BEST PRACTICES FOR DIVERSITY AND INCLUSION IN STEM EDUCATION AND RESEARCH: A GUIDE BY AND FOR FEDERAL AGENCIES

A Report by the

INTERAGENCY WORKING GROUP ON INCLUSION IN STEM

FEDERAL COORDINATION IN STEM EDUCATION SUBCOMMITTEE

COMMITTEE ON STEM EDUCATION

of the

NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

September 2021

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About the Federal Coordination in STEM Education Subcommittee

The Federal Coordination in STEM Education (FC-STEM) is a subcommittee of the NSTC Committee on STEM Education (CoSTEM), which was established pursuant to the requirements of Section 101 of the America COMPETES Reauthorization Act of 2010 (42 U.S.C. §6621). In accordance with the Act, CoSTEM reviews science, technology, engineering, and mathematics (STEM) education programs, investments, and activities, and the respective assessments of each, in Federal agencies to ensure that they are effective; coordinates, with the Office of Management and Budget, STEM education programs, investments, and activities throughout the Federal agencies; and develops and implements through the participating agencies a Federal STEM education strategic plan, to be updated every five years. FC-STEM advises and assists CoSTEM and serves as a forum to facilitate the formulation and implementation of the strategic plan.

About the Interagency Working Group on Inclusion in STEM

Six Interagency Working Groups (IWGs) support FC-STEM as it implements the Strategic Plan and brings together members who represent the Federal government’s foremost experts in STEM education. Four of the IWGs are concentrating their efforts on one of each of the four pathways outlined in the Strategic Plan. These pathways include Strategic Partnerships, Convergence, Computational Literacy, (educational pathways) and Transparency & Accountability. The National Science and Technology Council (NSTC) chartered a fifth IWG, the Interagency Working Group on Inclusion in STEM (IWGIS), in response to Section 308 of the 2017 American Innovation and Competitiveness Act and focuses on broadening participation in STEM as described in more detail below. A sixth IWG was formed in response to the 2020 Supporting Veterans in STEM Careers Act to improve veteran and military spouse equity and representation in STEM fields and careers.

About this Document

The purpose of the Interagency Working Group on Inclusion in STEM (IWGIS) is to advise FC-STEM on coordinating activities regarding inclusion in STEM fields across the Federal government, with a focus on identifying 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.

In October 2019, members of the IWGIS set out to accomplish the group's first strategic objective: to share among Federal agencies best practices for diversity and inclusion, both within agencies and in the programs they support. As part of achieving this objective, the group was tasked with developing a compendium on Best Practices for Diversity and Inclusion in STEM Education and Research for Federal Agencies. The group broke down the task into three parts. First, the group developed clear definitions of evidence-based, emerging, and promising practices. Second, the group conducted a literature search on evidence-based practices for diversity and inclusion in STEM. Third, the group incorporated data from a Best Practices Solicitation (information request) from FC-STEM Interagency Working Groups to FC-STEM agencies, collected in August 2020. The goal was not only to identify best practices and exemplary programs but also to establish the evidence base for the existing effective practices, including findings from robust evaluations. This report is the result of the extensive work conducted by the IWGIS. The compendium also includes recommendations for increasing diversity in Federal programs.

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Abbreviations and Acronyms

CoSTEM	Committee on Science, Technology, Engineering and Mathematics (STEM) Education
DOC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DHS	Department of Homeland Security
DOI	Department of the Interior
DOL	Department of Labor
DOS	Department of State
DOT	Department of Transportation
ED	Department of Education
EPA	Environmental Protection Agency
FC-STEM	Federal Coordination in STEM Education Subcommittee
HBCU	Historically Black Colleges and Universities
HHS	Department of Health and Human Services
IWG	Interagency Working Group
IWGIS	Interagency Working Group on Inclusion in STEM
MSI	Minority Serving Institution
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NSTC	National Science and Technology Council
OMB	Office of Management and Budget
OPM	Office of Personnel Management
OSTP	Office of Science and Technology Policy
SI	Smithsonian Institution
S&E	Science and Engineering
STEM	Science, Technology, Engineering and Mathematics
UREG	Underrepresented Racial and Ethnic Groups
USDA	U.S. Department of Agriculture

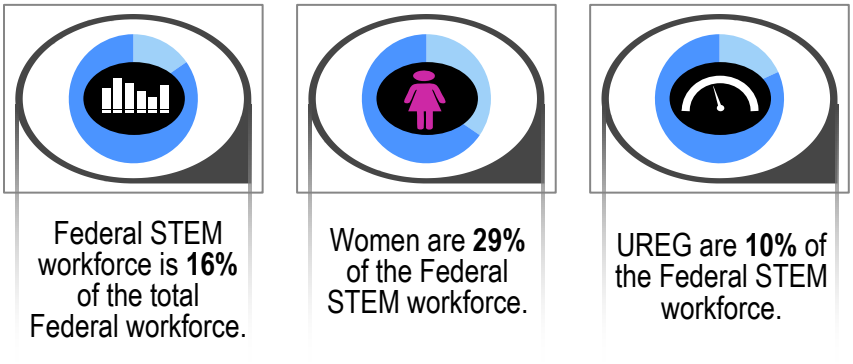
Executive Summary

This report is the result of the extensive work conducted by the Interagency Working Group on Inclusion in STEM (IWGIS). The document provides a summary of best practices that can be employed by Federal agencies as they implement strategies to promote diversity and inclusion in the Federal STEM workforce. The data in this document was derived from two sources.

The first is a comprehensive review of the literature on best practices for broadening participation of underrepresented racial and ethnic groups (UREG) in STEM. The second is a Best Practices Solicitation (information request) from FC-STEM Interagency Working Groups to FC-STEM agencies, collected in August 2020. An overview of the data from this solicitation (see Appendix 1) including the most commonly reported best practices and recommended policies for future implementation, is provided below.

Note: The COVID-19 pandemic has exacerbated the challenges identified in this document and should be kept in mind when considering best practices.

Demographics of the Federal STEM Workforce



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Barriers to Diversity and Inclusion in STEM

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- Cultivate partnerships and collaborations
- Engage Minority Serving Institutions (MSI) as equal partners with Federal agencies
- Provide authentic and culturally relevant STEM engagement and research experiences for youth and interns
- Develop and retain promising personnel through effective mentorship
- Conduct targeted outreach through clubs, conferences, and organizations

Top 5 Policies and Practices for Diversity and Inclusion in STEM Recommended by Federal Agencies as reported in the Best Practices Solicitation

- Develop a Human Capital Operating Plan that includes inclusive hiring strategies, focuses on retention, and assures equal access to advancement
- Develop explicit strategies for diversity and inclusion with measurable goals, and hold leadership and employees accountable
- Align diversity and inclusion goals with agency and organizational mission and goals
- Establish monitoring and assessment systems to measure progress toward goals
- Provide consistent and sufficient funding for diversity, equity, and inclusion initiatives, including opportunities for individuals from groups underrepresented in STEM

Key Recommendations for Diversity and Inclusion in STEM by and for Federal Agencies

- ✓ Use the definitions of evidence-based, emerging, and promising practices to help explain the levels of best practices that are adopted by each agency.
- ✓ Develop a pathways approach to STEM academic and career programs at each agency that allows for flexibility with multiple entry points and enables participants to build on academic achievement and research expertise at different levels and life stages.
- ✓ Identify barriers to access and participation in STEM programs offered by each agency and develop strategies to reduce or eliminate them by partnering with other agencies, institutions, and professional organizations.
- ✓ Expand recruitment for Federal jobs, work-based learning opportunities, scholarships and fellowships at minority-serving institutions and institutions with high levels of diversity through face-to-face and virtual outreach efforts.
- ✓ Set goals for outcomes and measurable impacts related to recruitment and retention efforts for employment to increase diversity of the STEM workforce.
- ✓ Provide opportunities for leadership training and skills development and create a plan for leadership and advancement that addresses barriers impacting groups underrepresented in STEM.
- ✓ Provide unconscious bias training for existing managers to raise awareness of how implicit bias can impact performance reviews, hiring, promotion, and access to training and leadership opportunities.
- ✓ Use existing hiring and special pay rate authorities to diversify the Federal STEM workforce at all levels.
- ✓ Develop more flexible hiring and pay authorities, particularly for entry-level positions. Create authority for Federal scholars and fellows to be hired noncompetitively into Federal service.
- ✓ Adopt or adapt promising and emerging practices to address recruitment, retention, and access challenges.
- ✓ Develop or expand work/life balance efforts.

Introduction

In 2018, the National Science and Technology Council Committee on STEM Education published *Charting a Course for Success: America's Strategy for STEM Education* (the Strategic Plan).[1]

The Strategic Plan is a North Star, guiding investments in science, technology, engineering, and mathematics (STEM) education for five years. The Strategic Plan lays out a vision for a future where all Americans will have lifelong access to high-quality STEM education and the United States will be the global leader in STEM literacy, innovation, and employment. The components of the Strategic Plan support three overarching aspirational goals:

1. Build Strong Foundations for STEM Literacy
2. Increase Diversity, Equity, and Inclusion in STEM
3. Prepare the STEM Workforce for the Future

The Strategic Plan's second goal—increasing diversity, equity, and inclusion in STEM—is key for achieving the other two goals. When an organization's workforce is diverse in terms of gender, race, socioeconomic status, ethnicity, ability, geography, religion and other identities, and when that organization provides an inclusive environment, it better retains talent, and is more innovative and productive.[2,3,4,5] Broadening participation is a fundamental prerequisite for making high-quality STEM education accessible to all Americans and will maximize the creative capacity of tomorrow's workforce. The National Science and Technology Council chartered the Interagency Working Group on Inclusion in STEM (IWGIS) to advise the Subcommittee on Federal Coordination in Science, Technology, Engineering, and Mathematics (STEM) Education (FC-STEM) on coordinating activities regarding inclusion in STEM fields across the Federal government, with a focus on identifying research, best practices, and policies on how to promote diversity and inclusion of all groups in the Federal STEM workforce, including underrepresented groups such as people who are Black or African American, Hispanic/Latinx, American Indian, Alaska Native, Native Hawaiian, and Pacific Islanders, women, and persons with disabilities.

This document presents a compendium on Best Practices for Diversity and Inclusion in STEM Education and Research for Federal Agencies. The IWGIS conducted a review of the literature on evidence-based approaches and strategies for effective recruitment, engagement, and retention of individuals from groups that are underrepresented and underserved in STEM. The literature review encompassed practices from private sector and academia as models for Federal Agencies. The goal is not only to identify best practices and exemplary programs but also to establish the evidence base for the existing effective practices and include recommendations for increasing diversity in Federal STEM programs, including those supported through Federal funding.

The document is laid out as follows. The Introduction provides important context for understanding the need for best practices in diversity and inclusion in STEM, including definitions of evidence-based, emerging, and promising practices, and an overview of institutional and individual barriers that

[1] Committee on STEM Education of the National Science & Technology Council (2018) Charting a Course for Success: America's Strategy for STEM Education Executive Office of the President of the United States.
[2] Saxena, Ankita (2014) Workforce Diversity: A Key to Improve Productivity Procedia Economics and Finance 11: 76-85.
[3] National Academies of Sciences, Engineering, and Medicine (2019) Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforces The National Academies Press.
[4] National Science Board (2019) Science and Engineering Indicators 2020: Science and Engineering Labor Force *Science and Engineering Indicators 2020* NSB-2019-8.
[5] National Science Board (2020) NSB Vision 2030 *NSB*

individuals from underrepresented groups confront as they progress in a STEM career. The next section provides an overview of a literature review on best practices for diversity and inclusion in STEM education and training programs, followed by a section summarizing a literature review on promising and emerging practices. The document concludes with a section that provides recommendations for Federal agencies, and with short concluding remarks.

