# Overcoming Barriers in Access to High Quality Education After Matriculation: Promoting Strategies and Tactics for Engagement of Underrepresented Groups in Undergraduate Research via Institutional Diversity Action Plans

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## Abstract

Considerable work is still required to eliminate disparities in postsecondary STEM persistence and success across student groups. Engagement in faculty-mentored research has been employed as one strategy to promote personal, professional, and academic gains for undergraduate students, although barriers exist that make it more difficult for some to participate than others. In this article, we highlight three guiding strategies for structuring institutional diversity action plans that will help ensure equitable access to undergraduate research experiences. Relevant to these three strategies, we propose five specific tactics that educators and institutional leaders will find attainable in relatively short time frames, in addition to a questionnaire for institutional self-assessment related to these tactics. By following the recommendations outlined in this article, and thereby establishing an infrastructure for equitable access to undergraduate research experiences, we assert that institutions can begin to close educational achievement gaps, meet growing U.S. workforce demands, and uphold the democratic ideals of higher education.

## Introduction

In 2012, the President's Council of Advisors on Science and Technology reported that, in addition to maintaining our current rate of entry into STEM professions, the United States will require an additional one million STEM professionals over the next ten years to uphold the nation's reputation for excellence in science and technology. The Council recommended increasing the number of students receiving STEM undergraduate degrees by an annual rate of 34% to reach this goal (President's Council of Advisors on Science and Technology, 2012). Policymakers and researchers alike recognize that fostering excellence and promoting diversity in STEM fields go hand in hand (Hong & Page, 2004; Page, 2008) and prioritize an increase in the representation and success of students from groups traditionally underrepresented in STEM (Hurtado, Newman, Tran, & Chang, 2010), including students of color, students who are low-income, women, and first-generation college students. Considerable work is still necessary towards building more diversity in STEM. In 2012-2013, only 16% (n = 290,000) of bachelor's degrees were awarded in STEM fields in the U.S. (National Center for Education Statistics, 2016). In 2012, students that identified as Hispanic, Black, and American Indian/Alaska Native remained underrepresented in U.S. science and engineering bachelor's degree programs when compared to their respective percentages of the national college-age population; that is, students that identified as Black, Hispanic, and American Indian/Alaska Native earned 8.8%, 10.3%, and 0.6% of science and engineering bachelor's degrees while they were 15%, 21%, and 0.9% of the college-age population, respectively (National Science Foundation, 2014).

National, state, and foundation initiatives (e.g., the Obama Administration's *2020 College Completion Goal* [Kanter, Ochoa, Nassif, & Chong, 2011] and *College Completion Toolkit* [U.S. Department of Education, 2011], as well as Lumina's "*big-goal*" [Lumina Foundation, 2008]) have renewed attention in increasing college completion and prompted postsecondary institutions to develop strategies that will reduce disparities in persistence and enhance student success overall across student groups (Russell, 2011). Recent years have shown a proliferation of advocacy for the use of "high-impact practices" to help students, especially those from underrepresented groups, overcome barriers that obstruct student success and lead to attrition in STEM. High-impact practices, as defined by Kuh (2008), are largely equated with active learning practices (e.g., learning communities, service learning, first-year seminars, study abroad, undergraduate research, and other forms of project-based learning). These practices are effective in promoting gains in GPA and persistence for all students because they demand a high degree of student involvement, allow for immediate feedback to students regarding their performance, encourage students' interactions with diverse cultures and situations, and promote meaningful exchanges between students and faculty and peers over time (Adedokun et al., 2014; Clarke, Flaherty, Wright, & McMillen, 2009; Kuh, 2008; Morgan & Streb, 2001; Starke, Harth, & Sirianni, 2001). Although disproportionately large, positive effects have been documented for students from traditionally underrepresented groups who participate in high-impact practices when compared with majority students, historically underrepresented students (namely first-generation and African American students) have been less likely to engage in these practices than other groups (Kuh, 2008).

