

# Diversity in STEM

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### **NCRL subject guide 2018-20**

<https://doi.org/10.25923/bk7r-3m38>

December 2018



U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
Office of Oceanic and Atmospheric Research  
NOAA Central Library – Silver Spring, Maryland

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## **Background & Scope**

The 2018 Knauss Diversity Committee seeks to identify opportunities to increase the diversity (i.e., representation across the spectrum) of race, ethnicity, gender, sexuality, socioeconomic class, disability, religion, citizenship status, age, and country of origin, within the John A. Knauss Marine Policy Fellowship program. A broader goal of the Committee is to make recommendations to promote diversity, equity, and inclusion (DEI) across all NOAA gateway opportunities. This bibliography is intended to supplement the Committee's recommendation memo to the NOAA National Sea Grant College Program, and initiate dialogues on ways to facilitate the inclusion and integration of minorities in marine policy and STEM. It is an overview of preliminary resources and may be expanded or supplemented with further appendices.

### **Section I - Barriers**

Section one is intended to provide an overview of barriers that prevent minorities from entering STEM fields.

### **Section II – Case Studies**

Section two is intended to provide an overview of research on the benefits of diversity in STEM, as well as general research on increasing diversity in STEM.

### **Section III – Best Practices**

Section three is intended to provide information on best practices for increasing diversity in STEM.

### **Section IV – Application in Public Agencies**

Section four is intended to provide an overview of how public agencies are working to increase diversity in their ranks.

### **Section V – Policy Documents**

Section five is intended to provide an overview of policy documents on diversity in STEM.

### **Section VI – Mentoring**

Section six is intended to provide an overview of the role mentoring can play in increasing diversity in STEM.

## **Sources Reviewed**

Along with a web search for news items and other relevant materials the following databases were used to identify sources: Clarivate Analytics' Web of Science: Science Citation Index Expanded, ProQuest's Science and Technology, BioOne Complete, and JSTOR. Only English language materials were included. There was no date range specification in order to cover any relevant research.

## Section I: Barriers

McNeely, C. L., & Fealing, K. H. (2018). Moving the Needle, Raising Consciousness: The Science and Practice of Broadening Participation. *American Behavioral Scientist*, 62(5), 551-562. <https://doi.org/10.1177/0002764218768874>

Research foundations for broadening participation in science, technology, engineering, and mathematics (STEM) education and the workforce appear in several different strains of social science research. The science of broadening participation (SoBP) is necessary to inform a comprehensive understanding of what the pertinent issues are, why they occur, and how various organizations in academia, business, and government are creating pathways toward more diverse, inclusive, and productive entities. Inspired by and building upon the 2016 Symposium on the Science of Broadening Participation, this special issue is a compendium of articles that are representative of the various topics that formed the core of the discussions that took place and of recommendations that ensued from them. Focused on questions linked to increasing the participation and inclusion of women, minorities, and persons with disabilities in STEM fields, matters related to frameworks, measurement, education, and the workforce were explored with the aim of SoBP delineation and the determination of research-based approaches for policy development and implementation. Moreover, a set of challenges is presented for scholars, analysts, and other stakeholders to pursue in furthering and supporting SoBP goals.

Wilson, M. A., DePass, A., & Bean, A. J. (2018). Institutional Interventions That Remove Barriers to Recruit and Retain Diverse Biomedical PhD Students. *CBE Life Sci Educ*, 17(2), ar27. <https://doi.org/10.1187/cbe.17-09-0210>

The faculty and student populations in academia are not representative of the diversity in the U.S. Population. Thus, research institutions and funding agencies invest significant funds and effort into recruitment and retention programs that focus on increasing the flow of historically underrepresented minorities (URMs) into the science, technology, engineering, and mathematics (STEM) pipeline. Here, we outline challenges, interventions, and assessments by the University of Texas MD Anderson Cancer Center UTHealth Graduate School of Biomedical Sciences (GSBS) that increased the diversity of the student body independently of grade point averages and Graduate Record Examination scores. Additionally, we show these efforts progressively decreased the attrition rates of URM students over time while eliminating attrition in the latest cohort. Further, the majority of URM students who graduate from the GSBS are likely to remain in the STEM pipeline beyond the postdoctoral training period. We also provide specific recommendations based on the data presented to identify and remove barriers that prevent entry, participation, and inclusion of the underrepresented and underserved in the STEM pipeline.

Hurtado, S. N., C.B.; Tran, M.C.; Chang, M.J. (2016). Improving the Rate of Success for Underrepresented Racial Minorities in STEM Fields: Insights from a National Project. *New Directions for Institutional Research*. <https://doi.org/10.1002/ir.357>

Both the National Institutes of Health (NIH) and the National Science Foundation (NSF) have invested in research projects and other initiatives that seek to address the widely publicized “science crisis” facing our nation (National Academy of Sciences, 2007). They have also focused specifically on increasing the numbers of African Americans, Latinos, and Native Americans in

science-related fields, as their rates of participation in science, technology, engineering, and mathematics (STEM) fields lag behind White and Asian Americans (National Science Foundation, 2007). Much of this investment focuses on training and program grants to develop initiatives that aim to reverse the negative trends observed in the American science pipeline. Certainly colleges and universities can adopt more broadly the important lessons learned from these efforts.

Nia, H., Susan, K. J., & Dara, M. W. (2015). A Life-cycle Analysis of Minority Underrepresentation in Natural Resource Fields. *Wildlife Society Bulletin (2011-)*, 39(2), 228-238.  
<http://www.jstor.org/stable/wildsocibull2011.39.2.228>

Racial and ethnic diversity in natural resource careers does not reflect U.S. population trends. To explore potential drivers of underrepresentation in this field, we used a life-cycle analysis to review 55 scholarly articles to identify barriers and supports influencing career choices (i.e., personal, contextual, self-efficacy, outcome expectations) across 4 age groups. The number of cited barriers differed significantly among age groups. Personal influences included race or ethnicity, gender, age, and perceptions or predispositions toward nature. The latter was the most cited barrier for youth. Contextual influences included social, familial, structural, and experiential, and varied significantly between age groups. Exposure to nature was the most cited contextual barrier for all groups: 59% for youth, 40% for high school, 43% for college, and 50% for career. Self-efficacy was emphasized in studies referencing youth, high school, and college age groups, and outcome expectations were only discussed in studies of the career group. After the literature analysis, we reviewed web sites, reports, and conducted personal interviews to explore how 21 federal natural-resource agency diversity programs address variables influencing minority recruitment. Participating agencies reported challenges recruiting individuals, ensuring funding, and creating welcoming environments for minority participants, many of whom have never experienced remote natural environments or nontraditional careers. Our analysis revealed the need for a modified Framework for Career Influences. The proposed framework combines existing theories on social career choice and minority involvement in natural resource activities, but identifies personal and contextual influences that are important for minority students, as endogenous variables that influence and are influenced by self-efficacy and outcome expectations.

Campbell, A. G. S., R.; Wortis, H; Thomas, S.; Ichiro Kawachi, I. and Christine Hohmann. (2014). NEST 2014: Views from the Trainees—Talking About What Matters in Efforts to Diversify the STEM Workforce. *CBE—Life Sciences Education*, 13, 587-592.  
<https://doi.org/10.1187/cbe.14-04-0068>

Efforts to diversify the U.S. science, technology, engineering, and mathematics (STEM) workforce have been led by various stakeholders across all disciplines but most notably by the funding agencies and by the trainers (National Research Council [NRC], 2007, 2011; Tabak and Collins, 2011; Wilder et al., 2013). However, missing from this work and these conversations are the voices of the trainees at all levels. While this work has now begun to include the views and opinions of the postdoctoral community ([www.nationalpostdoc.org](http://www.nationalpostdoc.org)), rarely does it involve trainees at mid- and entry levels of the pipeline. Interest in faculty careers decreases as training progresses (Gibbs and Griffin, 2013). Additionally, given that the greatest diversity in the scientific community is found at the undergraduate level, followed by the post baccalaureate and graduate levels (Ramdial and Campbell, 2014), there is an urgent need to capture these unfiltered viewpoints that form the foundations for career decisions and actions.

