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Cultivating Institutional Transformation and Sustainable STEM Diversity in Higher Education through Integrative Faculty Development

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Abstract An urgent need to broaden diversity and support the preparation of students and faculty members along proactive pathways to research and success can be facilitated by targeted faculty development and formalization of policies built on institutional commitment, engagement, and accountability. Involvement of the faculty in building institutional diversity will recognize equity-building initiatives as valid forms of faculty scholarship and as one way to address the growing public problem of educational disparities in the STEM fields. We propose systemic, institutional transformation centered on a foundation of faculty engagement, empowerment, and reward that reflects intentionality and accountability for developing diverse institutional communities.

Keywords Diversity · Faculty development · Higher education · Institutional transformation · STEM

Overview

Clearly there is a need for accelerated change in promoting the success of a diverse STEM constituency. Over 20 years ago, Wunsch and Chattergy (1991) predicted that the "face of

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higher education" would be drastically different by the year 2000 given the rapidly changing demographics of the United States and institutional efforts to address the varied needs of a diverse student body. However, changes in the demographics of individuals in academia, particularly in the faculty and administrative ranks, have been much slower than anticipated. Higher education institutions continue to have disproportionate underrepresentation of ethnic and racial minorities and women in many disciplines (Moreno et al. 2006), particularly in the sciences (Leboy and Madden, 2012). This problem is linked to a focus on promoting access of underrepresented minorities and the limited degree of attention to innovation in promoting retention and advancement of individuals from diverse backgrounds at and beyond the student level.

Given the recent recognition that the current rates of training will result in a shortage of nearly 1,000,000 workers in science, technology, engineering, and mathematics (STEM) disciplines, the President's Council of Advisors on Science and Technology (2012) noted an exigent need to improve student retention generally and the recruitment and retention of underrepresented minorities in STEM in particular. Progress in these areas is critically important for improving competitiveness in science and innovations, national workforce development, securing our nation's position in regards to economic and other national concerns, and supporting an ethical and moral imperative for equity. Although significant effort has been given to evaluating some programs aimed at increasing points of access and some factors associated with the success of underrepresented minority students in STEM, less attention has been given to consideration of the specific roles of STEM faculty members in the day-to-day training of these students. The opportunities, roles, and responsibilities that STEM faculty have in promoting institutional diversity and specific mechanisms by which faculty members should be both empowered and rewarded for integrating their research, teaching, and service in ways that promote their involvement, innovation, and success in the areas of training and in supporting a diverse constituency of students and junior faculty members in STEM have not been adequately addressed. We refer to faculty development efforts to promote the integration of faculty duties and to reward such efforts as *integrative faculty development*.

The Need for Intentional Institutional Reform

Studies have shown that the underrepresentation of particular groups, including women and minorities, is not just a matter of increasing entry into the pipeline, which is associated with the numbers of underrepresented individuals matriculating into degree programs (Moss-Racusin et al. 2012; Sethna 2011). Such studies also attribute underrepresentation at multiple levels in academia to noted differences in the success rates of completing student-level programs through entry into and progression in the faculty and leadership ranks for minorities relative to whites (Sethna 2011), as well as biases that can impact the opportunities available to individuals underrepresented in particular disciplines (Moss-Racusin et al. 2012). The lack of progression of faculty members results in a two-fold problem, i.e., a failure to increase representation of diverse individuals at proportions equal to their representation in the general population and a lack of senior role models and mentors to support the success of diverse students and junior faculty members. Thus, together with efforts to increase the numbers of underrepresented minorities in STEM, additional attention to support systems, sustained mentoring, and development programs is also needed in order to move individuals from diverse backgrounds into and through the academic ranks in proportions equal to non-underrepresented minorities (Sethna 2011).

Faculty Responsibilities and Opportunities

Many institutions have programs that seek to increase the recruitment of underrepresented minorities, particularly in STEM. Generally these initiatives focus on increased structural diversity at the student and faculty levels, and the student initiatives are primarily staff-driven efforts largely separate from core faculty scholarship (Fig. 1A) (Hrabowski 2011). A cultural change from viewing broad retention issues for particular student groups, including underrepresented minority students, as a staff or administrative responsibility to this responsibility being a campus-wide issue is associated with an environmental shift in institutional engagement and culture that supports the success of underrepresented minority constituents in STEM (Hrabowski 2011). Where engaged, faculty members are largely involved as hosts for student placement in hands-on research experiences (Fig. 1A). However, faculty members can strongly impact the institutional climate for the promotion of diversity. In fact, for long-term sustained change to occur, it must be facilitated through normal institutional practices and policies (Wunsch and Chattergy 1991) rather than largely isolated or "add-on" initiatives (Fig. 1B).