Despite progressive education reforms aimed at expanding postsecondary access (e.g., affirmative action and in-state tuition for undocumented students in select states), many students still struggle to gain equitable access to quality experiences after matriculating into a higher education institution. It is possible the disparity in involvement in high-impact practices is a result of social, academic, and structural barriers that exist for students underrepresented in postsecondary institutions. For example, Huber (2010) describes one first generation, low-income student who was unable to apply for state- and federally-funded campus undergraduate research programs because of her undocumented status. This disparity in access may be exaggerated as students from traditionally underrepresented groups continue to find themselves entering a system designed for groups possessing most societal power (Rendón, Garcia, & Person, 2004). Social barriers also include racial and gender bias that create unwelcoming social climates in STEM and undermine identification with a STEM field (Carlone & Johnson, 2007; Ong, 2005). Moreover, first-generation college students' social positioning can limit their access to key information and resources important for securing opportunities to engage in high impact practices (Martin, Miller, & Simmons, 2014).

In addition, students of color sometimes face academic barriers in college that stem from the disparity in financial resources, high-quality curricula, computer/internet access, and availability of qualified teachers during their years in the pre-college educational system (May & Chubin, 2003). These factors indicate that academic barriers have more to do with the opportunity structure than academic potential. As such, this can become especially problematic when high impact learning experiences are distributed based on academic merit.

Indeed, both social and academic barriers are inextricably connected to structural issues (Hurtado, Alvarez, Guillermo-Wann, Cuellar, & Arellano, 2012; Smedley,

Myers, & Harrell, 1993). Among these structural concerns are institutional rewards that discourage faculty engagement with diversity (Tuckman, 1979) and the underrepresentation of faculty of color and women faculty in STEM (Towns, 2010), especially since faculty of color and women faculty more often provide support to underrepresented students (Schwartz, 2012). Another salient structural barrier is that tuition prices at four-year institutions in the U.S. have increased at a faster rate than student aid programs and median family income (Delaney, 2014; Perna & Finney, 2014), forcing many financially insecure students to work during college. This added time commitment can detract from a student's involvement on campus and inhibit opportunities to seek support from professors and peers outside of class (Foor, Walden, & Trytten, 2007). These are just a few examples from a long list of barriers that students from underrepresented groups face within higher education institutions that cause inequities in access to high impact practices.

With these considerations in mind, we frame this paper around the importance of equity when promoting access to undergraduate research experiences. First, let us make a clear distinction between practices that promote *equity* – intentionally redirecting resources to support and to alleviate institutionalized barriers that adversely impact groups of students who are historically underserved – and practices that promote *equality* - providing equal resources for all students. While the former practice attempts to close opportunity gaps that exist between groups of students, we contend that the latter allows disparities in access to opportunities to persist. An important distinction is that equity strategies are informed by a contextual understanding of inequities as shaped by a history of discrimination and exclusion (Bensimon, 2005). We call on a broad audience of policy makers and leaders in education and industry to enhance access to transformational postsecondary experiences for historically underserved students through equity strategies, to promote the redirection of resources to those who have historically been dispossessed of them in order to alleviate barriers and enhance access.

## Institutional Diversity Action Plans to Support Access and Retention

Preventing underrepresented students from leaving higher education institutions is a major policy concern (Perna & Jones, 2013). Clewell and Ficklen (1986) note that, "from a policy perspective, the most important issue is not merely why [underrepresented] students drop out, but what can be done to prevent withdrawal" (p. i). The implementation of best practices for retaining students will look different across institutions, as each has its own set of priorities and challenges. While improving student success requires commitment from multiple stakeholders (e.g., federal, state, and institutional leaders, and policy makers; Perna & Jones, 2013), each college or university can work to address challenges and advance strategies for preventing attrition of students from traditionally underrepresented groups. The advancement of retention strategies is often attempted via formal university structures and related processes.

Iverson (2012) details structures and processes for advancing diversity-related strategies within postsecondary institutions. Campus officials may assemble a council to investigate issues associated with diversity (e.g. attrition of underrepresented students, discriminatory practices and policies). This diversity council may then produce official documents that are used to advance and guide policies for promoting an inclusive campus. These "diversity action plans" (p. 150) can provide a roadmap of strategies for promoting and supporting campus diversity and inclusion.

