Assessing Programs to Improve Minority Participation in STEM Fields:

What We Know and What We Need to Know

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PURPOSE

The chapter focuses on evaluations of programs designed and implemented to improve the participation of underrepresented racial/ethnic minorities (URMs) in science, technology, engineering and mathematics (STEM) disciplines in colleges and universities in the United States at the undergraduate, graduate, postdoctoral and junior faculty levels. We use the phrase “to improve the participation” to refer not only to increasing the quantity, but also the quality of URMs’ participation in STEM fields. The chapter reviews the relevant literature on various types of internal and external evaluations. The goal is not to be exhaustive, but rather to review selected published studies and unpublished documented reports of the most effective and/or promising programs in increasing STEM diversity at the various degree and early professional levels. Therefore, the primary purpose of the chapter is to identify what is known and what needs to be known about what works to diversify the participation of URMs in STEM disciplines.

BACKGROUND

Within the past 50 years, there have been major changes in the United States (US) in terms of both the economy and the population. The economic base has shifted from the manufacturing of durable goods to processing and analyzing information. In this information-driven economy, the most valuable assets are human resources. Therefore, in order to compete successfully in the global economy, the US needs citizens who are literate in terms of science and mathematics, and a STEM workforce that is well educated and well trained (Friedman 2005, National Academy of Sciences 2005, Pearson 2005). Consequently, the US cannot—literally or figuratively—afford to squander its human resources; it is imperative that the US develop and nurture the talent of all its citizens.

The demographic composition of the US has shifted insofar as the proportion of the US population, comprised of racial/ethnic minorities increased, while the proportion comprised of non-Hispanic White has decreased. In combination, these shifts have profound consequences for the US.

Traditionally, the US recruited its STEM workforce from a relatively homogenous talent pool consisting largely of non-Hispanic White males. However, this pool has decreased significantly due not only to comprising an increasingly smaller proportion of the total US population but also to declining interest among this group in pursuing careers in STEM. It is important to note that the need to improve the participation of underrepresented groups—especially underrepresented racial/ethnic groups—in STEM is NOT solely driven by demographics and supply-side considerations; an even more important driver is that STEM workers from a variety of backgrounds improve and enhance the quality of science insofar as they are likely to bring a variety of new perspectives to bear on the STEM enterprise—in terms of both research and application (BEST 2004; Jackson 2003; Leggon and Malcom 1994).

Generally, URMs tend to be younger than non-Hispanics Whites. This results in increasing contrasts between the racial/ethnic compositions of faculty and students; these contrasts are most pronounced at the post-secondary level. For example, in 2001, non-Hispanic Whites comprised 68.9 percent of the total US population, but only 61.9 percent of the population 18-24 years of age; Hispanics comprised 13 percent of the total population but 17.4 percent of those 18-24 years old. Blacks/African Americans comprised 12.7 percent of the total population, but 14.4 percent of those 18-24 years old (NSF 2004). At the undergraduate and graduate levels, the lack of racial/ethnic diversity among the faculty may negatively impact the mentoring relationships between a more diverse student body and a less diverse faculty (Maton and Hrabowski 2004; Nelson 2004). Despite significant increases in the proportion of the US population comprised particularly by African Americans and Hispanics, the US STEM workforce remains overwhelmingly White (BEST 2006; Leggon 2006).

Over the last 20 years, there has been a proliferation of programs to improve and increase the participation of racial/ethnic minority groups underrepresented in STEM fields. Yet, the proportion of STEM doctorates earned by members of underrepresented groups have shown modest improvement (CEOSE 2004). These programs can be broadly categorized in a variety ways including by

- **Level:** K-12, undergraduate, postdoctoral, entry level professional

- **Funding source:** colleges and universities, federal government agencies (e.g., National Science Foundation, National Institutes of Health, NASA); non-profit foundations (e.g., Sloan)
- **Institutional base:** an individual college or university (e.g., the Meyerhoff Scholars Program at the University of Maryland, Baltimore County); consortia (e.g., Leadership Alliance, GEM, NACME); and professional associations (e.g., American Chemical Society)
- **STEM field(s):** in broad terms (e.g., physical sciences) or along the lines of specific traditional fields (e.g., physics, social sciences)