Faculty members are largely driven by rewards within the academic review and promotion processes (O'Meara 2005; O'Meara and Braskamp 2005), which generally means time and effort are allocated to research, teaching, and service in direct proportion to the values reflected in those processes (Finnegan and Gamson 1996; O'Meara 2005; Ruscio 1987; Toews and Yazedjian 2007). Institutions, in turn, value those activities that contribute to their prestige. Institutional reputations are built, in large part, on the success of individual faculty members, which is largely determined by disciplinary research accomplishments (Fox, 1992) and can create conflict with individual or institutional commitment to innovations in teaching or service. Faculty members and higher education researchers (Antonio 2002; Gilligan et al.

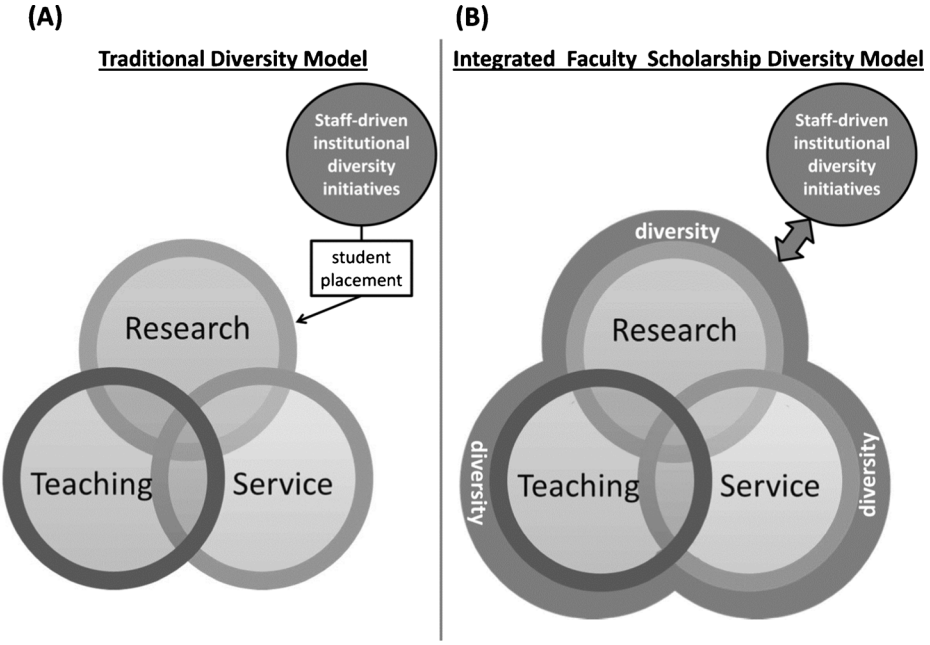

Figure 1 Academic diversity models. This figure provides a comparison of a traditional administrative, staff-based initiative (panel A) vs. an integrated faculty development-based model (panel B) for building and sustaining diverse academic communities.

2007; Hayes, 2010; Hurtado et al. 2011; Merchant and Omary 2010; O'Rourke 2008; Whittaker and Montgomery 2012) have recognized that efforts contributing to enhancing diversity are often not formally recognized or rewarded. Leshner (2011) argued that little is likely to change until mentoring a diverse student body in STEM fields is better rewarded.

Faculty Innovation and Active Engagement

To involve faculty members in guiding and sustaining diverse academic communities requires both individual and institutional understanding, support, reward, and recognition as well as individual faculty members making strategic career choices for collaboration, service, and other areas of faculty engagement. There are also complexities and distinctions associated with developing faculty careers that are discipline or institution-specific. However complex, we believe it can be done – at least much better than current efforts reflect. Recent studies and reviews of interventions to build and sustain diversity have noted several factors that promote or impede its development (e.g., Whittaker and Montgomery 2012). Supportive interventions generally target increased recruitment and development of underrepresented students. To ensure optimal and long-term results student-centered initiatives should be integrated with faculty development efforts. Faculty development can promote the integration of research, teaching and mentoring activities so as to maximize faculty efforts as a part of larger institutional goals for student development and faculty success (O'Meara and Braskamp 2005). These integrated student and faculty development efforts need to involve faculty members in the planning, execution, and assessment stages (Byars-Winston et al. 2011; Hrabowski 2011; Ramirez and Tonidandel 2009; Thompson and Campbell 2013; Wilson et al. 2012) and to be integrated into formal institutional strategic plans, practices, and policies (Hrabowski 2011; Whittaker and Akers 2009). Together, successful interventions and continuing needs for increasing diversity suggest a three-pronged model for institutional transformation, including development and engagement at the student, faculty, and institutional levels (Fig. 2). To do so will require three major institutional drivers – commitment, engagement, and accountability.