Unfortunately, diversity action plans and related initiatives have been criticized as ineffective towards building and sustaining inclusive campuses (Iverson, 2012), with some pointing to the existence of persistent inequalities as evidence that these plans have had little impact (Chang, 2002). Indeed, it seems that diversity action plans may primarily serve a symbolic role within intuitions (Clayton-Pedersen, Parker, Smith, Morena, & Teraguchi, 2007; Iverson, 2012), with little obvious impact on meaningful stakeholder action (Boyd, 1991). In an Association of American Colleges and Universities (AAC&U) report, Clayton-Pedersen et al. (2007) caution, "just having this commitment reflected in the mission is not enough to mobilize constituents to engage in comprehensive diversity work" (p. 26). If diversity action plans are to be effective, institutions must create the architecture for campus inclusivity through specific structures and strategies that can be implemented in realistic contexts.

### Institutional Structures and Strategies

The potential success of institutional diversity action plans may lie in how well they sync with other strategies and structures on campus. Clewell and Ficklen (1986) investigated programs with various types of activities at four predominately white institutions that have been effective in retaining students from underrepresented groups to identify characteristics that have contributed to their success. Characteristics similar across these institutions included "the presence of a stated policy on minority enrollments; a high level of institutional commitment; a substantial degree of institutionalization of the program; comprehensiveness of services; dedicated staff; systematic collection of data, monitoring, and follow-up; strong faculty support; and non-stigmatization of participants" (p. i). They highlight the importance of marrying institutional policy with programs that support diversity towards creating effective retention efforts and offer a policy-driven model for developing effective retention programs for students underrepresented within postsecondary institutions.

In the model proposed by Clewell and Ficklen (1986), institutional leaders first make policy decisions to support enrollment and retention of underrepresented students. Second, institutional leaders outline a plan to implement this policy and generate a policy statement with enumerated goals. Third, they create, implement, and monitor a policy-driven retention program. Finally, they evaluate the retention program and use outcomes to inform future needs assessment. In this paper, we use this model as a framework for specific tactics concerning steps two and three towards retention of students from underrepresented groups. We begin by detailing a targeted review of literature concerning promoting postsecondary STEM success and persistence for students from underrepresented groups. We specifically advance ways to foster more equitable access to one specific, "high-impact" strategy, the undergraduate research experience, shown to be a practice of promise for gains in success and persistence for students from groups underrepresented in STEM who engage in them (Lopatto, 2010; Thiry & Laursen, 2011).

## The Characteristics and Benefits of Undergraduate Research

While there may be different notions of what constitutes an undergraduate research experience, Laursen, Hunter, Seymour, Thiry, & Melton (2010) describe the model of undergraduate research experience that we adopt for this article, namely as having the following features: 1) students investigate an authentic research question that is specifically tailored to the student's ability, timeframe, and interests and is integrated into the area of interest of the faculty mentor; 2) the project continues across multiple weeks, is used as a teaching tool and exposes students to the challenges of research; 3) the student receives individualized mentoring by a professional role model; 4) the student becomes part of a research peer community; and 5) the student gets practice with scientific communication.

This definition, which is based on characteristic payoffs as well as the typical structures of such experiences, alludes to the benefits of such experiences documented in scholarly literature. Numerous scholars report that undergraduate research experiences lead to considerable personal, professional, and academic gains for students (Lopatto, 2003, 2007, 2010; Seymour, Hunter, Laursen, & DeAntoni, 2004; Zydney, Benett, Shahid, & Bauer, 2002). A growing body of literature more specifically elucidates the effect of these experiences for students from underrepresented groups. Thiry & Laursen (2011) found that interactions with research mentors led to gains in confidence and a better understanding of educational and career possibilities for African American and Hispanic students. Other studies have reported that undergraduate

research experiences provide opportunities for developing a science identity for women of color (Carlone & Johnson, 2007) and increasing retention rates for African American and Hispanic students (Jones, Barlow, & Villarejo, 2010; Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998). In one investigation of an undergraduate research program designed for students underrepresented in STEM, participants (in comparison to non-participants) were shown to graduate faster with higher GPAs, were more likely to graduate with a science degree, and to enter a science graduate program (Slovacek, Whittinghill, Flenoury, & Wiseman, 2012). Given the promise documented above, one might argue that such experiences should be available for all undergraduates, and especially those from groups underrepresented in STEM fields. Yet, significant social, academic, and structural barriers like those previously outlined above remain, preventing widespread participation in undergraduate research experiences.