LaVar, J. C., Sherri Ann, C., & Jerlando, F. L. J. (2014). Using Culturally Responsive Practices to Broaden Participation in the Educational Pipeline: Addressing the Unfinished Business of Brown in the Field of Computing Sciences. *The Journal of Negro Education*, 83(3), 400-419. <https://doi.org/10.7709/jnegroeducation.83.3.0400>

The effective integration of African American students into previously segregated careers was one of the main goals of the Brown decision and, in turn, the outcomes of such efforts have been the subject of much scholarly interest). This qualitative study, drawing on critical race theorist Derrick Bell's critique of Brown, makes the case for applying culturally relevant pedagogy theory (CRPT) to positively impact student achievement and career choice, particularly as it relates to the STEM field of computing sciences. Cultural barriers such as early exposure to technology, students' perceptions of their own potential in the field, and the lack of culturally relevant social support, often deter African American students from pursuing careers in STEM fields, particularly computing sciences. Although there is a dearth in the literature regarding how to expand the pipeline to computing sciences using culturally specific practices, this study produced results that suggest culturally responsive practices as an effective method for broadening participation in computing. Using CRPT, this qualitative study identifies culturally relevant practices that positively affect the persistence of African Americans in the STEM field of computing science.

## Section II: Case Studies

Garibay, J. C., & Vincent, S. (2018). Racially Inclusive Climates Within Degree Programs and Increasing Student of Color Enrollment: An Examination of Environmental/Sustainability Programs. *Journal of Diversity in Higher Education*, 11(2), 201-220. <https://doi.org/10.1037/dhe0000030>

Students of color remain severely underrepresented in many science, technology, engineering, and mathematics (STEM) disciplines, including environmental fields. Although there is a growing body of research on predictors of selecting a STEM major, generally, much less is known about factors, especially at the program level, that predict the enrollment of students of color into specific STEM degree programs. Additionally, theoretical frameworks and higher education research on college major choice have yet to consider whether the climate for racial/ethnic diversity specifically within academic degree programs may affect the enrollment of students of color in those programs. Given this theoretical and empirical gap, this study set out to investigate whether an inclusive climate for diversity within a degree program may contribute to an increasing enrollment of students of color in interdisciplinary environmental and sustainability (IES) degree programs. Using a national sample of 343 IES degree programs and extending dimensions of an inclusive campus climate for racial/ethnic diversity to degree programs, findings show that IES degree programs with a more inclusive curriculum and greater student compositional diversity are significantly more likely to report an increasing enrollment of students of color. Implications of the findings for broadening participation and understanding diverse students' college major/career choice are examined.

Hernandez, P. R., Woodcock, A., Estrada, M., & Schultz, P. W. (2018). Undergraduate Research Experiences Broaden Diversity in the Scientific Workforce. *BioScience*, 68(3), 204-211. <https://doi.org/10.1093/biosci/bix163>

New data highlight the importance of undergraduate research experiences (UREs) for keeping underrepresented science students on the pathway to a scientific career. We used a large-scale, 10-year, longitudinal, multi-institutional, propensity-score-matched research design to compare the academic performance and persistence in science of students who participated in URE(s) with those of similar students who had no research experience. Our results showed that students who completed 10 or more hours of co-curricular, faculty-mentored research per week across two or more academic semesters or summers were significantly more likely to graduate with a science-related bachelor's degree, to be accepted into a science-related graduate training program, and to be training for or working in the scientific workforce 6 years after graduation. Importantly, the findings show that just having a URE was not enough to influence persistence in science; it required a commitment of 10 or more hours per week over two or more semesters of faculty-mentored research.

Moss-Racusin, C. A. c. s. e., Pietri, E. S., Hennes, E. P., Dovidio, J. F., Brescoll, V. L., Roussos, G., & Handelsman, J. (2018). Reducing STEM Gender Bias With VIDS (Video Interventions for Diversity in STEM). *Journal of Experimental Psychology. Applied*, 24(2), 236-260. <https://doi.org/10.1037/xap0000144>

Gender biases contribute to the underrepresentation of women in STEM. In response, the scientific community has called for methods to reduce bias, but few validated interventions exist. Thus, an interdisciplinary group of researchers and filmmakers partnered to create VIDS (Video Interventions for Diversity in STEM), which are short videos that expose participants to empirical findings from published gender bias research in 1 of 3 conditions. One condition illustrated findings using narratives (compelling stories), and the second condition presented the same results using expert interviews (straightforward facts). A hybrid condition included both narrative and expert interview videos. Results of two experiments revealed that relative to controls, VIDS successfully reduced gender bias and increased awareness of gender bias, positive attitudes toward women in STEM, anger, empathy, and intentions to engage in behaviors that promote gender parity in STEM. The narratives were particularly impactful for emotions, while the expert interviews most strongly impacted awareness and attitudes. The hybrid condition reflected the strengths of both the narratives and expert interviews (though effects were sometimes slightly weaker than the other conditions). VIDS produced substantial immediate effects among both men and women in the general population and STEM faculty, and effects largely persisted at follow-up.

Ong, M., Smith, J. M., & Ko, L. T. (2018). Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. *Journal of Research in Science Teaching*, 55(2), 206-245. <https://doi.org/10.1002/tea.21417>

Counterspaces in science, technology, engineering, and mathematics (STEM) are often considered “safe spaces” at the margins for groups outside the mainstream of STEM education. The prevailing culture and structural manifestations in STEM have traditionally privileged norms of success that favor competitive, individualistic, and solitary practices—norms associated with White male scientists. This privilege extends to structures that govern learning and mark progress in STEM education that have marginalized groups that do not reflect the gender, race, or ethnicity conventionally associated with STEM mainstream success, thus necessitating spaces in which the effects of marginalization may be countered. Women of color is one such marginalized group. This article explores the struggles of women of color that threaten their persistence in STEM education

and how those struggles lead them to search out or create counterspaces. It also examines the ways that counterspaces operate for women of color in STEM higher education, particularly how they function as havens from isolation and microaggressions. Using a framework of Critical Race Theory (CRT) and intersectionality theory and drawing on interview data from 39 women of color about their STEM higher education experiences, we describe five ways in which counterspaces operate: in peer-to-peer relationships; mentoring relationships; national STEM diversity conferences; STEM and non-STEM campus student groups; and STEM departments. Whereas most research has discussed counterspaces as racially or ethnically homogeneous social groups of peers at the margins, our research found that counterspaces vary in terms of the race/ethnicity, gender, and power levels of participants. We found that counterspaces can be physical settings, as well as conceptual and ideological. Additionally, we identified counterspaces both at the margins and at the center of STEM departments. Thus, our research expands the existing understanding of the types and functions of counterspaces and broadens the definition of what locations can be and should be considered counterspaces.

Torres, W. J., Gilberto, J. M., & Beier, M. E. (2018). Using Funds of Knowledge to Address Diversity Issues in STEM. *Industrial and Organizational Psychology*, 11(02), 335-339.

<https://doi.org/10.1017/iop.2018.26>

Miner et al. (2018) call for industrial and organizational (I-O) psychologists to examine the societal structures that influence women's underrepresentation in STEM. Here we extend their ideas and suggest that diversity in STEM would benefit from considering how people develop within the context of their environment. Educational researchers refer to the knowledge people develop through daily experiences with their cultural milieu as funds of knowledge. Funds of knowledge essentially represent a person's expertise, and educational researchers have recognized that designing environments that draw from expertise facilitates success for students, including women and underrepresented minorities in STEM. Here we (a) describe the funds of knowledge framework, (b) highlight the value of this framework in facilitating success in STEM, and (c) suggest a research agenda for using funds of knowledge to address diversity issues in STEM schools and organizations. Our contribution is in introducing funds of knowledge as a viable framework for examining the success of women and underrepresented minorities in STEM and more generally as a useful approach in I-O psychology.

Winkle-Wagner, R., & McCoy, D. L. (2018). Feeling like an "Alien" or "Family"? Comparing students and faculty experiences of diversity in STEM disciplines at a PWI and an HBCU. *Race, Ethnicity & Education*, 21(5), 593-606. <https://doi.org/10.1080/13613324.2016.1248835>

This qualitative exploration of diversity experiences among undergraduate and graduate students and faculty in STEM disciplines at a predominantly White institution (PWI) and a historically Black college or university (HBCU) in a Mid-Atlantic state finds that the level of diversity and inclusiveness may matter to how Students of Color experience inclusion in their academic programs. Participants at the PWI described feeling excluded, voicing concerns about institutional struggles with creating an inclusive campus climate; whereas, participants at the HBCU perceived STEM disciplines to be diverse and viewed their programs and the institution as supportive of their needs.