To understand the factors associated with increasing the success of diverse individuals in STEM and to apply them to result in systematic and institution-wide changes, an assessment is needed of how such interventions can be integrated into the regular academic practices of faculty members, who directly impact the success or lack thereof of students and junior faculty members. In this article, based on a review of the relevant literature, we recommend specific ways to support faculty development, engagement, and scholarship that foster changes needed for intentionally cultivating diverse higher education communities.

Desired Outcomes

Calls have been issued to use diversity as a means for institutional transformation (Barceló 2010; Wunsch and Chattergy 1991), which requires institutional level goals, policies, support, and rewards (Campbell et al. 2009; Hrabowski 2011; Newman 2011; O'Rourke 2008; Tachibana 2012; Wunsch and Chattergy 1991). More widespread attention to faculty development and engagement as a means of ameliorating or removing institutional barriers to success for women (Wadia-Fascetti and Leventman 2000) and for underrepresented minorities (Whittaker and Montgomery 2012), as well as transforming institutional cultures, is clearly needed. Progress starts with acknowledging that inequities exist in access, cultural capital, and other areas, i.e., what have been called “educational inequities” (Whittaker and Akers 2009), that support the success of persons from underrepresented groups.

Figure 2 Synergistic model for building and sustaining diversity in STEM at academic institutions. The presented model for institutional transformation for promoting sustainable academic diversity includes integrative faculty development and engagement that recognize and reward innovations in diversity-based student initiatives which contribute to overall institutional transformation.

Addressing Access vs. Success

Many programs target improvement of access, generally in the form of attempting to increase numbers, which is understood as structural diversity (Howard Hughes Medical Institute 2008; Hurtado et al. 1998; Hurtado et al. 2008). Frequently such "pipeline-improving" attempts are linked to monetary awards to institutions, single faculty investigators, or national graduate fellowships for doctoral training. These financially-based attempts to address access issues are not leading to widespread successes or transformative gains in improving diversity long-term in academic environments (Whittaker and Montgomery 2012). We believe that the need for connections between access and success as a component of institutional accountability is not adequately emphasized by either institutions or funding agencies. Interventions that go beyond improving access alone to those that also actively support an integration of faculty-driven student engagement, faculty incentives, and performance measures for rewarding faculty innovation in regards to diversity and support of students and junior colleagues, and

institutional transformation and accountability could certainly provide the foundation for transformation (Fig. 2).

Provision of Mentoring as Cultural Capital

Increasing cultural capital, the lack of which can be an impediment to success for underrepresented individuals (e.g., Chanderbhan-Forde et al. 2012; Ovink and Veazey 2011), can be one outcome of faculty development and related student engagement. Cultural capital is not limited to but does include "knowledge and other advantages that people possess that help them to succeed in their endeavors, such as negotiating educational systems" (Chanderbhan-Forde et al. 2012, p. 180). The socialization that results in the accumulation of knowledge needed to succeed in the sciences and to make sense of experiences in the scientific environment is vitally important (Hurtado et al. 2009). Access to like-minded individuals or those with a shared history and vision is a type of cultural capital that is unequally available due to a lack of structural diversity or low number of women professors or professors of color (Chanderbhan-Forde et al. 2012; Davis 2007; Hayes 2010; Whittaker and Montgomery 2012). A lack of cultural and social capital can greatly increase the need for faculty mentoring for students who lack such capital (Chanderbhan-Forde et al. 2012; Dodson et al. 2009; Ovink and Veazey 2011) and for junior faculty members seeking to advance in rank. Mentoring and the presence of role models may be more important for promoting the success of women than men in STEM (Chanderbhan-Forde et al. 2012) and may be equally important for underrepresented minorities (Davis 2007; Dodson et al. 2009; Dorsey and Jackson 1995; Gardner 2008; Gray 2013; Newman 2011; Noy and Ray 2012). Providing this valuable mentoring to underrepresented students and junior faculty members becomes an uneven burden due to the limited number of individual faculty members of similar background who are willing to mentor others (Gilligan et al 2007; Hayes 2010; Hurtado et al. 2011; Merchant and Omary 2010; O'Rourke 2008; Whittaker and Montgomery 2012; Wunsch and Chattergy 1991). Such environmental barriers may ultimately and directly contribute to impediments in increasing the pool of candidates and their success as faculty members (Noy and Ray 2012). Thus, one cannot ignore the need for structural diversity at all levels. Institutions that perform well in regards to promoting the success of a diverse cohort of individuals in STEM hire diverse faculty members who are committed to fostering the success of students and junior colleagues (Gasman 2010). Environments that reward the diversity efforts of these faculty members further the impact of their work and perhaps mitigate what has been recognized as a high "activation energy" for getting faculty members involved in diversity- and equity-building efforts (Thompson and Campbell 2013).