## Strategies and Institutional-Level Tactics to Promote Equitable Access to Undergraduate Research

Promoting equitable access to undergraduate research experiences requires a commitment to inclusive excellence that reaches every corner of a postsecondary institution (Clayton-Pedersen et al., 2007), including the bases and impacts of institutional diversity action plans. Informed by our targeted literature review, and based on our experience with programming meant to foster more equitable access to successful undergraduate research experiences, we highlight three guiding strategies for structuring institutional diversity action plans that will help ensure equitable access to undergraduate research experiences: faculty professional development, institutional programming for students, and curricular reform (Figure 1). Alongside an enhanced review of relevant scholarly literature, we now describe these strategies and propose a set of five tactics that we recommend as part of diversity action plans.

### Faculty (and future faculty) professional development towards enhancing commitment to supporting undergraduate researchers from underrepresented groups

Without a commitment from well-educated faculty, ensuring equitable access to undergraduate research is very unlikely. Faculty are the gatekeepers to these opportunities and shape a student's experience while engaging in undergraduate research (Campbell & Skoog, 2008; Zydney et al., 2002). Expanding access to undergraduate research experiences requires educating individual faculty about the impacts of traditional selection criteria and cultural competency as it relates to research.

*Tactic #1: Create programming and incentives for research faculty to learn about and utilize more holistic measures of selection criteria when accepting undergraduate researchers.*

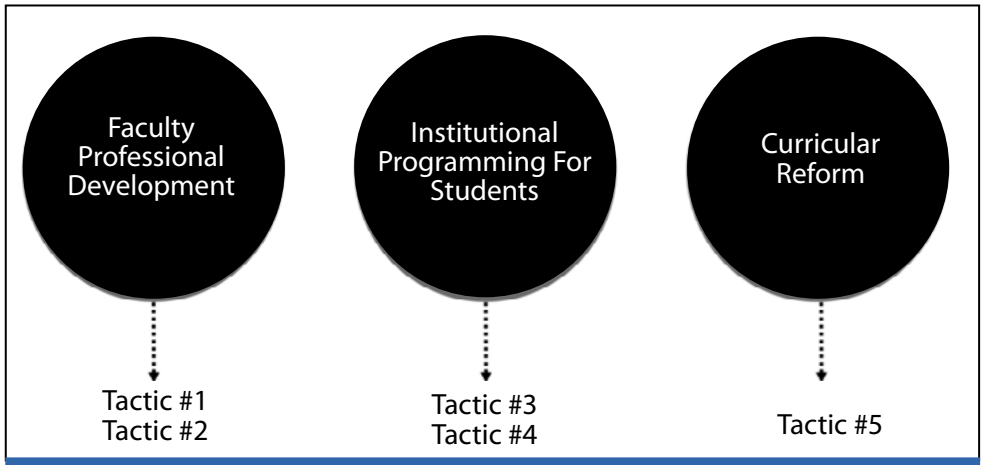


**Figure 1. Three guiding strategies for tactics related to ensuring equitable access to undergraduate research experiences that we recommend should be part of institutional diversity action plans.**

Many undergraduate research programs, based largely on the decisions of individual professors overseeing student experiences, select undergraduate researchers from applicants with strong grades in their college-level coursework (Laursen et al., 2010; Slovacek et al., 2012). However, personal, institutional, and societal barriers exist that can negatively impact the academic performance of underrepresented students in STEM (e.g. Martin et al., 2014). Thus, a method of selection based primarily on grades reduces opportunities for students who are struggling academically to participate in experiences that could lead to positive outcomes, including gains in academic performance. Unfortunately, faculty offering and supporting undergraduate research are often faced with institutional pressures to publish and secure external funding and prefer students who they believe can best help advance their agendas.

We recommend two related approaches for incentivizing research faculty to embrace a more holistic conception of merit when selecting undergraduate researchers to join their groups, considering traits like interests, drive, and commitment to learning. This may require a change in mindset to one that considers undergraduate research as a tool for cultivating opportunity and merit, rather than serve as a sorting mechanism that rewards those who already possess historic access and academic traits and, thus, are presumed to require little training (Gunier, 2015). Research faculty may be more likely to support diversity with institutional recognition. Towards this, institutions can change promotion and tenure guidelines so they reward faculty commitment to supporting diversity, a concept often overshadowed by the importance of research advances when tenure decisions are made (Tuckman, 1979). Second, given the importance of faculty mentoring on the success of students of color in STEM (Griffin, Perez, Holmes, & Mayo, 2010), institutions can instate prestigious awards for excellence in mentoring and the demonstration of a commitment to promoting diversity.