According to a report by BEST (2004), measurable objectives and formal evaluations are critical elements in assessing the effectiveness of programs. Evaluation represents the best strategy to provide information on what is effective and what is not. Moreover, evaluation can provide real time continuous feedback to guide in the design, planning and implementation so that relevant changes can be instituted. Program evaluations continue to be limited and lack rigor. The few programs that do track participants report that academic benefits accruing to the students may actually diminish over time

(Good, Halpin and Halpin 2002). Other effects, such as the probabilities of persisting in basic math and science courses and of graduating were assumed to persist (Bartlow and Villarejo, 2004). Many programs tracked participants only to the next one or two education milestones, but not for a sufficient period of time to assess the long-term impact of participating in the program.

Much of the early funding of programs to increase the participation of URMs in STEM fields did not include budgetary support for evaluation; consequently, evidence of program effectiveness was anecdotal, absent or minimal. Recently, this situation has begun to change (CEOSE 2004). While there seems to be more awareness of and inclusion of evaluative components in programs, funding still lags, and evaluation is frequently the first item cut or reduced when the requested funding amount is reduced (NSF 2005).

In addition to inadequate funding for evaluation, other impediments to evaluation stem from the programs' structure: goal statements; indicators; data collection and interpretation. Some programs have goal statements that are not clearly articulated and/or not measurable. Yet another impediment to program evaluation concerns program stakeholders who confuse and confound assessment with evaluation. For example, one-page surveys to elicit participants' opinions about specific program activities such as guest speakers or panel presentations are not the same as a rigorous, systematic evaluation of a program.

Despite the fact that 13 federal agencies spent $2.8 billion in fiscal year 2004 for 207 education programs designed to increase the numbers of STEM students and graduates (including programs to improve STEM education), "a comprehensive evaluation of federal programs is currently non-existent" (GAO 2006:17). According to a recent report by the GAO (2006), only about half of these 207 federally funded education programs were evaluated or being evaluated.

Jackson (2003) points out, that there is a lack of "authoritative, readily accessible information" on the most effective and promising programs, practices and policies designed to broaden the participation of URMs in STEM. Jackson also argues that lessons learned from program success as well as from failure may provide critical insight into replicability, transportability, and scalability. Providing this information was the primary objective of the Building Engineering and Science Talent (BEST) Initiative. Systematic formative and summative evaluation of the extent to which programs broaden participation in STEM fields is essential to understanding what works for which URMs and under what conditions, what does not work, and why (CEOSE 2004). BEST concluded that "scarce resources are devoted to the intervention rather than to documenting participants, processes, and outcomes" (BEST 2004:17-18).

BEST (2004) implemented a systematic process to identify and document effective programs that demonstrated promise in developing talent from among the populations which are currently underrepresented in the STEM workforce. Using a systematic search-and-nominate process, BEST identified a pool of 124 higher education programs. Most of these STEM programs were based at a single university and targeted minorities or women. However, it is significant that most of these 124 programs were unable to provide any documentation on program outcomes. Documentation consisted of a little more than counts of the numbers of students participating in the intervention program. Even decades- old programs lacked fundamental impact data; longevity does not ipso facto mean that the program is successful. Without designing and incorporating an evaluation component into an intervention from the outset, it is unlikely that the impact and texture of the program will ever be measured (BEST 2004).

BEST requested that each program complete a program profile covering goals, impact, growth, sustainability and evidence of effectiveness. After developing criteria to "assess the soundness of the programs and practices that foster achievement in higher education" (BEST 2004:5), a total of 36 programs were rated by a subset of the BEST Higher Education Blue Ribbon Panel. The review panel process gave more weight to programs that had monitored their participants' progress and attempted to evaluate outcomes. Based on six of BEST's eight criteria, seven programs were rated as exemplary, and five programs were categorized as promising. Of the seven programs identified as exemplary, three focused on undergraduates, two on graduate students, one on faculty, and one on a single discipline statewide effort. Our discussion of effective and promising intervention programs is disaggregated by the programs' focus in terms of level of education milestone: undergraduate, graduate, and faculty.

What works?

