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Improving persistence of underrepresented racial minority science majors: where to begin

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Many colleges and universities are interested in implementing effective strategies to support broaden participation and persistence of undergraduates, and especially underrepresented students, in Science, Technology, Engineering, and Mathematics (STEM) majors. While there are programs and models that have proven successful in this arena, many of these models are extremely resource intensive. This Perspective provides a distillation of key aspects of successful programs that institutions could consider implementing as a starting point when thinking about how to design programs to support students in STEM.

KEYWORDS

STEM persistence, underrepresented and minority groups, graduation and persistence rates, peer mentoring, cohort program, retention

1. Introduction

There is an awakening taking place nationally about the decline in the number of undergraduate students completing majors in Science, Technology, Engineering, and Mathematics (STEM) and embarking on careers in STEM fields. While this decline is a widespread phenomenon, attrition among underrepresented minority (which include African American, Latino/a, Chicano/a, Native American, and Pacific Islander students) students is particularly noteworthy. URM students plan to study in STEM fields at the same rate as majority students but do not graduate at the same rate. According to a report from the National Center for Education Statistics, about 35% (range 32%–52%) of students who enter college in STEM majors leave those majors within 3 years (Figure 1), and for Black/African American students, the rate is 65% due to students dropping out of college or switching majors (Chen, 2013; Leu, 2017). Studies have shown that the difference in persistence rates between URM students and their majority peers cannot be wholly attributed to pre-college academic preparation (Wright et al., 2011; Riegle-Crumb et al., 2019). In fact, more academically accomplished URM students are more likely to leave STEM majors (Rodriguez, 1997; Grandy, 1998; Chang et al., 2011; Hatfield et al., 2022).

There is a need and indeed room for more interventions aimed at closing the gap in URM student persistence in the sciences and capitalizing on the increased awareness that is being generated by the renewed interest in addressing issues of inequity and disparity in various arenas, including in higher education. Instead of creating brand new programs on a blank slate however, an approach that has been put forward by a committee of experts in URM education is to "build on what works," i.e., study and learn from programs that are known, through rigorous assessment, to be succeeding in this area (Estrada et al., 2016; Burt et al., 2023). This approach would reduce unintentional waste of time, effort, and resources.

As a naturalized US citizen and immigrant from Nigeria, my experience as a college student in the sciences was probably very different from those of many of my peers who were US-born and racial/ethnic minorities. My perspective was largely that of an outsider, which tacitly excluded me from many conversations about diversity and inclusion in the sciences as it relates to race and

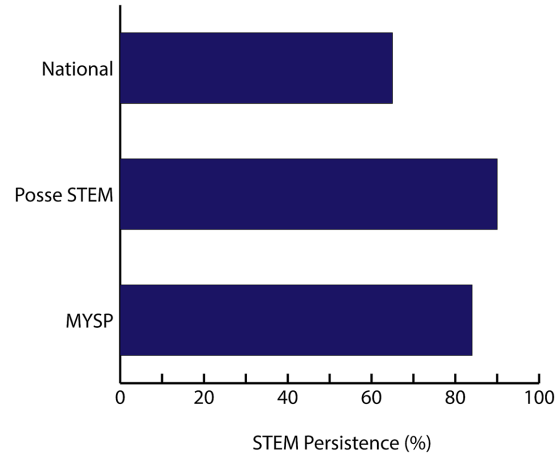

FIGURE 1
Persistence rates of undergraduate STEM majors. National 3-year persistence rate for STEM majors compared to Posse STEM and Meyerhoff Scholars Program (MYSP) graduation rates.

ethnicity in the United States. Additionally, attending a women's college provided some shelter from experiencing many obstacles related to gender. However, as I continued my studies at various predominantly white institutions, I became a witness to and, in some instances, a subject of forces that can contribute to departure from STEM fields, including isolation and poor mentoring (Lee et al., 2020). Now, as a faculty member, I am aware of some of the barriers that impede persistence of undergraduate students of diverse backgrounds on one hand and practices that stimulate persistence on the other. I am committed to contributing to the change that is needed in the ways we support and educate students of all backgrounds in STEM by continuing to engage in activities that enable me to be a better teacher and mentor and that help me be a more informed advocate for program initiatives and conversations within my institution, Northeastern University. This commitment is what led me to propose and pursue this project.

