Achieving Diversity at the Intersection of STEM Culture and Campus Climate

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INTRODUCTION

Organizations throughout the United States have invested millions of dollars in science diversity programs intended to increase diversity and shift demographic patterns in science, technology, engineering, and math (STEM) fields. While in most cases the needle has moved in the right direction, most students of color continue to be underrepresented: over a third of Black, Native American, and Latino students begin college interested in studying STEM, but only 16 percent obtain bachelor's degrees in these fields (National Center for Science and Engineering Statistics 2017).

Part of the problem is that practitioners, thought leaders, and policymakers have two separate conversations when attempting to increase STEM diversity: one is focused on STEM culture and the other is focused on campus culture. But the most effective approach happens when higher education works to improve both STEM culture and institutional climate at the same time. By unifying these two conversations, we can cultivate more inclusive learning environments for students of color through integrated interventions that simultaneously address the culture of STEM and the wider climate of the campus community.

THE DIVERSITY IMPERATIVE

Numerous policy reports, thought pieces, and journal articles have argued that increasing the representation and inclusion of underrepresented minority populations will significantly benefit the scientific enterprise. First, diversity leads to better thinking and better research. Diverse teams are better able to innovate and problem solve, developing better solutions to enduring, complex scientific problems (Gibbs 2014; Hong, Page, and Baumol 2004; Phillips 2014). Diverse voices and perspectives can also mitigate bias and groupthink, challenging commonly held assumptions that may not apply broadly across all communities, and proposing different perspectives on how data can be interpreted (Intemann 2009).

We cannot move the needle and increase diversity in science without addressing the systemic challenges minority students face on their paths into and through higher education.

Increasing diversity will also better position the United States to meet national and global science workforce needs. The National Science Foundation's Committee on Equal Opportunities in Science and Engineering (2013), the National Institutes of Health (Valentine and Collins 2015), and the National Academies (2011, 2017, 2019) have called attention to the demand for a domestic scientific workforce—a demand that will be impossible to meet without broadening participation of minority groups.

For these reasons, national and private organizations have invested millions of dollars in science diversity programs designed to shift patterns of representation in STEM in and beyond college. These strategies have largely focused on increasing students' interest in science, cultivating academic and research skills, providing mentorship, and developing a science identity. But we cannot move the needle and increase diversity in science without addressing the systemic challenges minority students face on their paths into and through higher education (Asai 2017; Fox, Sonnert, and Nikiforova 2009). To wit: programs that increase diversity in science by focusing on remediation and environmental adaptation are notably less successful than programs that address the barriers within the larger culture of science and traditional ways of identifying talent (Fox, Sonnert, and Nikiforova 2009).

To address this challenge, thought leaders, policymakers, and practitioners have engaged in two largely separate conversations. One conversation has focused on the culture of science, specifically noting how exclusionary norms and values translate to an unwelcoming environment in STEM classrooms, laboratories, and departments (e.g., Carlone and Johnson 2007; Hurtado et al. 2009; Fox, Sonnert, and Nikiforova 2009). The other conversation has turned to college and university campuses more broadly, unpacking how inconsistent institutional commitments to diversity and inclusion, acts of discrimination, and microaggressions in academic and nonacademic spaces translate to hostile climates for women and men of color (e.g., Ancis, Sedlacek, and Mohr 2000; Harper and Hurtado 2007; Museus, Nichols, and Lambert 2008).

Most studies that examine campus climate do not explicitly focus on STEM students, and few studies of STEM students acknowledge the larger campus climate to which students are exposed. But efforts to increase diversity in STEM departments and programs will not be successful if students experience the larger campus community as hostile and discriminatory. Similarly, a campus that is diverse and inclusive but has science departments and programs where women and men of color are underrepresented, unwelcome, and unrecognized will not be able to move the needle on STEM graduation rates and entry into the science workforce.