To systematically identify what works and why, this chapter builds on the foundation from the BEST initiative to discuss selected programs that are either examplary or promising in terms of increasing the participation of URMs in STEM fields in the US. Some of the programs discussed below were included in the BEST initiative, while others were not. The focus here is to identify, illustrate, and summarize lessons learned from some promising programs that are targeted to increase participation in STEM fields of URMs, and to identify extant knowledge gaps. The intervention programs selected for this discussion are disaggregated by the program's focus in terms of level of education milestone: undergraduate, graduate, and faculty.

Undergraduate Programs

At the undergraduate level, the following programs will be discussed: the Meyerhoff Scholars Program; the Mathematics Workshop Program (MWP); the Leadership Alliance Program (LA); and the Louis Stokes Alliances for Minority Participation (LSAMP).

The Meyerhoff Scholars Program. One of the undergraduate programs identified by BEST as exemplary is the Meyerhoff Scholars Program at the University of Maryland, Baltimore County (UMBC). The original goal of the program was to produce African-American students who continue their education beyond UMBC to earn a doctorate in a STEM discipline and join a college or university faculty (see Hrabowski and Pearson 1993 or Maton and Hrabowski 2004). Although historically this program targeted African-Americans, it is now open to all students. The Meyerhoff Scholars Program is one of the few intervention programs that is research-based. This program uses intense peer study groups as well as the total residential experience to focus on the needs of the whole student. The confluence of these and other practices create a strong sense of community which, in turn, facilitates a high level of academic achievement and an environment conducive to intellectual exchange.

What the Best Blue Ribbon Panel reported as most striking about this undergraduate program is its institutional commitment from the administration and the faculty. This is consistent with evaluation findings indicating that successful interventions to improve the participation of URMs in STEM fields must be institutionalized ( ). In this context, institutionalization means that the intervention is not a stand-alone or marginal component but rather an integral part of the standard operating procedures of an institution; and, as such, a criterion upon which the performance of faculty and administrators is evaluated (Leggon 2006). Moreover, institutionalization means that the intervention will not disappear when the funding that supported its inception ends.[1]

The Meyerhoff Scholars Program has undergone extensive internal evaluation. In 2000, Maton, Hrabowski and Schmidt reported that Meyerhoff students achieved higher grade point averages, graduated and STEM majors at higher rates, and gained acceptance to graduate schools at higher rates than multiple current and historical samples. In a recent article, Maton and Hrabowski (2004) project that if current trends in doctoral receipt rates of Meyerhoff graduates continue, UMBC will likely become the leading predominantly White baccalaureate origin institution for African-American STEM Ph.D.s in the US.

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[1] This notion of institutionalization is the basis for intervention programs that focus on institutional transformation, such as the NSF's ADVANCE Program.

The authors were able to locate only one external evaluation of the Meyerhoff program. Bridglall and Gordon conducted what they call a "connoisseurial" evaluation of the Meyerhoff Scholars Program. They describe this approach as follows:

> Connoisseurial evaluators are free to make use of objective and subjective measures. The connoisseur's judgment is not used to supplant empirically based evaluation, but rather to supplant, amplify, and explain more traditional evaluation research (Bridglall and Gordon 2004:16).

The researchers were primarily concerned with examining "how educators, scholars, communities, parents, and students themselves can reduce the persistent academic under productivity of African-American, Hispanic, Native American students "(Bridglall and Gordon 2004:17). They concluded that the extraordinary commitment of UMBC's leadership, faculty, and staff to minority students' academic achievement encourages them to constantly seek ways to enhance their students' academic performance.

Bridglall and Gordon speculated that the Meyerhoff Scholars Program "is one of the few isolated efforts at bridging curriculum and teaching, social science, and cognitive science to more effectively apply this knowledge to the problems of nurturing talent in underrepresented students" (p. 75). The authors believe of that the Meyerhoff model is transferable to other institutions.

Mathematics Workshop Program. The Mathematics Workshop Program (MWP) at the University of California-Berkeley represents one of the earliest programs that attempted to measure outcomes. MWP was implemented as an honors program to recruit first-year students regardless of race—although the enrollment tended to be predominantly African American, Mexican American, and Central American students. Fullilove and Treisman (1990) concluded that programs created at predominantly White colleges and universities to remedy African-American and other minority students' so-called "deficiencies" have failed. They point out that there is little evidence that such programs actually provide students with access to careers in STEM fields, nor is there evidence that these types of programmatic efforts have led to graduation rates proportionate to freshman enrollment rates.