2. Lessons learned from the Posse and the Meyerhoff Scholars Programs

During the summer and fall of 2020, I explored four different institutions that have subscribed to effective models of change. Brandeis University, Wellesley College, Pomona College, and the University of Maryland, Baltimore County (UMBC). My goals were (1) to try to pinpoint the fundamental considerations that contribute to the success of any new program that aims to address the issue of **persistence** of URM students in the sciences, and (2) to offer actionable items that an institution with boundless will but limited resources can implement.

Brandeis, Wellesley, and Pomona are Posse STEM partners. The Posse Program (The Posse Foundation, n.d.) recruits a cohort (Posse) of students from the same geographical location who matriculate together to the same selective college or university. The program provides a robust peer and mentor network that supports the Scholars and enables them to thrive and excel in their studies and as leaders in their institutions. While the flagship Posse Program includes Scholars with interests across all academic areas of study, the Posse STEM Program focuses on students who aspire to studies and careers in STEM fields. As of Fall 2019, 11 institutions, including Brandeis, Wellesley, and Pomona, participated in the Posse STEM Program. I specifically chose Brandeis, Wellesley, and Pomona so that I could observe how a program, Posse STEM, that has unified goals and a defined structure is implemented at different institutions and how elements of the program are adapted to fit the population, culture, and mission of each institution. Brandeis University is an R1 (2018 Carnegie Classification) private institution (similar to Northeastern University), Wellesley is a private, four-year liberal arts, women's college, and Pomona is a private, four-year liberal arts, co-ed college. From 2007 to 2018, the Posse STEM program selected 594 Scholars (73% URM and 54% first-generation students). The current graduation rate for Posse STEM Scholars is 90% (Figure 1), with close to 80% of the program's 105 alumni having graduated with a degree in a STEM field (The Posse Foundation, 2018).

The University of Maryland, Baltimore County (UMBC), a medium size, R2, public institution, is the home of the renowned Meyerhoff Scholars Program (MYSP) (n.d.). MYSP is a long-running program focused on advancing retention and academic excellence of high-achieving URM students in STEM and preparation of the Scholars for graduate and professional studies. Over the 30 years of the program, MYSP (which includes 70.8% URM students) has had an average graduation rate of 84% for STEM majors (Figure 1).

At each institution, I spoke with program directors, faculty affiliates, and program mentors to learn about their experiences—what worked, what did not, and common themes. In the following sections, I describe the findings of my exploration and my recommendations based on those findings.

The Posse Foundation has the following stated goals (The Posse Foundation, 2018):

1. To expand the pool from which top colleges and universities can recruit outstanding young leaders from diverse backgrounds.
2. To help these institutions build more interactive campus environments so that they can be more welcoming for people from all backgrounds.
3. To ensure that Posse Scholars persist in their academic studies and graduate so they can take on leadership positions in the workforce.

The Posse STEM program, which began as a pilot program at Brandeis University, aims to improve retention of underrepresented students in STEM fields by further providing support that addresses some of the unique challenges and goals of students in the sciences. Posse STEM Scholars originate from the same city and matriculate as a cohort, with each cohort consisting of 10 Scholars. Posse provides pre-collegiate training from a strengths-based perspective with no science remediation over the 8 months preceding matriculation and Scholars receive four-year full tuition funded by the institution. The college or university organizes a 10- to 14-day summer immersion program that provides some exposure to college-level work, jump-starts acculturation to the college life at the institution, and fosters a sense of cohesion among cohort members. On campus, each cohort is guided by a mentor, a faculty member or a senior graduate student or postdoctoral fellow. During the first two years, scholars meet with the mentor as a group once every week and individually every 2 weeks. Beginning in their first year, Scholars have the opportunity to participate in academic-year or summer research. The Program identifies faculty, secures these opportunities, and provides funding for Scholars who choose to participate in research. Scholars, faculty, administrators, and

"Posse-Plussers," a small number of non-Posse students invited by Scholars, gather to discuss an important social, cultural, or political issue chosen by Scholars at an annual weekend-long PossePlus Retreat.