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THE IMPORTANCE OF STEM CULTURE AND CAMPUS CLIMATE

While each science discipline is unique, scholars suggest that there are norms and values that predominate science departments and programs, creating an overall culture that is consistent across STEM fields (Blickenstaff 2005; Golombisky 2011; Subramaniam and Wyer 1998). The likelihood of success in science increases when students understand and adopt these norms and values, rooting their identity in the field (Jones, Ruff, and Paretti 2013). Moreover, studies have found that programs addressing the whole student bring added success. Early exposure to research and mentored experiences, for example, may be particularly important in supporting students as they develop their competency as scientists. This practice has been linked to minority students' retention in science majors (Chang et al. 2014; Espinosa 2011), development of research skills (Byars-Winston et al. 2015), and enhanced science career knowledge and aspirations (Byars-Winston et al. 2015; Hurtado et al. 2009).

Researchers also suggest that students from underrepresented minority backgrounds (Chang et al. 2014; Palmer, Maramba, and Dancy 2011), and women of color specifically (e.g., Espinosa 2011), are more likely to be retained in science and engineering programs if they have opportunities to discuss and deeply engage in STEM course content with peers, participate in undergraduate research, and join clubs and organizations related to science. Programs successful in recruiting and retaining women in science noted the importance of opportunities to develop deeper understandings of and connections to science through living-and-learning programs, broad mentoring, and opportunities to work closely with faculty in hands-on science experiences. These programs are successful because they foster broader access to and retention in science—going beyond a focus on competence and skill. They aim to build deeper connections to the field through opportunities to perform and be recognized as scientists, cultivating a broader science identity.

While campus climate can be useful for understanding how minority populations experience their environment, it is often misunderstood or confused with other concepts. For example, the term climate is often used synonymously with the culture of a campus or a discipline. These ideas are similar in that they both focus on the impact of context; however, culture is more enduring and reflects an organization's deeply embedded values and beliefs, which often unconsciously shape interactions, expectations, and interpretations of events (Kuh and Whitt 1988; Peterson and Spencer 1990). While climate is difficult to change and is often informed by the institutional culture, it is considered more malleable and subject to the current events within and outside of the institution (Hurtado et al. 1998; Peterson and Spencer 1990).

Somewhat separate from the conversations about diversity and inclusion in STEM, higher education scholars and practitioners have long been in conversation about how campus climate influences the experiences and outcomes of minority college students (see Griffin 2017; Harper and Hurtado 2007 for reviews). Decades of research suggest that negative experiences and perceptions of climate translate to lower rates of academic achievement, retention, and success (Hurtado et al. 2012). While these findings are true for students across race and gender, climate can have a particularly strong impact on the retention and academic success of students from minority populations (Harper and Hurtado 2007).

Early work on climate focused on the experiences of women, noting how persistent encounters with stereotypes rooted in sexist beliefs, harassment, and marginalization translated to diminished quality in their educational experiences, leaving women to perceive the climate as more "chilly" than their male classmates (e.g., Crawford and MacLeod 1990; Hall and Sandler 1982). Students of color generally, and Black students in particular, rate the climate as more hostile than their peers (e.g., Ancis, Sedlacek, and Mohr 2000; Fischer 2010; Harper and Hurtado 2007; Museus et al. 2008; Rankin and Reason 2005), and interestingly, women are more likely to perceive a negative racial climate than men (Rankin and Reason 2005).

While these issues are often discussed separately, the challenges that minority students face within STEM departments and programs, and on predominantly White campuses more generally, ultimately converge and can have an aggregative effect on student success and our collective efforts to promote diversity and inclusion. An inclusive campus climate may mean that students feel a sense of belonging institution-wide, but if they feel a lack of recognition as a scientist or fit with the culture of STEM, they will still be less likely to complete a science degree. Further, science students live and learn in the larger campus community and must feel welcome and supported in the larger environment to stay at the institution and in the field.

UNIFYING STEM CULTURE AND CAMPUS CLIMATE

Several scholars have begun to address how spaces outside of STEM departments and academic programs can facilitate students' science outcomes, with an initial focus on living-and-learning programs.

