BEST PRACTICES FOR REDUCING ORGANIZATIONAL, CULTURAL, AND INSTITUTIONAL BARRIERS IN STEM RESEARCH

A Report by the
INTERAGENCY WORKING GROUP ON INCLUSION IN STEM
FEDERAL COORDINATION ON STEM SUCOMMITTEE
COMMITTEE ON STEM
of the
NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

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Abbreviations

CDC	Centers for Disease Control and Prevention
DEIA	diversity, equity, inclusion, and accessibility
DOD	Department of Defense
IWGIS	Interagency Working Group on Inclusion in STEM
LEGACY	Leadership Experience Growing Apprenticeships Committed to Youth
NASA	National Aeronautics and Space Administration
NASEM	National Academies of Sciences, Engineering, and Medicine
NCSES	National Center for Science and Engineering Statistics
NIH	National Institutes of Health
NSF	National Science Foundation
NSTC	National Science and Technology Council
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
PKAL	Project Kaleidoscope
SF BUILD	San Francisco State University Building Infrastructure Leading to Diversity
STEM	science, technology, engineering, and mathematics
SVSH	Sexual Violence and Sexual Harassment
UC	University of California
WISELI	University of Wisconsin-Madison Inclusion in Science & Engineering Leadership Institute

Executive Summary

Since day one with the signing of the *Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*,[1] the Biden-Harris Administration has shown a commitment to advancing equity for all, including those in our nation's science, technology, engineering, and mathematics (STEM) ecosystem.[2] By eliminating systemic barriers to participation in STEM, our nation ensures all of the American public can contribute to and benefit from science, technology, and innovation. Full engagement and participation of our nation's STEM talent can enhance opportunities for discovery and innovation, bolster our global competitiveness, and protect our national security.

In response to the *CHIPS and Science Act of 2022* (Pub.L. 117-167; Sec. 10505)[3], this document provides an overview of the best practices designed to reduce organizational, cultural, and institutional barriers in STEM to optimize organizational climate[4] and participation in STEM. The report also conveys the roles and responsibilities of federally funded organizations and federal agencies to support such practices.

Organizational climate surveys can uncover factors that hinder organizational well-being and hamper individual success in STEM. This report outlines three steps to effectively use climate surveys to optimize organizational climate and rectify institutional barriers.

Step 1: Identify the organization's needs and the climate survey's purpose.

Step 2: Select measures that align with the identified purpose and provide accurate and useful information.

Step 3: Analyze climate survey results, including the use of benchmarking and disaggregated data, to provide a clear path forward for organizational improvement.

Ultimately, information from climate surveys should drive policy changes and organizational practices to improve organizational climate and address institutional barriers. This can take the form of targeted educational and training opportunities designed for leadership, managers, students, and staff of STEM

[1] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government

[2] The term "STEM ecosystem" means a local, regional, or statewide network, consortium, or multi-sector partnership, which may be led or co-led by a nonprofit organizational entity, that is operating in the United States with the goal of supporting participation in STEM study, activities, and career pathways as defined in the CoSTEM Annual Progress Report of 2020 with a broad range of non-federal partners. https://trumpwhitehouse.archives.gov/wp-content/uploads/2017/12/Progress-Report-Federal-Implementation-STEM-Education-Strategic-Plan-Dec-2020.pdf and https://www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf

[3] https://www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf

[4] Organizational culture is most often used for referring to values and understandings, broadly shared in an organization or in some part of an organization, that influence the thoughts and actions of organization members. The term "climate" is used for three purposes: (a) as psychological climate to describe questionnaire surveys that provide a broad profile of attitudes and perceptions of an organization's members covering more specific topics (e.g., job satisfaction, leadership, group dynamics), (b) as organizational climate to describe shared perceptions of organization members about their work environment and organizational policies and procedures that are likely to affect their well-being, and (c) as facet-specific climate to represent the distinctive value focus or profile of value priorities in an organization such as a climate for service or a climate for innovation. https://www.sciencedirect.com/topics/neuroscience/organizational-climate

organizations. Organizational leaders play a pivotal role in ensuring the effectiveness, sustainability, and accessibility of the policy changes and targeted educational and training opportunities.

To optimize the effectiveness of such efforts, there are additional steps for leveraging educational and training opportunities to reduce organizational, cultural, and institutional barriers in STEM.

Step 1: Identify educational and training opportunities, ensuring that all opportunities are accessible.

Step 2: Select an effective educational or training model, recognizing that the typical "one and done" professional development sessions tend not to have the intended impact on the organization that more prolonged approaches may have.

Step 3: Evaluate the effectiveness of educational and training opportunities on organizational culture and institutional barriers. Make sure that evaluation protocols are accessible and use those evaluations to drive targeted improvements in policy and professional development approaches.

To identify and eliminate organizational, cultural, and institutional barriers across STEM education, research, and workforce environments, there are seven considerations that were found to be important as organizations implement change.

1. An organization should keep its mission central while establishing clear, measurable, and actionable goals for reducing cultural and institutional barriers.
2. Effective leadership matters; working to ensure leadership understanding, buy-in and action is critical.
3. Accessibility for individuals with disabilities, a necessary precursor to disability inclusion, is often overlooked. Centering such efforts can open the STEM ecosystem to individuals with much to offer.
4. Using evidence to drive reflection and organizational action has the potential to save resources while improving outcomes.
5. From start to finish, building trust is central to organizational well-being and growth.
6. Recognizing biases and stereotypes and creating policies and practices to mitigate their effects can benefit an organization and its members.
7. Many of these changes can be cost neutral. Nonetheless, organizations should commit and budget for the necessary time and resources needed to effectively reduce barriers.

This report makes three overarching evidence-based recommendations to reduce cultural and institutional barriers that hinder recruitment, retention, and advancement of groups underrepresented in STEM education and careers. Federal agencies should consider updating and revising any guidance they provide to federally funded organizations to ensure equitable and accessible organizational climates that promote innovation and advances in STEM education, research, and the STEM workforce.

Recommendation 1: Implement and expand existing best practices, particularly in the use of climate surveys, and educational and training opportunities to support organizational change. This document provides several examples of best practices that organizations of varying sizes and missions can apply and improve upon.

Recommendation 2: Implement and expand funding opportunities, resources, and policies to reduce organizational barriers and promote diversity, equity, inclusion, and accessibility (DEIA).

Recommendation 3: Coordinate, standardize, and be transparent about organizational change and related DEIA initiatives across the organization, and identify and address gaps in the system where needed.

Introduction

A well-prepared and diverse science, technology, engineering, and mathematics (STEM) workforce is essential to maintain global leadership and to promote the ingenuity of Americans to accelerate breakthroughs and strengthen America's economic and national security.[5,6,7] Diversity in the workforce and within teams has been tied to greater innovation, more creativity, sounder decision-making, better problem-solving, enhanced productivity, and improved retention in the workforce.[3,8] Such crucial organizational impacts require acknowledging diversity as a core institutional strength, and concerted efforts to develop inclusive and accessible environments where all interested STEM students and workforce participants can thrive in STEM education pathways and in the STEM workforce.[1,9]

The White House underscores the importance and necessity of identifying and addressing the effects of organizational cultural and institutional barriers in order to expand the academic and federal STEM workforce and ensure all interested members of society can experience rewarding STEM careers. Concerted efforts to prevent exclusionary practices and create inclusive and accessible environments are especially important for those who have been underrepresented and underserved[10] throughout the STEM ecosystem. Furthermore, in accordance with civil rights laws (Title VI of the Civil Rights Act of 1964; Title IX of the Education Amendments of 1972; Section 504 of the Rehabilitation Act of 1973; and the Age Discrimination Act of 1975), recipients of federal financial assistance—for example, academic institutions—are required to ensure that that no person is excluded from participation in, denied benefits of, or otherwise subjected to discrimination in funded programs and/or activities. The removal of barriers to participation across the federally supported STEM ecosystem is foundational to complying with this obligation.

In response to the *CHIPS and Science Act* of 2022 (Pub.L. 117-167; Sec. 10505), this report details one approach to identifying and removing barriers to participation in STEM: climate surveys, used with educational and training opportunities. This document first provides best practices, defined as a procedure that has been shown by research and experience to produce optimal results and that is

[5]Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

[6]Reducing the Impact of Bias in the STEM Workforce: Strengthening Excellence and Innovation. Interagency Policy Group on Increasing Diversity in the STEM Workforce by Reducing the Impact of Bias. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/ostp-opm_bias_mitigation_report_20161129_final.pdf

[7]Presidential Memorandum. Promoting Diversity and Inclusion in the National Security Workforce. https://obamawhitehouse.archives.gov/the-press-office/2016/10/05/presidential-memorandum-promoting-diversity-and-inclusion-national

[8] Saxena A. Workforce Diversity: a key to improve productivity. Procedia Economics and Finance. 2014. https://doi.org/10.1016/s2212-5671(14)00178-6

[9] U.S. Surgeon General's Framework for Workplace Mental Health & Well-Being. US Department of Health and Human Services. 2022. https://www.hhs.gov/sites/default/files/workplace-mental-health-well-being.pdf

[10]"Underserved populations" refers to populations sharing a particular characteristic, as well as geographic communities, that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life (see also the definition for equity that follows). This definition is adopted from the Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government

established or proposed as a standard practice suitable for widespread adoption,[11] regarding the use of climate surveys to identify organizational cultural and institutional barriers in order to advance diversity, equity,[12] inclusion, and accessibility (DEIA) to expand the academic and federal STEM workforce. Climate surveys can be used as a tool to assess the broader system driving any organization, institution, or research entity receiving federal funds, including the National Laboratories. All of them can use climate surveys to better understand and address organizational barriers (e.g., stereotypes) and practices (e.g., gatekeeping) that hinder STEM innovation and retention.[13]

This report also provides guidance on possible approaches to leveraging educational and training opportunities, taken from across the federally funded STEM landscape, shown to help remove systemic barriers and create an inclusive and accessible climate where students, staff, and organizations can succeed and thrive. The report concludes with recommendations for policy and practice.

Data in this document originated from five sources: (1) a review of existing National Science and Technology Council (NSTC) efforts; (2) an Interagency Working Group on Inclusion in STEM (IWGIS) information call to 34 agency representatives requesting links, reports, and information; (3) results from data calls led by the Office of Management and Budget (OMB) and the Office of Science and Technology Policy (OSTP); (4) an iterative review of relevant references and federally funded projects, and (5) follow-up conversations with a small subset of government and academic groups to gain more detailed information. A full description of the methodology can be found in Appendix 1. Examples provided within the document should not be considered exhaustive. Likewise, practices highlighted in this document, as evidence-based, promising and/or emerging practices, should not be taken as an endorsement for a particular program or policy but as an opportunity for further exploration and investigation.

Best Practices for Climate Surveys

Climate Survey Overview

An organization's culture drives norms, values, practices, and policies that influence action at all levels and create conditions for structures that facilitate success or serve as barriers.[14] Organizational, institutional, and individual biases have the potential to produce and mask challenges within a department, division, or an entire organization. When seeking to identify and address organizational,

[11] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

[12] Equity is defined as the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as people who are Black/African American, Latino/Latina, Indigenous and Native American, Asian American and Pacific Islander, and other persons of color; members of religious minorities; people who are lesbian, gay, bisexual, transgender, or queer (LGBTQ+); persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality. This definition is adapted from the Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government

[13] Valentine H, et al. From the NIH: A Systems Approach to Increasing the Diversity of the Biomedical Research Workforce. CBE - Life Sciences Education. 2017. https://www.lifescied.org/doi/10.1187/cbe.16-03-0138

[14] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803

cultural, and institutional barriers, climate surveys help expose previously unrecognized, problematic factors that may impede individual and institutional success, and highlight areas where change is needed. Climate surveys include examinations of staff or students' insights, perceptions, observations, experiences, discernments, sensitivities, and perspectives of a department, division, and/or organization.

The most important asset in any organization is its people. Understanding how members of an organization experience and perceive the organization is critical for understanding the health of the organization. This understanding expands to staff and students' attitudes and concerns. The Surgeon General's Framework for Workplace Mental Health and Well-Being[15] emphasizes the connection between workers' perceived well-being and the health of organizations. Sustainable change must be driven by committed leaders in continuous collaboration with the valued workers who power each workplace. By choosing to center the voices of students and staff, particularly with the use of climate surveys, it becomes possible to ensure that everyone has a platform to thrive. Leaders who use information to enact changes that address and remove barriers in the system may allow the people within the system to succeed and thrive rather than struggle and potentially leave the institution or organization.

A tremendous amount of work has been conducted across the nation to engage and make use of results from climate surveys. This section will review best practices in measuring an organization's cultural climate and responding to the findings. Included are specific examples of how climate surveys have been carried out in the context of an organization's mission and its communities' goals to understand what is happening across their organization. Examples highlight how climate surveys can be used to identify pathways forward that increase inclusivity and accessibility to assure optimal recruitment, retention, and advancement of groups underrepresented and underserved in STEM education, research, and the STEM workforce.

Step 1: Identify the Organization's Need and the Climate Survey's Purpose

Climate survey work is more successful when surveys are tailored to the environment and interests of the institution or department. When used in this way, climate surveys serve as a springboard for discussion both before and after the surveys are completed, which allows for deeper investment across stakeholders in the purpose, the results, and the resolution. These discussions help develop trust in the process and the organization.

There are numerous attributes, concepts, and ideas that any organization or department can find with a climate survey that uncovers organizational cultural and institutional barriers hindering recruitment, retention, and advancement of groups historically underrepresented in STEM education and careers. The first step to conduct a successful climate survey is spending time identifying the goals of the climate survey, the information that needs to be understood, and the focal population and subgroups of staff or students unfairly affected by organizational cultural and institutional barriers.