Shishkova, E., Kwecien, N. W., Hebert, A. S., Westphall, M. S., Prenni, J. E., & Coon, J. J. (2017). Gender



Diversity in a STEM Subfield - Analysis of a Large Scientific Society and Its Annual Conferences. *J Am Soc Mass Spectrom*, 28(12), 2523-2531.

<https://doi.org/10.1007/s13361-017-1803-z>

Speaking engagements, serving as session chairs, and receiving awards at national meetings are essential stepping stones towards professional success for scientific researchers. Studies of gender parity in meetings of national scientific societies repeatedly uncover bias in speaker selection, engendering underrepresentation of women among featured presenters. To continue this dialogue, we analyzed membership data and annual conference programs of a large scientific society (>7000 members annually) in a male-rich (~70% males), technology-oriented STEM subfield. We detected a pronounced skew towards males among invited keynote lecturers, plenary speakers, and recipients of the society's Senior Investigator award (15%, 13%, and 8% females, respectively). However, the proportion of females among Mid-Career and Young Investigator award recipients and oral session chairs resembled the current gender distribution of the general membership. Female members were more likely to present at the conferences and equally likely to apply and be accepted for oral presentations as their male counterparts. The gender of a session chair had no effect on the gender distribution of selected applicants. Interestingly, we identified several research subareas that were naturally enriched (i.e., not influenced by unequal selection of presenters) for either female or male participants, illustrating within a single subfield the gender divide along biology-technology line typical of all STEM disciplines. Two female-enriched topics experienced a rapid growth in popularity within the examined period, more than doubling the number of associated researchers. Collectively, these findings contribute to the contemporary discourse on gender in science and hopefully will propel positive changes within this and other societies. Graphical abstract.

Briggs, C. (2016). The Policy of STEM Diversity: Diversifying STEM Programs in Higher Education. *Journal of STEM Education: Innovations & Research*, 17(4), 5-7.

<https://www.jstem.org/index.php/JSTEM/article/download/2167/1820>

The article discusses the diversification of STEM programs in the U.S. higher education. Topics include the importance of broader participation in STEM programs to improve American competitiveness in STEM education, goal of the National Science Foundation (NSF), and results of a 2013 study by the Program for the International Assessment of Adult Competencies (PIAAC).

Dobbin, F., & Kalev, A. (2016). Why Diversity Programs Fail. *Harvard Business Review* (July/August).

<https://hbr.org/2016/07/why-diversity-programs-fail>

It shouldn't be surprising that most diversity programs aren't increasing diversity. Despite a few new bells and whistles, courtesy of big data, companies are basically doubling down on the same approaches they've used since the 1960s - which often make things worse, not better.

Rincon, B. E., & George-Jackson, C. E. (2016). STEM intervention programs: funding practices and challenges. *Studies in Higher Education*, 41(3), 429-444.

<https://doi.org/10.1080/03075079.2014.927845>

This study examines the funding practices and challenges of diversity initiatives found in the science, technology, engineering, and mathematics (STEM) fields. Interviews with 55 intervention

program administrators, representing 48 unique STEM intervention programs, were conducted at nine large research-intensive universities. The interviews, which examined the design, structure, implementation, and funding challenges of STEM interventions, revealed that institutional funding priorities often run counter to national efforts to increase diversity within STEM. As institutions face budget cuts and reduced external funding, institutional support of STEM interventions reflects the university's commitment (or lack thereof) to diversifying the STEM fields. Many programs struggled with changes in funding over time, inadequate staffing and service delivery, and long-term program sustainability.

Unkovic, C., Sen, M., & Quinn, K. M. (2016). Does Encouragement Matter in Improving Gender Imbalances in Technical Fields? Evidence from a Randomized Controlled Trial. *PLoS ONE*, 11(4), e0151714. <https://doi.org/10.1371/journal.pone.0151714>

Does encouragement help address gender imbalances in technical fields? We present the results of one of the first and largest randomized controlled trials on the topic. Using an applied statistics conference in the social sciences as our context, we randomly assigned half of a pool of 3,945 graduate students to receive two personalized emails encouraging them to apply (n = 1,976) and the other half to receive nothing (n = 1,969). We find a robust, positive effect associated with this simple intervention and suggestive evidence that women responded more strongly than men. However, we find that women's conference acceptance rates are higher within the control group than in the treated group. This is not the case for men. The reason appears to be that female applicants in the treated group solicited supporting letters at lower rates. Our findings therefore suggest that "low dose" interventions may promote diversity in STEM fields but may also have the potential to expose underlying disparities when used alone or in a non-targeted way.

Holland, S. I. M. a. K. J. (2015). You, Me, or Her: Leaders' Perceptions of Responsibility for Increasing Gender Diversity in STEM Departments. 39(2), 210-215. <https://doi.org/10.1177/0361684314537997>

We examined how university leaders described what and who needed to change in order to increase the representation of female faculty in science, technology, engineering, and math (STEM) departments. Thirty-one (28 men and 3 women) STEM departmental chairs and deans at a large, public university participated in semi-structured interviews. Data were examined using both qualitative and quantitative procedures. Analysis focused on participants' descriptions of responsibility for changes related to gender equity. Using the distinction of high versus low responsibility, themes were examined for their qualitative characteristics as well as their frequency. Leaders who exhibited high personal responsibility most frequently saw themselves as needing to change and also named their male colleagues as concurrently responsible for diversity. Conversely, leaders who exhibited low personal responsibility most frequently described female faculty as responsible and described women's attitudes and their "choice" to have a family as obstacles to gender diversity in STEM. We argue that the dimensions of high and low responsibility are useful additions to discussions of leadership, workplace diversity initiatives, and gender equity more broadly. To this end, we provide several methodological tools to examine these subtle, yet essential, aspects of how diversity and change efforts are imagined and discussed.

American Association of American Colleges & Universities. (2014). AAC&U Work on Diversity, Equity, and STEM. *Peer Review*, 16(2), 28-28.

<https://www.aacu.org/peerreview/2014/spring>

The article focuses on the projects of the Association of American Colleges and Universities (AAC&U). It includes the Project Kaleidoscope (PKAL) which is the center of STEM higher education reform of AAC&U to empower STEM faculty and to develop a scientifically literate citizenry. It adds Teaching to Increase Diversity and Equity in STEM (TIDES) initiative which supports curriculum and faculty development activities.

Whittaker, J., & Montgomery, B. (2014). Cultivating Institutional Transformation and Sustainable STEM Diversity in Higher Education through Integrative Faculty Development. *Innovative Higher Education*, 39(4), 263-275. <https://doi.org/10.1007/s10755-013-9277-9>

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.

Malcom, S. M., & Malcom-Piqueux, L. E. (2013). Critical Mass Revisited: Learning Lessons From Research on Diversity in STEM Fields. *Educational Researcher*, 42(3), 176-178. <https://doi.org/10.3102/0013189X13486763>

Numerous legal scholars and social scientists have highlighted the ways in which research has informed judicial decision making (e.g., Dunn & West, 2008; Morgan & Pullin, 2010; Moses & Marin, 2006). Because, in part, of convincing empirical research presented in several landmark cases (e.g., Grutter v. Bollinger, 2003; Parents Involved in Community Schools v. Seattle School District No. 1, 2007), the consideration of race in educational policies has been deemed permissible, albeit in limited, narrowly tailored ways. Grutter also represented an affirmation of the importance of research for social scientists whose work provided empirical evidence of the educational benefits of diversity and the importance of a “critical mass” of underrepresented students, which served as a basis for the Court’s decision. Although the Court upheld the University of Michigan Law School’s admissions policy in Grutter, the opinion of the Court also stated the expectation that race would no longer need to be considered in a generation’s time. However, as evidenced by the oral arguments of Fisher v. University of Texas, which came just 9 years after Grutter, time may be running short for race-conscious admissions.

Wyatt-Nichol, H., & Badu Antwi-Boasiako, K. (2012). Diversity Management: Development, Practices, and Perceptions among State and Local Government Agencies. *Public Personnel Management*, 41(4), 749-772. <http://journals.sagepub.com/doi/abs/10.1177/009102601204100409>

As diversity increases among citizens and employees, human resource practitioners in the public sector have come to view diversity management strategies as essential for the effective performance of organizations. An examination of best practices among private and public

organizations reveals common components necessary for successful diversity initiatives. While there have been numerous studies on diversity management in the federal government, far less is known about diversity management at the state and local level. In light of the best practices research on the factors necessary for successful diversity management, this study examines the extent of diversity initiatives at various state and local government agencies. Measures used to develop diversity strategies, diversity management practices, professional development initiatives, organizational policies, and perceptions of effectiveness are considered. The findings demonstrate a few variations based on level of government, region, and size of agency. In addition, the majority of respondents believed that the organization's diversity strategy was effective at recruitment, retention, development, and promotion; however, there was uncertainty about the effectiveness of the diversity strategy on organizational performance.