- Szelényi and Inkelas (2011) found that women participating in women-only, STEM-focused living-and-learning programs were more likely to report interest in graduate programs in science as compared with their peers living in coeducational STEM living-and-learning environments, living-and-learning programs overall, and traditional residence halls. Regardless of their residence, being exposed to a socially supportive residence hall climate was related to STEM graduate school plans.

- Somewhat similarly, Soldner et al. (2012) note that participating in living-and-learning programs had an indirect effect on students' self-reported likelihood of completing a STEM degree, due to access to social supports like academically and socially focused peer conversations, interactions with faculty unrelated to course content, and perceptions of academic and social support.
- According to Johnson (2011), STEM women participating in living-and-learning programs reported more positive perceptions of campus climate. Johnson (2011, 2012) has also engaged in studies of STEM majors, specifically exploring how their perceptions of campus climate relate to their sense of belonging. In one study, Johnson (2012) found that women of color reported lower levels of belonging than their White peers; however, supportive academic and social climates in their residence halls and more positive overall perceptions of climate were related to higher rates of belonging. Johnson notes that this is particularly important, given that "the lack of racial and ethnic diversity in STEM departments in predominantly White institutions may elevate the salience of the campus racial climate for women of color in these majors. Positive perceptions of the broader campus racial climate may combat the negative racial climate in STEM described by women of color and support their racial and ethnic identity development" (342).

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As these studies show, programs that support students of color in multiple spaces simultaneously are far more effective than one-dimensional approaches. For too long, higher education has focused on "fixing" students, developing programs and strategies that help students perform well in inhospitable environments without addressing the challenges presented by campus environments that exclude and marginalize rather than include and affirm (Asai 2017; Fox, Sonnert, and Nikiforova 2009). Instead, institutions must turn their eyes to their own structures, policies, and practices to facilitate change.

RECOMMENDATIONS TO MOVE FORWARD

First, institutions must develop holistic initiatives that center on the unique needs and challenges facing minority students. Rather than focusing solely on academic skill development and performance, pushing students to conform with existing science norms and values, these programs address students' academic and psychosocial needs.

The Meyerhoff Scholars Program (MSP) at the University of Maryland, Baltimore County (UMBC) is a well-regarded example of this kind of programming and has been offering high-achieving students from minority backgrounds comprehensive support as they pursue degrees in STEM since 1988. Meyerhoff scholars are admitted and recruited to UMBC with a full scholarship and participate in a highly structured program that includes a summer bridge program, advising and mentoring, tutoring, and research opportunities (Stolle-McAllister, Domingo, and Carillo 2011). MSP also emphasizes community and shared values, promoting sense of belonging through participation in community service, living in the same residence hall during their first year, and the establishment of intentional connections to other MSP cohorts (Maton

et al. 2012). Multiple studies confirm that the combination of an affirming culture, family atmosphere, and academic support MSP provides have a positive impact on student success. When compared with similar students not enrolled in MSP, Meyerhoff scholars not only earn better grades and complete STEM undergraduate degrees at higher rates, but also are more likely to enter and complete science graduate programs (Maton et al. 2012).

An institution does not need the same resources or infrastructure as MSP to develop holistic diversity and inclusion programs on its campus. In fact, Kezar and Holcombe (2017) argue that campuses do not necessarily need more STEM programs to better serve a diverse student body and increase equity; rather, they needed existing support to be better coordinated through institution-wide partnerships. Academic affairs (which may be more focused on addressing STEM culture) and student affairs (which may be more focused on campus climate) often work in isolation, leading to the development of a multitude of programs serving small student populations (Kezar and Holcombe 2017). Working separately and in isolated silos leads to missed opportunities to share knowledge and resources, making it more difficult to develop the holistic communities of support that benefit students the most. Therefore, institutional leaders must thoroughly assess how many initiatives addressing STEM culture and campus climate are already in existence, create formalized means of communication and collaboration across interventions, and offer administrative and financial resources to support the time and labor these collaborations require.