The data in this document originated from two sources. The first is a comprehensive review of the literature on best practices for broadening participation of underrepresented racial and ethnic groups in STEM. The second is a Best Practices Solicitation (an information request) from FC-STEM Interagency Working Groups to FC-STEM agencies, collected in August 2020. An overview of the data from this solicitation. including the most commonly reported best practices and recommended policies for future implementation, can be found in Appendix 1.

Definition of Best Practices

The five Interagency Working Groups (IWGs) established under FC-STEM each have one or more deliverable in their work plan that calls for identifying best practices. The following definitions of best practices are designed to incorporate the needs of the five IWGs and to aid in the development of language to help standardize the use of the term and improve overall reporting of best practices.

The term "best practices" is ubiquitous and is used in a range of arenas such as education, research, business, industry, and public policy. The term has become so accepted that in many cases, people talk about "best practices" without identifying what exactly is meant by the expression. A generally accepted definition of a best practice is "a procedure that has been shown by research and experience to produce optimal results and that is established or proposed as a standard suitable for widespread adoption."[6]

This document follows the example set by the US Department of Education (ED) in the Education Department General Administrative Regulations (EDGAR) Evidence Definitions,[7] which include a *tiers of evidence* to distinguish the extent of the evidence base supporting the effectiveness of a project component in improving a relevant outcome.

This document uses three levels to distinguish among "best practices": evidence-based practices, promising practices, and emerging practices. The first task of the IWGIS was to develop these definitions in consultation with other FC-STEM IWGs. All IWGs have adopted these definitions.

Evidence-based practices

The National Institutes of Health (NIH) developed a definition of evidence-based medicine that was designed to *"transform the way evidence on clinical effectiveness is generated and used to improve health and health care."* It is proposed that this definition of evidence-based medicine be adapted to address STEM education more broadly: to the greatest extent possible, the decisions that shape STEM education programs and policies—by stakeholders alike—will be grounded on a reliable evidence base, will account appropriately for individual variation in stakeholders' and programs' needs, and will support the generation of new insights on program effectiveness. Evidence is defined here as information from

[6] Definition: Best Practice (n.d.) *Merriam-Webster*.
[7] Electronic Code of Federal Regulations (2021) *e-CFR*.

research and evaluation that has met some established test of validity. Processes that involve the development and use of evidence should be accessible and transparent to all stakeholders.[8]

Promising Practices

There are some cases when an agency or organization has been successfully implementing a particular practice but has not collected or generated sufficient evidence to clearly determine all the parameters associated with success of the practice. The Office of Personnel Management (OPM) and OSTP's report on *Reducing the Impact of Bias in the STEM Workforce* defines promising practices as those that are consistent with principles established by research but have not been verified by evaluation.[9] "Promising practices" can also be used to refer to practices that are known to be "evidence-based" under a specific context, but are being applied in a different context. For example, in seeking to better understand the issues that continue to impact the underrepresentation of women in STEM disciplines, a recent National Academies of Sciences, Engineering, and Medicine report found that some evidence-based practices improved outcomes for one group but were not as effective for another group. In this different context, the evidence-based practices were therefore designated as promising practices.[10]

Emerging Practices

Emerging practices are considered to be interventions that are new, innovative, or exploratory in nature, and while they may be based on some level of evidence, that evidence is not sufficient for it to be considered a promising practice.[11]

Note: These definitions are not meant to be the only way that an organization can define best practices. They are intended to be a guide to help the FC-STEM Interagency Working Groups develop best practices documents that span a range of topics. In addition, these definitions are designed to bring a level of consistency across IWGs.

Definition of Underrepresented

The IWGIS surveyed its membership about the operationalizations of the term "underrepresented" in each agency. Examples of these definitions can be found in Appendix 2. In many cases, legislation defines the scope of an agency's definition of "underrepresented," sometimes even for specific programs.

The IWGIS also held scholarly conversations to examine the use of inclusive language, specifically, the use of the phrase "underrepresented groups" to better understand how race and ethnicity are depicted in publications and the media. The summary of these conversations can be found in Appendix 3. The conversations enabled the IWGIS to better understand how scholars and laypeople use various terms to describe people of color in the U.S. and how diverse groups may be impacted by terms like

[8] Institute of Medicine (2008) Evidence-Based Medicine and the Changing Nature of Healthcare: 2007 IOM Annual Meeting Summary - Appendix C, IOM Roundtable on Evidence-Based Medicine Roster and Background National Academies Press.

[9] Interagency Policy Group on Increasing Diversity in the STEM Workforce by Reducing the Impact of Bias (2016) Reducing the Impact of Bias in the STEM Workforce: Strengthening Excellent and Innovation *Office of Science and Technology Policy, Office of Personnel Management.*

[10] National Academies of Sciences, Engineering, and Medicine (2020) Promising Practices for Addressing the Underrepresentation of Women in Science, Engineering, and Medicine: Opening Doors *The National Academies Press.*

[11] Interagency Policy Group on Increasing Diversity in the STEM Workforce by Reducing the Impact of Bias (2016) Reducing the Impact of Bias in the STEM Workforce: Strengthening Excellent and Innovation *Office of Science and Technology Policy, Office of Personnel Management.*

"underrepresented", "minorities", and "racial and ethnic minorities." The decision to consider and examine language was based on concerns raised about inclusive language following the heightened awareness of inequities that were amplified by the pandemic.

The IWGIS and IWG Transparency and Accountability (T&A IWG) Joint Subgroup sought to define the terms "minority", "underrepresented minority", and "underrepresented" to provide a common definition for FC-STEM working groups and members. Both the IWGIS and T&A IWG agreed that it is important to consider how these terms can or will be operationalized to collect data around participation rates under the COMPETES Act. The scholarly discussions held by the IWGIS were not meant to duplicate this effort but simply to better understand how these terms have evolved and are used (or misused) in scholarly and lay publications. While blogs and tweets are not scholarly literature, they are a common means of communication for non-scholars and were part of the motivation to examine inclusive language. It was also the intent to provide recommendations to FC-STEM that might be applied in future publications.

The Current Status of the Federal STEM Workforce

The Federal government relies on its scientific and technical workforce to perform critical functions in an array of areas, including space exploration, national security and information technology, management and protection of the environment, and transportation. The IWGIS also compiled a study to assess the current status of the Federal STEM workforce, which would serve as a point of reference for recommendations to address practices for diversity, equity, and inclusion in STEM. The data reported here are from OPM's FedScope database.[12] This data analysis was conducted to shed light on the demographics of the Federal STEM workforce. Highlights from the study include:

- Of the 2.1 million Federal employees, more than 330,000 people comprise the Federal STEM workforce (16%.)[13]
- While women and individuals from underrepresented racial and ethnic groups comprise about 43% and 38% of the total Federal workforce, respectively; they only comprise 29% and 10% of the Federal STEM workforce.[14]
- The top STEM employer is the Department of Defense, which employs 47% of the STEM workforce. Other agencies are smaller and represent a range, employing between .18 - 7% of the Federal workforce.
- Overall, growth in STEM careers has been overwhelmingly positive in various fields and careers. This is a testament to the government's broadening participation programs and recruitment efforts.
- Pay disparities among males and females remain. Women tend to make 7 cents less on the dollar than men, and a recent report from the Government Accountability Office[15] supported this finding.

[12] Fedscope (2019) *Office of Personnel Management.*

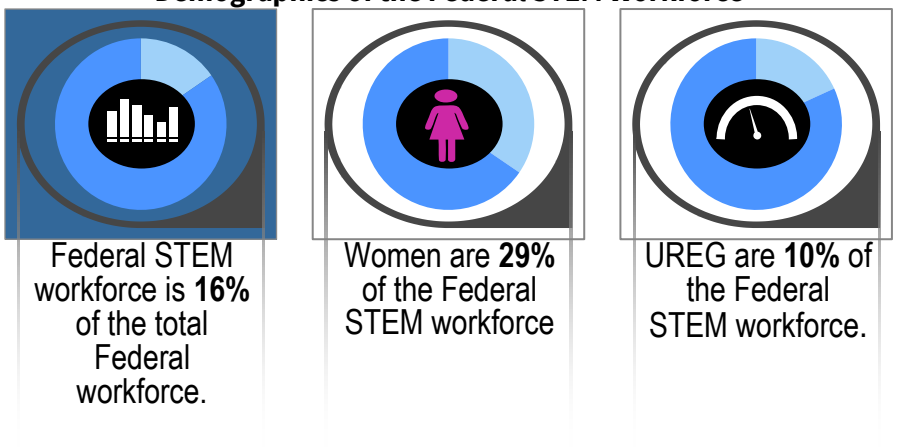
[13] The study considered the more than 280,000 (~14%) people who occupy engineering, information technology and mathematics, physical science and natural resources and life science careers. The analysis focuses on the STEM workforce for job tracks: 04xx Natural Resources and Life Sciences, 13xx Physical Science, 08xx Engineering & Architecture, and 22xx Information Technology and 15xx Math fields. This analysis does not include STEM employees in occupations such as sociology, psychology, management analyst, etc. or STEM workers in management or administrative positions (e.g., NSF). The Health fields are also not included in this report (~196,000 employees reported in Health Occupations). Data reported here includes the pay banding systems for GS, excepted service, SES, and agency-specific systems. Approximately 25% of STEM employees are in special pay systems at DOC, DOE, NSF and other agencies.

[14] Underrepresented women are counted twice in the study (as underrepresented groups and women).

[15] U.S. Government Accountability Office (2020) Gender Pay Differences: The Pay Gap for Federal Workers Has Continued to Narrow, but Better Quality Data on Promotions Are Needed *GAO-21-67*

- The STEM workforce is aging – 46% of the Federal STEM workforce is over the age of 50.

Demographics of the Federal STEM Workforce



Barriers to Diversity and Inclusion in STEM

This subsection provides an overview of leading institutional and individual barriers to diversity and inclusion in STEM. Understanding and identifying barriers within Federal agencies and across STEM pathways is integral to identifying and prioritizing the development and implementation of best practices across federally sponsored STEM education and research programs. This list was assembled from an extensive STEM literature review. It is beyond the scope of this document to dive deeply into all of the barriers indicated and that is not the intent.

While improvements in the participation of underrepresented groups in STEM have been made in the United States, STEM retention and degree attainment are persistently lower for underrepresented groups. These groups can include, but are not limited to, women, Black/African American, Hispanic/Latinx, American Indian, Alaska Native, or Native Hawaiian.[16,17] Please see Appendices 2 and 3 for further information.

There are many barriers to inclusion in STEM. Identifying and removing the institutional, social, economic, and academic barriers at play requires deliberate investigation and intervention. Federal agencies must have a strong grasp of the types of barriers that exist in order to effectively promote diversity, equity, and inclusion in Federal STEM efforts.

Policies

Institutional policies can be barriers to inclusion, often unintentionally, or they can play a significant role in both creating and preventing overcoming barriers to inclusion of underrepresented groups. Even the absence of a clear statement or mission recognizing the value of diversity can act as a "de facto"

[16] Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John ,G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., and Zavala, M. E. (2016) Improving underrepresented minority student persistence in stem *CBE Life Sciences Education* 15.

