging adulthood (Arnett and Tanner, 2006). Results also support and extend findings of the Meyerhoff Scholars Program's (MSP) positive impact on STEM psychosocial variables (Maton et al., 2016), as well as positive outcomes from similar programs (Atkins et al., 2020; Hernandez et al., 2013; Oseguera et al., 2020; White et al., 2019). The interactive processes that happen in the context of STEM program communities, where individuals are socialized by staff, peers, and faculty, are vital to the learning experience (Bronfenbrenner and Morris, 2006).

With repeated positive interactions, individuals develop a sense of community, which is important in acquiring skills and identity. In the context of the scientific community, where members are expected to have specialized knowledge and skills, the belief that one is capable of performing science contributes to development of identification with science--believing that one is a scientist. The Meyerhoff program community has been consistently reported by Meyerhoff

scholars over the years as one of the most helpful features of the program (Maton et al., 2012). The program's focus on minority achievement, positive representation of race, specifically African Americans in the sciences, and mentorship by faculty, including female of color faculty, have become defining features of the program which students view as extremely important aspects of their Meyerhoff experience (Stolle-McAllister et al., 2011). These features address important challenges facing female students of color pursuing undergraduate STEM degrees. Study groups is a related feature that gives students the opportunity to provide and receive academic help in difficult STEM courses, while enhancing a sense of connection with peers, and has been linked to academic gain in previous research (Gándara and Maxwell-Jolly, 1999). Academic advising from staff, peers, and mentors is important to help students make informed, strategic decisions about the number and type of courses to take (and retake) and which possible research opportunities to pursue (Gándara and Maxwell-Jolly, 1999; Seymour and Hewitt, 1997), and also enhances sense of program community (Maton et al., 2016).

Throughout the program experience, one overarching, contributing factor appears to be a sense of community. It has been proposed as central to the effectiveness of “cohort models” of STEM intervention programs, in which close relationships are developed among students and with staff in a program (Doerschuk et al., 2016; Tsui, 2010). Indeed, one of the primary purposes of a major component of the program, the Summer Bridge, according to Meyerhoff staff, is to develop a “family-like” community atmosphere among students, one in which students provide and receive high levels of support, both academic and psychological, from others. Group cohesion, group accountability, and academic and social integration into the university setting are some of the important benefits of the sense of community developed during Summer Bridge that may enhance student success. The finding supports the notion that sense of community plays

an important role in the academic success and persistence among African-American students in engineering and other STEM majors (Massi et al., 2012). Community fosters a sense of belonging, which, in turn, promotes social integration and facilitates adjustment to campus life.

The current findings suggest that a sense of community influences student outcomes by enhancing characteristics of STEM students to be effective scholars and emerging scientists. The mechanisms through which sense of community contributes to enhanced science self-efficacy and science identity require further empirical study, however. In particular, more detailed investigation of how sense of community and its components such as membership, influence, integration and fulfillment of needs, and shared emotional connection (McMillan and Chavis, 1986) become sources of science self-efficacy may be pursued. Likewise, how science identity is driven by the same elements of sense of community may be examined. In addition, to rule out alternative explanations of the findings, it is a priority for future research to assess at college entry, student levels of science identity and research self-efficacy. Such variables may contribute to sense of community, thus accounting for the observed empirical relationships, and ideally should be assessed and statistically controlled for in future research (Maton et al., 2016).

When examining the role of sense of community among women of color, it is important to emphasize the role of sense of belonging, the latter being a basis for membership, which is a major element of the construct (McMillan and Chavis, 1986). Sense of belonging refers to the extent to which individuals feel like they belong or fit in a given environment (Sax et al., 2018). Studies have shown that when college students have a greater sense of belonging, they are more likely to persist in their majors and graduate (Strayhorn, 2012). Sense of belonging can be characterized as feeling valued, cared about, and connected to the college environment. Indeed, a sense of belonging is crucial among college students of color in STEM, who often encounter

many social challenges that can result in isolation and exclusion. Studies, particularly those in computer science degree programs, have reported women and students of color experience these environments differently due to sexism and racism both historically and as part of the current culture (Barker et al., 2009; Margolis, 2008; Margolis et al., 1999). Furthermore, Sax et al. (2018) examined how gender and race/ethnicity shape the way incoming introductory computing students report their sense of belonging in the field of computing. The study found that sense of belonging among students of color and women's sense of belonging declined over time during the degree completion period.