In some instances mentoring has been conducted electronically in an attempt to overcome the limitations presented by low numbers of faculty of color or women faculty at particular institutions (e.g. Blake-Beard et al. 2011; Wadia-Fascetti and Leventman 2000) or even others committed to such efforts. However, such programs, some of which are fee-based (e.g. MentorNet, http://www.mentornet.net/; National Center for Faculty Development and Diversity, NCFDD, https://facultydiversity.site-ym.com/), potentially give the large number of participating member institutions (i.e., 90 academic institutions for MentorNet, http://www.mentornet.net/ and 140 academic institutions for NCFDD, http://www.facultydiversity.org/?Institutions_Served) a false sense of provision of access to mentors. Such "e-mentoring" efforts potentially circumvent the need to institutionalize local efforts to provide mentoring, are often not accurately measured or assessed, and do not provide mentors who have the local knowledge that may be needed to support student and junior faculty members success. Impediments to success for underrepresented students and faculty members in many institutions have been attributed to such environmental barriers (Whittaker and Montgomery 2012).

Achieving Institutional Change

Tenured faculty members who are long-term, if not permanent, employees can directly influence (for better or for worse) the potential success of underrepresented students, particularly graduate students and junior faculty members. They can impact graduate admissions and student success in ways that effect diversity in graduate programs (Thompson and Campbell 2013). Notably, faculty of color and women may perform better in providing holistic student support and in integrating service and scholarship so as to promote diversity. Yet studies directly addressing how faculty members can promote diversity are limited (Bensimon 2007; Peña 2012).

Several researchers have noted the importance of making diversity central to faculty work and of having faculty members participate in the planning and implementation of campus diversity initiatives (Fig. 1B). The need to address institutional-specific impacts on the efficacy of particular scholarship reforms has been highlighted for teaching (O'Meara 2005) as has the impact of disciplinary-specific aspects in policy reform efforts for integrating teaching and research (Finnegan and Gamson 1996). O'Meara (2005) reported that campuses which made policy reforms based on linking reward systems for teaching and service efforts function differently in regards to institutional recognition and effectiveness. This observation indicates that policy reforms in areas related to diversity will have similar lasting changes on institutions. Individual institutions will need to implement faculty development policies for promoting equity and diversity that address the challenges one would face in different institutional types and in different disciplines and departments. However, the ultimate goal in all cases would be to continue the development of institutional policies that address and dismantle inequities and the systematic institutionalization of processes to embrace and promote diversity (Espinosa and Rodríguez 2013; Whittaker and Akers 2009). Only recently have such reform policies for diversity begun to emerge as formalized approaches. For example, the University of California (University of California Office of the President 2011) has begun to acknowledge that "disparities are public problems that can and should be addressed by the teaching, research, and service work" of its faculty members (O'Rourke 2008, p. 41). The University of California goes a step further in acknowledging promotion of diversity as a form of "scholarship" or activity to be rewarded in promotion and tenure decisions.

The integration of the promotion and recognition of faculty diversity efforts must become more widespread in order to truly diversify higher education institutions so as to reflect national demographics. O'Meara (2005) argued that doctoral research universities will have to lead this reformation or transformation. We further posit that funding agencies have a role in increasing the systematic use of assessment and accountability measures relating to institutional diversification.