*Tactic #2: Require cultural competency, biases, and diversity training for faculty, postdoctoral researchers, and graduate students who engage with undergraduate researchers.*

Students from groups underrepresented in STEM may face cultural and institutional barriers to success even after joining a research group and institutional agents may perpetuate a culturally insensitive environment. While all students experience pressures and stress (e.g., academic demands) when acclimating to a new learning environment, students of color experience additional stresses (e.g., social climate stress—limited number of faculty and students of color, low expectations and negative treatment from white faculty and peers, etc.; interracial stress—trying to maintain ethnic/racial identity, etc.; racism and discrimination—stereotyping, etc.) related to their social status that adversely impact their academic performance (Smedley et al., 1993). Thus, students from groups underrepresented in STEM may experience more difficult transitions into research experiences as a result of additional stresses. For example, Ong (2005) found that young women of color were required to do a considerable amount of added work to learn the unspoken rules of the physics culture and become accepted by male faculty and peers. Another study followed the experiences of a Native American female student and found that the lab coordinator, department chair, and dean of the college were all insensitive to her concerns about dissecting mice which required committing cultural taboos regarding dead bodies (Carlone & Johnson, 2007). Thiry and Laursen (2011) warn that "research mentors of undergraduate students should be aware of the dual scientific and educational aspects of their advising role and its significance in shaping students' identities and career trajectories" (p. 1).

Towards this, we recommend an institutional policy that all STEM faculty, postdoctoral researchers, and graduate students (two future faculty groups who often work alongside faculty in their engagement with undergraduate researchers) complete a training on cultural competencies, implicit and explicit biases, and the value of

diversity in all corners of campus. Our recommendation is one promoted by others, including the AAC&U, which has urged postsecondary institutions to provide professional development opportunities for faculty to learn how to best support students from underrepresented groups (Clayton-Pedersen et al., 2007). We encourage that institutions learn from others already attempting such tactics, such as California State University at Fresno that has established a faculty development program aimed at better supporting students from underrepresented groups (Clewell & Ficklen, 1986). An organized undergraduate research program, in fact, may allow relatively easy implementation of, and motivation for, faculty professional development of such focus. Program organizers could require that the training is completed prior to the start of the program and is necessary to receive research development funds to support the work of the student.

### Institutional financial and programming support for underrepresented students to participate and succeed in undergraduate research experiences

Many institutions rely on external grant-funded support for programs that promote success of students from diverse backgrounds. However, without institutionalization, these programs often only last a few years and their benefits only reach students who matriculated during the years the grant was awarded. Institutional funding devoted to programming for students from underrepresented groups is necessary to meet long-term diversity goals.

*Tactic #3: Provide institutional funding for sustained undergraduate research programs that provide paid research experiences for students underrepresented in STEM.*

Students from low-income backgrounds often work while enrolled in school to pay for their education (Foor et al., 2007). Moreover, students from underrepresented groups are often more concerned with their ability to pay for college than students of European descent (Hurtado et al., 2007). These added pressures and work commitments mean students are excluded from important social, professional, and academic campus community-building events that take place outside of the classroom (Foor et al., 2007; Fournier & Bond, 2015), including undergraduate research experiences.

Institutions can encourage students from low-income backgrounds to stay engaged on college campuses by providing sustained funding for undergraduate research programs that offer paid research experiences. Several programs like this have already been established across the U.S., including the Minority Opportunities in Research (MORE) programs, which provide financial incentives for students from underrepresented groups who engage in undergraduate research (Slovacek et al., 2012). However, many programs similar to MORE are primarily funded through federal and state granting agencies and lack institutional support, meaning they may only last a few years. A commitment to diversity requires institutionalizing programs that demonstrate their effectiveness in promoting the success and retention of students from groups traditionally underrepresented in STEM.