According to Fullilove and Treisman, what distinguished MWP from standard mathematics discussion sections is organization. Specifically, MWP participants were organized into small groups (five to seven students) working together for two hours twice a week, on worksheets containing unusually difficult problems. Students were monitored and assisted by a graduate student. The students were encouraged to discuss the problems and instruct each other as to how solutions and proofs are derived. In short, this peer exchange allowed students not only to solve problems but also to understand the ideas on which the problems were derived. According to the authors, this created academically-oriented peer groups that were empowering. Evaluation results revealed that the program was successful in promoting high levels of academic performance among African-American mathematics students. Moreover, Fullilove and Treisman identified other institutions that were able to replicate the success realized at Berkeley. They suggest that the model can be equally replicated at high schools.

Leadership Alliance

The Leadership Alliance (LA) is a consortium of 32 of the leading U.S. research and teaching colleges and universities. This consortium includes institutions categorized as Ivy League, Research I, and minority-serving institutions – historically black colleges and universities (HBCUs), Hispanic-serving institutions (HSIs), and tribal colleges. The purpose of the Alliance is to provide students with opportunities which would otherwise be unavailable to them to conduct research. The Summer Research Experience Identification Program (SR – EIP) provides intensive research experience and culminates in a national symposium in which students give formal professional presentations.

Pearson et al. (2003) have been conducting formative evaluations of the Leadership Alliance Program since 2001. The evaluations have included both qualitative (i.e., interviews and focus groups) and quantitative (surveys) components. A summary of the major evaluation findings is provided below.

- *The Summer Research-Early Identification Program (SR-EIP) continues to work well for the clear majority of undergraduate students.* For example, 82 percent of the students surveyed in 2003 report that their overall summer experience was "very good" or "excellent," and 76 percent report that the summer program strengthened their commitment to pursue a research career.

- *Strengthened commitment to pursue a research career is positively correlated with several other factors.* Specifically, those students who report strengthened commitment are also more likely to report that: (a) the overall summer experience was excellent; (b) the program was useful for helping clarify future career plans; (c) the program improved their overall knowledge about the research process; and (d) the program's environment was socially supportive. The fact that these factors are all intercorrelated, suggests that satisfaction with both the summer experience and strengthened career commitment can be enhanced by insuring that students receive adequate information about the steps involved in pursuing a research career (e.g., how to apply to graduate programs and how to obtain financial support), adequate information about the research process, and adequate social support from mentors and other program representatives.

- *Instruction in methodological techniques is an important component of program pedagogy.* As the frequency of instruction in methodological techniques increases, so too does the student's satisfaction with the program, perceived usefulness of the program, reported gains in research knowledge, and perception of social support. In turn, all of these indicators strengthen student commitment to pursue a research career.

- *Many summer sites had mechanisms—formal and informal—for tracking students in their summer programs.* Several summer sites systematically track the success of the Leadership Alliance program as a recruitment tool. Typically, this is done by keeping records of Leadership Alliance students at their summer programs sites who applied to graduate and professional programs, those who were accepted, and those who attend their graduate programs. At least three sites had data for as long as their institution participated in the Leadership Alliance Program.

- *The Leadership Alliance can be expanded.* The Alliance has accumulated critical program expertise in both the national office and its senior program directors that could be more broadly disseminated. The Leadership Alliance is well positioned to serve as a clearing house for programs concerned with broadening the participation of URMs in STEM fields.

Louis Stokes Alliances for Minority Participation (LSAMP). In 1991, the National Science Foundation established the Louis Stokes Alliances for Minority Participation Program (LSAMP) to develop strategies to increase the quality and quantity of minority students who successfully complete baccalaureate degrees in STEM fields and pursue graduate studies in those fields (Clewell et al. 2006). To achieve these goals, LSAMP takes a multidisciplinary approach to student development and retention by creating partnerships among colleges, universities, national research laboratories, business and industry, and other federal agencies (Clewell et al. 2006). Through these partnerships LSAMP creates and sustains supportive environments that include adequate provision of financial and social support. Moreover, the program focuses on socializing students into academe in general and specific disciplines in particular.