In sum, sense of community and its accompanying component element, sense of belonging, play important roles in retaining women of color in STEM. Maton et al. (2016) stated that a sense of community encompasses one's sense of belonging to a community as well as one's relationships with community members. When individuals feel that they belong, and perceive a warm and welcoming environment, they might feel seen, heard, and valued. Additionally, McMillan and Chavis' (1986) theory of psychological sense of community makes the point that a sense of belonging, mattering, and integration within a community is a critical component of college environments and, more specifically, STEM programs.

The findings support previous literature on STEM program community having a meaningful effect on science self-efficacy (Beason, 2018; Fencil and Scheel, 2005; Marra et al., 2009; Vogt et al., 2007). Enhanced sense of community, because of engagement in STEM programs' integrative curricular and extracurricular offerings, increases self-efficacy in doing and achieving in science. This includes the high achieving students of color such as female Meyerhoff scholars reporting a stronger sense of community also experiencing higher research self-efficacy. The latter students, due to their belief that they can perform scientific tasks

successfully, value science and choose science as their field of study and as part of their identity (Robinson et al., 2019). The significant indirect effects of sense of community on science identity points to the importance of building self-efficacy via the STEM community as the latter is a mediator toward enhanced science identity (Williams and George-Jackson, 2014). In other words, the path toward increasing identification of female students of color as scientists, which is important for retention and achievement in STEM (Aschbacher et al., 2010), is made possible through an enhancement of self-efficacy in science due to the students' engagement in the STEM community.

7. LIMITATIONS

The current study has several limitations. One is that the psychosocial variables of interest were measured using self-report only. It is possible students who are positively predisposed may report higher levels on all measures. The findings may thus be a function of measurement bias through reliance on self-report measures rather than an indication of causal relationships.

Another limitation is the yet limited predictive validity of the measures of science identity and science self-efficacy. There has not been thorough research looking into the connection between these variables and the major outcome measures for the Meyerhoff Scholars Programs, namely STEM PhD entry and completion. Thus, we still do not know whether those who have enhanced levels of science self-efficacy and science identity are predicted to matriculate in, and complete STEM PhD degree programs. Future predictive studies of these academic outcomes will benefit from the current findings.

This study also included several engineering majors. While members of the Meyerhoff Scholars Program are trained to have the confidence to complete science-related tasks or to

identify as scientists, the items for science self-efficacy and science identity for engineering majors could have been more specific to the knowledge, skills, and attributes that they are expected to acquire in engineering classes or when engaged in engineering research programs. Thus, this may be considered a limitation of the study.

Still another limitation of the study is the relatively small sample size as the measures of both science self-efficacy and science identity were only recent additions to our study protocol. With an increased sample size in the future, a larger number of female African-American students will be available to conduct analyses on this subgroup. There was also a small subset of Latinas in the current study, and an increased number of Latina students may also produce more meaningful findings. With increased sample sizes, we will also be able to investigate the similarities and differences in levels of sense of community, science self-efficacy, and science identity across students of different ethnicities.

Finally, we do not know the generalizability of the findings of the study to programs in other colleges and universities. Programs have their own institutional and sociocultural context that have to be considered by researchers. The Meyerhoff Scholars Program has its own distinct focus, is comprehensive, and benefits from strong institutional commitment across multiple levels of the university.

8. IMPLICATIONS, FUTURE RESEARCH AND CONCLUSION

Despite the study limitations, the findings of this study point to a number of implications regarding practice and policy in training students of color, especially women, in the field of STEM. One implication is the need to define and implement mechanisms to identify talented science majors among women of color who may be feeling isolated to make them part of intervention programs such as the Meyerhoff Scholars Program.