Hill, P., Shaw, R., Taylor, J., & Hallar, B. (2011). Advancing Diversity in STEM. *Innovative Higher Education*, 36(1), 19-27. <https://doi.org/10.1007/s10755-010-9154-8>

Though progress has been made, greater efforts are needed to promote faculty diversity at the college and university levels, especially in STEM fields. Thus, it is important to elucidate best practices both for increasing awareness of diversity issues pertaining to higher education and for implementing change. This article focuses on the outcomes of a diversity workshop for college and university faculty hosted by the West Virginia Higher Education Policy Commission, Division of Science and Research. More specifically, it elucidates how participation in the workshop translated into practice at the faculty participants' home institutions.

Palmer, R. T., Maramba, D. C., & Dancy, T. E. (2011). A Qualitative Investigation of Factors Promoting the Retention and Persistence of Students of Color in STEM. *The Journal of Negro Education*, 80(4), 491-504. <http://www.jstor.org/stable/41341155>

The literature on science, technology, engineering, and mathematics (STEM) is abounding with the importance of increasing college access, retention, and persistence among students because of implications for America's global competitiveness. Particular emphasis has been placed on college students of color who remain underrepresented in STEM education. Therefore, increasing college access, retention, and persistence for students of color in STEM is not merely a matter of United States' economic competitiveness, but also a matter of equity. Using in-depth interview methods, this article delineates factors facilitating the retention and persistence of students of color in STEM education at a predominantly White institution. Implications for institutional practice and research are provided.

Dobbin, F., and Alexandra Kalev. (2007). The architecture of inclusion: evidence from corporate diversity programs. *Harvard Journal of Law & Gender*, 30(2), 279-301. <http://nrs.harvard.edu/urn-3:HUL.InstRepos:11315423>

Ever since the Civil Rights Act of 1964 outlawed employment discrimination, governments, colleges, and corporations have tried to understand what the law means. Employers have tried to integrate workforces, some with more enthusiasm than others. Change has been slower than those who passed the Civil Rights Act might have imagined it would be. Given the slow progress in the academy, National Science Foundation ("NSF") deputy director Joseph Bordogna designed the ADVANCE program in 1999 to promote the integration of women in the science and engineering

fields that the NSF funds. In 2001, ADVANCE, under the leadership of Alice Hogan, considered the first round of applications for grants for institutional change. The typical grant lasts for five years and provides several million dollars to colleges and universities that propose institutional changes to promote women in science and engineering. As with most efforts to reduce gender segregation in the government, academia, and the corporate world, ADVANCE has been little studied for evidence of its efficacy. Now some twenty programs have been initiated, and we have the opportunity to observe which strategies have succeeded and which have not. Susan Sturm provides the first systematic analysis of a landmark program, one that has clocked some of the greatest gains for women to date, at the University of Michigan.

Tsui, L. (2007). Effective Strategies to Increase Diversity in STEM Fields: A Review of the Research Literature. *The Journal of Negro Education*, 76(4), 555-581.  
<http://www.jstor.org/stable/40037228>

This literature review presents the research evidence that exists for ten intervention strategies commonly adopted by programmatic efforts striving to increase diversity in science, technology, engineering, and mathematics (STEM) fields. Also presented is empirical support for three model intervention programs: The Meyerhoff Program, Minority Engineering Program (MEP), and the Mathematics Workshop. The article concludes with a discussion of recommendations for future action and research in this area.

Uriarte, M., Ewing, H. A., Eviner, V. T., & Weathers, K. C. (2007). Constructing a Broader and More Inclusive Value System in Science. *BioScience*, 57(1), 71-78.  
<https://doi.org/10.1641/B570111>

A scientific culture that welcomes a diversity of participants and addresses a broad range of questions is critical to the success of the scientific enterprise and essential for engaging the public in science. By favoring behaviors and practices that result in a narrow set of outcomes, our current scientific culture may lower the diversity of the scientific workforce, limit the range and relevance of scientific pursuits, and restrict the scope of interdisciplinary collaboration and public engagement. The scientific community will reach its full intellectual potential and secure public support through thorough, multi-tiered initiatives that aim to change individual and institutional behaviors, shift current reward structures to reflect a wider set of values, and explicitly consider societal benefits in the establishment of research agendas. We discuss some shortcomings and costs of the current value system and provide some guidelines for the development of initiatives that transcend such limitations.

Kalev, A., Kelly, E., & Dobbin, F. (2006). Best Practices or Best Guesses? Assessing the Efficacy of Corporate Affirmative Action and Diversity Policies. *American Sociological Review*, 71(4), 589-617. <http://www.jstor.org/stable/30039011>

Employers have experimented with three broad approaches to promoting diversity. Some programs are designed to establish organizational responsibility for diversity, others to moderate managerial bias through training and feedback, and still others to reduce the social isolation of women and minority workers. These approaches find support in academic theories of how organizations achieve goals, how stereotyping shapes hiring and promotion, and how networks influence careers. This is the first systematic analysis of their efficacy. The analyses rely on federal

data describing the workforces of 708 private sector establishments from 1971 to 2002, coupled with survey data on their employment practices. Efforts to moderate managerial bias through diversity training and diversity evaluations are least effective at increasing the share of white women, black women, and black men in management. Efforts to attack social isolation through mentoring and networking show modest effects. Efforts to establish responsibility for diversity lead to the broadest increases in managerial diversity. Moreover, organizations that establish responsibility see better effects from diversity training and evaluations, networking, and mentoring. Employers subject to federal affirmative action edicts, who typically assign responsibility for compliance to a manager, also see stronger effects from some programs. This work lays the foundation for an institutional theory of the remediation of workplace inequality.

U.S. Government Accountability Office. (2005). *Diversity Management: Expert-Identified Leading Practices and Agency Examples: GAO-05-90*. <https://www.gao.gov/new.items/d0590.pdf>

A high-performance organization relies on a dynamic workforce with the requisite talents, multidisciplinary knowledge, and up-to-date skills to ensure that it is equipped to accomplish its mission and achieve its goals. Such organizations typically (1) foster a work environment in which people are enabled and motivated to contribute to mission accomplishment and (2) provide both accountability and fairness for all employees. To accomplish these objectives, high-performance organizations are inclusive, drawing on the strengths of employees at all levels and of all backgrounds—an approach consistent with diversity management. For purposes of our review, diversity management is defined as a process intended to create and maintain a positive work environment where the similarities and differences of individuals are valued, so that all can reach their potential and maximize their contributions to an organization's strategic goals and objectives. As part of a request that GAO report on the federal government's performance in managing its diverse workforce, GAO was asked to identify (1) leading diversity management practices and (2) examples of the identified practices in the federal government. This report contains no recommendations.

Pascarella, E. T., Whitt, E. J., Edison, M. I., Nora, A., & Hagedorn, L. S. (1997). *Women's Perceptions of a "Chilly Climate" and Their Cognitive Outcomes During the First Year of College*. [https://works.bepress.com/linda\\_hagedorn/21/](https://works.bepress.com/linda_hagedorn/21/)

In this study of 2- and 4-year colleges, the extent to which women students' perceptions of a "chilly campus climate" were related to first-year cognitive outcomes was investigated at 23 institutions. After a variety of potentially confounding influences were controlled for, several negative relationships were found between perceived chilly climates and women's cognitive growth. The negative relationships were more pronounced for women attending 2-year colleges than for their counterparts at 4-year institutions.

### **Section III: Best Practices**

Bellman, S., Burgstahler, S., & Chudler, E. H. (2018). Broadening Participation by Including More Individuals With Disabilities in STEM: Promising Practices from an Engineering Research Center. *American Behavioral Scientist*, 62(5), 645-656. <https://doi.org/10.1177/0002764218768864>

This article describes successful practices for including individuals with disabilities (e.g., leaders, students, faculty researchers, advisory board members) in the Center for Sensorimotor Neural Engineering (CSNE), an Engineering Research Center funded by the National Science Foundation. The methods, tools, and materials presented in this article can be used by others seeking to increase the inclusion of individuals with disabilities in postsecondary science, technology, engineering, and mathematics (STEM) programs. Methods are employed to ensure that the CSNE is welcoming and accessible to individuals with a wide range of abilities and to recruit individuals with disabilities into significant roles that support the Center's mission. These efforts have resulted in the engagement of individuals with disabilities in the Center's operations, activities, and research at a higher rate when compared with all Engineering Research Centers.