In addition to the obvious and tangible benefits to the students and the institution, the impact of the Posse program is far reaching. First, Posse Scholars often transfer what they learn through pre-matriculation training and campus programming to their peers, helping and providing valuable insight to other science students as they navigate the experience of being a science major. Second, the increased visibility and critical mass of underrepresented students is often self-perpetuating—the more diverse the student body, the more diverse the student body will become. Third, exposing faculty and students to more than a token number of high-achieving URM students changes hearts and minds faster than any single diversity training workshop could and contributes to creating a climate of respect that can have implications beyond the institution. To address the question of exclusivity and scale, it is important to point out that, in addition to Posse STEM, all three institutions have other success programs aimed at supporting STEM students that predated or were modeled after Posse STEM.

The Meyerhoff Scholars Program (MYSP) at UMBC is a long-running program focused on advancing retention and academic excellence of high-achieving URM students in STEM and preparation of the Scholars for graduate and professional studies. Over the 30 years of the program, MYSP (which includes 70.8% URM students) has had an average graduation rate of 84% for STEM majors. According to the 2019 Survey of Earned Doctorates from the National Center for Science and Education Statistics (National Center for Science and Engineering Statistics, 2019), UMBC ranks third in the United States for the number of Black or African American undergraduates who go on to complete a Ph.D. and first nationally for Black or African American undergraduates who complete an engineering Ph.D. MYSP has now been replicated at two institutions that are quite different from UMBC—University of North Carolina at Chapel Hill and Pennsylvania State University at University Park—with remarkably similar graduation rate results to UMBC. One of the hallmarks of the MYSP is the strong sense of community and belonging that it provides and encourages Scholars to uphold. Meyerhoff Scholars view their participation with deep and enduring pride and a sense of responsibility for other Scholars. Group work is an integral part of the program. The trajectory of the MYSP at UMBC also speaks to the importance of critical mass and visibility. The more high-achieving URM students were present, the more students *and* faculty recognized that being a member of a racial minority group was not antithetical to high achievement in STEM, the more welcoming the climate felt for URM students, and the more URM students were attracted to and thrived at UMBC.

3. Recommendations for improving STEM persistence

The premise of this project is that persistence and excellence go hand in hand. An equity-driven culture within the sciences—fostered by faculty *and* students—is a critical factor in the performance and retention of all undergraduate students, but particularly for students from traditionally underrepresented groups (Wilson et al., 2012; Dagley et al., 2016; Crawford et al., 2018; Burt et al., 2023; Lytle and Shin, 2023). I was able to distill out some key recommendations that, if implemented with deliberate, collective, and sustained effort, could enable an institution to make significant improvements in its culture, which in turn should translate to an improvement in our retention rates. The five key recommendations are:

1. Increase representation of URM students to achieve critical mass.
2. Improve access to and mentoring by faculty.
3. Improve access to collaborative learning and social connection within a positive supportive peer group.
4. Provide more opportunities to conduct scientific research as early as possible.
5. Conduct a thorough and impartial analysis and revamp, as needed, gateway courses to lower the barriers that students currently perceive or experience.

The question of how to achieve critical mass and increased representation is probably one that is slightly beyond the scope of this perspective but critical to the success of any effort aimed at addressing the retention issue by directly targeting the problem of isolation and stereotype threat that leads many URM students to exit the sciences. The constitution and learning environment at many Historically Black Colleges and Universities (HBCUs) and Minority Serving Institutions address at least the first three of the aforementioned recommendations (Chang et al., 2008; White et al., 2019). Scholars Programs, like Posse, MYSP, or similar highly resourced cohort programs are excellent opportunities that would go a long way to addressing at least the first four recommendations at PWIs while also serving to bolster a sense of science self-identity that is critical to persistence in STEM (Wilson et al., 2012; Dagley et al., 2016; Crawford et al., 2018; Thompson and Jensen-Ryan, 2018; Chen et al., 2021).