[17] Estrada, M., Hernandez, P. R., and Schultz, P. W. (2018) A Longitudinal Study of How Quality Mentorship and Research Experience Integrate Underrepresented Minorities into STEM Careers *CBE Life Sciences Education* 17.

policy barrier to ethnically and racially diverse hires.[18] A lack of relevant institutional policies may result in inequitable practices in hiring, promotions, and job placement practices based on race and gender.[19]

The mere presence of institutional or program policies is also not sufficient. The ineffective and inconsistent administration of diversity related policies and practices can render them ineffective. [20]

Even with effective policies in place, data collection strategies and policies can be a barrier when organizations do not collect data (or are prevented from doing so due to legal or policy barriers) in a way that allows for accurate characterization of the variables of interest, for example, data on disability status or disaggregation of intersectional demographic data.

Workplace Climate

Workplace climate can be a significant a barrier to inclusion when there are real or perceived differences in the way individuals are treated by peers and leaders based on their race, gender, disability, or other demographics that may, or may not, result from prejudice or animus and may or may not be intentional in nature.

Work-life balance disproportionately impacts female employees more than male. For example, women with children or caregiver responsibilities experience greater stress compared to men with children.[21] This situation can become a threat to career persistence, especially when institutional support for work-life balance is poor.

The correlate to a workplace for students early in their scientific career is the college campus. Experiencing a culture with a hostile or unwelcoming racial environment is correlated with social and academic withdrawal, academic isolation, and social isolation, along with other negative consequences.[22]

Regardless of the nature of the workplace, maintaining an inclusive workplace climate requires proactively employing strategies that promote inclusivity at all levels. Organizations that are most successful are also very intentional about their workplace climate actions.

Differential Compensation Packages

Similar challenges related to compensation packages are experienced in academia and in the Federal STEM workforce. In academia, compensation models and packages can incorporate hard and soft money methods of funding salaries. Hard money positions are funded by the institution for a defined period, while soft money positions depend on the successful rewarding of scientific grants.[23]

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[18] Institute of Medicine (US) Committee on Institutional and Policy-Level Strategies for Increasing the Diversity of the U.S. Healthcare Workforce, Smedley, B.D., Stith-Butler, A., and Bristow, L.R. (Eds.) (2004) In the Nation's Compelling Interest: Ensuring Diversity in the Health-Care Workforce *National Academies Press (US).*

[19] Yang, Y. and Konrad, A.M. (2011) Understanding Diversity Management Practices: Implications of Institutional Theory and Resource-Based Theory *Group & Organization Management* 36: 6-38.

[20] Ibid.

[21] López, C.M., Margherio, C., Abraham-Hilaire, L.M., and Feghali-Bostwick, C. (2018) Gender disparities in faculty rank: Factors that affect advancement of women scientists at academic medical centers *Social Sciences* 7.

[22] National Academy of Engineering, Engineering National Academies of Sciences, and Medicine (2016) Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways The National Academies Press.

[23] López, C.M., Margherio, C., Abraham-Hilaire, L.M., and Feghali-Bostwick, C. (2018) Gender disparities in faculty rank: Factors that affect advancement of women scientists at academic medical centers *Social Sciences* 7.

Some Federal agencies may have positions which encounter similar challenges. For example, the Department of Homeland Security (DHS) experiences a barrier with respect to extending cyber retention pay to Schedule A for persons with disabilities. Whereas non-Schedule A candidates may begin receiving cyber retention pay once they are cleared for duty, candidates that have been brought on via Schedule A for persons with disabilities are subject to a one-year probationary period before they are eligible to receive it -- a policy scenario where there is a disparity felt by individuals of an underrepresented community.

Individuals from underrepresented groups, especially women, have been greatly impacted by the disparity between these compensation mechanisms. Gaps or lapses in funding can occur more for women, who typically have greater responsibilities than men for family care. The lack of salary funding during a lapse has a direct effect on staff retention.[24,25]

Availability and Use of Data

A prerequisite to addressing barriers to inclusion is understanding the current situation; that requires accurate and relevant demographic data. In January 2021, President Biden issued a *Memorandum on Restoring Trust in Government Through Scientific Integrity and Evidence-Based Policymaking.*[26] Among other things, Section 5 of the Memorandum, which focuses on evidence-based policymaking, indicates new guidance will be forthcoming from the Office of Management and Budget (OMB) to improve agencies' evidence-building plans and annual evaluation plans; scientific-integrity principles shall be incorporated into agencies' data governance and evaluation approaches; and agencies shall (as appropriate and consistent with applicable law) expand open and secure access to various Federal data.

As required by the America COMPETES Act[27] and its subsequent reauthorization,[28] Federal agencies have begun reporting on the rates of participation of different demographics in Federal programs, including by individuals from underrepresented groups, women, and people in rural areas. The absence of accurate demographic data for the workforce in systems (local, state, Federal) and job sectors (education, business, technology) results in a limited ability to determine the systemic and individual factors that impact underrepresented groups in the STEM workforce.

Cost of Education

First generation STEM undergraduates from underrepresented groups often have greater college debt than students whose parents are college graduates.[29] This can hinder performance and negatively affect career progression. In addition, students who must work to afford college may miss out on professional growth opportunities accessible to more affluent students, such as unpaid research experience, professional meeting attendance, and summer academic experiences. Finally, early career

[24] Correll, S.J., Benard, S., and Paik, I. (2007) Getting a Job: Is There a Motherhood Penalty? *American Journal of Sociology* 112: 1297-338.
[25] López, C.M., Margherio, C., Abraham-Hilaire, L.M., and Feghali-Bostwick, C. (2018) Gender disparities in faculty rank: Factors that affect advancement of women scientists at academic medical centers *Social Sciences* 7.
[26] Presidential Actions (2021) Memorandum on Restoring Trust in Government Through Scientific Integrity and Evidence-Based Policymaking *The White House*.
[27] America Competes Act (2007) *Congress.*
[28] America Competes Reauthorization Act of 2010 (2010) *Congress.*
[29] Cadaret, M. and Bennet, S.R. (2018) College Students' Reported Financial Stress and Its Relationship to Psychological Distress *Journal of College Counseling* 22.

positions in some STEM fields do not typically provide high salaries.[30] The combination of high debt and low pay can result in individuals from underrepresented groups leaving the STEM workforce to find higher paying jobs.

Workplace Interactions

Professional interactions play a large role in STEM retention of individuals from underrepresented groups. In academia, negative student-faculty interactions, such as direct discrimination by faculty members, is associated with greater attrition of women, Black, and Hispanic students (compared to their male or white and Asian-American peers). In general, any interaction related to race and ethnicity that results in a person feeling uncomfortable is negatively linked to STEM retention. [31]

Individualized Barriers to the STEM Workforce

Individuals from underrepresented groups have a greater attrition rate as they move along STEM pathways. Meeting the needs of these individuals at each of these steps requires a concerted and deliberate plan.[32] An understanding of the barriers that individuals from underrepresented groups face is of paramount importance for planning a successful strategy to overcome them.

The strongest impact determining whether a secondary school student enters the STEM scientific workforce is their socioeconomic status.[33,34] The major factor affecting the economic status of students is the income of their parents. This factor affects many facets of a student's life, including students incurring a high level of debt during college. In addition, educational centers are often located in areas with a high cost-of-living. Thus, a lower household income level necessitates living further from the source of education. The longer commute time effectively acts as a barrier.

Another significant factor that can act as a barrier for individuals is the lack of a support system, among family, friends, and peers. While these groups are commonly among the most important supports for individuals, if family and friends have no experience navigating higher education, and peers are lacking in the college setting, the lack of a support system can exacerbate isolation and make it harder to persist and succeed.

A lack of diverse mentors contributes to the dearth of a support system. Mentorship provides individuals from underrepresented groups the potential to see themselves through the eyes of an influential guide.[35] Without formal or even informal mentors, individuals from underrepresented groups

[30] Jobs for the Future (2007) The STEM Workforce Challenge: The Role of the Public Workforce System in a National Solution for a Competitive Science, Technology, Engineering, and Mathematics (STEM) Workforce *U.S. Department of Labor, Employment and Training Administration.*

[31] Park, J. J., Kim, Y. K., Salazar, C., and Hayes, S. (2020) Student–Faculty Interaction and Discrimination from Faculty in STEM: The Link with Retention *Research in Higher Education* 61: 330-56.

[32] Acosta, D. and Olsen, P. (2006) Meeting the needs of regional minority groups: the University of Washington's programs to increase the American Indian and Alaskan native physician workforce *Acad Med*, 81: 863-70.

[33] Taylor & Francis Group (2020) 'Low' socioeconomic status is the biggest barrier to STEM participation *ScienceDaily.*

[34] Cooper, G. and Berry, A. (2020) Demographic predictors of senior secondary participation in biology, physics, chemistry and earth/space sciences: students' access to cultural, social and science capital I*nternational Journal of Science Education* 42: 151-66.

[35] National Academies of Sciences, Engineering, and Medicine (2019) The Science of Effective Mentorship in STEMM *The National Academies Press.*

may experience feelings of isolation and invisibility.[36,37] The sum effect of a lack of a support system can manifest as a difficulty in acclimation to majority culture and, ultimately, lead to retention failure.

In addition to socioeconomic status and support systems, the educational system itself can act as a barrier. Educational models are often implicitly built with the understanding that students come through a traditional education path. The lack of culturally responsive teaching can serve as a barrier for students from underrepresented groups.

Finally, discrimination of underrepresented groups is a direct barrier to career opportunities.[38] Overt racism and discrimination directly act to remove individuals from the STEM workforce.

Perception of STEM Programs

The perception that STEM programs are male dominated affects not only students but teachers and parents as well. Women and individuals from underrepresented groups in STEM confront gender stereotypes at academic institutions because of socio-cultural stereotypes regarding white males and academic STEM disciplines. Parents and teachers are also influenced and are less likely to believe in the capability of a student from an underrepresented group. This can result in students deciding not to pursue STEM careers without the encouragement of their mentors.[39,40]

Stereotypes and Stereotype Threat

Stereotype threat occurs when individuals fear that they will confirm a negative stereotype (e.g., not being expected to succeed) about a group to which they belong.[41,42,43] The fear of confirming stereotypes sometimes results in higher levels of anxiety and stress, especially for women and individuals from underrepresented groups. An African American or Latino student, for instance, may face stereotype threat during a scientific task or an exam; they may fear confirming the stereotype that African American or Latino students "underperform" in STEM.

[36] Martinez, M.A., Alsandor, D.J., Cortez, L.J., Welton, A.D., and Chang, A. (2015) We are stronger together: reflective testimonios of female scholars of color in a research and writing collective *Reflective Practice* 16: 85-95.

[37] Comer, E.W., Medina, C.K., Negroni, L.K., and Thomas, R.L. (2017) Women Faculty of Color in a Predominantly White Institution: A Natural Support Group *Social Work with Groups* 40: 148-55.

[38] Small, M. L., and D. Pager (2020) Sociological perspectives on racial discrimination *Journal of Economic Perspectives* 34: 46-97.

[39] Blackburn, H. (2017) The Status of Women in STEM in Higher Education: A Review of the Literature 2007–2017 *Science & Technology Libraries* 36: 235-73.

[40] Saucerman, J., and Vasquez, K. (2014) Psychological Barriers to STEM Participation for Women Over the Course of Development *Adultspan Journal* 13: 46-64.

[41] Steele, C.M. (1997) A threat in the air: How stereotypes shape intellectual identity and performance *American Psychologist* 52: 613–629.

[42] Carr, P.B. and Steele, C.M. (2010) Stereotype Threat Affects Financial Decision Making *Sage* 21: 1411-1416.

[43] Beasley, M. A. and Fischer, M.J. (2012) Why they leave: the impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors *Social Psychology of Education* 15: 427-48.