Booth, S. Boudreau, M. (2018). Canada Research Chairs - Equity, Diversity and Inclusion Practices. Retrieved from <http://www.chairs-chaires.gc.ca/program-programme/equity-equite/index-eng.aspx>

The Government of Canada and the Canada Research Chairs Program (CRCP) are committed to excellence in research and research training for the benefit of Canadians. Achieving a more equitable, diverse and inclusive Canadian research enterprise is also essential to creating the excellent, innovative and impactful research necessary to seize opportunities and for responding to global challenges. As such, the program is committed to the federal government's policies on non-discrimination and employment equity.

Chapman, R. N. (2018). The Thrive Mosaic Developmental Framework: A Systems Activist Approach to Marginalized STEM Scholar Success. *American Behavioral Scientist*, 62(5), 600-611. <https://doi.org/10.1177/0002764218768859>

The science of broadening participation explains how science thrives with appropriate frameworks for addressing complex issues. This article presents a developmental framework for equitable STEM scholar development, access, and opportunity. Few issues in academia are more complex than ensuring all scholars can thrive without unwarranted obstacles of intentional disruption or benign indifference. The Thrive Mosaic developmental framework coalesces the best elements of a scholar's networks to support scholar development, advocacy, and self-care, while also working to forestall systemic marginalization and obstructionist practices. The framework uses a systems thinking approach where aspects of the ecology of academia important to scholar success are conceptualized as systems that can be adapted to benefit the scholar and support scholar activism. The goal is to mitigate environmental internal and external factors that impede scholar success. Thrive Mosaic is both a resource and a tool for realizing scholar thriving, particularly within privileged and noncollegial environments.

Wiley, C., & Monllor-Tormos, M. (2018). Board Gender Diversity in the STEM&F Sectors: The Critical Mass Required to Drive Firm Performance. *Journal of Leadership & Organizational Studies*, 25(3), 290-308. <https://doi.org/10.1177/1548051817750535>

This study investigates the link between board gender diversity (BGD) and firm performance (FP). The analysis is conducted using Fortune 500 firms in the Science, Technology, Engineering, Mathematics, and Finance (STEM&F) sectors covering a period of seven years, from 2007 to 2013.

The theoretical framework combines several theories that give shape to the critical mass effect of BGD on FP. This shape shows that below the critical mass threshold, BGD may represent a disadvantage to the board as it may facilitate the formation of subgroups, dysfunctional conflicts, and distrust. However, at or above the critical mass threshold, BGD facilitates better monitoring of management, greater resource provisions, and divergent thinking. To ensure sound results, this study addresses endogeneity concerns regarding omitted variable bias, reverse causality, and dynamic endogeneity. These results support a significant U-shaped relationship between the number of female directors and FP in the STEM&F sectors. That is, BGD yields higher FP when there is a critical mass of women on the board. This finding remains robust when alternative proxies for BGD and FP are employed and is consistent with the predictions of our theoretical framework. Our analysis also reveals that the positive effect of BGD on FP increases when there is at least a critical mass of 30% of women on a corporate board. This finding suggests that boards that have reached a critical mass of 30% of women present a favorable environment to capitalize on innovative ideas arising from BGD.

Allen-Ramdial, S.-A. A., & Campbell, A. G. (2014). Reimagining the Pipeline: Advancing STEM Diversity, Persistence, and Success. *BioScience*, 64(7), 612-618.  
<https://doi.org/10.1093/biosci/biu076>

Achieving trainee diversity in science, technology, engineering, and mathematics is rapidly becoming a challenge faced by many nations. Success in this area ensures the availability of a workforce capable of engaging in scientific practices that will promote increased production capacity and creativity and will preserve global scientific competitiveness. The near-term vision of achieving this goal is within reach and will capitalize on the growing numbers of underrepresented minority groups in the population. Although many nations have had remarkable histories as leaders in science and technology, few have simultaneously struggled with the challenge of meeting the educational and training needs of underrepresented groups. In this article, we share strategies for building the agency of the scientific community to achieve greater diversity by highlighting four key action areas: (1) aligning institutional culture and climate; (2) building interinstitutional partnerships; (3) building and sustaining critical mass; and (4) ensuring, rewarding, and maximizing faculty involvement.

Fine, E., & Handelsman, J. (2012). *Searching for Excellence & Diversity: a Guide for Search Committees at the University of Wisconsin-Madison* (Second ed.). Madison, WI: WISELI (Women in Science & Engineering Leadership Institute).

Hiring and retaining an excellent and diverse faculty is a top priority for colleges and universities nationwide. Vast amounts of time and considerable monetary resources are devoted to searching for and hiring new faculty. If the search is successful and results in the hiring of productive faculty who make valuable and lasting contributions to the discipline and the university, the time and money are well spent. If the search is unsuccessful or newly hired faculty members do not remain in their positions, the time, effort, and expenses incurred in conducting repeated searches can become burdensome. Consequently, many universities are looking critically at their hiring processes and are recognizing that faculty search committees receive little education about the process. These schools are implementing programs to provide faculty with information, advice, and techniques that will help them attract excellent and diverse applicant pools, conduct fair and equitable evaluations, and successfully hire new faculty members who will contribute to the excellence and diversity of their institutions. This guidebook serves as a supplement to workshops



the Women in Science and Engineering Leadership Institute (WISELI) provides for faculty search committees at the University of Wisconsin-Madison and as a resource for individual members of search committees.

Charvat, L. J. (2009). *Exemplary Practices in Equity and Diversity Programming*.  
[https://equity.ubc.ca/files/2010/06/exemplary\\_practices\\_in\\_-equity\\_-and\\_diversity\\_programming\\_UBCV.pdf](https://equity.ubc.ca/files/2010/06/exemplary_practices_in_-equity_-and_diversity_programming_UBCV.pdf)

Diversity and equity matter at the University of British Columbia. Fostering and sustaining diversity and equity are critical to UBC's strategic mission, which is to "provide its students, faculty, and staff with the best possible resources and conditions for learning and research, and create a working environment dedicated to excellence, equity, and mutual respect." This matters not only to the current state of affairs within the University community, but also to securing UBC's place in the university and global arena of tomorrow. Compliance and meeting global targets notwithstanding, UBC is committed to and actively working towards equity and diversity because it is the right thing to do.

DiBartolo, P. M., Gregg-Jolly, L., Gross, D., Manduca, C. A., Iverson, E., Cooke, D. B., . . . Swartz, J. E. Principles and Practices Fostering Inclusive Excellence: Lessons from the Howard Hughes Medical Institute's Capstone Institutions. *CBE Life Sci Educ*, 15(3).  
<https://doi.org/10.1187/cbe.16-01-0028>

Best-practices pedagogy in science, technology, engineering, and mathematics (STEM) aims for inclusive excellence that fosters student persistence. This paper describes principles of inclusivity across 11 primarily undergraduate institutions designated as Capstone Awardees in Howard Hughes Medical Institute's (HHMI) 2012 competition. The Capstones represent a range of institutional missions, student profiles, and geographical locations. Each successfully directed activities toward persistence of STEM students, especially those from traditionally underrepresented groups, through a set of common elements: mentoring programs to build community; research experiences to strengthen scientific skill/identity; attention to quantitative skills; and outreach/bridge programs to broaden the student pool. This paper grounds these program elements in learning theory, emphasizing their essential principles with examples of how they were implemented within institutional contexts. We also describe common assessment approaches that in many cases informed programming and created traction for stakeholder buy-in. The lessons learned from our shared experiences in pursuit of inclusive excellence, including the resources housed on our companion website, can inform others' efforts to increase access to and persistence in STEM in higher education.