Recently, this program was evaluated by the Urban Institute. This evaluation had two parts: process –how the program is implemented; and outcome—the extent to which the program is meeting its stated goals. The evaluators concluded that LSAMP was indeed meeting its goals. Student participants in LSAMP pursued post- bachelor's coursework, enrolled in graduate programs, and completed advanced degrees at greater rates than national comparison groups of underrepresented minorities, and white and Asian students (Clewell at al. 2006:2). Specifically, almost 80% of LSAMP participants pursued post baccalaureate education, and 66% later enrolled in a graduate program to pursue masters, doctoral or professional degrees.

Graduate Programs. The section discusses two programs: the National Consortium for Graduate Degrees for Minorities and Science and Engineering (GEM); National Institutes of Health (NIH) Minority Research and Training Programs.

National Consortium for Graduate Degrees for Minorities in Science and Engineering (GEM). GEM is the only student program at the graduate level that BEST identified as exemplary. For more than a quarter century, GEM's major contribution has been finding critical resources for students in need of funding graduate degrees in STEM fields. This is not trivial because for many minority students, the availability of financial support makes the difference between persisting or not persisting to earn a graduate degree before entering the STEM workforce. Minority students are more likely than non-minority students to fund their education through personal savings and loans. Specifically, American Indian and black doctoral students are more likely to rely on their own resources to finance their doctoral education than are Whites and Hispanics; Asians are the least likely to do so (NSF 2004).

There are notable race/ethnicity differences in the use of various types of program – and institution – based support. For example in the physical sciences and engineering, both "Asians and whites are more likely than blacks and Hispanics to rely on research assistantships, and less likely to have fellowships or grants as their primary source of support" (NSF 2004:26). Moreover, financial assistance eliminates time constraints caused by working and frees up time to focus on study. In sum, GEM identifies qualified students and provides them with resources and a bridge from universities to corporate employers.

National Institutes of Health (NIH) Minority Research and Training Programs. In 2005, the National Research Council's (NRC) Committee for The Assessment of The NIH Minority Research Training Programs released its findings from the third phase of the assessment. The committee sought to answer the fundamental question "do the NIH minority research training programs work?" The NRC assessment found that although the primary goal of the program has been to increase the number of Ph.D.-level minority biomedical researchers, "success in reaching this goal was not quantified among any of the program announcements" (NAS 2005:2). A lack of consensus among program stakeholders on program goals and/or on the priority of these goals also impedes program evaluation (Matyas). Another impediment to conducting evaluations concerns the lack of adequate definitions of what constitutes "success" and "failure". For example, is a student who earns an advanced degree in the STEM field – but does not pursue a career in academe – a "success" or a "failure?" One important principle concerning minority programs is that those program participants who exit the pipeline early to become part of the scientific workforce are not program failures (NAS 2005). Moreover, without extensive longitudinal data it is impossible to determine whether a program participant has exited the pipeline for good (dropping out) as opposed to exiting the pipeline temporarily (stopping out). It is critically important to be able to distinguish between stopping out and dropping out because minorities often tend to be characterized by the stopping out pattern; that is pursuing higher education degrees incrementally. For example, they may pursue an associate's degree, and then stop out to work to finance the next degrees. Lack of long-term tracking of program participants can result in erroneously categorizing students who stop out temporarily as permanent dropouts and as such an indicator of program failure. Longitudinal data on program participants must be disaggregated by race/ethnicity and gender and collected in such a way as to facilitate distinguishing between students who are stopped outs from those who are dropouts.

The National Research Council's 2005 phase 3 evaluation of the NIH minority training programs severely criticized NIH – funded programs for failing to collect, keep and analyze data on the outcomes of these training programs (NIGMS 2006). In response to that criticism, NIH's division of Minority Opportunity's in Research (MORE) inaugurated the "Efficacy of Interventions to Promote Research Careers" grants to examine and analyze both the outcomes and assumptions of various NIH programs.

One effort initiated by the NIGMS provides multiple graduate and postdoctoral minorities supplements for each research grant to enable investigators to support underrepresented minority undergraduate, graduate and postdoctoral fellows working in their labs (NIGMS 2006). This strategy can be viewed as an add-on, which tends to be less effective than a strategy that is integrated into the standard operating procedures of an institution or program (Gateway 2006).