Second, campus leaders must intentionally consider unique contexts as they develop policies and programs to promote diversity in STEM. Institutions can and should refer to highly regarded best practices. However, these practices should be used as a starting point and adapted in ways that address the unique challenges and needs of each department, college, and campus.

Kezar and Holcombe (2017) assessed the effect of high-impact programs implemented through the California State University (CSU) STEM Collaboratives. Eight CSU campuses received funding to implement three integrated, high-impact practices: a summer experience, first-year experience, and redesign of introductory STEM coursework. Each campus developed programs that fit within these broad categories but was mindful of the unique needs of the student body (Kezar and Holcombe 2017). For example, CSU Dominguez Hills offered multiple short-term summer bridge sessions in a class format, meeting for a few hours multiple times a week to support students regardless of preparation for STEM. This strategy reflected its needs as a commuter campus serving a large population of first-generation, low-income students of color with diverse levels of preparation in math and science. Humboldt State, which is a more residential campus with a larger population of full-time students, created and implemented four-day summer immersions at the Klamath River. The river was then integrated in various ways throughout first-year curriculum. While both Dominguez Hills and Humboldt were implementing similar high-impact practices, they critically assessed their strengths, challenges, and students' needs before creating their programming, allowing the programs to be more successful.

Third, leaders must acknowledge the critical role of faculty in the success of diversity and inclusion initiatives (Fox, Sonnert, and Nikiforova 2009). In addition to shaping students' access to content knowledge through classroom and laboratory interactions, faculty and their biases and beliefs about minority students and their abilities can influence the students' overall experience (Museus and Jayakumar 2012; Pascarella and Terenzini 2005). Further, faculty serve as gatekeepers, determining the next generation of scientists through their roles as teachers, mentors, and decision makers in admissions and faculty hiring (Griffin and Muniz 2015; Posselt 2016). As they engage in these activities, faculty often unwittingly convey the norms and practices that are seen as valuable within STEM disciplines. When faculty draw on these dominant disciplinary

values, they narrowly frame what it means to be a scientist and miss science talent and potential in their minority students (Carlone and Johnson 2007; Gardner 2008; Griffin and Muniz 2015).

To address these concerns, institutions have increasingly implemented programs targeting the science curriculum and faculty pedagogy, creating opportunities to learn about how implicit bias and stereotypes create hostile environments that challenge rather than affirm science identity. Unfortunately, institutional leaders note that faculty can be difficult to engage in these efforts, and participation is often inconsistent. While there are certainly exceptions, I would argue that most faculty are not overtly against seeing more minority students in science; however, many express discomfort with and opposition to strategies, programs, and initiatives that, in their minds, run counter to scientific norms and values.

Further, there is little incentive to invest time and energy in equity and inclusion-based initiatives that help institutions make progress on their diversity goals. Faculty-reward structures rarely acknowledge or encourage inclusive practice, instead emphasizing other metrics like scholarly productivity or consistently high teaching evaluations (Tapia, Lanius, and Alexander 2003). Thus, as institutions aim to improve the STEM culture and campus climate, it is critical to not only offer training opportunities, but also properly reward and incentivize participation to encourage engagement. Offering supplemental grants and summer salary, course or time releases, or renegotiated engagement in other professional activities may encourage participation in more inclusive practices. Leaders can also consider how to do more to visibly recognize investment in this work with prestigious awards or endowed professorships, highlighting how diversity and inclusion align with institutional goals and benefit the scientific enterprise.

IN CLOSING

A critical examination of how minority students' experiences are simultaneously rooted in STEM disciplinary norms and broader campus climates creates new opportunities to develop innovative interventions that may make greater progress in addressing persistent barriers to retention and success. Promoting students' sense of belonging and validating their identities inside and outside of science classrooms holds great promise for promoting more equitable outcomes for all and hastening our progress toward a STEM community of scholars that more closely resembles the diversity of our nation.

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