#### **Section IV: Application in Public Agencies**

Joshi, A. M., Inouye, T. M., & Robinson, J. A. (2018). How does agency workforce diversity influence Federal R&D funding of minority and women technology entrepreneurs? An analysis of the SBIR and STTR programs, 2001–2011. *Small Business Economics*, 50(3), 499-519.  
<https://doi.org/10.1007/s11187-017-9882-6>

US Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)

programs provide Federal research and development (R&D) grants to technology ventures. We explore how grantor demographic diversity explains why demographically diverse grantees experience different odds for successfully transitioning from initial to follow-on R&D grants. We empirically analyze 52,126 Phase I SBIR/STTR awards granted by 11 Federal agencies (2001–2011). We find a positive association between agency workforce diversity and Phase II funding for Phase I grantees, but minority and women technology entrepreneurs are less likely to receive this funding than their non-minority and male counterparts. Agencies valuing workforce ethnic diversity or leveraging gender homophily positively influence the likelihood of women technology entrepreneurs obtaining Phase II funding. We discuss evidence-based implications for policy and practice.

Lewis, G. B., & Pitts, D. W. (2017). LGBT–Heterosexual Differences in Perceptions of Fair Treatment in the Federal Service. *The American Review of Public Administration*, 47(5), 574-587. <https://doi.org/10.1177/0275074015605378>

Although we still lack objective data on treatment of lesbians, gays, bisexuals, and transgenders (LGBTs) in the federal service, a huge recent survey of federal employees allows us to compare LGBT and heterosexual employees' perceptions of the treatment they receive. LGBTs have several reasons for more negative perceptions of their treatment: 70 years of federal policies that explicitly discriminated against LGBTs in large and small ways; sizable minorities who still condemn homosexuality even as public attitudes are increasingly accepting; and continuing pay gaps between comparably educated and experienced gay, bisexual, and transgender (GBT) and heterosexual men in the general economy. We examine differences in satisfaction with pay, performance appraisals, promotions, raises, prohibited personnel practices, commitment to diversity, agency leadership, and relationships with supervisors and co-workers. LGBTs are less satisfied with their treatment across the board.

Moon, K.-K. (2017). The Effects of Diversity and Transformational Leadership Climate on Organizational Citizenship Behavior in the U.S. Federal Government: An Organizational-Level Longitudinal Study. *Public Performance & Management Review*, 40(2), 361-381. <https://doi.org/10.1080/15309576.2016.1216002>

Although interpersonal conflicts caused by social categorization processes in diversified workforces impede organizational citizenship behavior (OCB), little empirical research has been conducted on managing employee diversity in public sector organizations. Using panel data from the U.S. federal government, this article examines how bio-demographic (i.e., gender and race) and job-related (i.e., functional background and tenure status) diversity affect OCB at the organizational level and how a transformational leadership (TFL) climate moderates these relationships. The results showed that gender and functional diversity are negatively associated with OCB. When moderated by TFL, relationships were weakened. However, both racial climate and tenure diversity and their interactions with TFL climate yielded mixed results. Overall, this article provides evidence for the significant role of TFL climate in encouraging diverse employees to perform beyond their job roles.

Werblin, S., & Muhammad, D. (2014). Congress, Banking and the Politics of Diversity. *Crisis* (15591573), 121(4), 44-45. [https://www.huffingtonpost.com/dedrick-muhammad/congress-banking-and-the\\_b\\_5508999.html](https://www.huffingtonpost.com/dedrick-muhammad/congress-banking-and-the_b_5508999.html)

The article discusses the establishment of U.S. government entities known as Offices of Minority and Women Inclusion (OMWIs) by the 2010 legislation the Dodd-Frank financial reform law. According to the article, OMWIs were established in U.S. financial regulatory agencies. The article examines the significance of OMWIs, support for OMWIs by the U.S. Congress and agency leadership, and the progress of OMWIs since 2010 in expanding the financial industry to include women and minorities.

Elias, N. M. R. (2013). Shifting Diversity Perspectives and New Avenues for Representative Bureaucracy. *Public Administration Quarterly*, 37(3), 331-373.

[https://www.jstor.org/stable/24372111?seq=1#page\\_scan\\_tab\\_contents](https://www.jstor.org/stable/24372111?seq=1#page_scan_tab_contents)

This work explores the meaning of diversity for bureaucratic representation. In light of the United States becoming an increasingly racially and ethnically diverse society, attitudes and approaches toward diversity are likewise shifting. It is important to consider the way we think and talk about diverse representation, which in turn, contributes to different actions and policies within federal agencies. To evaluate this process of meaning-making, federal policy seeking to increase representation in the following Executive Orders: 13078, 13163, 13171, 13518, 13548, and 13585 is analyzed. Prime emphasis is devoted to the most recent and comprehensive efforts, Executive Order 13583: Establishing a Coordinated Government-wide Initiative to Promote Diversity and Inclusion in the Federal Workforce issued on August 18, 2011 and the Government-wide Diversity and Inclusion Strategic Plan. This research demonstrates significant implications for management and governance, particularly in the text, discursive practice, and social practice surrounding the meaning of "diversity" purported for the federal bureaucracy.

Lim, N., Haddad, A., Butler, D. M., & Giglio, K. (2013). Current DoD STEM Initiatives. In N. Lim, A. Haddad, D. M. Butler, & K. Giglio (Eds.), *First Steps Toward Improving DoD STEM Workforce Diversity* (pp. 31-58): RAND Corporation.

<http://www.jstor.org/stable/10.7249/j.ctt5vjw4b.12>

Over the course of the Summit, leaders from the Armed Forces presented descriptions of programs designed specifically to develop qualified STEM professionals from the U.S. population. In this chapter, we offer some initial observations and analysis drawn from the presentations and the information made available to us after the Summit. We do not include all programs discussed or presented at the Summit; for example, the programs developed or sponsored by Historically Black Colleges and Universities (HBCUs) that were discussed are not represented, as we limit our focus to those programs for which DoD has primary responsibility.

Rainey, M. (2012). A Shining Example. *INSIGHT into Diversity*(Winter), 6-10.

The article provides information on the National Institutes of Health (NIH) of the U.S. Dept. of Health & Human Services (DHHS) that uses a multi-faceted strategy to promote the diversity of the country. An overview of the department's practice of diversity and inclusion which become its main point of service is offered. It highlights the Office of Equal Opportunity and Diversity Management (OEODM) management system of NIH directed by Lawrence N. Self.

Choi, S. (2011). Diversity and Representation in the U.S. Federal Government: Analysis of the

Trends of Federal Employment. *Public Personnel Management*, 40(1), 25-46.

This article aims to describe the trends in the current federal employment with regard to diversity and representation. To do so, it examines the diversity and representation of federal employee populations by agency and by pay or grade level. While the federal government has been successful in diversifying its employee populations by employing women and minorities, their employment still appears to be concentrated on the lower- and middle-level positions, resulting in large underrepresentation at the higher managerial and executive levels. This study, by analyzing the 2004 demographic data of federal employees by agency and by grade level, evaluates the horizontal and vertical integration of women and minorities in the federal government. The findings show that while race or gender groups in the federal government are equally represented across federal agencies, women and minorities are still underrepresented at the higher echelons. This article provides insight into improving the representation of women and minorities in the federal government.

Pitts, D. (2009). Diversity Management, Job Satisfaction, and Performance: Evidence from U.S. Federal Agencies. *Public Administration Review*. <https://doi.org/10.1111/j.1540-6210.2008.01977.x>

A number of organizations across sectors have begun efforts toward managing workforce diversity. At the federal level in the United States, almost 90 percent of agencies report that they are actively managing diversity. However, very little empirical research has tied diversity management to work group performance or other work-related outcomes. This paper uses a survey of U.S. federal employees to test the relationships between diversity management, job satisfaction, and work group performance. The findings indicate that diversity management is strongly linked to both work group performance and job satisfaction, and that people of color see benefits from diversity management above and beyond those experienced by white employees.

Naff, K. C., & Kellough, J. E. (2003). Ensuring Employment Equity: Are Federal Diversity Programs Making a Difference? *International Journal of Public Administration*, 26(12), 1307-1336. <https://doi.org/10.1081/pad-120024399>

In the last two decades, many public sector agencies have instituted a wide array of “managing diversity” programs designed to remove barriers to the full participation of women and people of color. Meanwhile, agencies are also increasingly responding to pressure to develop measures to monitor performance of all of their programs. Yet there have been few efforts in place to measure the effectiveness of diversity management programs. This article argues that such an evaluation is essential, and offers a preliminary government wide estimation of the success federal agencies have had in breaking down these barriers. We found, for the most part, that there is little evidence that broad-based diversity programs, nor any of their programmatic components, have created a more equitable work environment for women or people of color. We then examine the programs at two federal agencies with significant diversity efforts, in depth, and find again that the results have been mixed. While not meant to be the final word, we suggest that these findings can serve as the basis for generating greater discussion and analysis of these important, but under-evaluated, programs.