Faculty Programs. Of the two programs concentrating on faculty diversity identified by BEST as examplary, the Compact for Faculty Diversity targets racial/ethnic minorities, while Preparing Future Faculty focuses on diversifying faculty in terms not only of race and ethnicity, but also gender and other characteristics. In addition to these programs, two other faculty programs will be discussed briefly: the Alliance for Graduate Education and the Professoriate (AGEP); and the Integrative Initiative for Graduate Education and Research Training (IGERT).

Compact for Faculty Diversity. In 1993, the Compact for Faculty Diversity was formed by the Southern Regional Education Board (SREB), the New England Board of Higher Education, and the Western Interstate Compact for Higher Education. The Compact for Diversity website describes the program as a "partnership of regional, federal and foundation programs that focus on minority graduate education and faculty diversity" (http://www.instituteonteachingandmentoring.org/Compact). The only goal of the Compact is to increase the number of minority students earning doctoral degrees and becoming college and university faculty. To achieve this goal, the compact endeavors to

- Increase the percentage of minority students earning the doctoral degree in STEM fields and seeking faculty positions
- Diversify the pool of qualified faculty candidates
- Increase the participants' probability of success as faculty members.

In sum, the program has an intensive approach to creating a "multilayered web of support" (Norton and Abraham 2000). Financial support provided by the program consists of stipends to support fulltime study for three years, and one year of support to write the dissertation. In addition to financial support, the program provides extensive social support by facilitating sustained regular contact among the scholars, and between the scholars and the program. The Institute on Teaching annually provides a forum lasting several days for students and faculty mentors to engage in professional development, networking, and professional socialization. The Institute not only benefits students, but mentors as well insofar as it provides opportunities for mentors to enhance their mentoring skills and experience. The retention rate of program participants was 90%

as compared to retention rates of 37% for minority scholars in general, and 40 to 60% for students of all race/ethnicity backgrounds.

Preparing Future Faculty (PFF). Founded in the 1990s, the Preparing Future Faculty program seeks to better prepare graduate students for the professoriate by exposing them to a variety of academic settings. This exposure enhances students' ability to make informed choices in terms of the academic setting in which they will seek full-time employment. The PFF helps to socialize graduate students into the teaching profession, as well as to acculturate them into the academy. In addition, PFF encourages "graduate programs to integrate the professional development of graduate students more directly into education" (DeNeef 2002:1). An evaluation found that PFF has started to change the climate on the campuses of the graduate schools participating in the program. One change is that the PFF has spurred graduate faculty to realize the importance of pedagogical issues to graduate students. Another change is that PFF has led to an expansion of the definition of "success" to include teaching in liberal arts colleges and community colleges, as well as in research intensive universities. PFF Further expanded the definition of a successful academic career to include administration as well as research and teaching. The evaluators concluded that "PFF not only smoothed the transition between graduate school and the graduate student participants' initial academic position, but it is also brought them into the larger conversation of academic reform and generally" (DeNeff 2002:19).

The Alliance for Graduate Education and the Professoriate (AGEP). AGEP is designed to "create a future faculty of color" in STEM fields (MacLachlan 2004:6). It may be short-lived because it is "an add-on to campus life;" therefore, one researcher concludes that "it will likely disappear when the funding does" (MacLachlin 2004: 6).

Integrative Initiative Graduate Education and Research Traineeship Program (IGERT). IGERT was developed to meet the challenges of educating US Ph.D. scientists, engineers, and educators with interdisciplinary backgrounds, and technical, professional, and personal skills to become leaders and creative agents for change in their own careers. The program is intended to catalyze a cultural change in graduate education for students, faculty, and institutions (NSF introduction to the IGERT http://www.nsf.gov/crssprgm/igert/intro). A recent addition to IGERT, the IGERT National Recruitment Office, is described by an evaluation conducted by the Government Accountability Office as a stand-alone program dedicated to helping IGERT projects enhance recruitment of its targeted programs (GAO 2004: 65). However, this evaluation report cautions that it may be too early to determine the programs impact.

Summary and Conclusions: what do we know and what do we need to know?