[15] U.S. Surgeon General's Framework for Workplace Mental Health & Well-Being. US Department of Health and Human Services. 2022. https://www.hhs.gov/sites/default/files/workplace-mental-health-well-being.pdf

Example: The National Science Foundation's (NSF) ADVANCE: Organizational Change for Gender Equity in STEM Academic Professions[16] program funded a project at the North Carolina A&T State University in Greensboro, North Carolina.[17] At the start of this project, only one-fourth of their tenure track faculty in STEM including social, behavioral, and economics sciences, were women. Women faculty were not represented in the rank of full professor. This project identified a series of system barriers that could be contributing to this difference.[18] The administration of "life interviews" as a form of climate survey uncovered that women faced a greater likelihood of having their expertise questioned and felt increased pressure to work harder to have their contributions valued.[19] They were also experiencing difficulty establishing and sustaining research activities, which negatively impacted their standing at the institution.[20] Through the use of climate surveys, policies and practices were changed that transformed the university and improved outcomes for women STEM faculty.[17]

Example: The U.S. Department of Justice's Bureau of Justice Statistics completed a report on the results of a nine-school pilot test designed to develop and validate a campus climate survey that collects school-level data on sexual victimization of undergraduate students.[21] Undergraduate students of all genders, often experience sexual violence and intimidation. Understanding the prevalence of sexual victimization across an organization is necessary to make targeted, systemic improvements on college campuses. This report describes the development of the survey instrument and procedures for data collection that can be used by any campus to better understand experiences that undergraduate students are having in relation to sexual violence and intimidation. As with challenging topics like sexual assault, non-responses are more common. This report reviews how to conduct a non-response bias analysis to better understand the true prevalence, not merely the reported prevalence, of sexual assault, rape, and sexual battery across an organization. In addition, the report examines the relationship between measures of campus climate, in general, and rates of sexual victimization.

Example: The National Institutes of Health (NIH) created a Diversity Program Consortium of research entities that have developed and honed "hallmarks of success" for biomedical research careers.[22] The hallmarks of success identify attributes at the institutional level that can contribute and support successful research careers. Some examples of hallmarks of success include: *high self-efficacy as a mentor to a diverse group of biomedical research trainees; evidence of receiving training in areas to foster inclusive research training environments; and evidence of creating, enhancing, and/or maintaining diverse, inclusive, and culturally appropriate research and research training environments*.

[16] ADVANCE: Organizational Change for Gender Equity in STEM Academic Profession. National Science Foundation: https://new.nsf.gov/funding/opportunities/advance-organizational-change-gender-equity-stem
[17] NCA&T ADVANCE Institutional Transformation: Catalyzing Gender, Leadership, and Scholarship Equity through Institutional Change for All. National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=1409799&HistoricalAwards=false
[18] Corneille M, et.al. Barriers to the advancement of women of color faculty in STEM. Equality, Diversity and Inclusion: An International Journal. 2019. https://doi.org/10.1108/edi-09-2017-0199
[19] Lee A, et.al. Narratives of Black Women STEM Faculty: Breaking barriers to promote institutional transformation at historically Black colleges and universities. The Advance Journal 2022. https://doi.org/10.5399/osu/advjrnl.3.1.5
[20] Lee, AK, et.al. Pathways to institutional transformation at HBCUs: recommendations from HBCU Black women STEM Faculty. SN Social Sciences. 2021. https://doi.org/10.1007/s43545-021-00089-7
[21] Campus Climate Survey Validation Study Final Technical Support. US Department of Justice. 2016. https://bjs.ojp.gov/content/pub/pdf/ccsvsftr.pdf
[22] Hallmarks of Success. National Institutes of Health. 2022.https://nigms.nih.gov/training/dpc/Pages/success.aspx

Example: A recent consensus study by the National Academies of Sciences, Engineering, and Medicine (NASEM)[23] commissioned in part by NSF and NIH details a wide variety of organization climate-related attributes and studies that demonstrate how specific attributes are impacting productivity, innovation, retention, evaluation, well-being, and much more. The findings in the report can help identify and hone the purpose and goals of an organization climate survey. This report can also provide insights into how the results can be used to make system-wide change. For example:

- Quality mentorship experiences are significantly associated with the integration of and long-term success of minoritized individuals in STEM.[24]
- Implicit bias[25] contributes to several behaviors that can create organizational barriers including gatekeeping,[26] race-focused social exclusion,[27] inequitable employment decisions,[28] and racial disparities in school discipline.[29]
- Research focusing on the gender diversity of teams found that having a critical mass of women in science is an important antecedent of promoting greater inclusion and a positive climate.[30,31]
- Having diversity across all levels of management teams[32] and having greater congruence between team diversity and the diversity in the local community[33] improves organizational outcomes.

Each of these important organizational climate findings could become the central focus for a climate survey. Ultimately, organizations benefit by taking time and reflecting upon the needs of the organization and the purpose for the climate survey prior to selecting a measure. Once a department, division, or organization develops an understanding of the needs and goals for the climate survey, the

[23] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803

[24] Estrada M, et.al. A Longitudinal Study of How Quality Mentorship and Research Experience Integrate Underrepresented Minorities into STEM Careers. CBE- Life Sciences Education. 2018 https://doi.org/10.1187/cbe.17-04-0066

[25] Implicit Bias is a type of implicit cognition, including perception, memory, thinking, and decision making that is taking place outside of one's conscious attentional focus. This definition is adopted from Greenwald, A. G., Nosek, B. A., & Narayanan, S. (2006). Consequential validity of the Implicit Association Test: Comment on Blanton and Jaccard (2006). American Psychologist, 61(1), 56–61. https://doi.org/10.1037/0003-066x.61.1.56

[26] Jost JT, et.al. The existence of implicit bias is beyond reasonable doubt: A refutation of ideological and methodological objections and executive summary of ten studies that no manager should ignore. Research in Organizational Behavior. 2009. https://doi.org/10.1016/j.riob.2009.10.001

[27] Rudman LA & Ashmore RD. Discrimination and the Implicit Association Test. Group Processes and Intergroup Relation. 2007. https://doi.org/10.1177/1368430207078696

[28] Jost JT, et.al. The existence of implicit bias is beyond reasonable doubt: A refutation of ideological and methodological objections and executive summary of ten studies that no manager should ignore. Research in Organizational Behavior. 2009. https://doi.org/10.1016/j.riob.2009.10.001

[29] Chin MJ, et.al. Bias in the Air: A Nationwide Exploration of Teachers' Implicit Racial Attitudes, Aggregate Bias, and Student Outcomes. Educational Researcher, 2020. https://doi.org/10.3102/0013189X20937240

[30] Griffith EE & Dasgupta N. How the Demographic Composition of Academic Science and Engineering Departments Influences Workplace Culture, Faculty Experience, and Retention Risk. Social Sciences. 2018. https://doi.org/10.3390/socsci7050071

[31] Ong, M, et.al. Counterspaces for women of color in STEM higher education: Marginal and central spaces for persistence and success. J Res Sci Teac. 2018. https://doi.org/10.1002/tea.21417

[32] Richard OC, et.al. Effects of Racial Diversity Congruence between Upper Management and Lower Management on Firm Productivity. Academy of Management Journal. 2021. https://doi.org/10.5465/amj.2019.0468

[33] Richard OC, et. al. The impact of store-unit–community racial diversity congruence on store-unit sales performance. Journal of Management. 2017. https://doi.org/10.1177/0149206315579511

next step is selecting measures. In that design, research suggests that leaders work across divisional lines to ensure adequate resources and comprehensive content.[34]

Step 2: Select Measures

Several options are available to support STEM departments and organizations in understanding cultural and institutional barriers through climate survey measures. A vast number of existing measures are available for immediate use. Question banks, like the one developed by the Department of Education for K-12 and primary schools,[35] are available. These question banks guide organizations in developing measures that align with their climate survey needs. In determining which questions to ask, there many federal guidance documents that cover best practices for asking about race, sexual orientation, gender, disability status, and other demographic characteristics that can be used to understand experience at specific intersections of identity.[36,37,38,39] It is also possible to create a measure specific to the organization's goals; however, such efforts require highly skilled teams and are not detailed in this report. By building upon the expertise of other teams, using existing measures can save time and can often be modified to meet the needs of the institution. In some cases, existing measures come with comparison data (e.g., norms or criteria) that can be used for interpreting an organization's results beyond a single institution.

Issues of diversity, inclusion, and accessibility need to be kept front and center during the identification or creation of a climate survey. It often makes sense for an organization to use a climate survey that is seeking to identify potential accessibility barriers, both attitudinal and structural, that could impede progress of members from groups historically and continually underrepresented in STEM.

Additionally, the climate survey measure itself must be accessible. Issues like professional jargon, readability, print size, responses needed, or even allocating time to complete the measure, could hinder accessibility. These issues could impede the response from subgroups of an organization's population taking the climate survey thus impacting the accuracy and usefulness of the results.

In selecting existing measures, understanding who the measure was designed for and in what context it can be administered is essential as this affects whether the measure will be accurate or useful for the chosen purpose. The accuracy and usefulness of a measure is technically referred to as its *validity*. Changes to a measure designed to increase its accessibility (e.g., translating to another language) or alterations in the administration of the survey to other age groups, organizational types, cultures, or physical abilities can result in a previously validated survey requiring to be re-validated because of the

[34] Multi-Pronged Initiatives to Address URM Faculty Retention and Climate. University of California. https://ucop.edu/faculty-diversity/advancing/campuses/los-angeles/improved-climate-and-retention/ucla-uci-multiprong.html
[35] ED School Climate Surveys. US Department of Education. https://safesupportivelearning.ed.gov/edscls
[36] Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity. US Office of Management and Budget. https://www.govinfo.gov/content/pkg/FR-1997-10-30/pdf/97-28653.pdf
[37] Revision of Statistical Policy Directive No. 15. US Office of Management and Budget. https://spd15revision.gov/
[38] Recommendations on the Best Practices for the Collection of Sexual Orientation and Gender Identity Data on Federal Statistical Surveys. Office of the Chief Statistician of the United States. https://www.whitehouse.gov/wp-content/uploads/2023/01/SOGI-Best-Practices.pdf
[39] Progress on Implementation of the Recommendations of the Equitable Data Working Group. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2023/03/Progress-on-Equitable-Data-Mar2023.pdf

changes. Psychometricians conduct detailed analyses to assure optimal accuracy and usefulness of climate surveys (e.g., Climate Persistence Faculty Scale described below).[40]

Identified below is a selection of existing measures organizations use in understanding cultural and institutional barriers.

Example: The U.S. Department of Justice's Bureau of Justice of Statistics has a measure to assess campus climate and sexual victimization that was discussed above.[41] This document includes information on the methodology for creating and validating the measure along with the items and how the measure can be used on any college campus.

Example: The U.S. Department of Education and National Center on Safe Supportive Learning Environments (NCSSLE) has partnered to create a list of validated school climate surveys that can be used by educational organizations.[42] Each measure is clearly defined for the population use (e.g., high school students, K-12 faculty, etc.) as well as the purpose of the measure (e.g., overall workplace satisfaction). In addition to surveys, the toolkit also includes survey administration materials, data reports, and a webtool for data collection.

Example: NSF's Directorate for STEM Education Core Research Program is designed to advance fundamental research that contributes to general knowledge and/or methodology underlying STEM education. In seeking to better understand STEM faculty persistence and how to measure it effectively, projects were funded[43] to examine and characterize persistence in tenure-track women faculty in engineering. Faculty persistence is generally associated with a healthy organizational climate. This measure is designed to understand climate in the context of diversity and career advancement experienced by faculty. Through this funding, the *Climate Persisting Faculty Scale* was created and validated to provide organization's information about their climate regarding variables including social identity, quality of career, work-life balance, and feelings of belonging. By administering the survey, organizations can identify cultural and institutional barriers in need for improvement and implement any necessary changes in training, policy, or practice.[44]

Example: NIH has a freely available "materials (measures) library."[45] This list of measures is not comprehensive and is currently undergoing a formative evaluation. As such, measures should be

[40]Yoon SY, et.al. Development and Validation of the Workplace Climate and Persistence Scale for STEM Faculty Framed in Intersectionality of Gender, Race/Ethnicity, and Socioeconomic Background. Research in Higher Education. https://www.doi.org/10.1007/s11162-022-09724-5

[41] Campus Climate Survey Validation Study Final Technical Support. US Department of Justice. 2016. https://bjs.ojp.gov/content/pub/pdf/ccsvsftr.pdf

[42] Summary Table of Office of Safe and Supportive Schools, Approved School Climate Surveys. US Department of Education. https://safesupportivelearning.ed.gov/sites/default/files/Summary%20Table%20of%20OSSS%20Approved%20School%20Climate%20Surveys_3.24.2023.pdf

[43] National Science Foundation Award Abstract Numbers 1535456 and 1712618 https://www.nsf.gov/awardsearch/showAward?AWD_ID=1535456; https://www.nsf.gov/awardsearch/showAward?AWD_ID=1712618

[44] Yoon SY, et.al. Development and Validation of the Workplace Climate and Persistence Scale for STEM Faculty Framed in Intersectionality of Gender, Race/Ethnicity, and Socioeconomic Background. Research in Higher Education. https://www.doi.org/10.1007/s11162-022-09724-5

[45] https://projects.wcer.wisc.edu/materials-library/material/?wpv_post_search&wpv-post_tag%5B%5D=cultural-awareness&wpv-post_tag%5B%5D=institutional-environment&wpv-post_tag%5B%5D=satisfaction&wpv_view_count=48

selected to address the organization's needs (see Step 1 above) while also considering the inclusion and accessibility of the measure. A subset of relevant measures is listed below.