Still another implication is the need for programs to design and integrate activities that highlight shared community, the value of accomplishing scientific tasks together successfully, and building self-efficacy even in small ways. This can be done through peer-oriented engagements that build social capital. Furthermore, university and program policies that encourage community building and group learning that use developmental and empowering approaches among women of color majoring in STEM should be put in place to make sure of the sustainability of practices similar to what the Meyerhoff Scholars Program implements.

While the Meyerhoff Scholars Program is not one exclusively for women of color, more thorough examination of the impact of the program on this subset of scholars is warranted. Among the steps that future researchers may take to further this aim would be systematic comparisons of their experiences across different intervention approaches, their level of program involvement, and engagement in different components, which may include focus groups to collect qualitative data. Study design enhancements should be pursued, such as the use of multiple measures of known reliability and validity to assess each construct, and the use of multiple methods of assessment including from mentors and peers. Ideally, the psychosocial variables need to be assessed, from the start through the end of college, and a comparison sample added to directly compare changes over time on the psychosocial variables of focus. Research is also needed at the university level to examine how student expectations of faculty may have been changing over the years, as more students of color are becoming increasingly engaged in influencing teaching and learning conditions, such as in redesigning courses and mentoring systems.

Finally, a more granular look at the components of the Meyerhoff Scholars Program will provide a broader understanding of how this type of intervention for women of color affects their

academic and professional trajectories in STEM fields. For example, a comparison of those who attend the Summer Bridge versus those who do not will allow us to make more definitive conclusions about the impact of this element of the larger program in fostering enhanced level of sense of community as well as to examine whether the summer bridge experience has long-term effects in terms of enhanced science self-efficacy and science identity.

Enhancing the academic success of female students in STEM fields is an important national priority. It represents a critical part of the U.S. agenda to correct the persistent gender and racial imbalance in STEM fields. Increased understanding of the mechanisms through which STEM programs contribute to positive outcomes among women represents a critical priority for future work.

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APPENDIX

APPENDIX 1: SENSE OF PROGRAM COMMUNITY^a

How much do you agree about the following statements regarding your experience in the Meyerhoff Scholars Program?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
a. I get important needs of mine met because I am part of the ----- Scholars program.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Program members and I value the same things.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. When I have a problem, I can talk about it with members of the program.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. I can trust people in the program.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. I can recognize most of the members of the program.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

f. Most program members know me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. Being a member of the ---- --- Scholars program is a part of my identity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. I have influence over what the program is like.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. If there is a problem in the program, members can get it solved.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. I am with the other ----- Scholars a lot and enjoy being with them.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. I expect to be a part of the program for a long time, even after graduation from -----.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l. Members of the program care about each other.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

^aScale was adapted from McMillan and Chavis (1986).

APPENDIX 2: SCIENCE IDENTITY^b

The following questions ask how you think about yourself and your personal identity. We want to understand how much you think that being a scientist is part of who you are.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
a. I have a strong sense of belonging to the community of scientists.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. I derive great personal satisfaction from working on a team that is doing important research.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. I have come to think of myself as a scientist.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. I feel like I belong in the field of science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. The daily work of a scientist is appealing to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

^bFrom Chemers et al. (2010)

APPENDIX 3: SCIENCE SELF-EFFICACY

This section assesses your confidence in your abilities to function as a scientist in your area. Indicate the extent to which you are confident you can successfully complete the following tasks. Please select the best answer on the scale from (1) not at all confident to (5) absolutely confident.

	Not at all confident	Somewhat confident	Moderately confident	Very confident	Absolutely confident
a. Use technical science skills (use of tools, instruments, and/or techniques)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Generate a research question to answer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. Figure out what data I should collect	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. Collaborate with other scientists	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. Figure out the methods I should use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

f. Show integrity as a scientist	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. Be persistent in seeking an answer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. Be a good lab citizen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. Be open to criticism	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. Be meticulous in record keeping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. Create explanations for the results of the study	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l. Use scientific literature and/or reports to guide research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
m. Develop theories by integrating and coordinating results from multiple studies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

n. Report research
results in an oral
presentation

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