Biases

Biases, such as sexism, can often be found in the workplace culture. Indeed, both explicit bias and implicit bias (with regard to gender, racial, and ethnic stereotypes) are prevalent in the United States and in science.[44,45]

Implicit bias is typically associated with individual behaviors; however, an implicit bias can influence entire systems and institutional practices and structures. This can also be said for racism, which is typically associated with individual behaviors, but has a pervasive systemic and structural impact in science and in STEM. [46]

Science Identity

Science identity can be described in terms of how an individual seeks to be a scientist.[47,48] STEM persistence may be negatively affected if a person is not given an opportunity to develop their STEM identity.[49] Conversely, a person with a strong science identity would exhibit *competence* about scientific concepts, the potential for scientific *performance* (in terms of using scientific tools and navigating scientific social situations), and *recognition* as a scientist to both themselves and others in the field.[50] The concept of science identity and how individuals strive to become valued members of the STEM disciplines is an expanding area of research.[51,52]

A strong science identity positively influences the likelihood of pursuing a career in science.[53,54,55] Conversely, weak or underdeveloped science identity among underrepresented groups and women is a barrier to recruitment, retention and persistence in STEM careers.[56,57,58] Strategies to expose students

[44] Pietri, E.S., Johnson, I.R., Ozgumus E., and Young, A.I. (2018) Maybe She Is Relatable: Increasing Women's Awareness of Gender Bias Encourages Their Identification With Women Scientists *Psychology of Women Quarterly* 42: 192-219.
[45] Handley, I.M., Brown, E.R., Moss-Racusin, C.A., and Smith, J. L. (2015) Quality of evidence revealing subtle gender biases in science is in the eye of the beholder *Proc Natl Acad Sci USA* 112: 13201-6.
[46] Thorp, H. H. (2020) Time to look in the mirror *Science* 368: 1161.
[47] Gee, J. P. (2000) Identity as an Analytic Lens for Research in Education *Review of Research in Education* 25: 99-125.
[48] Bucholtz, M., Barnwell, B., Skapoulli, E., & Lee, J. (2012) Itineraries of Identity in Undergraduate Science *Anthropology & Education Quarterly* 43: 157-172.
[49] Vincent-Ruz, P. and Schunn, C.D. (2018) The Nature of Science Identity and its Role as the Driver of the Student Choices *International Journal of STEM Education* 5.
[50] Carlone, H. B., and Johnson, A. (2007) Understanding the science experiences of successful women of color: Science identity as an analytic lens *Journal of Research in Science Teaching* 44: 1187-218.
[51] Stryker, S., and Burke, P.J. (2000) The Past, Present, and Future of an Identity Theory *Social Psychology Quarterly* 63: 284-97.
[52] Büyükgöze, H. and Gün, F. (2017) Building the professional identity of research assistants: a phenomenological research *Educational Sciences: Theory & Practice* 17.
[53] Estrada, M., Hernandez, P. R., and Schultz, P. W. (2018) A Longitudinal Study of How Quality Mentorship and Research Experience Integrate Underrepresented Minorities into STEM Careers *CBE Life Sciences Education* 17.
[54] Stets, J., Brenner, P., Burke, P., and Serpe. R. (2016) The science identity and entering a science occupation *Soc Sci Res* 64.
[55] White, A. M., DeCuir-Gunby, J.T., and Kim, S. (2019) A mixed methods exploration of the relationships between the racial identity, science identity, science self-efficacy, and science achievement of African American students at HBCUs *Contemporary Educational Psychology* 57: 54-71.
[56] National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2007) Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering The National Academies Press.
[57] Burt, B.A., Williams, K.L., and Smith, W.A. (2018) Into the Storm: Ecological and Sociological Impediments to Black Males' Persistence in Engineering Graduate Programs *American Educational Research Journal* 55: 965-1006.
[58] Villa, E., Wandermurem, L., Hampton, E., and Esquinca, A. (2016) Engineering Education through the Latina Lens J*ournal of Education and Learning* 5: 113.

early to the experiences and benefits of science and to ensure that students from underrepresented groups receive mentoring throughout their career help to cultivate science identity. [59]

Science identity is a dynamic factor that changes in response to societal context as well as situational factors. Thus, measuring the identity of an individual at one point in time in a situation is not a static determination. Five science identities were found from a study of 52 college students, mostly from underrepresented groups, that affected their feelings of being ready to apply to a doctoral program after their undergraduate studies.[60] These students were followed up later to show how their identities have changed as they progressed in their scientific careers.[61] Through various domains of development, participants were enabled to develop their identities as graduate students and to anticipate being seen by others as highly prepared for PhD training. Supporting and nurturing science identities is crucial for recruitment and retention of a diverse scientific workforce.

Accessibility for Individuals with Disabilities

Individuals with disabilities experience lower levels of career success when compared to peers without disabilities.[62] There are multiple barriers that individuals with disabilities face:

- Many workplaces have limited staff resources to provide employee training on accessibility issues.
- There are added costs associated with purchasing appropriate technology or resources for accommodations. One method to overcome this barrier is to create a central budget at the institute level for accommodations. This avoids requiring department budgets, which are smaller, to cover these costs. In addition, some federally funded research may use grant funds to cover the costs of accommodations.[63]
- There is a lack of representation of employees with disabilities on advisory boards and leadership teams at institutions.
- There is a lack of data on individuals with disabilities in Federal, state, and local databases related to STEM careers and workforce. Disability is stigmatized, and often individuals do not report disabilities in surveys and other demographic reporting formats. Limited or inaccurate data fail to provide a clear depiction of the population for the purpose of tracking participation rates, changes over time, and other key information that can help program and policy.
- There is a lack of work-based learning opportunities for employees with disabilities.
- There is a lack of a common assessment tools for data collection and evaluation of individuals with disabilities.
- There is a lack of system-wide recruitment and engagement of individuals with disabilities.

The next section provides an overview of a literature review conducted by IWGIS members on best practices for diversity and inclusion in STEM.

[59] Aikens, M. L., Robertson, M. M., Sadselia, S., Watkins, K., Evans, M., Runyon, C. R., Eby, L. T., and Dolan, E. L. (2017) Race and Gender Differences in Undergraduate Research Mentoring Structures and Research Outcomes *CBE Life Sci Educ* 16.

[60] Gazley, J.L., Remich, R., Naffziger-Hirsch, M.E., Keller, J., Campbell, P.B., and McGee, R. (2014) Beyond preparation: Identity, cultural capital, and readiness for graduate school in the biomedical sciences *Journal of Research in Science Teaching* 51: 1021-48.

[61] Remich, R., Naffziger-Hirsch, M. E., Gazley, J. L., and McGee, R. (2016) Scientific growth and identity development during a postbaccalaureate program: Results from a multisite qualitative study *CBE Life Sciences Education* 15.

[62] Bellman, S., Burgstahler, S., and Chudler. E.H. (2018) Broadening Participation by Including More Individuals With Disabilities in STEM: Promising Practices from an Engineering Research Center *American Behavioral Scientist* 62: 645-56.

[63] Kuo, M. (2015) Science in sign language *The American Society for Biochemistry and Molecular Biology*.

Key Areas for Advancing Diversity and Inclusion in STEM

Members of the IWGIS conducted a literature review to compile **evidenced-based best practices** for promoting diversity and inclusion in STEM in the Federal and non-Federal landscape. The following Key Areas emerged as central themes for best practices: STEM Pathways, Access and Recruitment, Retention and Achievement, and Advancement.

The Key Areas below are structured as follows. Each key area contains an overview of the issue, touching on barriers from the previous section. Subsection titles under each key area are best practices that emerged from the literature search and contain brief descriptions of the best practice and provide further information and examples. The examples following each key area originate from a Best Practices Solicitation (information request) to FC-STEM agencies, collected in August 2020. These examples represent some of the many exemplars of programs implementing best practices for diversity and inclusion across the Federal government. See Appendix 1, Table 3 for further examples of programs from the Best Practices Solicitation Results.

Key Area 1: STEM Pathways

Individual journeys from education to occupation are often complex. Increasingly robust sources of data have the potential to more accurately capture the multiple entry and exit points of individuals and lead to the development of better tools to understand the nuances within individuals' trajectories in STEM.[64]

A Pathways Approach

The "STEM pipeline" model suggests a straightforward, linear progression from formal STEM education to STEM occupation. This model does not reflect the full range of career opportunities available to STEM degree holders and the many factors that influence career choices over a lifetime.[65] A "STEM pathways"

[64] Lord, S.M., Ohland, M.W., Layton, R.A., Camacho, M.M. (2019) Beyond pipeline and pathways: Ecosystem metrics *Journal of Engineering Education* 108: 32-56.
[65] National Science Foundation (n.d.) STEM Education and the Workforce Pathways, Not Pipelines *National Science Board.*

model better represents the relationship between degree and jobs, in which STEM degree holders follow career paths into STEM and non-STEM jobs, or both, over the course of their working lives.[66]

An emphasis on career pathways encourages a shift in the focus of questions concerning workforce competitiveness from "how many degrees/workers" do we have to "what STEM **knowledge and skills**" should all U.S. workers have.[67]

Decades of data show that workers with STEM degrees follow numerous pathways leading to careers in and out of their field of study and even into non-STEM jobs. A focus on pathways highlights our collective challenge to ensure that all students have access to STEM pathways, and that roadblocks to their success are identified and removed.[68]

Among college-educated U.S. workers with their highest degree in a science and engineering (S&E) field, just under half (49%) are employed in an S&E or S&E-related job. Non-S&E jobs held by S&E degree holders include management, sales, marketing, social services, and teaching in non-STEM fields.[69]

Guided Pathways

Students take a variety of paths to completing a STEM program, often transferring between institutions, stopping for a period and switching into or out of STEM majors. They pursue a range of different STEM credentials, including degrees and certificates, at different types of 2-year and 4-year institutions (e.g., research university, liberal arts college, nonprofit or for-profit 2-year college). Given this variety of pathways, it is important to promote **successful navigation** into and through STEM programs of study through institutional structures, policies, and practices that provide a variety of entry/exit points and strengthen STEM readiness for entering and enrolled college students.[70] Some of these activities are funded by Federal agencies, such as:

- Guided pathways (map of courses)
- Inter-institution articulations
- Preparation support
- Developmental education approach
- Bridge programs [71]

Pathways for Military Veterans

Military veterans returning from deployment frequently possess technical training and have significant experience with sophisticated machinery and systems, yet they face obstacles to embarking on STEM pathways. Veterans may not readily know how to translate their experience to civilian careers. Veterans with disabilities encounter especially daunting challenges.[72]

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[66] Ibid.
[67] Ibid.
[68] National Science Foundation (2015) Revisiting the STEM Workforce: A Companion to Science and Engineering Indicators 2014 *National Science Board*.
[69] National Science Foundation (n.d.) STEM Education and the Workforce Pathways, Not Pipelines *National Science Board.*
[70] Guided Pathways (n.d.) *CCRC and the AACC Pathways Project.*
[71] National Academies of Sciences, Engineering, and Medicine (2018) Indicators for Monitoring Undergraduate STEM Education *The National Academies Press.*
[72] National Science Foundation (2015) Revisiting the STEM Workforce: A Companion to Science and Engineering Indicators 2014 *National Science Board*.