*Tactic #4: Offer free preparatory programming regarding undergraduate research experiences for students underrepresented in STEM*

Some students lack necessary coaching on why and how to seek an undergraduate research experience. Unlike some continuing-generation students, first-generation students may not realize the significance of undergraduate research when they enter college (Pascarella, Pierson, Wolniak, & Terenzini, 2004) and their parents may be unaware that undergraduate research often serves as a pathway to graduate school (Slovacek et al., 2012). Additionally, to secure an undergraduate research opportunity, a student must know how to identify a faculty mentor to work with, contact and meet the faculty mentor face-to-face, and make a strong argument for why they are interested in research. This practice may be more daunting for first-generation students, who sometimes encounter more difficulty locating support and resources for navigating university processes (Martin et al., 2014). In particular, first generation college students must exert additional effort to acquire the similar types of resources readily available to continuing generation students through their immediate networks. Due to this disparity in key forms of social and cultural capital, continuing-generation students have greater access to undergraduate research experiences than first-generation students.

In a review of undergraduate programs that were successful in retaining students from underrepresented groups, Clewell and Ficklen (1986) highlight orientation programming as a critical component of success. Schneider et al. (2016) echo the importance of "pre-research" programming in their analysis of three different pre-research course models. The authors found that over 50% of students who participated in a pre-research course were involved in undergraduate research one year after taking the course and over 75% of students were involved two years after taking the course. Eighty percent of students who became involved in research after the course felt that it prepared them for participation in research and 74% felt that it made them a better candidate for research experience.

Thus, we recommend that institutions offer workshops or classes that serve as an orientation to undergraduate research experiences in order to demystify the processes involved in securing and succeeding in undergraduate research. This curriculum should include understanding the benefits of undergraduate research, identifying professors to work with, and utilizing best practices for approaching and communicating with faculty. It should also address the norms and expectations within research environments, including what to expect in research group meetings, how to keep a detailed lab notebook, and how to read peer-reviewed literature. This programming may also be intentionally structured to cultivate a network of support among participants and institutional agents that can be accessed to navigate undergraduate research opportunities and experiences upon completion of the workshop or course. This offering should be available to any student who would benefit and should be free to avoid the added financial pressure of enrolling.

### Curricular reform to enhance research experiences across undergraduate programming

Classroom instruction is the cornerstone of our higher education institutions. Because each student has access to learning experiences within the classroom, institutions can integrate opportunities for engagement in research-based learning within these regularly attended educational settings.

*Tactic #5: Integrate undergraduate research experiences into the classroom.*

As students from underrepresented groups face barriers that could affect their ability to access an undergraduate research experience, including a lack of social and cultural capital, financial constraints, an absence of culturally relevant role models, and inadequate academic preparation (Foor et al., 2007; Martin et al., 2014; May & Chubin, 2003; Tsui, 2007), we also recommend that institutions build undergraduate research experiences within the courses in which students are already engaged. Wei and Woodin (2011) highlight several innovative approaches to integrating research into a biology curriculum and found that students reported benefits, including increased interest in science, increased confidence in scientific skills, and an enhanced understanding of the scientific process.

Integrating research into classroom learning is especially important for students with no prior exposure to undergraduate research or who are unaware of what research entails and the gains associated with involvement in undergraduate research specifically. In this case, a student will reap some of the benefits of undergraduate research through in-class, high-impact learning and may be predisposed to seek out additional opportunities they might not otherwise have. Additionally, because many students are unable to engage in undergraduate research because they work long hours outside of class time (Foor et al., 2007), this tactic allows students to derive the benefits of the experience without having to devote valuable out-of-class time. Ultimately, this tactic has the potential to impact all students and not just those traditionally underrepresented in STEM.

## Institutional Self-Assessment

Each of the tactics outlined above serves to address an underlying equity concern within postsecondary education. Table 1 provides a list of questions that institutional

leaders can ask when assessing whether, and to what extent, these concerns are being attended to at their institutions and, relatedly, to what extent they are promoted/stipulated by their institutional diversity action plans. Given these considerations, leaders can make decisions about how diversity action plans should be revised and where enhanced equity efforts should be focused.