Commitment to Career

Self-Report or Assessed by Other: **Self-Report**
Assessment Focus: **Attitudes**
Validated or Not: **Validated**
Target Population: **Graduate Student, Postdoc, Faculty**

Tags: **Career Intention**, **Satisfaction**

Culturally Aware Mentorship Self-Efficacy – Mentors

Self-Report or Assessed by Other: **Self-Report**
Assessment Focus: **Attitudes**
Validated or Not: **Validated**
Target Population: **Postdoc, Faculty**

Tags: **Cultural Awareness**, **Mentorship Practices**

Frequency of Culturally Aware Mentorship Behaviors

Self-Report or Assessed by Other: **Self-Report**
Assessment Focus: **Skills**
Validated or Not: **Validated**
Target Population: **Undergraduate Student, Graduate Student, Postdoc, Faculty**

Tags: **Cultural Awareness**, **Mentorship Practices**

Mentorship Competency Assessment (MCA)

Self-Report or Assessed by Other: **Self-Report**
Assessment Focus: **Attitudes**
Validated or Not: **Validated**
Target Population: **Graduate Student, Postdoc, Faculty**

Tags: **Cultural Awareness**, **Mentorship Practices**

Microaffirmation Frequency

Self-Report or Assessed by Other: **Self-Report**
Assessment Focus: **Attitudes**
Validated or Not: **Validated**
Target Population: **Undergraduate Student**

Tags: **Institutional Environment**

Satisfaction with Career

Self-Report or Assessed by Other: **Self-Report**
Assessment Focus: **Attitudes**
Validated or Not: **Validated**
Target Population: **Undergraduate Student, Graduate Student, Postdoc, Faculty**

Tags: **Career Intention**, **Satisfaction**

Example: A promising practice,[46] defined as one that is evidence-based in a particular context yet has not been fully testing in a wide-array of contexts and cannot yet be classified as a "best practice", on using climate surveys was developed by a team of scholars from the University of California. They created and validated an item bank of climate survey questions that enables a department or division

[46] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

to create a measure specific to the needs of a college's or university's campus. DEIBlueprint[47] is a multi-campus pilot project at the University of California designed to facilitate healthy academic department climates using a blueprint that enables departments to assess and use those findings to address issues related to diversity, equity, inclusion, and belonging. Some examples of areas an institution can chose to measure include academic advising and mentoring, respect, exclusion, inequitable workloads, microaggressions, bullying, and sexual harassment. The team has also created support for potential users to create, use, and analyze the newly synthesized climate survey. It is also possible to select and combine previously developed items to create a new measure that targets the specific needs of a STEM organization.

Example: The Center for Disease Control and Prevention's (CDC) National Institute for Occupational Safety and Health has created and validated the Worker Well-Being Questionnaire (WellBQ).[48] This measure is intentionally designed to not pose a burden on respondents while capturing information in five areas associated with organizational well-being.

1. Work Evaluation and Experience
2. Workplace Policies and Culture
3. Workplace Physical Environment and Safety Climate
4. Health Status
5. Home, Community, and Society

This questionnaire comes with materials to help understand how to administer it and interpret the results, including videos and other resources.

Example: Several federal agencies including the Health Resources and Services Administration, NIH, and NSF, as well as nonprofit organizations, have funded extensive work on a series of climate surveys designed to evaluate perception of campus climate from the students' perspective,[49] faculty perspective,[50] and staff perspective.[51] These measures are designed to assess perceptions of several targeted attributes associated with a diverse and healthy campus climate (e.g., belongingness, cross-racial interactions, and experience with discrimination). All three measures have been designed to be used together though they can also be used independently.

Step 3: Analyze Climate Survey Results

After identifying the purpose of a climate survey and selecting the appropriate measure, the results need to be analyzed in a way that helps identify the organizational, cultural, or institutional barriers that hinder the recruitment, retention, or advancement of groups who have been underrepresented in STEM education and careers. The climate surveys and their results can serve as a springboard for

[47] AFD Climate and Retention Pilot Intervention Program. University of California Berkeley. https://ofew.berkeley.edu/sites/default/files/_deiblueprint_afd_climate_and_retention_proposal_davis_berkeley_san_francisco.pdf

[48] Worker Well-Being Questionnaire. Centers for Disease Control and Prevention https://www.cdc.gov/niosh/twh/wellbq/default.html

[49] Diverse Learning Environments Survey. University of California Los Angeles. https://heri.ucla.edu/diverse-learning-environments-survey/

[50] HERI Faculty Survey. University of California Los Angeles. https://heri.ucla.edu/heri-faculty-survey https://heri.ucla.edu/heri-faculty-survey/

[51] Staff Climate Survey. University of California Los Angeles. https://heri.ucla.edu/staff-climate-survey https://heri.ucla.edu/staff-climate-survey/

discussion, allowing for deeper investment across stakeholders in the results and data-informed, organizational-level resolution.

Benchmarking Data

Benchmarking data by using historical or other comparison data to the results from the current analyses can help identify an institution's progress in meeting its DEIA goals. Benchmarking data are analyzed in a way that provides a snapshot of the organization's climate at a specific time period. These data can then be used to understand progress and growth over time. Critical with benchmarking is the use of the same metric administered in the same manner each time which allows for comparisons. Equally critical is understanding that over time, people and organizations change even in the absence of intentional mitigating efforts (e.g., historical events such as the COVID-19 pandemic). Such events and artifacts need to be considered when interpreting results.

Example: NIH's Scientific Approach to Inclusive Excellence provides information regarding benchmarking using the NIH Workplace Climate and Harassment Survey.[52] The purpose of this survey is to gather a general sense of the organizational climate coupled with information on the rates of sexual harassment incidents in scientific research environments. Benchmarking data (i.e., obtaining results from the first time the measure is administered) allows for comparisons of those results and an understanding of the impacts and changes in sexual harassment and organizational climate over time. With benchmarking, it becomes possible to understand the impact of organizational change efforts including new policies or practices designed to address existing organizational culture, barriers or culture that could have contributed to prior observed, and issues such as sexual harassment.

Disaggregating Data

It is a best practice to disaggregate data in order to understand how individuals from different demographic groups may be differentially impacted by an organization's structures and climate. [53,54,55] The Equitable Data Working Group of the NSTC Subcommittee on Equitable Data defines disaggregated data as "data about groups separated out by race/ethnicity, gender identity, veteran status, geography, sexual orientation, income level, disability status, rural/urban location, and other factors."[56] Disaggregated data is particularly necessary when working to identify and mitigate organizational barriers for those that have historically and continue to be overburdened and underserved and to understand organizational health.

When collecting demographic data, it is imperative that individuals' anonymity be protected. Effective practices for collecting and disaggregating data by demographics are detailed in the interagency report

[52] NIH Workplace Climate and Harassment Survey Executive Report. National Institutes of Health. https://diversity.nih.gov/sites/coswd/files/images/docs/NIH_Workplace_Climate_and_Harassment_Survey_Executive_Report_508.pdf

[53] Progress on Implementation of the Recommendations of the Equitable Data Working Group. Office of Management and Budget. https://www.whitehouse.gov/wp-content/uploads/2023/03/Progress-on-Equitable-Data-Mar2023.pdf

[54] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

[55] Measuring, Monitoring, and Improving Organizational Health and Organizational Performance in the Context of Evolving Agency Work Environments. Office of Management and Budget. https://www.whitehouse.gov/wp-content/uploads/2023/04/M-23-15.pdf

[56] Progress on Implementation of the Recommendations of the Equitable Data Working Group. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2023/03/Progress-on-Equitable-Data-Mar2023.pdf

from the Equitable Data Working Group.[57] The report recognized that OMB has made considerable progress in its ongoing work to revise the minimum race and ethnicity standards used by federal agencies and has released best practices for the collection of sexual orientation and gender identity data in federal health surveys. In addition, the working group published an evidence agenda that provides a roadmap for federal agencies to build evidence to advance equity for the LGBTQI+ community.

The Best Practices for Diversity and Inclusion in STEM report[58] also recommends that data collection and analyses should assess subgroup differences, including disability status, along with the intersection of various demographic data categories. Analyses that explore how individuals who belong to different intersecting demographic groups are differentially impacted by an organization's barriers and climate can be extremely powerful in uncovering hypothesized or unexpected results. Examples of these intersections include rural teens, Black women, and Ph.D. candidates who are from groups underrepresented in STEM. Understanding intersectional impacts is made possible when climate surveys are collected from larger groups of people or when they are intended to serve the purpose of understanding the experience of the institution's policies, practices, and culture for specific groups of people with intersectional identities.

Example: NIH conducted a climate survey of researchers and leaders at universities and research facilities that was specifically designed to understand the impact of COVID-19 on faculty progress towards retention, tenure, and promotion. Because they took a deliberate, disaggregated data approach, they were able to better understand that COVID-19 negatively impacted subgroups' career progress differentially. For example, female, early-career researchers with caregiving requirements felt that their research was most disrupted and had greater concerns about future tenure and promotion decisions. In analyzing climate survey data, the disaggregation should make theoretical sense and be driven by the purpose of the climate survey. Collected data were disaggregated based on gender, including more complicated gender identities. They looked at caregiver responsibilities, time in career, mental and physical health conditions, race/ethnicity, and other distinguishing variables. By looking at subgroup differences, the results of this survey provided a fuller view of the systemic differential impacts of COVID-19 on STEM researchers.[59]

Alternative Climate Survey Methods

The examples provided in the sections above align with the classic example of a climate survey method—a formalized series of quantitative questions with a scale or scales designed to assess constructs and experiences. In those instances, measures are typically designed to administer to a person via survey software (e.g., Qualtrics, Survey Monkey, Microsoft Forms), after confirming that a given survey format is accessible. However, there is wider variation in climate survey methodology, where the goal is to gather information that may go beyond the use of a Likert Scale set of items. In addition to more quantitative examples, organizational climate studies may take qualitative routes such as focus groups or interviews to better understand cultural and institutional barriers that hinder

[57] Progress on Implementation of the Recommendations of the Equitable Data Working Group. Office of Management and Budget. https://www.whitehouse.gov/wp-content/uploads/2023/03/Progress-on-Equitable-Data-Mar2023.pdf

[58] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

[59] Report of Findings: COVID-19 Impact on Extramural Research Surveys. National Institutes of Health. https://diversity.nih.gov/sites/coswd/files/images/Extramural_Research_Survey_Narrative_Report_03-31-2021_508_v2.pdf

recruitment, retention, and advancement of groups historically and continually underrepresented in STEM education and careers. They may also be less formalized, though no less intentional or impactful. Some variations in methods include:

a. Qualitative Design – This type of design allows for more comprehensive data collection around sensitive questions with opportunities for data collectors to follow up to capture nuances in response.
b. Evaluative Surveys – Hypothesized areas of concern can be fleshed out more deliberately by evaluating specific inequities such as performance evaluation outcomes or distribution of workloads.
c. Exit Interviews – These interviews can provide more candid responses to sensitive questions and can be vital for understanding retention challenges for underrepresented staff that are leaving the organization. Communication accommodations must be provided for exit interviews with staff requiring communication accessibility.

Example: NSF's ADVANCE: Organizational Change for Gender Equity in STEM Academic Professions funded the Faculty Workload and Rewards Project,[60] which looks at efforts at 51 different institutions of higher education regarding equitable workloads for faculty. Through the process of reflection, departments were provided with a series of activity sheets that support departmental level discussion and reflection in assuring more equitable workloads. In this instance, the climate study takes the form of evaluation efforts that occur through intentional and guided departmental discussions. The purpose of this study is to understand workload balance and to identify and mitigate a common imbalance where individuals from underrepresented populations end up with workloads that are heavier in teaching or service than their white male counterparts. These unexamined imbalances can have negative impacts on research activities, impeding innovation and productivity across STEM as well as evaluation and promotion within the STEM ecosystem.[61]

Example: NIH and NSF, along with several nonprofit organizations dedicated to advancements in STEM, asked the National Academies of Sciences, Engineering, and Medicine to convene a committee with expertise in several disciplines (e.g., social psychology, industrial and organizational psychology, sociology) to understand how to ensure that pathways into the STEM workforce are inclusive and equitable. For example, Black, Latino/Latina, and Native American students enter college with aspirations to major in STEM at levels similar to their white and Asian peers. Even with such aspiration, Black, Latino/Latina, and Native American students are less likely to remain in programs through degree completion. When exit interviews designed to understand the climate the students experience are conducted, such interviews can help uncover whether campus climate such as bias (e.g., racial, gender, disability perception, etc.) is underlying students' exiting the program earlier than those not experiencing issues with organizational climate. Research entities with exit interview policies can better understand the biases and barriers that inhibit diversity with their systems and the larger STEM enterprise.

Example: In the summer of 2023, NASEM, supported by NSF, held the Disrupting Ableism and Advancing STEM national leadership summit. The session on Creating Disability-Inclusive Workforce and Workplaces at the National Academies' 2023 summit provides a wealth of information including the

[60] The Faculty Workload and Rewards Project. University of Maryland. https://advance.umd.edu/fwrp/home
[61] Equity-Minded Faculty Workloads. American Council on Education. https://www.acenet.edu/Documents/Equity-Minded-Faculty-Workloads-Worksheet-Booklet.pdf

experiences of individuals with disabilities have had in the STEM workforce. Recommendations for understanding and breaking down barriers for individuals with disabilities can come in the form of creating and leveraging an affinity group. Affinity groups[62] come in many variations, including employment resource groups[63] also called business resource groups. Research looking at how organizations that are successful in hiring and retaining diverse individuals often see the employment of affinity groups for individuals with disabilities as central to their efforts.[64] Affinity groups have the opportunity to provide useful insight, like an informal "climate survey" from individuals with disabilities, or to provide insight that can be used in the creation of new policies in ways similar to those seen with more formalized climate surveys. When seeking advice from these groups, it is important to enter these efforts authentically and with the purpose of advancing the accessibility and inclusivity of the STEM organization.

Climate surveys help organizations understand areas of strength and uncover opportunities for targeted improvements to organizational climate. Optimizing organizational climate improves STEM outcomes, including innovation.[65,66,67] This needs to be accomplished with intentionality. Such intentionality often begins with developing explicit, measurable goals that advance diversity, inclusion, equity, and accessibility efforts and including measurable goals that can be evaluated and tracked.[68] When areas of growth have been identified through climate surveys, organizations often turn to a variety of educational and training opportunities (e.g., workshops, mentoring, communities of practice) to improve organizational outcomes. Such efforts are discussed in the next section.