Roles for Funding Agencies

There is variation in institutional policies, accountability, and oversight mechanisms related to recognition of faculty participation or leadership in diversity-building efforts. Some institutions lack effective policies whereas others have policies that are not enforced. Public and private sources have funded diversity-building programs at a wide range of institutions, including common initiatives that implement recruitment strategies targeting underrepresented minorities. Furthermore, faculty members may take cues from funding agencies about priorities for research and service, particularly in regards to the need for increasing the numbers of diverse persons in STEM. Based on current funding priorities, there are many institutional level

programs that support entering graduate students; but equal commitment to seeking faculty of diverse backgrounds to mentor these students and ensure bilateral student and faculty engagement and success is less evident (Ponjuan 2011). Furthermore, some grant-supported efforts may be problematic in that institutional or funding agency oversight has been limited or non-existent. Although the National Science Foundation (NSF) has called for diversity-building efforts to be incorporated into its funded research as one form of NSF broader impacts, there are limited requirements to show outcomes of commitment, engagement, performance, or institutionalization of pathways to promote success for underrepresented minorities. Even when requirements exist, there remains the challenge of appropriate evaluation and assessment of qualitative outcomes and potential impact. Some researchers have called for funding agencies such as the NSF (Fortenberry et al. 2009) and National Institutes of Health (Sherley 2011) to implement and/or improve institutional oversight.

Funding agencies can contribute to driving institutional transformation and faculty development. In this regard, they should move beyond providing financial support mainly for increasing numbers entering the pipeline (Fig. 2) to requiring the assessment of progress and the success and sustainability of interventions and should insist on institutional accountability to address the issue of entry intro and advancement through the academic ranks, a continuing problem for underrepresented minorities (Moss-Racusin et al. 2012; Sethna 2011). Program oversight will be a critical intervention point for a potentially transformational impact on faculty members, students, and institutions (Fig. 2). While the need for institutional policy changes (e.g. O'Meara 2005) and accountability (Fortenberry et al. 2009; Sherley 2011) has been clearly recognized, the need for faculty education, development, and empowerment in these efforts is also critical but often overlooked.

Integrated Institutional Transformation and Faculty Development

The nature of initiatives that must be enacted at institutions will be dictated by the available resources and challenges in each specific environment. The particulars of changes needed to create an equitable academic environment depend upon the history of inclusion of some groups and policies and exclusion of others as well as existing policies and practices (Bauer-Dantoin and Ritch 2005; Harper 2012; Hurtado et al. 1998), which can be revealed through assessments of climate and barriers (Dowd et al. 2013; Elliott et al. 1996; Hurtado et al. 1998, 2008; Thompson and Campbell 2013; Whittaker and Montgomery 2012). Change associated with transformation must include evidence-based strategies for addressing the issues that are identified (Hrabowski 2011) and detailed and strategic institutional evaluation and planning (Fig. 2; Hrabowski 2011; Whittaker and Montgomery 2012). The outcomes of such institutional assessments will dictate the specific interventions and policy reforms needed for promoting and sustaining institution-wide diversity. However, we offer some general recommendations for promoting institutional diversity through faculty developmental initiatives (Fig. 3).

Formalized policies and developmental support Formalized policies and developmental support for recognizing or developing individual faculty initiatives that support the building of diversity and promote the success of individuals from diverse backgrounds at all career levels are needed. Pertinent policies and support can include release time from teaching or other service initiatives for faculty engagement in *active and successful* efforts to increase