Several initiatives, focused on academic advising, internships, networking services and peer support are underway to alleviate the roadblocks that veterans, including disabled veterans, encounter.[73] Many of these initiatives are highlighted in the National Science Board reports on the Skilled Technical Workforce.[74] In addition, the Federal Government initiated a program to offer career development opportunities for returning veterans interested in Federal science-related jobs.[75]

Appealing STEM Pathways

If essential STEM pathways are not attractive relative to other career options, too few students may undertake and persist in STEM courses of study. The state of STEM pathways also affects incumbent workers. If the condition of these pathways is poor, incumbent workers may find them less appealing and consider other careers out of their field of degree or out of STEM altogether.[76]

It is important to monitor and **assess the condition** of these pathways and identify risks and challenges. Labor market indicators such as earnings and unemployment rates as well as related indicators addressing why individuals with STEM degrees work out of their field of degree help provide information about the availability and condition of STEM pathways.

Examples:

In 2017 the **Department of Labor's** (DOL) Employment and Training Administration published a research brief titled Building Early College Pathways to STEM Careers Bridgeport Tries a New Tack to Meet Employer Demand for Skilled Workers. The brief describes the design and implementation of the STEM Early College Expansion Partnership in Bridgeport, Connecticut, which aims to create career **pathways** in advanced manufacturing and health care for underserved high school students. The goal is to make learning more relevant to students by matching the curriculum with the knowledge and skills they would need on the job and to promote college and career success for students from disadvantaged backgrounds. The brief also identifies four emerging lessons and challenges to meet employer demands: small costs can be significant barriers to students; attrition highlights the need for clear expectations and strong support systems; gender diversity in manufacturing is a continuing goal; and covering tuition and other costs is an ongoing challenge.

The **United States Department of Agriculture's (USDA)** Agricultural Research Service (ARS) has developed hiring **pathways** for interns already onboard within the agency. This allows ARS to access a wide pool of diverse candidates for any upcoming vacancies within the agency. Specific examples include internships via the Pathways Program and partnerships with third-party organizations such as the Hispanic Association of Colleges and Universities (HACU); the agency hires several dozen HACU interns each year. In addition, ARS recently hired two USDA 1890 National Scholars into entry level STEM positions in the agency. The 1890 National Scholars program supports one scholar at each of the country's nineteen 1890 land grant institutions.

The **National Aeronautics and Space Administration (NASA)** Community College Aerospace Scholars (NCAS) is a nationwide activity designed for post-traditional learners enrolled in an accredited 2-year institution in the U.S. who are interested in a STEM career. NCAS helps students make the connection

[73] Ibid.
[74] National Science Board (2019) The Skilled Technical Workforce: Crafting America's Science & Engineering Enterprise *National Science Foundation.*
[75] Feds Hire Vets (n.d.) *U.S. Office of Personnel Management*.
[76] National Science Foundation (2015) Revisiting the STEM Workforce: A Companion to Science and Engineering Indicators 2014 *National Science Board*.

between a STEM degree and NASA career opportunities and realize that working in STEM is an attainable goal. Additionally, NCAS prepares and motivates students to participate in other competitive NASA projects, programs, and internships, and encourages community college students to finish their 2-year degree and pursue a 4-year degree or career in a STEM field. To increase the efficiency and effectiveness of NCAS, new infrastructure was put into place in Fiscal Year 2019 as NCAS piloted the 'NASA on Campus' expansion model. NASA on Campus takes the successful evidence based NCAS model implemented at NASA centers and trains community college faculty to achieve the same positive student outcomes on their local campus. The pilot allowed NCAS to add six onsite events and helped refine a model for full implementation. The campuses produced an 18% increase in the number of students completing the full NCAS experience from the previous year.

The Human Exploitation Rescue Operative (HERO) Child-Rescue Corps is a program developed by U.S. Immigration and Customs Enforcement's Homeland Security Investigations, and in conjunction with the Department of Defense and the National Association to Protect Children. The HERO Child-Rescue Corps Program provides training in high-tech computer forensics and law enforcement skills to wounded, injured and ill Special Operations Forces. Trainees assist Federal agents in the fight against online child sexual exploitation. With successful completion of the program, HERO interns have the knowledge, skills, and experience to apply for careers with Federal, state, and local police agencies, and other organizations, in the field of computer forensics.

Key Area 2: Access and Recruitment

In addressing diversity and inclusion in STEM, access and recruitment are two distinct but related issues.[77,78,79,80] Because individuals' journeys in STEM are complex, broad access and intentional recruitment is critical for building an inclusive workforce.

Partnerships in Support of Individuals from Underrepresented Groups

Changing demographics will have a direct impact on the STEM talent pool.[81, 82]

- Create initiatives to increase diversity and inclusion in student populations. Initiatives should focus on reducing barriers and supporting individuals from underrepresented groups, including providing financial support for internships.[83]

[77] Definition: Access (n.d.) *Merriam Webster*.
[78] Definition: Recruitment (n.d.) *Smart Recruiters.*
[79] Definition: Recruitment (n.d.) *Business Dictionary.*
[80] Access is defined as a way or means of approaching or entering a place; permission, liberty, or ability to enter, approach, or pass to and from a place or to approach or communicate with a person or thing.
Recruitment refers to the process of identifying, attracting, interviewing, selecting, hiring, and onboarding employees. In other words, it involves everything from the identification of a staffing need to filling it. A second definition of recruitment is the process of finding and hiring the best-qualified candidate (from within or outside of an organization) for a job opening, in a timely and cost-effective manner. The recruitment process includes analyzing the requirements of a job, attracting employees to that job, screening and selecting applicants, hiring, and integrating the new employee to the organization.
[81] National Academies of Sciences, Engineering, and Medicine (2019) Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce *The National Academies Press.*
[82] "A clear takeaway from these population estimates is that the educational outcomes and STEM readiness of students of color will have direct implications on the nation's economic growth, national security, and global prosperity."
[83] Henneberry, S.R. and Radmehr, R.,(2020) Quantifying impacts of internships in an international agriculture degree program *PLOS ONE* 15(8).

- Recognize that Minority Serving Institutions[84] are an underutilized resource for strengthening the STEM workforce.[85] Efforts should be made to actively engage with MSIs and scientific societies that serve persons from underrepresented groups.[86,87]
- The National Science Foundation's NSF INCLUDES program documents several strategies that have demonstrated success in increasing access for individuals from underrepresented groups.[88] These evidence-based strategies include culturally responsive pedagogical practices, summer bridge programs, research experiences, and mentoring, among others.

Leverage Human Resources Departments

It is important to recognize the role of Human Resources Departments in addressing the issues of diversity and inclusion in recruitment.[89, 90]

- Identify and change recruitment and hiring practices that fail to be inclusive.[91] Consider marketing materials, recruitment sources, qualifying questions and candidate scoring rubrics, make-up of hiring committees, and the interview processes.
- Address unconscious bias. For example, rather than viewing hiring persons with disabilities as just being "the right thing to do," it must be viewed as part of a talent strategy that will benefit the organization and outweigh what they see as the potential expenses and risk.[92]
- Use appropriate data for comparison when assessing diversity and inclusion internal to your agency. For example, only 13% of companies in the U.S. have reached the Department of Labor's target of having 7% disability representation in their workforce.[93]

Examples:

The **National Oceanic and Atmospheric Administration's (NOAA)** José E. Serrano Educational Partnership Program with Minority Serving Institutions (EPP/MSI) has demonstrated its ability to increase inclusion, retention, and achievement of supported scholars through financial support,

[84] Minority Serving Institutions (MSIs) are traditionally defined by one of two overarching categories: historically defined or enrollment-defined institutions. Historically defined MSIs were established with the express purpose of providing access to higher education for a specific minority group and include Historically Black Colleges and Universities (HBCUs) and Tribal Colleges and Universities (TCUs). Enrollment-defined MSIs are Federally designated based on student enrollment and institutional expenditures and include Hispanic Serving Institutions (HSIs), Alaska Native-Serving and Native Hawaiian-Serving Institutions (ANNHIs), Asian American and Native American Pacific Islander-Serving Institutions (AANAPISIs), Predominantly Black Institutions (PBIs), and Native American-Serving Nontribal Institutions (NASNTIs).

[85] National Academies of Sciences, Engineering, and Medicine (2019) Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce *The National Academies Press.*

[86] Wolfe, B.A. and Riggs, E.M. (2017) Macrosystem Analysis of Programs and Strategies to Increase Underrepresented Populations in the Geosciences *Journal of Geoscience Education* 65: 577-593.

[87] Bruno, B.C., Wren. J.L.K., Noa, K., Wood-Charlson, E.M., Ayau, J., Leon Soon, S., Needham, H., and Choy, C.A. (2016) Summer bridge program establishes nascent pipeline to expand and diversify Hawai'i's undergraduate geoscience enrollment *Oceanography* 29(2):286–292.

[88] National Science Foundation INCLUDES Coordination Hub, Research Brief (2020) Evidence-based Strategies for Improving Equity and Inclusion of Individuals in Underrepresented Racial and Ethnic Groups National Science Foundation.

[89] Waite, A.M., & McDonald, K.S. (2019) Exploring Challenges and Solutions Facing STEM Careers in the 21st Century: A Human Resource Development Perspective *Advances in Developing Human Resources* 21(1), 3–15.

[90] "Human resource development (HRD) has largely been absent from the discussion on potential contributions it may provide to address recruitment, development, and retention issues that threaten a diverse, sustained supply of career ready STEM workers. Considering the changing nature of knowledge-intensive jobs and continuing growth in STEM occupations, HRD's role to advance STEM careers in the 21st century is significant"

[91] Kennedy, T.J., Jerdee, C., and Henneborn, L. (2019) 4 Ways to Improve Your Company's Disability-Inclusion Practices. *Harvard Business Review.*

[92] 2019 Employment Tracker Results (2019) *National Organization on Disability.*

[93] Ibid.

internships, and professional engagement. This investment has resulted in a significant increase in the education and graduation of students from underrepresented communities in STEM fields that support NOAA's mission. With performance metrics as a program requirement, EPP/MSI has developed a database that contains student data and other information used to track and assess program performance. An article published in the *Journal of Geoscience Education* highlighted the best practices of the EPP/MSI program and describe how NOAA and its academic partners have supported the program's objectives. Collaborative planning and program design with key partners, collaborations with NOAA scientists, having the partnerships led and impacts realized mostly by MSIs, using cooperative agreements rather than grants, and a commitment from NOAA leadership to support the program have been important components of the success of EPP/MSI.

The **Department of Transportation (DOT)** is currently developing a Recruitment Plan to eliminate the underrepresentation of minorities, females, and persons with disabilities. Recruitment activities include the Fall Historically Black College and University (HBCU) Recruitment Conference; the Department of Transportation Mentoring Program; Department of Transportation Youth Employee STEM Mentoring Program; Employee Resource Groups like Federally Employed Women – Women on the Move Chapter; Summer Transportation Internship Program for Diverse Groups; and the Federal Aviation Administration's Minority Internship Program.

The **Veterans Benefits Administration's (VBA)** Edith Nourse Rogers Science Technology Engineering Math (STEM) Scholarship allows eligible veterans and dependents in high-demand STEM fields to extend their Post-9/11 GI Bill or Fry Scholarship benefits. In launching the Rogers STEM Scholarship, the VBA has been transparent with students and schools in promoting the availability of the scholarship and encouraging its use. In addition, the method by which the scholarships are reviewed is a blind system thereby removing demographic characteristics as well.

The **Department of Education's (ED)** Gaining Early Awareness and Readiness for Undergraduate Program (GEAR UP) is a discretionary grant program for states and for partnerships designed to increase the number of low-income students who are prepared to enter and succeed in postsecondary education. GEAR UP funds are also used to provide college scholarships to low-income students. GEAR UP provides six-year grants to states and partnerships to provide services at high-poverty middle and high schools. GEAR UP grantees serve an entire cohort of students beginning no later than the seventh grade and follow the cohort through high school. GEAR UP funds are also used to provide college scholarships to low-income students. The program supports fellowships to students pursuing terminal degrees in academic disciplines designated as areas of national need.