[62] An affinity group is comprised of individuals with a common, shared identity attribute. This identity attribute is typically underrepresented within an organization. The affinity group can, as such, bring together such individuals and provide them with a place where their experiences can be better understood and potentially leveraged at the org organizational level.
[63] Employee Resource Groups are employee-led, voluntary groups designed to address DEIA focused issues within an organization.
[64] Gould R, et.al. Disability, diversity, and corporate social responsibility: Learning from recognized leaders in inclusion. Journal of Vocational Rehabilitation. 2020. https://doi.org/10.3233/jvr-191058
[65] Presidential Memorandum: Promoting Diversity and Inclusion in the National Security Workforce. https://obamawhitehouse.archives.gov/the-press-office/2016/10/05/presidential-memorandum-promoting-diversity-and-inclusionnational#:~:text=This%20memorandum%20supports%20that%20effort,complements%20ongoing%20actions%20that%20agencies
[66] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf
[67] Reducing the Impact of Bias in the STEM Workforce: Strengthening Excellence and Innovation. Interagency Policy Group on Increasing Diversity in the STEM Workforce by Reducing the Impact of Bias. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/ostp-opm_bias_mitigation_report_20161129_final.pdf
[68] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

Guidance for Educational and Training Opportunities

Educational and Training Opportunities Overview

While climate surveys can identify where an organization's culture drives norms, values, practices, and policies that help or hinder DEIA in STEM education and careers,[69] educational and training opportunities help mitigate and address the identified organizational and institutional barriers and individual biases. Effective leadership can use this information, along with organizational policies and commitments, to enact change that addresses and removes barriers in the system to create a climate where students and staff can succeed and thrive.[70]

The impact of educational and training opportunities for reducing organizational cultural and institutional barriers underlying underrepresentation in STEM education and careers has been well established. For example, results from two meta-analyses[71,72] provide strong evidence for an overall significant positive impact for education and training programs that develop knowledge, skills, and attitudes related to diversity as a way to address organizational cultural barriers and work toward removing institutional barriers underlying underrepresentation in STEM. However, for positive impacts to be realized, the context and conditions under which the training is implemented must also be taken into consideration. Diversity training and education may be more effective when:

- The focus is on cognitive-based and skill-based outcomes instead of emotional-focused outcomes.
- Expectations surrounding training are focused on more proximal outcomes such as knowledge, skills, and attitudes. The proximal outcomes can in turn impact more distal outcomes such as retention and promotion.
- There is strong and committed leadership.[73]
- There is strong accountability. Accountability could include pay, promotion, and performance evaluation based on contributions to DEIA goals. Accountability can also include clear, measurable, and realistic metrics of success based on the practices/interventions used.
- Training is ongoing, intentional, measured, and integrated into the work of the organization. Short-term trainings do not generally have a strong enough effect to change behavior in and of themselves.[74]

[69] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803
[70] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803
[71] Kalinoski ZT, et. al. A meta-analytic evaluation of diversity training outcomes. Journal of Organizational Behavior. 2012. https://doi.org/10.1002/job.1839
[72] Bezrukova K, et.al. A meta-analytical integration of over 40 years of research on diversity training evaluation. Psychological Bulletin. 2016. https://doi.org/10.1037/bul0000067
[73] Beyond Compliance: Promoting the Success of People with Disabilities in the STEM Workforce. National Academies of Sciences, Engineering, and Medicine. https://www.nationalacademies.org/our-work/beyond-compliance-promoting-the-success-of-people-with-disabilities-in-the-stem-workforce
[74] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803

It is also important that organizations and their leaders are aware of and prepared for potential counterproductive effects so that they can be avoided and thoughtfully addressed if they arise. These include:[75]

- Training may activate the ingroup/outgroup bias, further strengthening thoughts of stereotypes.
- Training may inspire an unrealistic expectation that the program eliminated bias when it, in fact, merely raised attention to its existence.
- Efforts to promote multiculturalism in training may result in participants from groups who are overrepresented (within STEM or within an academic research setting) feeling left out or resistant to change.
- Even when faced with evidence of bias, people tend to be unable to recognize the bias in themselves.

Multiple studies across academia, the private sector, and the federal government report and affirm the importance of an inclusive environment for students and staff to succeed in academic and STEM research settings. This section presents best practices with specific examples for using educational and training opportunities to address organizational cultural or institutional barriers to the recruitment, retention, or advancement of groups historically and continually underrepresented in STEM education and careers. When possible, the information below distinguishes between the contexts of STEM education for students and STEM careers for faculty.

Step 1: Identify the Needs and Purpose of the Educational and Training Opportunities

Successfully employing educational and training opportunities requires first identifying the need and purpose. This includes determining the rationale. The rationale may come from any combination of organizational climate survey results, organization mission or policy, or legislation. For example, provisions of the Executive Order on Diversity Equity, Inclusion, and Accessibility[76] advise that agencies: (a) assess whether training policies and practices are equitable, (b) implement or increase the availability of DEIA training to all staff to promote respectful and inclusive workplaces, and (c) provide resources and repositories for best practices to enhance DEIA training programs. This also requires identifying which group(s) of people are being negatively impacted by the barriers. This could be students, faculty, staff, and people who belong to specific groups or intersecting groups who are systematically underserved and underrepresented (e.g., due to race, ethnicity, gender, disability status). Part of the purpose is knowing who within the organization needs to learn and grow from the educational and training opportunities to best impact and to directly address issues with organizational culture and organizational institutional barriers. This could include those contributing to organizational cultural and institutional barriers from within the student body, faculty and staff, or leadership and search committees. Finally, the purpose should include the mitigation goals and identify the specific areas for improvement for the organization. Mitigation may focus on sexual violence and harassment or unconscious bias; improvement may be focused on organizational climate or recruitment, evaluation, and promotion. By being clear about the need and purpose of educational and

[75] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803

[76] Executive Order on Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/06/25/executive-order-on-diversity-equity-inclusion-and-accessibility-in-the-federal-workforce

training opportunities with clear, measurable, and realistic metrics of success, departments, divisions, and organizations can better develop approaches that are ongoing, intentional, and integrated into the work of the organization. They can also better evaluate the impacts of educational and training opportunities and adjust to strengthen improvements over time.

Mitigating Barriers and Improving Climate for Students

Several institutions that receive federal funding for STEM research and development offer examples of ways to build inclusive student environments that mitigate organizational cultural and institutional barriers that hinder recruitment, retention, and advancement of students from groups historically and continually underrepresented in STEM education and careers. Below is a subset of these.

Example: The American Association of Colleges and University's Project Kaleidoscope (PKAL),[77] under their Office of Undergraduate STEM Education, is dedicated to empowering STEM faculty, including those from underrepresented groups, to graduate more students in STEM fields. PKAL provides STEM faculty with resources, professional development, and training opportunities. Established in 2005 using NSF funding, PKAL regional networks aim to support faculty professional development, enhance undergraduate student learning and content mastery, and facilitate institutional change. In addition, the PKAL STEM Leadership Institute is designed for STEM faculty, principal investigators, and administrators to gain the skills and tools needed to embrace differences, initiate social change, and guide reform in undergraduate STEM education. Participants in the PKAL STEM Leadership Institute can use My Tenure Trek®,[78] a diversity simulation which guides participants through real world experiences that are representative of cultures, norms, and traditions that are distinctly different from their own. According to data provided by the institute, over 65% of institute alumni noted a significant increase in their ability to: 1) facilitate change, 2) effectively respond to problems, and 3) fully consider diverse cultures in designing policies and practices for institutional transformation.[79]

Example: Within the Department of Defense (DOD), the United States Air Force Leadership Experience Growing Apprenticeships Committed to Youth (LEGACY) program is a three-phase program that is designed to propel middle school students into an Air Force STEM career after college graduation. This three-phase program is open to all students but also includes target candidates based on DOD's identified underserved/underrepresented definition that includes Title I,[80] rural, and urban schools. LEGACY strives to introduce students to scientists and engineers of all backgrounds to address possible organizational systemic limitations/barriers that many students have (such as limited access to diverse STEM professionals with whom students have shared lived experiences.) The LEGACY program provides students with the opportunity to collaborate with individuals from all sectors of America and to network with individuals from their cultural backgrounds in a career they may be interested in. LEGACY's efforts center on providing an opportunity for everyone and ensuring individuals are treated with respect.

[77] Project Kaleidoscope. American Association of Colleges and Universities. https://www.aacu.org/initiatives/project-kaleidoscope

[78] My Tenure Trek. American Association of Colleges and Universities: https://www.aacu.org/office-of-undergraduate-stem-education/my-tenure-trek

[79] Assessing Underserved Students' Engagement in High-Impact Practices. Association of American Colleges and Universities. https://files.eric.ed.gov/fulltext/ED582014.pdf

[80] Title I is a US Department of Education program designed to provide funding to Local Education Agencies serving a high percentage of students from low-income households to help assure students achieve their state's academic standards. https://oese.ed.gov/offices/office-of-formula-grants/school-support-and-accountability/essa-legislation-table-contents/title-i-part-a

Mentoring is a strong component of the program to help assure inclusion goals are met. These elements of the Air Force LEGACY program (ensuring participation from underserved/underrepresented student participants; ensuring exposure to diverse STEM professionals; and mentoring) are central elements of the numerous STEM opportunities offered across the Department for students.

Example: An NIH grant from the Enhancing the Diversity of the NIH-funded Workforce[81] program was awarded to San Francisco State University for their Building Infrastructure Leading to Diversity (SF BUILD) project. This project demonstrates the importance of having an organizational-level deliberative process to create a diverse and inclusive environment. Recognizing that the underrepresentation of some groups in the nation's biomedical research workforce severely restricts innovation and decreases productivity, SF BUILD aims "to enhance diversity of the biomedical research workforce by transforming the teaching and research environments at San Francisco State."[82] SF BUILD developed programs focused on students[83] and faculty,[84] provided resources for faculty, and created scholarships for undergraduate and graduate students while tackling systemic, organizational-level barriers.

Mitigating Barriers and Improving Recruitment, Retention, and Promotion for Faculty and Staff

Several institutions that receive STEM federal funding for research and development have developed approaches to mitigating organizational cultural and institutional barriers that are negatively impacting their staff and faculty. These educational and training opportunities include campus-wide bias training, support for leadership and search committees, climate-related skill-building, and more. Organizations that provide transparent career pathways and advancement opportunities for all workers help foster inclusion and diversity in the workplace and the broader STEM enterprise. Below are several examples that showcase the ongoing and integrated nature of such efforts.[85]

Example: Through an NSF grant under the ADVANCE program,[86] Michigan State University developed and implemented an initiative to increase the number of women recruited in the Colleges of Natural Science, Social Science and Engineering, improve their retention and advancement, and improve the climate for women in these three Colleges. A resource developed under this grant included a toolkit[87] to assist search committees and administrators within Michigan State University's colleges, departments, schools in conducting successful faculty searches that includes a focus on increasing the diversity of applicant pools and reducing the influence of conscious and unconscious biases. The toolkit includes a detailed checklist and recommendations on how to develop position descriptions, principles for the effective recruitment of diverse candidates, and the selection process.

[81] Hallmarks of Success. National Institutes of Health. https://nigms.nih.gov/training/dpc/Pages/success.aspx https://www.nigms.nih.gov/training/dpc
[82] SF BUILD. San Francisco State University. https://sfbuild.sfsu.edu/for-students/programs/bridges-program
[83] Kepple C, et.al. Pedagogy training for the development of GTA mindsets and inclusive teaching practices. Proceedings of the 2020 Physics Education Research Conference. https://www.per-central.org/items/detail.cfm?ID=15495
[84] Ben-Zeev A, et.al. 'Speaking truth' protects underrepresented minorities' intellectual performance and safety in STEM. Education sciences. 2017. https://doi.org/10.3390/educsci7020065
[85] Workplace Mental Health & Well-Being — Current Priorities of the U.S. Surgeon General. US Department of Health and Human Services. https://www.hhs.gov/surgeongeneral/priorities/workplace-well-being/index.html#mattering-at-work
[86] ADVANCE: Organizational Change for Gender Equity in STEM Academic Professions. National Science Foundation. https://new.nsf.gov/funding/opportunities/advance-organizational-change-gender-equity-stem
[87] Faculty Search Toolkit, A Resource for Search Committees and Administrators at Michigan State University. Michigan State University. https://inclusion.msu.edu/_assets/documents/hiring/FacultySearchToolkit-final.pdf

Example: In an emerging practice, defined as a promising practice that is new, innovative, or exploratory in nature grounded in some level of evidence, yet not sufficiently so to be considered a promising practice,[88] the University of California (UC) system is using a multipronged approach to improve recruitment and retention of underrepresented minority faculty and staff. One approach that is being developed and tested across multiple UC campuses is the DEIBlueprint Pilot intervention,[89,90] which examines how departments can sustainably improve campus climate and experience, along with how department climate impacts faculty retention. The project is ongoing and extends through June 2024. The climate survey portion was described above. The second component of DEIBlueprint is the development of a "Climate Toolkit" as an intervention for use by individual departments. The Climate Toolkit includes strategies such as skill-building, in-person training, online guides for departments to work through, and one-on-one consultations provided by campus offices. The ultimate goal of the DEIBlueprint pilot program is to enable departments to perform annual or biennial climate assessments that can be used to track progress over time, surface any new issues that arise, and respond to them quickly and appropriately.

Example: Funding from the National Science Foundation's ADVANCE: Organizational Change for Gender Equity in STEM Academic Professions[91] to the University of Wisconsin-Madison Inclusion in Science & Engineering Leadership Institute (WISELI)[92] established a research center focused on increasing the representation, advancement, and workplace satisfaction of women, gender minorities, and/or members of groups currently underrepresented in faculty and leadership positions at UW–Madison. WISELI offers a variety of workshops, courses, and guest lectures for faculty search committees. These workshops are aimed at faculty search committees to understand and minimize the influence of unconscious or implicit bias and to improve department climate. Importantly, WISELI also conducts research to assess the effectiveness of their programs and initiatives. According to the University, this project demonstrates that some of their efforts are resulting in improvements.[93] For example, there were notable decreases in the gaps of climate experiences for women, faculty of color, and, to a lesser extent, faculty with disabilities. Though improvements were also found with faculty salaries, challenges remain in the STEM workplace (e.g., LGBTQ+ faculty appear to be experiencing an increasingly less-favorable climate compared to their peers).