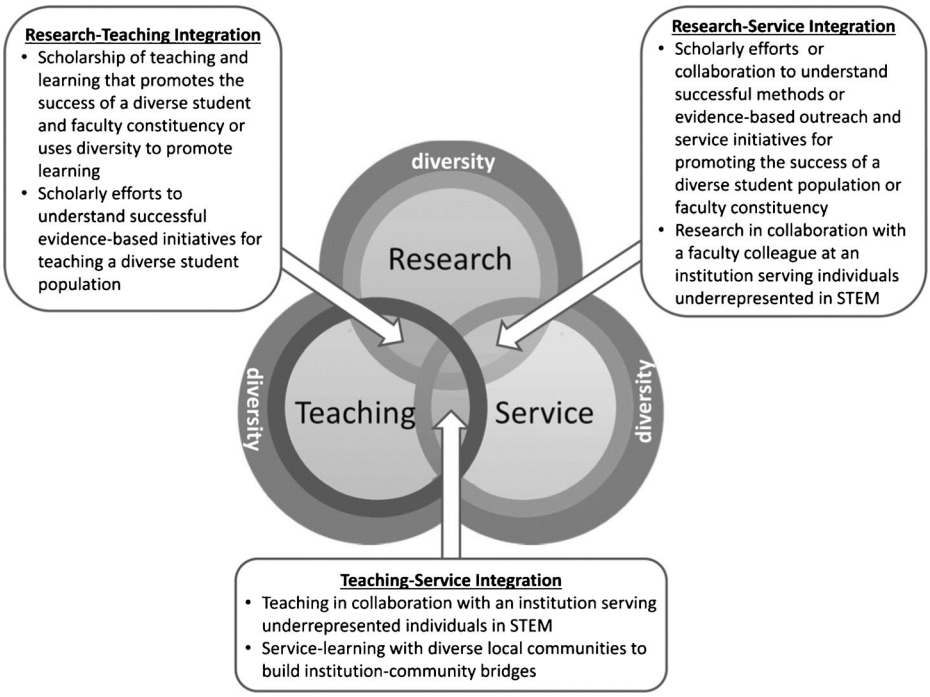

Figure 3 Specific recommendations for promoting institutional diversity through faculty development. Avenues for integrating areas of faculty scholarship, including research, teaching and service, with diversity initiatives for the development of a productive and engaged faculty that supports broader institutional diversity goals are presented.

recruitment, retention and/or mentoring activities to develop graduate students and junior faculty members from groups underrepresented in STEM (University of California Office of the President 2011).

The integration of research and service We recommend supporting faculty involvement in the *integration of research and service* (Fig. 3) such as through inter-institutional partnerships that contribute to the success of diverse students (Gibau et al. 2010; Stassun et al. 2010; Stassun et al. 2011; Williams et al. 2011). These partnerships have been shown to lead to increased understanding between diverse groups and help to identify barriers as well as opportunities for advancement for underrepresented minorities (Williams et al. 2011), which can ultimately support the transformation that would foster long-term diversity achievements. The provision of developmental support for promoting research and service integration, including scholarly efforts or research collaborations between faculty members at minority-serving and predominately white institutions to explore successful methods or evidence-based outreach and service initiatives for promoting the success of a diverse student population or faculty constituency, is an example of institutional support.

The integration of teaching and service Also needed is faculty development support for efforts promoting the *integration of teaching and service* initiatives (Fig. 3) centered

on the scholarship of diversity, e.g., formal credit for collaborative teaching or serving on student committees at HBCUs or other minority-serving institutions. Such efforts contribute to building bridges between students and faculty members at these institutions and can support recruitment and successful transitions (Brown 2011; Gibau et al. 2010; Malone and Barabino 2009; Stassun et al. 2010; Stassun et al. 2011; Williams et al. 2011); and they can promote reciprocal, synergistic faculty development.

The integration of research and teaching Supporting the *integration of research and teaching* (Fig. 3) includes promoting and advocating for the funding of work for diversity building, e.g., scholarly efforts to explore evidence-based initiatives for promoting inclusive learning and teaching. Both internal and external funding to support such efforts will allow institutions to overcome problems that are centered on individual efforts for building diversity and broadening participation. Individually-driven efforts are bottom-up approaches rather than active and strategic engagement from the top down. Engagement of institutional leadership, in terms of the commitment of internal funds, demonstrates investment in institutional transformation. The provision of such institutional support will mirror similar calls for initiatives to provide support for teaching excellence (Anderson et al. 2011). Institutional support does not necessarily need to be new funding; it can arise from a redistribution of existing funding that becomes tightly linked to outcomes and accountability measures. Integrating such efforts with ongoing educational outreach to K-12 and other community-based efforts such as service-learning can serve as an institutional umbrella for developing integrated approaches in order to maximize the use of resources and to amplify diversity efforts. Internal support of such activities can ultimately lead to enhanced external support. While external funding may not result in the standard research grant and may not bring in as much overhead or indirect costs support, it will be just as valuable and important due to the tangible and intangible long-term impact that such activities can have on transforming an institution into one that promotes the success of a diverse pool of constituents while still demonstrating growth in the research enterprise.

Ultimately, all efforts in this area should support *innovative thinking* that extends beyond current, individual, faculty-driven partnership models to models that support integration and interaction across multiple levels of inter-institutional partnerships, which honor the commitment, engagement and accountability of each of the partnering institutions.

Conclusion

Integrative faculty development initiatives, such as those described here, support a multi-level approach to achieving diversity goals and institutional transformation. The academy needs systemic institutional change that includes faculty development, support, and empowerment in fostering an institutional culture which cultivates diversity at all levels. Implementation and assessment will lead to faculty-driven achievement and best practices in the promotion of diversity that can serve as an important component of an intentional, institutional agenda based on commitment, engagement, accountability, and oversight for enhancing equity and diversity in academic communities. Together with student and institutional development and engagement, innovative approaches to faculty development allow academic institutions to promote systemic change in how diversity is addressed in STEM and more generally within the institution as a whole.

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