## Section V: Policy Documents

NOAA. (2017). NOAA Diversity and Inclusion Strategic Plan FY 2017–2019.

<http://www.eeo.noaa.gov/d&i/NOAA%20Diversity%20and%20Inclusion%20Strategic%20Plan.pdf>

NOAA's unique mission of science, service and stewardship demands a diverse workforce to reflect, understand, and respond to the varied communities and stakeholders we serve. Equally important is an inclusive work environment that drives employee and organizational performance. NOAA recognizes that a sustained commitment to strengthening diversity and inclusion is critical to enable a future where societies and the world's ecosystems reinforce each other and are mutually resilient in the face of sudden and prolonged change. NOAA's Diversity and Inclusion Strategic Plan establishes a framework for action to strengthen diversity and inclusion, and, ultimately, NOAA's workforce capabilities. The plan builds on the FY 2012–2016 DOC Diversity and Inclusion Strategic Plan, and considers the workforce gaps from NOAA's Management Directive 715 results. The plan also complies with Executive Order 13583 – Establishing a Coordinated Government-wide Initiative to Promote Diversity and Inclusion in the Federal Workforce, and is based on guidance provided by OPM. This plan sets forth the goals, objectives, and tactics necessary to recruit a diverse, highly capable workforce, build an inclusive work environment, and ensure continued progress and commitment. Table 1 summarizes NOAA's diversity and inclusion goals and objectives for FY2017–2019. Details for each goal, including specific tactics and key success indicators, comprise the body of this plan.

NOAA Sea Grant. (2017). Looking Outward and Reaching Inward Building Sea Grant Resilience from the lens of Diversity, Equity, and Inclusion (DESG A/I-15).

[https://seagrant.noaa.gov/Portals/1/Network%20Visioning/DiversityandInclusion\\_NetVis\\_2017\\_Proposal.pdf](https://seagrant.noaa.gov/Portals/1/Network%20Visioning/DiversityandInclusion_NetVis_2017_Proposal.pdf)

The Sea Grant network is a conglomerate of small programs that work on important, but disparate projects given the unique coastal communities that each program serves. Depending on state priorities, Sea Grant programs have addressed issues of diversity, equity, and inclusion (DEI) with distinct, as well as piecemeal approaches. The Sea Grant Community of Practice (CoP) on Inclusion and Diversity (SGID) formed in 2016 to bring a systematic analysis and application of DEI principles across the network. For the first time, Diversity and Inclusion were recognized as “cross-cutting principles” in the 2018-2021 Sea Grant Strategic planning. To build on the efforts of SGID CoP and develop a long-term resilience vision for Sea Grant, Mona Behl (GASG) and Jane Harrison (NCSG) will co-lead the Sea Grant resilience visioning effort on DEI. The theme of our resilience visioning is simple yet powerful – Looking Outward and Reaching Inward. It signifies the goal to extend Sea Grant's solid foundation of "science serving coastal America's coasts;" share our 50-year success; anticipate, prepare and respond to future changes; and model the way as a visionary program that embraces and advances all aspects of DEI. Accomplishing this vision will require Sea Grant to define its role in advancing DEI; develop advanced professional capabilities; and measure and evaluate its efforts towards meeting DEI goals and objectives.

Greenlining Institute. (2015). Offices of Minority and Women Inclusion: 2014 Snapshot of Financial Regulators' Diversity and Inclusion. <http://greenlining.org/wp-content/uploads/2015/08/OMWI-Fact-Sheet-8.2015.pdf>

The financial crisis of 2008 disproportionately impacted low income Americans and communities of color. Congress - recognizing the importance of regulatory agencies that better reflect, understand, and effectively utilize these communities - took action to diversify the financial sector to help prevent this from happening again. In 2010, Section 342 of the Dodd-Frank Act established Offices of Minority and Women Inclusion (OMWIs) in eight financial agencies: CFPB, FDIC, FHFA\*, NCUA, OCC, SEC, the Treasury, FBG, and the 12 regional Federal Reserve Banks. Section 342 stipulates that OMWIs must create standards for workforce and supplier diversity (procurement with diverse vendors) for their respective agencies and the more than 70,000 companies they regulate.

Obama, B. (2011). Executive Order 13583—Establishing a Coordinated Government-Wide Initiative to Promote Diversity and Inclusion in the Federal Workforce. *Federal Register*, 76(173). <https://obamawhitehouse.archives.gov/the-press-office/2011/08/18/executive-order-13583-establishing-coordinated-government-wide-initiativ>

Our Nation derives strength from the diversity of its population and from its commitment to equal opportunity for all. We are at our best when we draw on the talents of all parts of our society, and our greatest accomplishments are achieved when diverse perspectives are brought to bear to overcome our greatest challenges. A commitment to equal opportunity, diversity, and inclusion is critical for the Federal Government as an employer. By law, the Federal Government’s recruitment policies should “endeavor to achieve a work force from all segments of society.” (5 U.S.C. 2301(b) (1)). As the Nation’s largest employer, the Federal Government has a special obligation to lead by example. Attaining a diverse, qualified workforce is one of the cornerstones of the merit-based civil service.

Garcia, F. (2008). Sustained Attention Needed to Build on Gains in SES and Managers. *GAO Reports*, 1-15. <https://www.gao.gov/products/A84130>

The article presents the testimony of Frances Garcia, inspector general of the U.S. Government Accountability Office's (GAO), concerning the agency's diversity management practices. The report notes that between fiscal years 2002 and 2007, increased the diversity of both its Senior Executive Service and managerial ranks. The agency has made a commitment to diversity management, and is using a number of leading diversity management practices to recruit, hire, promote and retain its employees.

Office of Diversity and Inclusion. Diversity & Inclusion Reports. <https://www.opm.gov/policy-data-oversight/diversity-and-inclusion/reports/>

Page hosts links to Government wide Inclusive Diversity Strategic Plan, Federal Opportunity and Recruitment Program, Hispanic Employment Program, Disability Employment Program, and Federal Employment Statistics.

## **Section VI: Mentoring**

Estrada, M., Hernandez, P. R., & Schultz, P. W. (2018). A Longitudinal Study of How Quality

Mentorship and Research Experience Integrate Underrepresented Minorities into STEM Careers. *Cbe-Life Sciences Education*, 17(1). <https://doi.org/10.1187/cbe.17-04-0066>

African Americans, Latinos, and Native Americans are historically underrepresented minorities (URMs) among science, technology, engineering, and mathematics (STEM) degree earners. Viewed from a perspective of social influence, this pattern suggests that URMs do not integrate into the STEM academic community at the same rate as non-URM students. Estrada and colleagues recently showed that Kelman's tripartite integration model of social influence (TIMSI) predicted URM persistence into science fields. In this paper, we longitudinally examine the integration of URMs into the STEM community by using growth-curve analyses to measure the development of TIMSI's key variables (science efficacy, identity, and values) from junior year through the post baccalaureate year. Results showed that quality mentorship and research experience occurring in the junior and senior years were positively related to student science efficacy, identity, and values at that same time period. Longitudinal modeling of TIMSI further shows that, while efficacy is important, and perhaps a necessary predictor of moving toward a STEM career, past experiences of efficacy may not be sufficient for maintaining longer-term persistence. In contrast, science identity and values do continue to be predictive of STEM career pathway persistence up to 4 years after graduation.

Hernandez, P. R., Bloodhart, B., Barnes, R. T., Adams, A. S., Clinton, S. M., Pollack, I., . . . Fischer, E. V. (2017). Promoting professional identity, motivation, and persistence: Benefits of an informal mentoring program for female undergraduate students. *PLoS ONE*, 12(11). <https://doi.org/10.1371/journal.pone.0187531>

Women are underrepresented in a number of science, technology, engineering, and mathematics (STEM) disciplines. Limited diversity in the development of the STEM workforce has negative implications for scientific innovation, creativity, and social relevance. The current study reports the first-year results of the PROMoting Geoscience Research, Education, and Success (PROGRESS) program, a novel theory-driven informal mentoring program aimed at supporting first- and second-year female STEM majors. Using a prospective, longitudinal, multi-site (i.e., 7 universities in Colorado/Wyoming Front Range & Carolinas), propensity score matched design, we compare mentoring and persistence outcomes for women in and out of PROGRESS (N = 116). Women in PROGRESS attended an off-site weekend workshop and gained access to a network of volunteer female scientific mentors from on- and off-campus (i.e., university faculty, graduate students, and outside scientific professionals). The results indicate that women in PROGRESS had larger networks of developmental mentoring relationships and were more likely to be mentored by faculty members and peers than matched controls. Mentoring support from a faculty member benefited early-undergraduate women by strengthening their scientific identity and their interest in earth and environmental science career pathways. Further, support from a faculty mentor had a positive indirect impact on women's scientific persistence intentions, through strengthened scientific identity development. These results imply that first- and second- year undergraduate women's mentoring support networks can be enhanced through provision of protégé training and access to more senior women in the sciences willing to provide mentoring support.