## Trade-Offs and Related Considerations

Like most new initiatives, and associated strategies and tactics, there will be trade-offs. This is especially true as postsecondary institutions, and their college and department units, continue to attend to a greater diversity of student needs and strive for programming that is relevant to modern society and workforce needs, all the while feeling ever more squeezed financially. As always, it is savvy to consider where resources might be diverted from and to design creative approaches for minimizing costs associated with new initiatives. Such consideration may also guard against the disconnect of espoused goals and strategies stipulated in institutional diversity action plans and stakeholder actions. We now turn to exploring these issues in relation to the recommended strategies and tactics above.

The costs associated with creating incentives for research faculty to utilize more holistic measures of selection criteria when accepting undergraduates into the group (Tactic #1) are difficult to elucidate. The adjustment of promotion and tenure guidelines is likely to implicate extensive administrative time and effort, more so than financial investment. The creation of a prestigious award for excellence in mentoring could be a relatively quick, inexpensive alternative. However, an award would have much less impact on institutional change than the adjustment of promotion and tenure guidelines, which should be considered in the context of an institution's diversity action plan.

While there are no immediate costs to professors associated with employing more holistic measures of selection criteria, institutions should consider the role that this first tactic will have on a professor's ability to maintain a competitive research agenda. Mentoring students can be time-consuming for faculty; however, mentoring can be a communal effort that involves graduate students, senior undergraduates, and post-doctoral researchers. Graduate students can themselves derive benefits from mentoring others (Feldman, Divoll, & Rogan-Klyve, 2013; Reddick, Griffin, Cherwitz, Cérda-Pražák, & Bunch, 2012). These benefits include deeper understanding of themselves and their discipline, professional development as future teachers, contribution to diversifying the field, and greater awareness of the reciprocal nature of mentoring that involves viewing the ability to pass on knowledge gained from past mentoring relationships as a benefit (Reddick et al., 2012). Thus, mentoring can become less onerous and potentially have the added benefit of creating a more cooperative and inclusive culture in STEM. That being said, institutions should be attentive to an equitable distribution of mentoring since faculty of color and women faculty tend to take on much of these commitments (Guarino & Borden, 2016; Umbach, 2006). Despite the emotional, professional and financial costs that can come with engagement with undergraduate research, faculty of color's investment in students is motivated by a desire to counter the general disregard and mistreatment of students of color among the larger faculty body (Schwartz, 2012).

| Tactic | General Equity Concern | Specific Considerations Related to Proposed Tactic |
|---|---|---|
| 1 | Are faculty encouraged to embrace a holistic, democratic conception of merit when selecting students? | • How can we improve promotion and tenure guidelines to recognize commitment to diversity?<br>• Can we put awards in place that recognize excellence in mentoring and a commitment to diversity? |
| 2 | Do all members of a research group know how to best support students from underrepresented groups? | • What type of training is available to promote cultural competency? How can this be improved?<br>• How can faculty be motivated to engage? |
| 3 | Are those who must work to stay in school excluded from research opportunities? | • To what extent are opportunities available for paid undergraduate research experiences and how can this be improved? |
| 4 | Do all students know why/how to engage in undergraduate research? | • To what extent are free preparatory workshops or courses offered for those who need additional help getting involved in undergraduate research? How can this be improved? |
| 5 | Are there opportunities for research for those who are unaware of the benefits of engaging in it and/or those who have commitments that prevent them from taking part in opportunities outside of coursework? | • To what extent have undergraduate research opportunities been integrated into the curriculum? How can this be improved? |

**Table 1. General Equity Concerns Related to Accessing Undergraduate Research and Specific Considerations for Each Tactic Proposed**

Finally, it is worth noting that effective research mentoring can yield benefits for mentors that are often overlooked, including research productivity and professional development (Morrison-Beedy, Aronowitz, Dyne, & Mkandawire, 2001). Morrison-Beedy et al. (2001) make the important point that "the professional successes for the faculty mentor ultimately become successes for the college and university, as well as contributes to the scientific advancement of the… profession" (p. 296). Thus, emphasizing potential gains from mentoring may help encourage broader faculty participation.