With fewer resources, a "Science Scholars" program with clearly defined goals, expectations, potential benefits, and robust oversight—that inherently targets minority, first generation, and lower socioeconomic status students, but could be open to any student, should be considered. Such a program would be presented as an honor to participants. The aspiring scientists who are selected for this Science Scholars program would be

- provided with financial support in the form of tuition, course credit, research stipends, or combinations thereof;
- assigned to fixed cohorts;
- required to attend a summer bootcamp that is not focused on academic remediation but on building familiarity, community, and insight into life as a STEM major;
- mentored by faculty or experienced graduate students or postdoctoral fellows who are dedicated, trained, and incentivized;
- provided with (maybe guaranteed) opportunities for first year/second semester introduction to research to start developing their scientific identity and to be visible to faculty. This could be an impetus for teaching faculty to incorporate more course-based research assignments and projects into their courses.

With even fewer resources, two potentially high-impact interventions can take advantage of existing expertise, resources, and framework, and bolster current efforts to make the culture of learning and excellence in the institution more inclusive and equitable.

1. **Foster an inclusive learning climate among students**. The impact of an inclusive learning climate on retention in STEM undergraduate courses, especially foundational courses, has

been noted (Haak et al., 2011; Tanner, 2013; Audette et al., 2023). Creating an inclusive climate should involve bolstering students' awareness of their role in contributing to achieving this goal. Some students are often not aware of challenges that some of their peers might be enduring and may say or do things (or *not* say or do things) that inadvertently exacerbate the negative experiences of their peers. To help foster an increased awareness of the importance of an inclusive learning culture among students, I propose, among other things, a mobile-building workshop for **students**, similar to that offered in Northeastern University's erstwhile HHMI NU-SCI Inclusive Teaching Program (Howard Hughes Medical Institute, 2017) for faculty, to encourage awareness of and an honest discussion of privilege and assets. This workshop is a hands-on single-session activity that highlights the potential impact of access to resources (or lack thereof) and how one's background and self-perception can shape one's experience (Tanner, 2013; University of Chicago Race and Pedagogy Working Group, 2019). The activity helps participants appreciate subtle, non-traditional, but high impact, factors that can contribute to academic success, e.g., asking for help.

2. **A peer mentoring and study group program.** In almost every conversation I had with faculty, staff, and students for this project, the importance of a positive, supportive peer study group arose. Indeed, studies have shown that quality peer mentoring can contribute to increased persistence of URM STEM students (Kiyama and Luca, 2013; Brown et al., 2023). Interestingly, the positive impact of these peer groups extends beyond the students who join the groups. Students who do not participate witness that their peers are resilient, diligently working together, supporting each other, and excelling, and may become aware of their own behaviors or beliefs surrounding ability, meritocracy, and equity. At the same time, faculty members witness that more experienced URM students are willing and able to serve as effective mentors to younger students, which can help perpetuate a cycle of encouragement and recognition (from faculty) and achievement (from students). Because presence and visibility can be immensely impactful, the peer mentors should aim to visit first-year classes as a group at the beginning of the semester to make an announcement and get students in the course excited about the resource. This peer support program would be designed in such a way that it is seen as an honor to participate as a mentor and is attractive to the student who would otherwise take another job, not consider being a peer mentor, or traditionally not get asked to be a peer mentor. The program would need dedicated space where students can meet either for study or social activities and some financial support to pay the peer mentors and purchase refreshments as needed. Peer mentors would be carefully selected by targeting (to secure a meaningfully diverse group of peer mentors) and through an open application process. To be rigorous, adaptable, and sustainable, this program would likely require oversight and administration by a dedicated part-time or full-time employee with a Ph.D. in the sciences, a passion for mentoring undergraduates, and who identifies/is identified as a racial minority in the US, specifically Black, Latino, Native American, or Pacific Islander.

4. Summary

The aim of this project was to learn from non-minority-serving institutions that have high rates of participation, persistence, and graduation of URM students in STEM through the implementation of excellence programs, including Posse STEM and the Meyerhoff Scholars Program. The specific goal of the project was to explore the common characteristics of the programs that contribute to student success and what other colleges could learn from these programs to begin to address the disparities in retention and graduation rates of our URM undergraduate students. The conclusion of the project is that the key contributors to persistence in STEM include significant representation of URM students to achieve critical mass, a supportive community, and early immersion in scientific research, and that this process can begin with a low-resource intensive strategy like a robust peer mentoring and study program featuring a high number of URM students.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

OO: Conceptualization, Funding acquisition, Investigation, Writing – original draft, Writing – review & editing.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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