Step 2: Select Educational and Training Models

A variety of educational and training models and approaches have been developed and studied in support of STEM departments and organizations mitigating cultural and institutional barriers. Individual workshops, workshop series, mentoring, and communities of practice can improve

[88] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

[89] AFD Climate and Retention Pilot Intervention Program. University of California Berkeley. https://ofew.berkeley.edu/sites/default/files/_deiblueprint_afd_climate_and_retention_proposal_davis_berkeley_san_francisco.pdf

[90] Establishing a plan and using the toolkit. Office for Faculty Equity & Welfare. University of California Berkeley. https://ofew.berkeley.edu/data-and-initiatives/deiblueprint/part-5-establishing-plan-and-using-toolkit

[91] ADVANCE: Organizational Change for Gender Equity in STEM Academic Professions (ADVANCE). National Science Foundation. https://new.nsf.gov/funding/opportunities/advance-organizational-change-gender-equity-stem

[92] University of Wisconsin-Madison Inclusion in Science & Engineering Leadership Institute. University of Wisconsin-Madison. https://wiseli.wisc.edu/

[93] Study of Faculty Worklife at UW–Madison. University of Wisconsin-Madison. https://wiseli.wisc.edu/research/sfw/

organizational climate, practices, policies, and well-being. When considering the various models, it is necessary to find approaches that support ongoing and comprehensive training. Research cautions institutions to avoid the temptation to "bring in an expensive outside consultant for a single training or workshop to try to solve the identified 'climate problem.[94] Effective training models often explore the historic context of the organization particularly in understanding past efforts to address issues of exclusion, increasing diversity, or developing mentoring programs.[95] Through research funded by NSF, researchers at the University of Massachusetts Amherst found that "the factors that shape inclusion and exclusion play out in individual perceptions and interactions, but are embedded in the organization of the department and university, which is further embedded in policy and historical contexts."[96] These broader considerations should be taken into account when selecting among models to ensure lasting and systemic organizational change.

A range of educational and training models follows to provide a sense of the options available to organizations as they determine which approaches are best aligned with the organization's specific areas for improvement.

Enriched Professional Development Workshops

Professional development workshops, enriched with strong organizational commitment and follow-up activities, can be a highly impactful source of educational and training opportunities to enact organizational change. The CDC offers guidance on how to optimize professional development efforts in its Guide to Promoting Professional Development.[97] Among the tips included in the guide is the concept that "one and done" in professional development may not be enough. Instead, effective professional development activities strengthen knowledge and skill development through intentional and targeted follow-up support activities. Below is a strong example of enriched professional development workshops in practice.

Example: According to the National Academies' report on Re-envisioning Promotion and Advancement,[98] mentoring commitments often go disproportionately to faculty from minoritized groups, who are expected to mentor all students from minoritized groups. When such time-consuming endeavors are not factored into faculty workload and promotion, inequities arise. This notable issue is at the center of the NSF ADVANCE-funded Faculty Workload and Rewards Project.[99] This action research project worked with 51 departments and academic units with the purpose of promoting equity in how faculty work is taken up, assigned, and rewarded, drawing from theories of behavioral economics and

[94] Multi-Pronged Initiatives to Address URM Faculty Retention and Climate. University of California. https://ucop.edu/faculty-diversity/advancing/campuses/los-angeles/improved-climate-and-retention/ucla-uci-multiprong.html
[95] Misra J, et.al. Creating inclusive department climates in STEM fields: Multiple faculty perspectives on the same departments. Journal of Diversity in Higher Education. 2022. https://doi.org/10.1037/dhe0000402
[96] Misra J, et.al. Creating inclusive department climates in STEM fields: Multiple faculty perspectives on the same departments. Journal of Diversity in Higher Education. 2022. https://doi.org/10.1037/dhe0000402
[97] Centers for Disease Control and Prevention. 2017. Guide to Promoting Professional Development. https://www.cdc.gov/healthyschools/tths/17_279948-A-MPDS-Guide_WEB-508.pdf#:~:text=set%20of%20recommended%20Professional%20Development%20Practices%20that%20are,in%20group%20settings%20like%20work%C2%ADshops%2C%20presentations%2C%20and%20webinars
[98] Re-envisioning Promotion and Advancement for STEM Faculty: Proceedings of a Workshop in Brief. National Academies of Sciences, Engineering, and Medicine. https://doi.org/10.17226/25742
[99] The Faculty Workload and Rewards Project. (n.d.). Advance University of Maryland. https://advance.umd.edu/fwrp/home/

the principles of equity-mindedness. The four-part workload intervention[100] includes training on workload inequity, creating a faculty work activity dashboard, developing an equity action plan, and individual faculty professional development on managing time-use.[101] Workbook assignments have been created to guide a department through the process of mitigating these barriers.

Relatedly, the National Academies' report identified the following strategies that departments seeking workload and award equity benefit from:[102]

- Transparency: having widely visible information about faculty work activities available for department members to see.
- Clarity: clearly identified and well-understood benchmarks for faculty work activities.
- Credit: recognizing and rewarding faculty members who are expending more effort in certain areas.
- Norms: having an explicit commitment to ensuring faculty workload is fair and have put systems in place that reinforce these norms.
- Context: acknowledging that different faculty members have different strengths, interests, and demands that shape their workloads and offer workload flexibility to recognize this context.
- Accountability: having mechanisms in place to ensure that faculty members fulfill their work obligations and receive credit for their efforts.

When considering professional development training, in order to address organizational barriers to accessibility, it may make sense to address misconceptions regarding individuals with disabilities. Some common, preconceived notations surrounding individuals with disabilities include misconceptions regarding reasonable accommodations under existing federal law. For example, contrary to most people's understanding, the plurality of accommodations for an individual with a disability come with no cost associated with it, such as assigning lab or classroom space on a ground floor or near an elevator for individuals with mobility disabilities. The next most common forms of accommodation come with minimal cost (e.g., printing material in larger font).[103] Climate surveys, affinity groups, and other forms of evaluation are great ways to understand misconceptions and knowledge gaps across the organization. Knowledge gaps and misconceptions driving cultural and institutional barriers can be addressed during enriched training.

Example: In FY23, the U.S. Patent and Trademark Office (USPTO) put in place its first Diversity Officer and required all employees to take Unconscious Bias training, which also was embedded into new employee orientation. To ensure sustainability of an incredibly diverse workforce of various backgrounds and cultures, the Diversity Officer conducted more than 90 DEIA-focused workshops for new and established Patent examiners and other business unit employees, including other federal departments and agencies such as Department of Agriculture, Department of Commerce (including

[100] Equity Minded Faculty Workloads: Worksheet Booklet. American Council on Education. https://www.acenet.edu/Documents/Equity-Minded-Faculty-Workloads-Worksheet-Booklet.pdf
[101] Translating Equity-Minded Principles into Faculty Evaluation Reform. American Council on Education. https://www.acenet.edu/Documents/Equity-Minded-Faculty-Evaluation-Reform.pdf
[102] Re-envisioning Promotion and Advancement for STEM Faculty. Proceedings of a Workshop in Brief. National Academies of Sciences, Engineering, and Medicine. https://doi.org/10.17226/25742
[103] Disrupting Ableism and Advancing STEM Creating Disability-Inclusive Workforces and Workplaces. National Academies of Sciences, Engineering, and Medicine. 2023. https://www.nationalacademies.org/event/06-05-2023/disrupting-ableism-and-advancing-stem-a-national-leadership-summit

Census Bureau and National Oceanic and Atmospheric Administration), Department of Education, Department of Health and Human Services (including CDC and Administration for Children and Families), Department of Homeland Security, Department of Transportation (including Federal Aviation Administration), and Federal Election Commission. Nearly 31,000 individuals participated in the sessions.

Mentoring as Training Model

Mentoring can be an effective model for mitigating the negative effects of organizational cultural and institutional barriers while advancing individuals through STEM education and career pathways.[104] In the Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide by and for Federal Agencies,[105] mentoring was identified as being one of the top five best practices for developing and retaining promising personnel and addressing barriers to diversity and inclusion.

The mentor-mentee relationship has the potential for both members of the mentoring team to learn and grow in important areas associated with DEIA barrier identification and mitigation.[106] While mentoring often takes the form of information delivery from the mentor to the mentee, emerging efforts suggest a more high-quality mentoring relationship approaches knowledge and understanding as bidirectional. Rather than taking a deficit approach that envisions mentorship as a tool for fixing a perceived weakness within the mentee, an asset-based approach identifies the strengths the mentee brings to their work. In a bidirectional model of mentoring, both sides of the mentoring pair engage in reflection to learn and grow with knowledge about how to navigate the system while providing insight and opportunities for the mentor and organization to make systemic changes to ensure broader success, particularly in areas like accessibility and inclusion. Emerging research on the role of bidirectional mentoring with K-12 teachers has found this approach advances both junior and senior teachers while also contributing to career development and psychosocial supports for both members of the mentoring team.[104][107] Ultimately, an effective mentoring program with the potential to improve both the individuals and the larger system includes a theoretical framework hypothesizing growth (e.g., science identity development,[108] social cognitive career theory,[109] etc.), while also helping the mentor and mentee develop DEIA-centered skills (e.g., reducing the impact of bias, being culturally responsive, etc.).[110]

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[104] Pfund C. Defining attributes and metrics of effective research mentoring relationships. Aids and Behavior. 2016. https://doi.org/10.1007/s10461-016-1384-z

[105] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

[106] Pfund C. 2016. https://doi.org/10.1007/s10461-016-1384-z

[107] Chen, Y. (2018) https://doi.org/10.1080/13611267.2018.1511948

[108] Williams M & George-Jackson CE. Using and Doing Science: Gender, Self-efficacy, and Science Identity of Undergraduate Students in STEM. Journal of Women and Minorities in Science and Engineering. 2014. https://doi.org/10.1615/jwomenminorscieneng.2014004477

[109] Lent, RW, et.al. Toward a unifying social cognitive theory of career and academic interest, choice, and performance. Journal of Vocational Behavior. 1994. https://doi.org/10.1006/jvbe.1994.1027

[110] STEM Mentoring: Emerging Strategies for Inclusion. American Association for the Advancement of Science. https://www.aaas.org/sites/default/files/2019-04/19-018%20AAAS%20STEM%20Mentoring_final_web.pdf?adobe_mc=MCMID%3D49775004427751005813100654661833963822%7CMCORGID%3D242B6472541199F70A4C98A6%2540AdobeOrg%7CTS%3D1692376419

Example: The National Academies' document on Advancing Antiracism, Diversity, Equity, and Inclusion[111] provides several examples of how mentoring can be used to advance retention of individuals from minoritized populations in STEM. For example, a one-year mentoring relationship with a same-sex peer mentor during the first year of college was found to be enormously effective for female engineering students at protecting them against academic anxiety. Same-sex peer mentoring also protected the female students' well-being, enabled them to have increased success in obtaining experiential learning opportunities (e.g., engineering internships), and increased their retention in engineering and other STEM majors.

Example: NASEM held the Disrupting Ableism and Advancing STEM: A national leadership summit with a forthcoming report expected soon. Peer mentorship was highlighted during this summit as having a role in advancing accessibility. Current leaders of an organization who are living with a disability can provide a role model for success for newly recruited individuals with disabilities. Equally as important to supporting individuals with disabilities through mentorships is the use of mentorship to help facilitate leadership understanding of employees with disabilities. Thus, mentoring can help increase knowledge and empathy of individuals in leadership positions.[112]

Train the Trainer

Train the trainer models support ease of educational and training dissemination, while also deepening commitments to topics identified for mitigating the negative effects of organizational cultural and institutional barriers. As a best practice, the CDC recommends having a diverse group of individuals who have been coached by experts regarding a particular topic, skill, or program to support the expansion of knowledge, understanding, and practices throughout the organization.[113] An example of a train the trainer model follows.

Example: The University of California Berkeley has an emerging practice for graduate students. Sexual Violence and Sexual Harassment (SVSH) Prevention Training is required for incoming graduate students. This two-module program helps ensure that new students are aware of UC Berkely's community expectations of respect and to inform graduate students of their rights and resources.[114] This program trains graduate students to deliver mandatory SVSH Prevention and Education training to their peers. This training model is designed to increase the influence peers have in social and academic spaces while allowing student leaders to actively shape campus and department culture.[115]

Communities of Practice

One critical barrier across the STEM ecosystem is accessibility to information and other individuals with similar interests and backgrounds. Communities of practice can support professionals by sharing

[111] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803

[112] Disrupting Ableism and Advancing STEM Creating Disability-Inclusive Workforces and Workplaces. National Academies of Sciences, Engineering, and Medicine. 2023. https://www.nationalacademies.org/event/06-05-2023/disrupting-ableism-and-advancing-stem-a-national-leadership-summit

[113] Understanding the Training of Trainers Model. Centers for Disease Control and Prevention. https://www.cdc.gov/healthyschools/tths/train_trainers_model.htm

[114] Required Sexual Violence and Sexual Harassment Prevention Training. University of California Berkley. https://grad.berkeley.edu/students/required-sexual-violence-and-sexual-harassment-prevention-training/

[115] Train the Trainer Program—Path to Care. University of California Berkeley. https://care.berkeley.edu/prevention-first/train-the-trainer-program/

resources, ideas, and challenges. Though the use of communities of practice as a direct means for improving climate in the STEM ecosystem is not well documented, it is an emerging approach worthy of further exploration. Examples of using communities of practice to mitigate barriers in STEM career pathways are listed below.

Example: The National Aeronautics and Space Administration's (NASA) Office of STEM Engagement created the CONNECTS Community of Practice[116] for formal and informal (e.g., museum) educators to engage in a community of STEM educators, fueled by real connections to NASA personnel and educational content. Open to pre-service and in-service educators across all grade-levels and their informal education counterparts, CONNECTS breaks down systemic barriers by enabling open access to NASA content, real opportunities for collaboration, sharing of best practices with their peers, and the opportunity to sign-up the students they serve for unique engagement events. Though managed at the national level, communities of practice are often designed to systematically bring together people to share information and develop skills associated with a targeted area.[117] CONNECTS leverages this concept by allowing members to join many subgroups, or suggest the creation of new ones, to synergize like-minded colleagues around a particular area of education or a particular educational challenge.