In 2019, the **U.S Patent and Trademark Office (USPTO)** in response to the Study of Underrepresented Classes Chasing Engineering and Science Success (SUCCESS) Act was required by Congress to identify publicly available data on women, minorities, and veterans and to provide legislative recommendations on how to encourage and increase participation by these groups as inventor-patentees and entrepreneurs. As part of this effort, the USPTO organized a National Council to help in the development of a national strategy to increase American Innovation. Innovation is inherent in STEM and in who becomes an inventor in America. The USPTO is striving to make the vital connection between STEM and innovation For example; its annual National Summer Teacher Institute offers transdisciplinary professional development opportunities to support K-12 educators in fostering innovation and STEM through intellectual property creation and protection. USPTO builds innovation capacity through strategic partnerships: AAAS/NSF HBCU Making & Innovation Showcase training on intellectual property and invention education for students and faculty at Howard University, University

of Puerto Rico, and University of Houston/Texas Southern University, YMCA, FIRST Robotics, Center for Science and the Public, among others. In the recent past, USPTO joined forces with youth development and employment programs such as the Urban Alliance, to provide workforce training for underserved high school seniors. USPTO works with various affinity groups such as the Society for Hispanic Professional Engineers and the National Society of Black Engineers among others to build intellectual property literacy and make the connection between STEM, innovation, and its importance to building future innovators and entrepreneurs.

Key Area 3: Retention

Retention is a key issue for maintaining diversity and inclusion in STEM. Many factors can affect retention, including: a hostile institutional climate that is not aligned with policies that support diversity and inclusion; a lack of institutional commitment and accountability; and aggregation of categories of data, which can distort or impede understanding of critical factors that affect retention for different populations. Evidence-based practices to mitigate these factors are outlined below.

Alignment of Institutional Culture and Climate

Federal agencies can learn from practices and policies that academic institutions have implemented to create mutually supportive communities that foster a strong sense of belonging to increase retention.[94,95,96,97,98,99,100]

- Implement confidential, third-party climate-assessment surveys and create an equity office that offers a 'safe space' for employees. Build critical mass to ensure employees do not feel isolated.[101,102]
- Support the establishment of employee resource groups, new employee initiatives, virtual resource centers, and programs and policies that support career-life balance. [103]

[94] Allen-Ramdial, S.A., and Campbell, A.G. (2014) Reimagining the Pipeline: Advancing STEM Diversity, Persistence, and Success *Bioscience 64*: 612–618.
[95] Charvat, L.J. (2009) Exemplary Practices in Equity and Diversity Programming *University of British Columbia – Vancouver*.
[96] Dewsbury, B. M. (2017) On faculty development of STEM inclusive teaching practices *FEMS Microbiology Letters* 364.
[97] Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John ,G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., and Zavala, M. E. (2016) Improving underrepresented minority student persistence in STEM *CBE Life Sciences Education* 15.
[98] Killpack T. L. and Melón L.C. (2016) Toward inclusive STEM classrooms: what personal role do faculty play? *CBE Life Sciences Education* 15.
[99] National Research Council (2013) Seeking Solutions: Maximizing American Talent by Advancing Women of Color in Academia: Summary of a Conference *The National Academies Press*.
[100] Redding, C. (2019) A teacher like me: A review of the effect of student-teacher racial/ethnic matching on teacher perceptions of students and student academic and behavioral outcomes *Review of Educational Research* 89: 499-535.
[101] Allen-Ramdial, S.A., and Campbell, A.G. (2014) Reimagining the Pipeline: Advancing STEM Diversity, Persistence, and Success *Bioscience 64*: 612–618.
[102] Charvat, L.J. (2009) Exemplary Practices in Equity and Diversity Programming *University of British Columbia – Vancouver*.
[103] Turk-Bicakci, L. and Berger, A. (2014) Leaving STEM: STEM Ph.D. Holders in Non-STEM Careers *American Institutes for Research.*

- Implement diversity and equity training for professional development. Enable effective mentoring and coaching opportunities and develop specialized assistance for groups at risk for leaving the organization.[104,105,106,107]
- Support programs that develop students' science efficacy, motivation, identity, and values, such as internships, fellowships, and undergraduate research experiences. [108]

Institutional Commitment and Accountability

Incorporate "inclusion" in the institutional mission, core values, and strategies and coordinate strategic investments for inclusivity efforts and increase institutional accountability through data.[109]

- Ensure that leadership consists of a diverse group of individuals with a range of experiences and thinking. [110,111]
- Ideally, institutions should track hiring actions and separations with a number of demographic markers and monitor trends.[112,113]
- Federal agencies should monitor the status and quality of STEM education programs to insure their efficacy. Improved federal data systems might allow tracking students' engagement across federal programs.[114]

Data Disaggregation and Intersectionality

To adequately understand the issues that impact retention, institutions must look at differences by population and STEM discipline as an important factor in implementing effective strategies for change.

- Data disaggregated by populations, geographical regions, and race/ethnicities is critical to STEM participation, identifying target populations, and capturing their unique characteristics.[115]

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[104] Dewsbury, B. M. (2017) On faculty development of STEM inclusive teaching practices *FEMS Microbiology Letters* 364.

[105] Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John ,G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., and Zavala, M. E. (2016) Improving underrepresented minority student persistence in stem *CBE Life Sciences Education* 15.

[106] National Research Council (2013) Seeking Solutions: Maximizing American Talent by Advancing Women of Color in Academia: Summary of a Conference *The National Academies Press*.

[107] Redding, C. (2019) A teacher like me: A review of the effect of student-teacher racial/ethnic matching on teacher perceptions of students and student academic and behavioral outcomes *Review of Educational Research* 89: 499-535.

[108] Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John ,G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., and Zavala, M. E. (2016) Improving underrepresented minority student persistence in stem *CBE Life Sciences Education* 15.

[109] National Research Council (2013) Seeking Solutions: Maximizing American Talent by Advancing Women of Color in Academia: Summary of a Conference *The National Academies Press*.

[110] Charvat, L.J. (2009) Exemplary Practices in Equity and Diversity Programming *University of British Columbia – Vancouver*.

[111] Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John ,G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., and Zavala, M. E. (2016) Improving underrepresented minority student persistence in STEM *CBE Life Sciences Education* 15.

[112] National Academies of Sciences, Engineering, and Medicine (2018) Indicators for Monitoring Undergraduate STEM Education *The National Academies Press.*

[113] Estrada, M., Burnett, M., Campbell, A. G., Campbell, P. B., Denetclaw, W. F., Gutiérrez, C. G., Hurtado, S., John ,G. H., Matsui, J., McGee, R., Okpodu, C. M., Robinson, T. J., Summers, M. F., Werner-Washburne, M., and Zavala, M. E. (2016) Improving underrepresented minority student persistence in stem *CBE Life Sciences Education* 15

[114] National Academies of Sciences, Engineering, and Medicine (2018) Indicators for Monitoring Undergraduate STEM Education *The National Academies Press.*

[115] National Academy of Engineering (2012) Colloquy on Minority Males in Science, Technology, Engineering, and Mathematics *The National Academies Press.*

- Furthermore, data must be disaggregated by sex within race/ethnicity, disability, citizenship, and STEM discipline to understand the experiences at the intersection of different identities. Using disaggregated data should be a part of regular management practices at the organizational level; it should not be viewed as added work. [116]
- Evaluation studies with disaggregated data can help leaders set goals related to their duties and responsibilities and be more reflective about their decision-making processes.[117]

Examples:

In an effort to increase institutional commitment and accountability, all **NIH** institutional research training grant applications are required to address (a) plans for the recruitment of individuals from groups underrepresented in STEM and (b) the retention of appointed trainees. The Recruitment Plan to Enhance Diversity and Trainee Retention Plans in the application should provide a detailed plan for recruitment to enhance diversity and a plan to sustain the scientific interests as well as monitor the academic and research progress (i.e., retention) of trainees from all backgrounds within a program. Applicants may use the Program Plan section to expand upon the Trainee Retention Plan and to provide evidence of the program's commitment to ensuring the well-being and success of all trainees throughout their graduate training. Institutions submitting renewal applications are also required to report on their records in recruiting prospective participants from underrepresented groups and retaining appointed trainees.

The **Department of Defense's (DOD)** LEGACY Program is under the Wright-Patterson Air Force Base (WPAFB) Educational Outreach Office, which has a multitude of programs that support local schools. The program specifically focuses on students from underrepresented groups and in underserved schools and areas around all four AF installations. As students progress through the program, LEGACY staff keep in communication with families to check in and see if they need any support. The WPAFB Educational Outreach Office provides support through tutoring, mentoring, and resources to assist students with their coursework or project. One-on-one mentoring and support throughout the school year demonstrate to families that the Air Force is interested in and invested in students' well-being. The Wright-Patterson LEGACY also provides apprenticeship opportunities for students, where they can work on base with mentors and receive hands-on research experiences.

The **Department of Transportation (DOT)** has a Human Capital Operating Plan designed to improve, streamline, and enhance the effectiveness of the department's processes and maximize employee and organizational performance. Metrics are used to track onboarding for women, Latinos, persons with disabilities, and persons with targeted disabilities.

Key Area 4: Achievement and Advancement

In addressing diversity and inclusion in STEM, achievement and advancement are two distinct but related issues. The best practices for these issues, outlined below, create opportunity, support, and growth of an individual in their career. An important distinction is that while achievement can be related to individuals, the *opportunity for achievement* is systemic. There are systems that support, enable, encourage, and help people reach their career goals and systems that provide barriers and discourage individuals from reaching their career goals.

[116] George, Y. S., and Malcolm, S. M. (2011) Measuring diversity: An evaluation guide for STEM graduate school leaders *American Association for the Advancement of Science.*
[117] Ibid.

- Achievement: Achievements encompass accomplishments in a given field, project, or task, and can also include successful completion of academic coursework or degrees. The National Assessment of Educational Progress and the Trends in International Mathematics and Science Study equate achievement with performance.[118,119]
- Career Advancement: "The upward progression of one's career. An individual can advance by moving from an entry-level job to a management position within the same field, for instance, or from one occupation to another." (https://www.thebalancecareers.com/advancement-525653). [120] Advancement includes promotion, as well as tenure for academic positions.

Establish clear guidelines for employee evaluation and promotion

Implicit bias can greatly influence workplace culture and impede opportunities for achievement or advancement.[121,122,123]

- Ensure guidelines/criteria for employee evaluation and promotion are clearly established and reviewed before the review process (various sources, including Canada Research Board Chairs and McKinsey & Co Report).[124,125]
- Consider the promotion of equity, diversity, and inclusion principles in an individual's work as criteria for recognition, awards, etc. For example, provide credit to individuals who mentor and participate in service-related activities. [126]
- Provide unconscious bias training to all employees, including those that participate in entry-level performance reviews (not just those that participate in senior-level reviews). [127]

Develop robust systems of support

A lack of systems of support can negatively affect motivation, morale, and persistence, thus hindering achievement and advancement in the workplace (e.g., inexperienced leadership; lack of diverse mentors and colleagues; lack of professional development opportunities; workplace inflexibilities; and lack of open environments that foster communication or opportunities for giving and receiving feedback, etc.)