The cost of requiring a training for professors who engage with undergraduate researchers (Tactic #2) would be minimal and, assuming it is offered in an online-format, only includes the cost of creating the training. The materials/resources needed to create this training could be borrowed from existing professional development opportunities at the institution (e.g. social justice trainings). Providing paid research opportunities for students underrepresented in STEM, including low income students (Tactic #3), will be the most expensive tactic to implement. Of course, the cost will vary depending on the size of the institution and the number of undergraduate researchers the intuition is willing to support. These decisions will have to be made on a case-by-case basis. One way to reduce cost to the institution would be to encourage the use of work-study hours for eligible students within the program. However, an active commitment to campus inclusion ultimately requires devoted funds towards equitable access to high-impact practices.

Offering free research preparatory workshops or courses (Tactic #4) could only include the cost of the instructor. Many higher education institutions already house an office of undergraduate research that would be an ideal entity to take responsibility for this offering. Integrating undergraduate research into the classroom (Tactic #5) will be time and resource-consuming for faculty. However, faculty can seek guidance from education-based units, such as institutional centers for teaching and learning. This course transition could also become the independent study work of a graduate student that would yield experience with curriculum design/redesign. To incentivize this important transition, institutions could provide small curriculum re-design grants to professors willing to make these changes.

Although expanding research opportunities may potentially require additional time dedicated to guidance and mentoring, we encourage institutions to consider

the important trade-offs of focusing on teaching over research. According to Perna and Finney (2014), "When public resources are finite, pursuing research excellence may come at the expense of other statewide goals, particularly statewide efforts to promote the overall educational attainment of its population and to reduce gaps in attainment across groups" (p. 22). Rather than sacrifice research excellence to focus on student success, we propose focusing on both at the same time. Undergraduate research allows professors to maintain their research-focus while contributing to student success in the capacity that most know best. Increasingly, student retention and persistence has become a barometer of institutional quality and prestige (Volkwein & Sweitzer, 2006). Reducing disparities also addresses government demands for improved performance. Thus, such outcomes can advance the school's reputation for inclusive excellence and for fostering a culture of undergraduate research success for all students.

## Conclusion

The proposed strategies and tactics offered above represent research-based recommendations towards increasing the success and persistence of students from groups traditionally underrepresented in postsecondary STEM, explicitly through involvement in undergraduate research experiences. We think our recommendations are particularly timely as educational opportunity gaps persist while societal issues we face continue to grow in scope and complexity. Beyond increasing retention for students from underrepresented groups (Nagda et al., 1998), the diversity-related outcomes resulting from these tactics should extend beyond the institution to benefit the greater U.S. society in two important ways. First, these tactics would contribute to the U.S. goal of producing additional STEM professionals to meet our workforce demand, boosting our economy, and maintaining our reputation of excellence in science and technology (President's Council of Advisors on Science and Technology, 2012). This is closely tied to enhancing our ability to address complex societal problems, which require effectively leveraging the talents and capabilities of individuals from diverse backgrounds (Hong & Page, 2004; Page, 2008). Second, increasing educational attainment would save individuals, state and federal governments, and society a considerable amount of resources that are lost when students leave higher education institutions before graduating (Perna & Finney, 2014).

We believe such explicit strategies and tactics should be part of institutional diversity action plans. In her policy analysis, Iverson (2012) found that institutional diversity action plans expressed the need to "identify obstacles and barriers to full participation in the academic, cultural, and social life of the university" (p. 159). Beyond enumerating such barriers, institutions must outline concrete, tractable tactics that create sustainable change by eliminating these barriers. This paper looks at one high-impact practice that can be leveraged to close achievement gaps for students by providing equitable access to involvement in a type of experiential learning has been shown to lead to gains in academic, personal, and professional performance. By following the tactics outlined above, we assert that institutions can begin to close educational achievement gaps and uphold the democratic ideals of higher education.

In addition to nurturing the capacity of students of color to reach their full potential, the intentional cultivation of inclusion within STEM education is an investment poised to have societal benefits. These efforts will in turn help us build a stronger STEM U.S. workforce and promote heightened STEM literacy among our populace.

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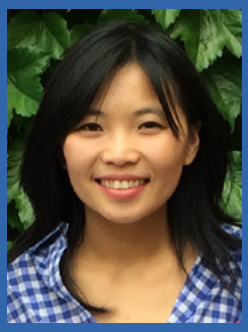

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