Example: The American Association of Colleges and Universities hosts STEM Central,[118] an online community networking platform designed specifically to support STEM faculty, education researchers, administrators, funders, directors, coordinators, evaluators, and leaders at every level with the tools they need to achieve their goals in the realm of STEM higher education reform. To support the climate within the broader STEM higher education ecosystem, the platform allows all members to connect and collaborate with colleagues across the nation, engage in meaningful discussions, share ideas and expertise, and learn from experts on topics of interest.

Step 3: Evaluate Educational and Training Opportunity Effectiveness

After identifying the need and purpose of educational and training opportunities, and selecting the appropriate education and training model, the next step is to evaluate the impacts of the educational and training opportunities to determine progress toward achieving the organization's DEIA goals. It is imperative to understand how the organization is mitigating cultural or institutional barriers to the recruitment, retention, or advancement of groups underrepresented in STEM education and careers. Evaluation is essential for understanding growth, identifying and addressing any counterproductive effects, revising and adjusting plans for continued development, and to strengthen improvements over time. Climate surveys administered on a continuous basis can be a great tool for evaluating where targeted improvements to organizational climate (e.g., through educational and training opportunities) have been successful and where additional improvements or areas of growth may be needed.

[116] Connecting Our NASA Network of Educators for Collaborating Together in STEM. National Aeronautics and Space Administration. https://stemgateway.nasa.gov/connects/s/

[117] Townley A. Leveraging Communities of Practice as Professional Learning Communities in Science, Technology, Engineering, Math (STEM) Education. Education Sciences. 2020. http://dx.doi.org/10.3390/educsci10080190

[118] STEM Central Initiative. Association of Colleges and Universities. https://www.aacu.org/initiatives/stem-central

Example: The Department of Defense has produced a Human Capital Framework Evaluation Handbook,[119] which details the following four outcomes of effective evaluation of professional development training:

- Continuous and innovative improvement: results of the evaluation are used to make improvements to the training efforts.
- Holistically informed decisions: evaluation efforts can also be used to shape policy, practices, and other efforts designed at reaching the intended goals of the training.
- Integrity: using evaluation to inform mission-related decisions based on reliable data helps provide integrity to the evaluation and training process, as well as assuring cost-effective uses of taxpayer funding.
- Excellence: by establishing high success standards through training efforts helps guide performance expectations and outcomes.

Important Considerations for Implementation

Understanding and eliminating organizational cultural and institutional barriers in the STEM ecosystem is a process, and each part of the process supports the larger team and/or organization in meeting the overarching goal. There is no "one-size-fits-all." Successful efforts do not always require a tremendous amount of time or resources. Successful efforts do, however, require careful considerations (as in reflection, intentionality, and appreciation) for the entire team undertaking the process. Seven overarching considerations were identified to help support the successful implementation of climate surveys in the STEM ecosystem.

1. Keeping Mission and Goals Centered
2. Effective Leadership Matters
3. Ensuring Accessibility
4. Using Evidence to Drive Reflection and Responsivity
5. Building Trust
6. Mitigating Biases and Stereotypes
7. Providing Sufficient Support and Resources

Keeping Mission and Goals Centered

Climate surveys are designed to measure a wide variety of audiences, attributes, and organizational needs. Some climate surveys are designed by organizational type. These include surveys designed to be taken by students in high school, college, graduate school, etc. Some climate surveys are for instructors or staff.[120] Audience type is not the only focus of climate surveys. Many differ by what they hope to measure. Some are designed to capture a specific experience like sexual assault,[121] whereas

[119] Human Capital Framework Evaluation Handbook. US Department of Defense. https://www.dcpas.osd.mil/sites/default/files/2021-04/Human_Capital_Framework_(HCF)_Handbook_v11_FINAL.pdf

[120] Yoon SY, et.al. Development and Validation of the Workplace Climate and Persistence Scale for STEM Faculty Framed in Intersectionality of Gender, Race/Ethnicity, and Socioeconomic Background. Research in Higher Education. 2023. https://doi.org/10.1007/s11162-022-09724-5

[121] Wood L, et.al. Climate surveys: An inventory of understanding sexual assault and other crimes of interpersonal violence at institutions of higher education. Violence Against Women. 2016. https://doi.org/10.1177/1077801216657897

other campus climate surveys look at organizational variables such as trust and effective communication.[122] Additionally, others measure how the organization impacts members,[123] such as through eliciting stereotype threat. When developing a climate survey and/or training opportunities, the process should begin and end with a focus on the organization's mission and the needs of its community.

As described above, climate surveys can be used for varying purposes and there are varying corresponding educational and training activities. Examples include professional development workshops designed to help employees or students understand concepts such as unconscious bias or microaggressions and the negative impacts these concepts have on the quality of a university or workplace climate.[124] Therefore, it is important for each organization and team to adopt practices that align with the mission of the organization and the goals and needs of its community members.

Effective Leadership Matters

Leadership is deemed a critical component to optimizing organizational climate, particularly in the DEIA space.[125,126] This is supported by evidence showing that "culture change is an essential ingredient for systemic and transformational change, and that such change begins at the top of an organization and permeates multiple levels."[127] Leaders at the very top of the organization such as presidents and chief executive officers have the unique opportunity to shape the culture and climate of an organization by setting priorities that can shape the norms, values, policies, and practices that comprise its culture and climate. Without leadership support for changing organizational structures, culture change may not be sustained or may advance unevenly in the organization. Thus, consistent leadership commitment is critical for advancing innovation and outcomes in a STEM environment.

Leadership is also critical with regard to engaging in and modeling effective practice and professional development designed to remove barriers and advance diversity, equity, inclusion, and accessibility (DEIA) efforts within an organization.[128] Organizational leaders can prioritize DEIA norms by putting relevant policies, programs, and practices in place. Inclusive leadership is vital for fostering diversity among team members and is required to support a work environment where everyone feels valued and represented.[129] Leadership efforts are often needed to broaden participation and create an environment that fosters innovative thinking and cooperation among students, faculty, and

[122] Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways. National Academies of Sciences, Engineering, and Medicine. 2016. https://doi.org/10.17226/21739
[123] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803
[124] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803
[125] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803
[126] U.S. Surgeon General's Framework for Workplace Mental Health & Well-Being. (2022). Health and Human Services: https://www.hhs.gov/sites/default/files/workplace-mental-health-well-being.pdf
[127] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803
[128] Disrupting Ableism and Advancing STEM Creating Disability-Inclusive Workforces and Workplaces. (2023, June 7). National Academies. https://www.nationalacademies.org/event/06-07-2023/disrupting-ableism-and-advancing-stem-creating-disability-inclusive-workforces-and-workplaces
[129] U.S. Surgeon General's Framework for Workplace Mental Health & Well-Being. US Department of Health and Human Services. https://www.hhs.gov/sites/default/files/workplace-mental-health-well-being.pdf

researchers. When diversity is celebrated as a source of strength, workers experience less stress and anxiety as bias and prejudice are not tolerated. Individuals leading hierarchical organizations typically have the ability to set the tone, make decisions regarding values, and articulate priorities. This can take the form of facilitating a climate of comfort, inclusion, accessibility, and allocation of resources including financial, material, mentorship, and even prestige.[130,131]

Example: The U.S. Patent and Trademark Office's internal Leadership Forum and Leadership Forum Extra, held every other year, include DEIA and Reasonable Accommodation training sessions, presented by the Equal Employment Opportunity Director, Diversity Officer, and Reasonable Accommodation Program Manager. Approximately 1,500 managers and supervisors participate in the Leadership Forum and receive the RA training. In the FY23 Leadership Extra Forum, the Diversity Officer provided workshops on Psychological Safety. Other forum sessions supported the 10 USPTO Ideal Leader Profile Qualities, particularly communication skills, management expertise, and inclusivity/collaboration.

Ensuring Accessibility

While several resources for reducing organizational cultural and institutional barriers are summarized in this document, they are limited in their consideration and focus on the needs of individuals with disabilities including those with episodic disabilities.[132, 133] The Best Practices for Diversity and Inclusion in STEM Education and Research report[134] outlines the importance of creating an accessible environment for individuals with varying abilities. Individuals with disabilities often experience lower levels of career success, in part due to addressable barriers that they face because of inaccessibility of the workplace and discriminatory attitudes, regardless of work quality, that are often due to the workplace culture. Considering approximately 27% of all individuals within the country are classified as disabled,[135] understanding how accessible a climate is to such a diverse group of individuals is important for all STEM research and learning environments.

NSF's National Center for Science and Engineering Statistics (NCSES) gathers data and publishes a report on individuals from groups underrepresented in STEM. Their recent report, Diversity and STEM: Women, Minorities, and Persons with Disabilities 2023[136] provides insights on graduation rates and employment rates, and highlights opportunities for growth in these segments of the STEM ecosystem.

[130] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803
[131] Broadening Participation in STEM through Diversity, Equity, and Inclusion. National Science Foundation. https://www.nsf.gov/edu/Pubs/BroadeningParticipationWebinar2020.pdf
[132] Episodic disabilities are often from chronic conditions (e.g., sickle cell anemia, cancer, depression) for which there may be intermitted periods of wellness followed by symptomatic periods.
[133] Gignac MA, et. al. Disclosure, privacy and workplace accommodation of episodic disabilities: organizational perspectives on disability communication-support processes to sustain employment. Journal of Occupational Rehabilitation. 2021. https://doi.org/10.1007/s10926-020-09901-2
[134] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf
[135] Disability and Health Data System. Centers for Disease Control and Prevention. http://dhds.cdc.gov
[136] Diversity and STEM: Women, Minorities, and Persons with Disabilities. National Science Foundation. https://ncses.nsf.gov/pubs/nsf23315/report/introduction

In examining results from NCSES report,[137] we see disabilities reported across all age groups, races, and ethnicities. Yet, while nearly one-quarter (24%) of individuals in the United States are employed in STEM occupations, only 3% of those employed in STEM report a disability. People with disabilities experience a significantly higher unemployment rate, part time employment rate, and seeking employment rate in STEM fields than individuals without disabilities. Additionally, for those who are working part time, individuals with disabilities report a desire to work full time at nearly twice the rate of individuals working part time without a disability (28% vs. 15%). There is an opportunity for STEM organizations to engage in more intentional accessibility efforts to assure a fully diverse, innovative, and productive workforce.

The Equal Employment Opportunity Commission offers general recommendations for recruiting, employing, and retaining people with disabilities.[138] Planning ahead to ensure that job descriptions specify the essential functions of a job and stating that reasonable accommodations may be requested for the job interview help ensure that candidates with disabilities do not get screened out before hiring officials begin reviewing applicants while also serving to highlight the importance of disability diversity within the organization.

Universal Design is an architectural design approach to minimizing barriers, for individuals with disabilities. This approach has been adopted in STEM learning and work environments,[139] as a means of advancing accessibility and inclusion for individuals with disabilities to learn and thrive as students and employees in the STEM ecosystem.

Example: The University of Washington's Disabilities, Opportunities, Internetworking, and Technology DO-IT Center promotes awareness and accessibility in the classroom and the workplace. Their resource, Equal Access: Universal Design of Instruction,[140] contains a comprehensive list of recommendations and resources for K-12, postsecondary, and workplace efforts that can remove barriers and support a more inclusive and accessible STEM ecosystem. Guidance includes:

- *Ensure physical access to facilities.* Use classrooms, labs, workspaces, and fieldwork sites that are accessible to individuals with a wide range of physical abilities;
- *Provide content in accessible, universally designed formats*. Select or create materials (including textbooks, syllabi, lesson pages, presentation materials) that are universally designed.

Example: The Smithsonian Institution's Smithsonian Education Center has created the reference, Zero Barriers in STEM Education Accessibility and Inclusion Workbook, that can be used by informal and formal STEM learning environments with the goal of achieving accessibility and inclusivity.[141] This workbook provides examples of activities that can be adopted in educational and workforce settings that apply the principles of universal design strategies to engage students in learning and to develop

[137] Diversity and STEM: Women, Minorities, and Persons with Disabilities. National Science Foundation. https://ncses.nsf.gov/pubs/nsf23315/report/introduction

[138] Recruiting, Hiring, Retaining, and Promoting People with Disabilities. US Equal Employment Opportunity Commission. https://www.eeoc.gov/sites/default/files/migrated_files/eeoc/interagency/employing_people_with_disabilities_toolkit_february_3_2015_v4-2.pdf

[139] Izzo MV & Bauer WM. Universal design for learning: enhancing achievement and employment of STEM students with disabilities. Universal Access in the Information Society. 2013. https://doi.org/10.1007/s10209-013-0332-1

[140] Equal Access: Universal Design of instruction. University of Washington. https://www.washington.edu/doit/equal-access-universal-design-instruction

[141] Zero Barriers in STEM Education: Accessibility & Inclusion Workbook. Smithsonian Institute. https://ssec.si.edu/sites/default/files/other/zerobarriers/ZeroBarriersWorkbook-.pdf

individuals across the STEM ecosystem. Through the application of universal design principles, whether in the classroom or for professional development and policy approaches, this can ensure equitable accessibility to STEM curriculum and instruction and decreased barriers across the workforce. Rather than approaching accessibility as an afterthought or only on a case-by-case basis, universal design principles help educators and leaders increase accessibility to a wider array of individuals across the STEM enterprise. These principles focus on providing equitable access to STEM content, learning, and work environments by providing:

- Several ways to represent content (e.g., text-to-speech, audible passages),
- Several ways for individuals to demonstrate their knowledge and skills (e.g., verbal, speech-to-text), and
- Multiple approaches for engagement (e.g., telework).

This resource is focused on STEM education in formal and informal learning settings but can be adopted in professional development settings and other STEM environments.