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[118] The National Assessment of Educational Progress (n.d.) A Common Measure of Student Achievement *IES NCES.*
[119] Martin, Michael, Mullis, I.V.S, and Foy, P. (2017) TIMMS 2019 Assessment Frameworks *TIMSS & PIRLS International Study Center.*
[120] National Academies of Sciences, Engineering, and Medicine (2018) Engineering Societies' Activities in Promoting Diversity and Inclusion: Proceedings of a Workshop in Brief *The National Academies Press.*
[121] Ibid.
[122] "Barriers to advancement are no longer primarily a result of 'bad apples' who resist the inclusion of underrepresented minorities, said Cech. Instead, subtle beliefs and practices, such as microaggressions, cognitive biases, and cultural processes, create disadvantages that progressively accumulate. Furthermore, she reported that a plateauing in the percentage of women receiving bachelor's degrees in science and engineering over the past two decades suggests that these beliefs and practices do not necessarily improve over time."
[123] "The sociologist Lauren Rivera's examination of interviews for elite positions, such as those in professional services firms, indicates that hobbies, particularly those associated with the rich, feature prominently as a selection criterion." Your Approach to Hiring is All Wrong *Harvard Business Review*
[124] Booth, S. and Boudreau, M. (2018) Equity, Diversity and Inclusion Practices *Canada Research Chairs.*
[125] Huang, J., Krivkovich, A., Starikova, I., Yee, L., & Zanoschi, D. (2019) Women in the Workplace 2019 *McKinsey & Company.*
[126] Booth, S. and Boudreau, M. (2018) Equity, Diversity and Inclusion Practices *Canada Research Chairs.*
[127] Huang, J., Krivkovich, A., Starikova, I., Yee, L., & Zanoschi, D. (2019) Women in the Workplace 2019 *McKinsey & Company.*

- Develop a mentorship program where senior employees can serve as mentors to early career employees. Establish institution-wide rewards for effective mentorship, mentorship education, and a review system as part of the program.[128]
- Intentionally encourage and establish sponsorship programs within the organization.[129]
- Work with professional societies and employee resource groups and networks to advance individuals from underrepresented groups.[130,131,132,133]
- Offer greater flexibility in the workplace (e.g., flexible hours) to support work/life balance and accommodate transitions.[134]
- Conduct research on work/life balance, salary equity, and other conditions with employees who have left or are considering leaving.[135]
- Create initiatives to support individuals from underrepresented groups, such as employee resource groups and professional development training.[136,137,138]
- Recognize and reward individuals or institutions for their achievements and excellent work. Consider the promotion of equity, diversity, and inclusion principles in an individual's work as criteria for recognition, awards, etc.[139]

Create ample opportunities and pathways for growth

Issues with hiring and limited opportunity pathways hinder professional growth.

- Create and offer opportunities for leadership and overall professional achievement, such as high-profile assignments, leadership training, sponsorship, and mentorship.[140,141]
- Consistently use targets to guide hiring and promotions processes. Set a goal for getting more women and individuals from underrepresented groups into first-level management.[142]

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[128] National Academies of Sciences, Engineering, and Medicine (2019) The Science of Effective Mentorship in STEMM *The National Academies Press.*
[129] Huang, J., Krivkovich, A., Starikova, I., Yee, L., & Zanoschi, D. (2019) Women in the Workplace 2019 *McKinsey & Company.*
[130] Haydon, I., Herpoldt, K-L., Hosseinzadeh, P., Kang, C., Kang, L.J., Montoni, N.P., & Tatum, W.K. (2018). Workforce diversity: Strategies for cultivating inclusion in research *eLife Sciences Magazine.*
[131] National Academy of Engineering (2014) Advancing Diversity in the US Industrial Science and Engineering Workforce: Summary of a Workshop *The National Academies Press.*
[132] National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2011) Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads *The National Academies Press.*
[133] National Academies of Sciences, Engineering, and Medicine (2019) Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce *The National Academies Press.*
[134] National Academy of Engineering (2014) Advancing Diversity in the US Industrial Science and Engineering Workforce: Summary of a Workshop *The National Academies Press.*
[135] Huang, J., Krivkovich, A., Starikova, I., Yee, L., & Zanoschi, D. (2019) Women in the Workplace 2019 *McKinsey & Company.*
[136] National Academy of Engineering (2014) Advancing Diversity in the US Industrial Science and Engineering Workforce: Summary of a Workshop *The National Academies Press.*
[137] National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2011) Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads *The National Academies Press.*
[138] National Academies of Sciences, Engineering, and Medicine (2019) Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce *The National Academies Press.*
[139] Booth, S. and Boudreau, M. (2018) Equity, Diversity and Inclusion Practices *Canada Research Chairs.*
[140] Balakrishnan, A., Zuckerman, B.L., Acheson-Field, H., and Simon, I.D. (2018) STEM Campus Climate: A Webinar of the Broadening Participation Interagency Working Group (BP IWG) *IDA Science & Technology Policy Institute.*
[141] Haydon, I., Herpoldt, K-L., Hosseinzadeh, P., Kang, C., Kang, L.J., Montoni, N.P., & Tatum, W.K. (2018). Workforce diversity: Strategies for cultivating inclusion in research *eLife Sciences Magazine.*
[142] Huang, J., Krivkovich, A., Starikova, I., Yee, L., & Zanoschi, D. (2019) Women in the Workplace 2019 *McKinsey & Company.*

- Require a diverse pool/slate of candidates for hiring and promotions.[143]

Examples:

National Institute of Standards and Technology (NIST) International and Academic Affairs Office (IAAO) implements several of the best practices outlined above to support inclusion in STEM through achievement and advancement, as well as retention. IAAO utilizes affinity groups and employee resource groups to raise awareness and expand networks for diversity and inclusion in STEM. For instance, the mission of the Steering Group for Equity in Career Advancement is to identify the causes of apparent inequities in **promotions at NIST for women and minority researchers** and make recommendations. The agency is also forming a diversity council to provide recommendations on retention, inclusion, achievement, and advancement. Likewise, in an effort to provide accountability and support for ongoing diversity and inclusion initiatives, NIST is in the process of hiring a Chief Diversity and Inclusion Officer.

The **NSF** ADVANCE Program focuses on addressing systemic barriers that impact the diversity, equity, and inclusion of diverse STEM faculty in academic teaching, research, and administrative positions in institutions of higher education. Systemic (or organizational) inequities may exist in areas such as policy and practice as well as in organizational culture and climate. For example, practices in academic departments that result in the inequitable allocation of service or teaching assignments may impede research productivity, delay advancement, and create a culture of differential treatment and rewards. Similarly, policies and procedures that do not mitigate implicit bias in hiring, tenure, and promotion decisions could lead to women and racial and ethnic minorities being evaluated less favorably, perpetuating historical under-participation in STEM academic careers, and contributing to an academic climate that is not inclusive. Further resources and research can be found through the ADVANCE Resource and Coordination (ARC) Network, which seeks to achieve gender equity for faculty in higher education STEM disciplines.

Promising and Emerging Practices

In addition to evidence-based practices highlighted in the four key areas above, the group conducted a literature search to identify promising and emerging practices. While there were many sources for evidence-based practices, few sources highlighted promising and emerging practices. The issues addressed in this section include emerging hiring practices at agencies, promising interventions for closing the equal opportunity gaps in the Federal workforce, and suggestions for consistency in STEM leadership development programs across agencies.

Continuing efforts to improve employment outcomes for workers with disabilities

Key areas addressed: Access & Recruitment; Retention

Promising and emerging practices to increase the inclusion of individuals with disabilities in the workforce include:

- Reframing the challenge of recruitment and retention of individuals with disabilities as a marketing case, and using a strategic and tactical marketing framework, beginning with a segmentation of the employer based on their readiness to support diversity and inclusion. Findings show three distinct market segments in the private employer base—Choir, the Inclusive,

[143] Ibid.

and the Uninitiated. Choir is defined as "Companies with existing programs and a culture that supports the hiring and advancement of people with disabilities." Inclusive companies are "companies that support a diverse workforce, but do not explicitly include people with disabilities in their initiatives." Finally, uninitiated companies have not introduced any programs or initiatives to include people with disabilities.[144]

- Consider collaborating with the Small Business Administration to develop resources to encourage companies below the Fortune 1000 level to apply tactical strategies identified in the Employer Engagement Strategy Marketing Framework.
- Marketing framework strategies may include: Adjusting Communications (e.g., Use visual communication, when appropriate, to signal cultural change); Engaging the Organization (e.g., Recognize and reward vendors that support advancement of people with disabilities); and Creating a Roadmap

- Forming strategic partnerships and working with offices/institutions that serve people with disabilities. Consider reaching out to potential veteran participants and contributors through veteran organizations.[145]
  - **Example:** In 2019 the **National Science Foundation (NSF)** funded traineeships to support the re-entry of women and women veterans into the STEM workforce through NSF INCLUDES. These traineeships were partially funded by The Boeing Company as part of its Women Make Us Better and Women in Leadership Initiatives. The traineeships focus on providing training and professional development—including mentorship and leadership development—and offering internships and research experiences. Fields of study include applied sciences, skilled trades, and modern technologies and subject areas such as advanced manufacturing, agriculture, computer and information science, energy, engineering, geospatial sciences, micro- and nanotechnology, and safety and security. The women supported through these traineeships are pursuing their STEM dreams at different points in their careers and several have been featured in the NSF INCLUDES National Network blog.
  - **Example:** The **U.S. Geological Survey (USGS)** developed a job-training program for young adults with cognitive disabilities in partnership with school districts and public programs that train disabled adults. The result has been experience, job growth, and employment for the participants and the advancement of USGS science for the bureau.
  - **Example:** In December 2020, the **National Geospatial-Intelligence Agency** under the **Department of Defense** launched the Neurodiverse Federal Workforce pilot program to increase opportunities for neurodiverse individuals in geospatial and imagery analysis roles. The pilot – a collaborative effort with MITRE, a non-profit R&D company – is a six-month internship program that also provides an intensive one-week training and interview workshop. The pilot originated as a result of the Office of Management and Budget and General Service Administration's Government Effectiveness Advanced Research Center Challenge - a competition to solicit proposals to solve the Federal government's toughest management problems while collaborating with the private sector, academia, and the public.
- Recruiting individuals with disabilities onto advisory boards and leadership teams.[146]

[144] EMPLOYER ENGAGEMENT STRATEGYs Office of Disability Employment Policy Contract Number: DOLU139434942 Period of Performance: September 30, 2013 – September 29, 2014 FINAL REPORT (2015) *Department of Labor*.
[145] Bellman, S., Burgstahler, S., & Chudler, E. H. (2018). Broadening Participation by Including More Individuals With Disabilities in STEM: Promising Practices from an Engineering Research Center. *American Behavioral Scientist* 62: 645–656.
[146] Ibid.

- Sending staff to disability-related conferences.[147]
- Applying universal design strategies in all areas of work (products and environments) to increase accessibility.[148]
    - **Example**: Consider utilizing any of the following resources: The DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center has developed numerous resources to promote universal design in science and engineering, including the Center for Universal Design in Education, Equal Access: Universal Design of Engineering Departments, and Equal Access: Universal Design of Engineering Labs.

Establishing consistency in use of telework authority across the Federal agencies

Key areas addressed: Access & Recruitment; Retention

Prior to the COVID-19 pandemic, there was a lack of consistency in the use of telework authority across Federal agencies. Federal telework programs are established primarily to meet agency mission and operational needs. Telework saves financial resources by helping Federal agencies reduce real estate and energy costs and promote management efficiencies and makes agencies more resilient in severe weather and other emergencies. It is a promising and emerging practice for inclusion, as telework can improve the quality of employee work-life balance and increase employment opportunities for persons with disabilities.[149]

- **Example**: Feedback from Federal agencies on successful use of maximum telework during COVID-19 stay at home orders.