What do we know? Regardless of the level of intervention – undergraduate, graduate, postdoctoral, faculty—the preceding review of programs identifies a commonality of elements and factors that are effective in increasing the participation of URMs in STEM fields. These factors include

- Enhancing substantive knowledge and technical skills (Leadership Alliance; LSAMP; Meyerhoff Scholars Program; MWP)
- Providing and sustaining a comprehensive web of support: financial, academic, professional, and social (GEM; Leadership Alliance; LSAMP; Meyerhoff Scholars Program)
- Facilitating the creation of networks (Compact for Faculty Diversity; GEM; Leadership Alliance; LSAMP; Meyerhoff Scholars Program)

- Providing extensive and intensive professional socialization (GEM; Leadership Alliance; LSAMP; Meyerhoff Scholars Program; Compact for Faculty Diversity; Preparing Future Faculty)
- Extensively and intensively tracking program participants – including faculty and mentors
- Providing bridge experiences to facilitate transition from one education milestone to another (Leadership Alliance; LSAMP; GEM; Compact for Faculty Diversity; Preparing Future Faculty)

In sum, the most effective and promising programs are based on a perspective that is holistic insofar as it addresses all of the needs of the participants. Among the programs discussed above, examples of this include GEM, Leadership Alliance, Meyerhoff Scholars Program; Compact for Faculty Diversity, and Preparing Future Faculty. The term "participants" is used broadly to include not only the students targeted, but also other participants such as faculty, mentors, and institutions. Effective programs address mentors' concerns about what is expected of them in their role as mentor, and provide ways to enhance their mentoring.

What do we need to know?

Analyses of extant data enhance knowledge of what is effective in improving the participation of URMs in STEM fields. However, these data are largely “snapshots” taken at different periods of time. Longitudinal data on program participants are needed to enable identification and assessment of the long-term impacts of these programs on all participants—students, faculty, mentors, and institutions.

Students. The evaluation literature has documented the positive effects of participating in at least one intervention program. However, we need to know whether participating in a given intervention program increases the likelihood of participating in other intervention programs. In addition, we need to know in what ways the careers of the students who participated in a single intervention program differ from those who participated in multiple programs. Evidence from evaluations indicates that social support for URMs pursuing graduate degrees in STEM fields is a critical element in increasing faculty diversity in STEM fields. However, more needs to be known about the factors that enhance and sustain such support.

Longitudinal data must be available by race ethnicity and gender (NAS 2005) for many reasons. Longitudinal data may provide insight into the factors that account for differences in career outcomes, and are crucial to examine the extent to which participating in targeted intervention programs results in research collaborations during a participant's career. Disaggregating data by race, ethnicity and gender facilitates the identification of gender differences that may interact with race/ethnic differences in terms of career outcomes. For example, what accounts for the finding that African-American and Hispanic women's progress in earning bachelor's degrees in STEM fields is not reflected in terms of their earning master's and doctoral degrees in those fields? Although some programs and practices that work for URMs also work for all students, it is imperative that data are collected and analyzed by race, ethnicity, and gender to pinpoint those practices and policies that are especially effective for URM students.

Faculty and Mentors. More data are needed on the dynamics of creating and sustaining social support networks not only among students and between students and faculty, but also among faculty and mentors. Also, more information is needed about effective mentoring in targeted intervention programs.

Institutions. Longitudinal data are needed to assess the long-term impact on institutions that have participated in targeted intervention programs. This impact includes changes or shifts in institutional culture as well as changes in the demographic composition of faculty, students, administrators, and staff. There is a paucity of adequate information or evidence on scalability and transportability of successful programs. Although a few institutions are beginning to replicate some key features of effective programs, external evaluations appear to be either nonexistent or under-reported. Specifically, we need to know not only which institutions successfully incorporate policies, practices, and programs to improve the participation of URMs in STEM fields in general, and on STEM faculties in particular; equally important is knowing how this institutionalization can achieved and sustained.

A major knowledge gap concerns the degree to which targeted intervention programs impact one another. For example, does participating in a particular program increase the likelihoods of participating in other targeted intervention programs and being awarded grants, fellowships and prizes? To fill this knowledge gap, what is needed is a relational database that collects data on participants in all targeted programs by level (undergraduate, graduate, postgraduate) and by type of assistance – traineeships, fellowships, research assistantships, and teaching assistantships (A similar suggestion was made in the NIH Minority Research and Training Program evaluation. See NAS 2005.). This database should also enhance the ability to track participants' professional careers. Such a rich longitudinal data base will provide valuable information concerning not only the impact on individuals of participating in multiple intervention programs, but also on the mechanisms that sustain and enhance articulation between and among these programs.

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