Using Evidence to Drive Reflection and Responsivity

The workplace climate can be a potential barrier to inclusion, access, retention, advancement, and organizational success. Maintaining an inclusive workplace climate requires understanding how members underrepresented in STEM, including those members with disabilities or foreign-born STEM professionals, experience that climate. Climate surveys and other forms of evaluation can aid in securing evidence, thus providing organizational learning regarding progress and to inform improvements.[142] In addition, it is equally important to create time and space to reflect on the results from the climate surveys and evaluations and how they can improve the organization's policies and practices. Whether the results from the survey or evaluations show positive or negative trends, the data should be used to inform a path forward in identifying and mitigating barriers to retention or promotion or improving an organizations' climate and success. There are resources that guide organizations through the process of effectively using data to inform policy, practices, or other improvements.[143] Responsiveness to evidence is also linked to trust, which is described next.

Build Trust

Trust is an important organizational attribute that is known to support organizational well-being. Supportive work relationships, and the trust they help engender, can improve engagement, innovation, and employee performance.[144] Leaders can build trust through listening, clear, direct, and consistent communication, and sharing the rationale behind key decisions with their teams. Leaders can also demonstrate trust by acting on their values consistently. In conversations with researchers and government agencies, teams were asked to describe how they built trust in their efforts. There are a variety of approaches to establishing trust in either the findings of climate surveys or the approaches employed to respond to climate survey results. Across the board, engaged leadership who make and maintain strong commitments help institutions reach their full potential for a diverse and equitable

[142] Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways. National Academies of Sciences, Engineering, and Medicine. 2016. https://doi.org/10.17226/21739

[143] Equity-Minded Faculty Workloads. American Council on Education. https://www.acenet.edu/Documents/Equity-Minded-Faculty-Workloads-Worksheet-Booklet.pdf

[144] U.S. Surgeon General's Framework for Workplace Mental Health & Well-Being. US Department of Health and Human Services. https://www.hhs.gov/sites/default/files/workplace-mental-health-well-being.pdf

environment that advances excellence in STEM. In addition, having dedicated, long-term staff whose roles are to advance DEIA among staff and/or students helps build trust and improve satisfaction with the organization's climate. In some situations, these staff engage departments in conversations regarding their intentions and interests surrounding a climate survey, co-design the survey with those staff using established measures, and support interpretation, communication, and identification and implementation of responses to address organizational challenges.

NSF Science of Organizations program funded a CAREER grant that studied the importance of organizational trust.[145,146] One way that an organization can aid trust when administering surveys (e.g., climate surveys) is to not ask for demographic information to ensure anonymity and promote honesty, while also avoiding the potential risk of revealing individual identities. Instead, researchers recommended that if there is a particular area of interest or harm unearthed by the survey, follow-up focus groups could be conducted by a confidential entity. In yet another setting, an approach to building trust in the responses to survey findings was to provide educational and training opportunities for staff to craft DEIA statements and to include their DEIA efforts in evaluations that accelerate staff advancement. Looking to government funded projects, trust appears to be a requisite for innovation with it being central to how teams approach their work and/or communicate to support a sense of belief in each other.

Mitigating Biases and Stereotypes

A fundamental theme running through the information gathered for this report is that there are cognitive biases—due to aspects of the human brain's shortcuts, processing, and/or limitations[147]—that are likely to negatively impact climate, recruitment, evaluation, and promotion. Stereotypes are a related underlying mechanism that also negatively impacts climate, recruitment, evaluation, promotion, and organizational success. Stereotypes are based on assumptions that people hold regarding a group of people. This topic is thoroughly reviewed in the National Academies' report on Advancing Antiracism, Diversity, Equity, and Inclusion.[148] For example, the National Academies' report highlights people's strong tendency to favor their ingroup relative to their outgroup in social evaluations and resource allocation. This pervasive tendency has been further used to explain people's intergroup preferences as well as people's discriminatory behavior towards people who are in their outgroup.[149] Compounding this issue, people also make differing assumptions of competency in the face of errors, depending on whether the person making the error is in their own ingroup or outgroup. Research has demonstrated that when someone from one's outgroup makes an error, the assumption is that the individual from the outgroup is inherently flawed whereas when someone from one's ingroup makes the same error, efforts are made to look towards systems and practices to make improvements to mitigate errors. Mitigating biases and stereotypes can improve the organizational climate and improve recruitment, retention, and promotion of a diverse STEM workforce, thereby maximizing the

[145] CAREER: Bilateral Extensions to Studying Trust in Organizations. National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=1943688&HistoricalAwards=false

[146] Schilke, et.al. Trust in Social Relations. Annual Review of Sociology. 2021. https://doi.org/10.1146/annurev-soc-082120-082850

[147] Understanding Bias: A Resource Guide. US Department of Justice. https://www.justice.gov/file/1437326

[148] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803

[149] Antiracism, Diversity, Equity, and Inclusion in STEMM Organizations: Beyond Broadening Participation. National Academies of Sciences, Engineering, and Medicine. 2023. https://doi.org/10.17226/26803

opportunity for innovation in STEM.[150] While this report provides several examples of training and educational opportunities to mitigate bias and stereotypes, it is important to understand that when poorly done, trainings can have the *opposite effect* of increasing biased thinking and behaviors. This is partially due to the fact that biases and stereotypes actively keep us from revising how we think and act (e.g., the Ostrich Effect, where we ignore feedback that goes against our thinking). Therefore, "one and done" or short-term trainings are less effective in helping to mitigate biases and stereotypes. The importance of the organization's processes becomes even clearer when looking at federally funded studies that explore ways of mitigating targeted biases (e.g., confirmation bias) like a CAREER grant funded through NSF[151] that looks to move beyond status quo practices often associated with biases. Ultimately it is not one bias that must be attended to, but that there be a process for which a STEM ecosystem engages in organizational awareness to understand what underlies unintended barriers to STEM success and innovation.[152]

Providing Sufficient Support and Resources

To optimize organizational well-being and identify and mitigate barriers to inclusion and accessibility, it is important to recognize that one barrier often faced by many organizations and the communities they serve is resources. See Appendix 2 for a list of opportunities that may fund practices towards reducing barriers and/or may serve as a resource for better understanding practices towards reducing barriers.

[150] Reducing the Impact of Bias in the STEM Workforce: Strengthening Excellence and Innovation. Interagency Policy Group on Increasing Diversity in the STEM Workforce by Reducing the Impact of Bias. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/ostp-opm_bias_mitigation_report_20161129_final.pdf

[151] CAREER: Disrupting the Status Quo Regarding Who Gets to be an Engineer. National Science Foundation. https://www.nsf.gov/awardsearch/showAward?AWD_ID=2042377&HistoricalAwards=false

[152] London JS, et.al. CAREER: Disrupting the Status Quo Regarding Who Gets to be an Engineer – Insights from Year 1. American Society for Engineering Education (ASEE) Annual Conference. 2022. https://peer.asee.org/career-disrupting-the-status-quo-regarding-who-gets-to-be-an-engineer-insights-from-year-1.pdf

Concluding Recommendations

The sections above details new approaches and best practices for climate surveys, and educational and training opportunities that reduce organizational cultural and institutional barriers. Pulling from those insights, this section highlights recommendations that support the research above and include policies and practices that institutional policy makers (and federal agencies) can build upon or further implement in their organization, as well as new concepts derived from the research outlined in this report.

Recommendation 1: Implement and Expand on Existing Best Practices

Climate Surveys

- ✓ **Develop and Use Tools to Assess**: Climate survey work is more successful when surveys have been confirmed to be inclusive (e.g., accessible with Section 508 conformance) and are tailored to the environment and interests of the institution and its community. Climate surveys should serve as a springboard for discussion both before and after the surveys are completed, allowing for deeper investment across stakeholders in the purpose, the results, and the organizational-level resolution. These early discussions help develop trust in the process, the leadership, and the organization.
- ✓ **Disaggregate Climate Survey Results**: Disaggregated data are particularly necessary when identifying and remediating disparities for those that have historically been overburdened and underserved.[153] Knowing where an organization's culture and structures are creating barriers across intersecting demographic factors is essential to supporting the organization's, individual's, and nation's STEM health and well-being, innovation, problem solving, decision-making, creativity, and success.
  - *If federal agencies collect demographic data from federally funded organizations, collecting disaggregated data is recommended.*
- ✓ **Reflect and respond:** Climate surveys help organizations understand areas of strength and uncover gaps and opportunities for targeted improvements to organizational climate (e.g., the need to update DEI policies to reflect DEIA priorities for expanding accessibility.) Optimizing organizational climate optimizes outcomes. This needs to be accomplished through reflection on climate survey results and intentionality in responses. Such intentionality often begins with developing explicit, measurable goals that advance diversity, equity, inclusion, and accessibility within the organization.

Educational and Training Opportunities

- ✓ **Effective Leadership is essential:** Climate surveys can identify where an organization's culture drives norms, values, practices, and policies that help or hinder DEIA in STEM education and careers. Leadership then needs to use this information, along with organizational policies and commitments, to enact change that removes barriers and creates a climate of inclusivity and accessibility where students and staff can succeed.

[153]Progress on Implementation of the Recommendations of the Equitable Data Working Group. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2023/03/Progress-on-Equitable-Data-Mar2023.pdf

- *Where allowable and appropriate, federal agencies should include opportunities for federally funded organizations to allow educational and training opportunities for organizational leadership (beyond students and staff, for example).*

✓ **Employ Comprehensive Educational and Training Models:** Avoid the temptation to bring outside experts in for a single training or workshop. Instead, research entities can create policies that promote comprehensive training that addresses the issue more systematically. For example, part of the comprehensive training should include exploring the historic context local to the organization surrounding the cultural and institutional barriers. Comprehensive training should include opportunities for leadership to develop skills to respond to climate survey data and address institutional barriers impacting groups underrepresented and underserved in STEM.[154]

- *If federal agencies fund educational and training opportunities at federally funded organizations, flexibility to include and use climate survey-informed, effective, and contextual educational and training modalities is recommended.*

✓ **Evaluate the Impact:** Evaluation is essential for understanding growth, identifying and addressing any counterproductive effects, revising and adjusting plans for continued development, and to strengthen organizational improvements over time. Evaluation helps an organization understand whether and how it is mitigating cultural or institutional barriers to the recruitment, retention, or advancement of groups historically and continually underrepresented in STEM education and careers.

- *Where allowable and appropriate, federal agencies should include opportunities for federally funded organizations to evaluate the impact of their interventions and improvements, either separately or to contribute data to a larger collective, for assessing outcomes and impact.*

Recommendation 2: Implement and Expand Funding Opportunities, Resources, and Policies to Remove Institutional Barriers and Better Promote DEIA

✓ **Leverage existing federally funded programs and toolkits** that support diversity, equity, inclusion, and accessibility initiatives. Building institutional level change into the work, rather than focusing on individual level supports, has greater impact for the organization, its faculty, its students, and the nation.

- *Where allowable and appropriate, federal agencies should ensure current federally funded toolkits and resources be available to currently federally funded organizations and that new federally funded toolkits and resources be publicly accessible.*

✓ **Implement policies that promote DEIA.** In accordance with Title VI of the Civil Rights Act of 1964; Title IX of the Education Amendments of 1972; Section 504 of the Rehabilitation Act of 1973; and the Age Discrimination Act of 1975, federal agencies are obligated to ensure that that no person is excluded from participation in, denied benefits of, or otherwise be subjected to discrimination under federally conducted and federally funded programs

[154]Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

and/or activities. Consider policies and practices that go beyond compliance with a focus on what can help measurable improve the organization's climate.[155]

- *Where allowable and appropriate, federal agencies should regularly collect best practices that go beyond compliance for broad dissemination.* [156]

✓ **Implement policies that reinforce the importance and need for training.** The knowledge and skills described in this report require time and resources to engage in educational and training opportunities that reduce cultural and institutional barriers. Organizations must commit to and prioritize in their budget the implementation of diversity, equity, inclusion, and accessibility training programs for their leaders, faculty, staff, and/or students. Such training may address systemic and institutional racism and bias against underserved communities, building skillsets to promote respectful and inclusive workplaces and eliminate workplace harassment, improving knowledge of agency accessibility practices, and increased understanding of implicit and unconscious bias.[157]

✓ **Implement policies that focus on accessibility-related training**. Often, DEIA training courses have limited resources to provide training on inclusivity for persons with disabilities. Specific resources dedicated to improving accessibility-related training is imperative.[158] This should include updating training modules that omit consideration of disability and accessibility needs, identifying new modules that may be needed, and using a universal design approach to provide reasonable accommodations in the modern workforce, including in STEM careers which may be particularly dependent on use of appropriate technology accommodations.

Recommendation 3: Coordinate, Standardize, and be Transparent across the Organization

✓ **Implement policies that standardize demographic questions** used in surveys and evaluations to ensure they cover a wide range of intersectional identities. Stay abreast of existing standards for demographic data collection through the Subcommittee on Equitable Data,[159] the existing standards,[160] and the upcoming revisions.[161]

✓ **Implement policies that encourage broad coordination** of climate surveys as well as educational and training opportunities. Coordination across an organization enhances commitments, maximizes potential by providing more resources to plan, analyze, and implement actions, and provides a clearer picture of what is working well and where growth is needed.

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[155] Guidelines for the Review of Inclusion on the Basis of Sex/Gender, Race, Ethnicity, and Age in Clinical Research. National Institutes of Health. https://grants.nih.gov/grants/peer/guidelines_general/Review_Human_Subjects_Inclusion.pdf

[156] Title IX &STEM: Promising Practices for Science, Technology, Engineering, & Mathematics. National Aeronautics and Space Administration. https://www.nasa.gov/wp-content/uploads/2018/08/71900_hi-res.8-4-09.pdf

[157] Executive Order on Diversity, Equity, Inclusion, and Accessibility in the Federal Workforce. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/06/25/executive-order-on-diversity-equity-inclusion-and-accessibility-in-the-federal-workforce/

[158] Best Practices for Diversity and Inclusion in STEM Education and Research: A Guide By and For Federal Agencies. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2021/09/091621-Best-Practices-for-Diversity-Inclusion-in-STEM.pdf

[159] Progress on Implementation of the Recommendations of the Equitable Data Working Group. National Science and Technology Council. https://www.whitehouse.gov/wp-content/uploads/2023/03/Progress-on-Equitable-Data-Mar2023.pdf

[160] Revisions to the Standards for the Classification of Federal Data on Race and Ethnicity. Office of Management and Budget. https://www.govinfo.gov/content/pkg/FR-1997-10-30/pdf/97-28653.pdf

[161] Revision of Statistical Policy Directive No. 15. Office of Management and Budget. https://spd15revision.gov/

- *Where allowable and appropriate, federal agencies should revisit and revise existing federal research programs, practices, and policies to allow for the collection of and from federally funded organizations the types and frequency of efforts made, changes to policies and practices, and evidence of impact, in order to remove or reduce cultural and institutional barriers limiting the recruitment, retention, and success of groups underrepresented in STEM research careers.*

✓ **Have clear and openly available action plans, policies, and practices**. Transparency is imperative to creating an inclusive environment, reducing structural barriers, and building trust. In addition, having a transparent and openly accessible action plan is vital to turning results from climate surveys and educational and training opportunity evaluations into real tools for organizational change.