McGlynn, T. P. (2017). Identity Matters: Communicating About Equity and Opportunity for Students in Minority-Serving Institutions. *Annals of the Entomological Society of America*, 110(5), 480-483. <https://doi.org/10.1093/aesa/sax050>

The entomological community recognizes the imperative for diversifying our profession, by promoting an agenda to broaden participation of junior scientists who are members of groups underrepresented in our discipline. Progress has been inadequate. I describe approaches to professional development and recruitment of students from Minority-Serving Institutions that can result in more equity and diversity in our community. I describe an informal science communication project, using a blog and social media, to communicate with other scientists about effective practices supporting the inclusion of undergraduates in the context of a Minority-Serving Institution. I provide a set of recommendations for entomologists who wish to support the professional development of students from underrepresented groups and communicate about this work more broadly.

Prunuske, A., Wilson, J., Walls, M., Marrin, H., Clarke, B., & Gibbs, K. (2017). Efforts at Broadening Participation in the Sciences: An Examination of the Mentoring Experiences of Students from Underrepresented Groups. *CBE Life Sci Educ.*  
<https://doi.org/10.1187/cbe.16-01-0024>

Diversifying the scientific enterprise entails understanding how students from underrepresented backgrounds experience mentored research. Qualitative data were collected from mentees enrolled at community colleges about their research experiences. The themes were compared with previously collected data from mentors associated with the program.

Adams, A. S., Steiner, A. L., & Wiedinmyer, C. (2016). The Earth Science Women's Network (ESWN): Community-Driven Mentoring for Women in the Atmospheric Sciences. *Bulletin of the American Meteorological Society*, 97(3), 345-354. <https://doi.org/10.1175/bams-d-15-00040.1>

Women are a growing percentage of undergraduate and graduate students in the atmospheric sciences, yet they remain a minority in senior positions. One approach for the retention of women is increased mentoring, which is linked to successful promotions, higher incomes, and greater career satisfaction. Informal peer networking is a form of mentoring that may be effective for underrepresented groups. The Earth Science Women's Network (ESWN) was established in 2002 with the mission to promote career development, build community, provide informal mentoring and support, and facilitate professional collaborations for early career women in the Earth sciences. Over time, ESWN has developed a mentoring philosophy that has reduced some barriers and challenges that women face in traditional mentoring relationships. The five main principles of the ESWN's mentoring philosophy have evolved to include community-driven mentoring, diverse mentoring approaches for diverse individuals, mentoring across career phases, combined personal and professional mentoring, and effective mentoring in a safe space. Surveys of ESWN members report gains in areas that are often considered barriers to career advancement, including recognition that they are not alone, new understanding of obstacles faced by women in science, and access to professional resources. These gains have been accomplished through online and in-person ESWN activities guided by the ESWN's mentoring philosophy. Understanding the success of the ESWN, as well as its limitations, has the potential to inform the larger atmospheric science community of additional strategies to improve mentoring and retention of women in the atmospheric sciences.

Mondisa, J. L., & Ieee. (2015). *Increasing Diversity in Higher Education by Examining African-*



*American STEM Mentors' Mentoring Approaches*. Paper presented at the Proceedings of 2015 International Conference on Interactive Collaborative Learning, 321-326.

<https://ieeexplore.ieee.org/abstract/document/7318046/>

National reports and initiatives indicate a critical need to produce more U.S. scientists and engineers and specify plans to fulfill this need by tapping into underrepresented populations such as women and minorities. Thus, it is crucial to address how diversity plays a role in higher education environments and the persistence of these populations in science, technology, engineering, and mathematics (STEM) majors. Mentoring may be a mechanism that assists minority students, such as African Americans, with persisting in STEM majors which may help to increase diversity in higher education. However, there is a lack of understanding about what is occurring in African-American mentoring relationships and how mentors advise their protégés. The purpose of this study is to understand and interpret the mentoring approaches of select African-American STEM mentors in higher education. Ten select African-American STEM mentors were interviewed. Polkinghorne's narrative analysis and an open coding process were used to identify pervasive themes that emerged about mentors' mentoring approaches. Findings indicate that African-American STEM mentors employ mentoring approaches with their African-American STEM undergraduates that focus on providing resources and listening and relating to their protégés.

Prunuske, A. J., Wilson, J., Walls, M., & Clarke, B. (2013). Experiences of Mentors Training Underrepresented Undergraduates in the Research Laboratory. *Cbe-Life Sciences Education*, 12(3), 403-409. <https://doi.org/10.1187/cbe.13-02-0043>

Successfully recruiting students from underrepresented groups to pursue biomedical science research careers continues to be a challenge. Early exposure to scientific research is often cited as a powerful means to attract research scholars with the research mentor being critical in facilitating the development of an individual's science identity and career; however, most mentors in the biological sciences have had little formal training in working with research mentees. To better understand mentors' experiences working with undergraduates in the laboratory, we conducted semi structured interviews with 15 research mentors at a public university in the Midwest. The interviewed mentors were part of a program designed to increase the number of American Indians pursuing biomedical/bio behavioral research careers and represented a broad array of perspectives, including equal representation of male and female mentors, mentors from underrepresented groups, mentors at different levels of their careers, and mentors from undergraduate and professional school departments. The mentors identified benefits and challenges in being an effective mentor. We also explored what the term underrepresented means to the mentors and discovered that most of the mentors had an incomplete understanding about how differences in culture could contribute to underrepresented students' experience in the laboratory. Our interviews identify issues relevant to designing programs and courses focused on undergraduate student research.

Wilson, Z. S., Holmes, L., Degrauelles, K., Sylvain, M. R., Batiste, L., Johnson, M., . . . Warner, I. M. (2012). Hierarchical Mentoring: A Transformative Strategy for Improving Diversity and Retention in Undergraduate STEM Disciplines. *Journal of Science Education and Technology*, 21(1), 148-156. <https://doi.org/10.1007/s10956-011-9292-5>

In the United States, less than half of the students who enter into science, technology, engineering, and mathematics (STEM) undergraduate curricula as freshmen will actually graduate with a STEM

degree. There is even greater disparity in the national STEM graduation rates of students from underrepresented groups with approximately three-fourths of minority students leaving STEM disciplines at the undergraduate level. A host of programs have been designed and implemented to model best practices in retaining students in STEM disciplines. The Howard Hughes Medical Institute (HHMI) Professors Program at Louisiana State University, under leadership of HHMI Professor Isiah M. Warner, represents one of these programs and reports on a mentoring model that addresses the key factors that impact STEM student attrition at the undergraduate level. By integrating mentoring and strategic academic interventions into a structured research program, an innovative model has been developed to guide STEM undergraduate majors in adopting the metacognitive strategies that allow them to excel in their programs of study, as they learn to appreciate and understand science more completely. Comparisons of the persistence of participants and nonparticipants in STEM curricular, at the host university and with other national universities and colleges, show the impact of the model's salient features on improving STEM retention through graduation for all students, particularly those from underrepresented groups.

Pfund, C., Maidl Pribbenow, C., Branchaw, J., Miller Lauffer, S., & Handelsman, J. (2006). The Merits of Training Mentors. *Science*, 311(5760), 473.

<http://science.sciencemag.org/content/311/5760/473.abstract>

In research universities and colleges, mentoring is one of the most important skills for faculty because it affects both research productivity and the quality of training for undergraduate students, graduate students, and postdoctoral researchers. Moreover, the diversity of science is dependent on the quality of mentored research, because this experience is a key to attracting underrepresented groups to science. In the past, many faculty learned skills such as mentoring on the job. In recent years, various organizations have developed training programs to help prospective and new faculty learn skills such as grant writing, laboratory management, and classroom teaching, but mentoring has been largely absent. In response to this need, we developed and evaluated a mentor-training seminar. The seminar is intended to improve mentors' skills and to enhance the research experiences of undergraduate students.