- *Where allowable and appropriate, as federal agencies revisit and revise policies related to the review and/or awarding of federal research awards, and as federal agencies review the evidence of impact of such policies, any changes to agency policies or practices based on that review should also be reflected and shared in the guiding policies that federally funded organizations use to inform their organization's policies and practices.*

Appendix 1. Methodology

This section of the report outlines the methodology used to capture, evaluate, and synthesize best practices for identifying and reducing organizational cultural and institutional barriers for expanding the STEM workforce in federally funded STEM research organizations and beyond. The Interagency Working Group on Inclusion in STEM (IWGIS) brings together representatives across federal agencies and departments to identify research, best practices, and policies on how to promote diversity and inclusion of all groups in the federal STEM workforce, including women, people from underrepresented racial and ethnic groups, and persons with disabilities.

Within IWGIS, a subgroup was formed focused on reviewing:

- recent National Science and Technology Council efforts;
- existing federal policies required of STEM research grantees;
- existing federal trainings provided to STEM research grantees;
- existing federal reports and recommendations related to climate surveys and effective education and training practices for ensuring a healthy and accessible organizational climate that reflects unbiased recruitment, evaluation, and promotion within the STEM education and workforce; and
- challenges to implementation by federal agencies and research institutions.

Across the federal government, numerous agencies and federally sponsored STEM research entities have implemented plans and strategies to reduce the organizational cultural and institutional barriers impeding the STEM ecosystem. This diversity of initiatives and programs posed an interesting challenge in evaluating the state and impact of the various efforts. To address this challenge, IWGIS used a multipronged approach to understand the use of climate surveys and training efforts with a particular focus on identifying and addressing organizational cultural and institutional barriers to the recruitment, retention, or advancement of groups who have been historically and continue to be underrepresented in the STEM research ecosystem.

The process included the following approaches:

1. **Information Gathering**

a. *Initial review of existing National Science and Technology Council efforts.* A search through public NSTC documents, with input from OSTP leadership, resulted in twelve reports that focus on climate surveys and approaches to supporting diversity, equity, inclusion, and accessibility in the STEM ecosystem. These documents included best practices plans, strategic plans, action plans, methodology recommendations, and climate survey examples. This set of reports was also used to provide context in the information call.

b. *IWGIS information call*. Based on the review of NSTC efforts, an information call went to 34 agency representatives requesting links, reports, or information they and their networks have regarding:

   i. Existing climate surveys including those aimed at improving DEIA.
   ii. Organizations or departments' climate survey implementation and responses, including practices related to improving DEIA.
   iii. Reports/dissemination of climate survey results including those that explore questions of DEIA.

iv. Scope of work for contracts related to climate surveys.
v. Best practices for trainings that support unbiased recruitment, evaluation, or promotion.
vi. Any literature related to organizational cultural and institutional barriers for DEIA in STEM and/or research.

This call resulted in 36 additional documents, ranging from government-wide reports to requirements from across a single government agency to recent National Academies in Science, Technology, Engineering and Medicine (NASEM) consensus studies. These reports also ranged from quantitative and qualitative research on climate funded through government agencies to promising or emerging practices in specific university systems. Results also included climate surveys specific to government employees and referenced a wide variety of climate surveys used by organizations who receive federal research funding.

c. *Federal STEM Data Call.* Data calls led by OMB and OSTP in 2022 yielded information regarding STEM education investments across federal agencies. Agencies responded to multiple questions including the purpose of their investments, the participants served by their investments, and how these investments are supporting DEIA efforts in the STEM enterprise.
d. *Iterative Information Gathering*. Throughout the review of the above documents, highly relevant references from within the reports were also gathered. Whenever possible, this report relies on the synthesis of government reports and NASEM consensus studies rather than re-reviewing each citation. Throughout the synthesis process, the IWGIS subgroup also pulled from relevant federally funded projects and practices to provide additional examples.

2. Coding and compiling information

Each report was reviewed by at least one member of the IWGIS, and relevant information was inputted into a common database for a variety of topics, including but not limited to:

a. Climate Surveys
    i. Focus on organizational cultural barriers (e.g., respect for multiple approaches, open to many ways of knowing, considers workplace comradery and environment for all)
    ii. Focus on institutional barriers (e.g., recruitment, retention, advancement)
    iii. Measures and constructs
    iv. Studies on impact and/or effectiveness
    v. Federal policies to support climate surveys at the STEM research entities that receive Federal funding
b. Training Opportunities for research entities (videos, workshops, courses, toolkits)
    i. Focus on unbiased recruitment
    ii. Focus on unbiased evaluation
    iii. Focus on unbiased promotion
    iv. Studies on impact and/or effectiveness
    v. Examples of research entity policies (e.g., proposal applicants need to add a plan for diversity and equity, bias training for researchers, etc.)

3. Conversations with agencies and academic entities

Four government and academic groups were selected for 30- to 60-minute follow-up conversations. These groups were selected because of the breadth and/or depth of their organization's climate survey and training efforts aimed at reducing organizational cultural and institutional barriers. These conversations helped the IWGIS ascertain more detailed information, understand the range of experiences and evidence supporting various aspects of the work, and develop examples and vignettes for this report that are grounded in real-world practice. Information from the interviews was summarized in a written document and, when appropriate, included in this report's analysis.

4. Synthesis of best practices and analysis for themes

After information from each report was compiled into specific topic areas, the team reviewed all related materials. This review process allowed the team to extract best practices, evidence, policies, challenges, and opportunities. Through a series of meetings, potential themes were discussed among the subgroup allowing for refinement and synthesis across the subsections of the report and provided an opportunity for the subgroup to gather consensus for final recommendations.

5. Review of draft document related to accessibility

During reviews and edits of the draft document, it was determined that because of a dearth of "best practices" submitted through the data call regarding accessibility, there were gaps in the document. As such, there were expanded efforts to seek evidence-supported efforts related to disability inclusion and accessibility for people with disabilities. Accessibly needs to be thought of in two ways, pragmatic/logistic accessibility and attitudinal forces that could impede an accessible and inclusive environment. The document was enriched to ensure focus on this important topic for a healthy and accessible STEM ecosystem.

Appendix 2. Related Funding Opportunities and Resources

- U.S. Department of Commerce. STEM Talent Challenge.[162]
- U.S. Department of Education. Regional Educational Laboratories.[163]
- U.S. Department of Education. Research in Special Education.[164]
- U.S. Department of Energy has a program called, Jump Into STEM[165] which is designed to broaden participation in building science. The Jump into STEM competition had two primary goals: to increase the number and diversity of students involved in building science. Jump Into STEM provides students with learning experiences in building science innovation and research through a competition framework. Thus, the entry to engagement is less likely to be a barrier to participation.[166] This program has been found to be effective at engaging a diverse array of participants from a variety of backgrounds, including historically underrepresented backgrounds, and the program has been effective at promoting career paths in STEM, and more specifically, in energy efficiency.[167]
- U.S. Department of Energy. Minority Serving Institution Partnership Program (MSIPP) & including the Tribal Education Partnership Program.[168]
- As part of U.S. Department of Health & Human Services (HHS), National Institutes of Health (NIH)'s Diversity Program Consortium (DPC), NIH has two funding programs, Building Infrastructure Leading to Diversity (BUILD) and the National Research Mentoring Network (NRMN) that support grantees in institutional climate assessment and/or trainings that help address diversity and equity in their institutions.[169]
- HHS/NIH-funded Training Resource. Searchable webpage listing publications as well as technical briefs, white papers, literature reviews and more that have been developed by the DPC awardees.[170]
- HHS/NIH-funded Training Resource. Enhancing the Diversity of the NIH-Funded Workforce. [171]
- HHS/NIH-funded Training Resource. NIH Materials (Measures) Library. [172]
- HHS/NIH's National Institute of General Medical Science (NIGMS) requires a Recruitment Plan to Enhance Diversity in all training grant applications. NIGMS emphasizes the importance of student feedback and climate surveys in the training grant programs. All NIGMS grantees are required to submit yearly progress reports, which include sections in which they should report on appointment and retention outcomes. Awardees also submit demographic data on their participants in these reports. Although there are not specific recruitment metrics, grantees are

[162] https://www.eda.gov/funding/programs/stem-challenge
[163] https://ies.ed.gov/ncee/rel/
[164] https://ies.ed.gov/ncser/
[165] http://www.jumpintostem.org/
[166] Hubbard M, et.al. Increasing Diversity in Energy Efficiency Professions: JUMP into STEM. Oak Ridge National Laboratory, US Department of Energy. https://jumpintostem.org/wp-content/uploads/2022/08/ACEEE-Paper_2020.pdf
[167] Rippy K & Joseph W. Building a Diverse and Inclusive STEM Workforce: The JUMP into STEM Program. Proceedings of the American Solar Energy Society National Conference. 2022. https://jumpintostem.org/wp-content/uploads/2022/09/ASES-conference.pdf
[168] https://www.energy.gov/nnsa/articles/nnsa-announces-funding-opportunity-tribal-and-minority-serving-institution-junior-and
[169] https://www.nigms.nih.gov/training/dpc
[170] https://diversityprogramconsortium.org/resource-center
[171] https://nigms.nih.gov/training/dpc
[172] https://projects.wcer.wisc.edu/materials-library/material

encouraged to ensure participants come from a variety of different backgrounds, and to enhance participation of individuals traditionally underrepresented in biomedical, clinical, behavioral, and social sciences. At a student/ researcher level, NIGMS offers a variety of training and education awards (e.g., U-RISE, G-RISE, Bridges to the Baccalaureate, Bridges to the Doctorate, PREP) that provide support to awardee institutions so that they can prepare a diverse cohort of research-oriented students.[173]

- HHS/NIH. Notice of NIH's Interest in Diversity.[174]
- HHS/NIH. Faculty Institutional Recruitment for Sustainable Transformation (FIRST) Program[175], is intended transform organizational culture at NIH-funded extramural institutions by building a self-reinforcing community of scientists committed to diversity and inclusive excellence.
- U.S. Department of Homeland Security has a program specifically designed to provide research grant funding for faculty and students through its Minority Serving Institutions (MSIs) Program.[176] This program provides grant support to facilitate research partnerships among MSIs, R-1 Universities, and private industry. Additionally, it provides grant funds for summer research teams involving early career faculty and undergraduate/graduate students.
- U.S. Department of State's Benjamin A. Gilman International Scholarship Program enables students of limited financial means to study or intern abroad, providing them with skills critical to our national security and economic prosperity. This program addresses both STEM and DEIA. To be eligible, applicants must be receiving a Federal Pell Grant during the time of application or provide proof that they will be receiving a Pell Grant during the term of their study abroad program or internship. By supporting undergraduate students who have high financial need, the program has been successful in supporting students who have been historically underrepresented in education abroad, including but not limited to first-generation college students, underrepresented racial/ethnic students, students with disabilities, students attending HBCUs or other MSIs, students attending community colleges, rural students, and students coming from U.S. states with less study abroad participation.
- U.S. Department of State's Fulbright Program[177] has engaged students, scholars, teachers, and professionals of all backgrounds. A hallmark of the Fulbright Program has been its longstanding commitment to DEIA. The Fulbright Program actively engages and supports individuals from all backgrounds and identities throughout their experience with the program and strives to ensure that Fulbright reflects and values the diversity of U.S. society and societies. The Fulbright Program has facilitated workshops for Fulbright Program Advisers and Scholar Liaisons at MSIs to provide training and support for their campus engagement efforts.
- U.S. Department of Transportation. National Summer Transportation Institute.[178]
- NASA's Minority University Research and Education Project (MUREP)[179] is designed to invest in the research, academic, and technology capabilities of MSIs. These institutions recruit and retain underrepresented and underserved students, including women and girls, and persons with disabilities, into STEM fields. MUREP awarded over $5M to seven Women's Colleges and Universities to research and develop strategies that increase retention of women in STEM degree

[173] https://www.nigms.nih.gov/training/Pages/TWDPrograms.aspx
[174] https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-031.html
[175] https://grants.nih.gov/grants/guide/rfa-files/RFA-RM-22-008.html
[176] https://www.dhs.gov/science-and-technology/minority-serving-institutions-program
[177] https://www.fulbrightprogram.org/initiatives/diversity-inclusion/
[178] https://www.fhwa.dot.gov/innovativeprograms/centers/workforce_dev/nsti_presentation.aspx
[179] https://www.nasa.gov/learning-resources/minority-university-research-education-project/

programs and careers,[180] and $11.7M to eight HBCUs to conduct innovative data science research that contributes to NASA's missions.[181]

- NSF's Broadening Participation site[182] provides a wide list of relevant funding opportunities, such as the ADVANCE: Organizational Change for Gender Equity in STEM Academic Professions program.[183]

[180] https://www.nasa.gov/news-release/nasa-awards-5-million-to-womens-colleges-tackling-stem-gender-gap/
[181] https://www.nasa.gov/learning-resources/minority-university-research-education-project/murep-deap/
[182] https://new.nsf.gov/funding/initiatives/broadening-participation
[183] https://new.nsf.gov/funding/opportunities/advance-organizational-change-gender-equity-stem