Expanding and Reevaluating Traditional Recruitment and Retention Efforts

Key areas addressed: Access & Recruitment; Retention

Hiring the right talent to advance the mission of the organization is the number one priority for employers. According to the Census and Bureau of Labor Statistics, 95% of hiring is done to fill existing positions. Most vacancies are a result of turnover due to a lack of opportunities for advancement internally and results in external hiring (retention as a key issue).[150]

Barriers to hiring into the Federal workforce are well documented, most recently in the final report of the National Commission on Military, National and Public Service.[151,152] The Commission reported that Federal agencies have over 100 different hiring authorities. Only 25 percent of positions are filled using the competitive Civil Service system and more than 50 percent of job announcements do not result in a hiring action. As reported in the FY2020 President's Budget request, new hires of student interns fell from 35,000 in 2010 to 4,000 in 2018 (2010 is the year the Pathways program replaced other more flexible student authorities). To address barriers to Federal jobs: reform the hiring process by providing

[147] Ibid.
[148] Ibid.
[149] Guide to Telework in the Federal Government (2011) *United States Office of Personnel Management.*
[150] Cappelli, P. (2019) Hiring-Recruiting: Your Approach to Hiring is All Wrong *Harvard Business Review*
[151] National Commission on Military, National, and Public Service (2020) Inspired to Serve: The Final Report of the National Commission on Military, National, and Public Service *National Commission on Military, National, and Public Service*.
[152] Edwards, K.A., McCollester, M., Phillips, B., Acheson-Field, ., Leamon, I., Johnson, N., and Lytell, M.C. (2021) Compensation and Benefits for Science, Technology, Engineering, and Mathematics (STEM) Workers: A Comparison of the Federal Government and the Private Sector *Rand.*

agencies greater flexibility to recruit and select candidates; and expand noncompetitive hiring, especially for Federal scholarship and fellowship recipients.

Innovative and inclusive hiring practices for STEM employers to consider include:

- Requiring that all postings be posted internally and track the percentage of hires from within
- Designing jobs with realistic requirements. Consider whether a job truly requires "10 years of experience." Unrealistic requirements can deter potential hires from applying.
- Using a diverse team to evaluate job announcements for potentially unconscious biased language that would dissuade females or other underrepresented groups to apply.[153]
- Updating the recruitment and interview process. Implicit and explicit biases most often play a role during the interview process. Consider the ways in which interviewing protocols can lend themselves to biases and can be changed to be more inclusive (see the "Access & Recruitment" section above for further examples).
- Developing more flexible hiring authorities to remove barriers to Federal hiring, particularly for students participating in Federal scholarship and fellowship programs.
- Providing assistance in the job application process

Examples:

NASA's HBCU/MSI Technology Infusion Road Tour is an example of a **promising practice** to support broadening participation in STEM. Led by NASA's Office of STEM Engagement, the NASA Technology Infusion Road Tour is a multi-day forum allowing Minority Serving Institutions the opportunity to collaborate with members of NASA's Offices Small Business Programs, STEM Engagement, the Space Technology Mission Directorate, and NASA's prime contractors, including Boeing and Lockheed Martin. In addition, leaders from NASA mission directorates share opportunities available in respective organizations. Hosted on an MSI campus, representatives from various MSIs showcase their research capabilities with the long-term goal of gaining access to funding through more lucrative Federal contracts. Networking activities include tours of the host MSI research facilities and a match-making session, allowing for direct interaction between MSIs and representatives from NASA, prime contractors, and other invited Federal agencies. NASA is the only Federal agency with a 1% goal for contracts with MSIs. In calendar year 2019, NASA Technology Infusion Road Tour events were held at Tuskegee University, New Mexico State University, and the University of Puerto Rico, Rio Piedras.

The **Food and Drug Administration (FDA)** is actively working to recruit and retain underrepresented minorities in STEM positions. The agency is accomplishing this through:

- Evaluating and revamping the Diversity and Inclusion Strategic Plan, specifically outreach and recruitment efforts
- Expanding outreach and recruitment by actively seeking out partnerships with organizations that target individuals from underrepresented racial and ethnic groups in STEM
- Participating in specific events with Historically Black Colleges and Universities and other Minority Serving Institutions, including conferences

Additionally, the FDA supports potential candidates by providing information about the work that FDA is accomplishing and assisting with navigating employment opportunities.

[153] Gaucher, D., Friesen, J., and Kay, A.C. (2011) Job advertisements that use masculine wording are less appealing to women. *Journal of Personality and Social Psychology* 101:109-128.

Developing Leadership in the STEM Workforce

Key areas addressed: Retention; Achievement & Advancement

Retention of an inclusive Federal workforce is dependent upon the opportunities provided for advancement. There is a **need** for effective and diverse leadership at all levels of the Federal STEM workforce. Federal leadership development programs provide employees with opportunities for development.[154] Federal employers should consider career-long training that enlightens employees and strengthens their skills to enable high performance, retention, and effective leadership.[155]

- **Example**: The Excellence in Government Fellows Program, for instance, is a year-long program that strengthens the leadership skills of GS-14 and GS-15 Federal career employees through a proven combination of innovative coursework, best practices benchmarking, challenging action-learning projects, executive coaching, and government-wide networking.

Continuing to increase the representation of women in STEM

Key areas addressed: Access & Recruitment; Retention; Achievement & Advancement

The Interagency Policy Group on Increasing Diversity in the STEM Workforce identified several promising practices, such as developing and utilizing diversity toolkits, and emerging practices, such as unconscious bias training for search committees and hiring and promotions safeguards. A key recommendation from that group is that each Federal agency should exercise leadership at all levels in increasing representation of women.[156,157]

- **Example**: To address gender equity within the agency, NIH implemented evidence-based interventions as well as promising practices. Evidence-based interventions include providing resources on mentoring, retention, and career advancement; leadership development; training opportunities; work-life integration; and helping to connect students and career professionals with professional societies that promote their interests.[158] In 2019, NIH also published the "NIH Scientific Diversity Toolkit," which institutions and agencies can use to help advance their own diversity and inclusion practices.

[154] Services for Agencies: Federal Leadership Development Programs (n.d.) *United States Office of Personnel Management.*
[155] Policy, Data, Oversight (n.d.) Training and Development *Office of Personnel Management.*
[156] National Academies of Sciences, Engineering, and Medicine (2020) Evidence-Based Interventions for Addressing the Underrepresentation of Women in Science, Engineering, Mathematics, and Medicine: Proceedings of a Symposium–in Brief *The National Academies Press.*
[157] Interagency Policy Group on Increasing Diversity in the STEM Workforce by Reducing the Impact of Bias (2016) Reducing the Impact of Bias in the STEM Workforce: Strengthening Excellent and Innovation *Office of Science and Technology Policy, Office of Personnel Management.*
[158] National Academies of Sciences, Engineering, and Medicine (2020) Evidence-Based Interventions for Addressing the Underrepresentation of Women in Science, Engineering, Mathematics, and Medicine: Proceedings of a Symposium–in Brief *The National Academies Press.*

Best Practices Solicitation Results Overview

The data reported on in this section was derived from a Best Practices Solicitation (information request) from FC-STEM Interagency Working Groups to FC-STEM agencies, collected in August 2020. Data was provided by 16 FC-STEM agencies. Some agencies provided more than one response, on behalf of a different office, branch, or directorate within the agency.

The IWGIS request was phrased as follows:

The Interagency Working Group on Inclusion in STEM (IWGIS) would like for you to address the following two questions:

a. What are the best practices utilized by your organization to increase the retention, inclusion, achievement, or advancement of individuals from groups that are underrepresented and underserved in STEM? Please provide specific examples or evidence that supports this best practice.
b. If you could implement one policy or practice that would drive positive change for diversity and inclusion in STEM, what would it be?

All responses from the solicitation are documented in Appendix 1. Below are the top 5 best practices for diversity and inclusion in STEM currently used by Federal agencies, as well as the top 5 policies and practices recommended by Federal agencies to drive positive change for diversity and inclusion in STEM.

Top 5 Best Practices for Diversity and Inclusion in STEM <u>Currently Used</u> by Federal Agencies

- Cultivate partnerships and collaborations
- Engage Minority Serving Institutions as equal partners with Federal agencies
- Provide authentic and culturally relevant STEM engagement and research experiences for youth and interns
- Develop and retain promising personnel through effective mentorship
- Conduct targeted outreach through clubs, conferences, and organizations

Top 5 Policies and Practices for Diversity and Inclusion in STEM <u>Recommended</u> by Federal Agencies

- Develop a Human Capital Operating Plan that includes inclusive hiring strategies, focuses on retention, and assures equal access to advancement
- Develop explicit strategies for diversity and inclusion with measurable goals and hold leadership and employees accountable
- Align diversity and inclusion goals with agency and organizational mission and goals
- Establish monitoring and assessment systems to measure progress toward goals
- Provide consistent and sufficient funding for diversity, equity, and inclusion initiatives, including opportunities for individuals from groups underrepresented in STEM

Recommendations

Based on the compendium of practices in this document, the Interagency Working Group on Inclusion in STEM developed the following policy recommendations to help increase the recruitment, retention, achievement, and advancement of individuals from groups that are underrepresented in the Federal STEM workforce and STEM programs in institutions of higher education that receive Federal funding.

Definitions

- ✓ Use the definitions of evidence-based, emerging, and promising practices to help explain the levels of best practices that are adopted by each agency. These definitions will clarify what works and why a practice is adopted for a specific group, while also substantiating expectations of effectiveness.

Barriers to Participation in STEM Programs and Pathways

- ✓ Identify barriers to access and participation in STEM programs offered by each agency and develop strategies to reduce or eliminate them by partnering with other agencies, institutions, and professional organizations. Create a comprehensive plan to highlight and address, by providing incentives for participants and grantees to demonstrate progress.
- ✓ Focus on one or more institutional barriers to STEM such as policies, workplace climate, differential compensation package, data, and peer-to-peer interactions. Require program participants and grant recipients to spell out how they will reduce or eliminate institutional barriers to diversity in STEM.
- ✓ Focus on one or more individualized barriers to participation in STEM such as mentoring, support systems, discrimination, perception of STEM programs, stereotypes and stereotype threat, bias, and STEM identity. Design programs to address these elements and constructs that impact students' participation and retention in STEM.
- ✓ Focus on one or more barrier impacting STEM participation for individuals with disabilities. Develop policies and practices to ensure representation of individuals with disabilities in leadership and decision-making bodies to ensure that accessibility, recruitment and retention issues are addressed.

Key Areas for Diversity and Inclusion

- ✓ Develop a pathways approach to STEM academic and career programs at each agency. Allow for flexibility with multiple entry points that enable participants to build on academic achievement and research expertise at different levels and life stages.
- ✓ Identify barriers to access and participation in STEM programs offered by each agency and develop strategies to reduce or eliminate them by partnering with other agencies, institutions, and professional organizations.
- ✓ Expand recruitment for Federal jobs, work-based learning opportunities, scholarships and fellowships at Minority-Serving Institutions and institutions with high levels of diversity through face-to-face and virtual outreach efforts. Create authority for Federal scholars and fellows to be hired noncompetitively into Federal service.
- ✓ Set goals for outcomes and measurable impacts related to recruitment and retention efforts for employment to increase diversity of the STEM workforce.
- ✓ Provide opportunities for leadership training and skills development that will support professional advancement. Create a plan for leadership and advancement that addresses barriers impacting groups underrepresented in STEM. Take advantage of existing Federal programs or create leadership development efforts at each agency to support diversity efforts.

- ✓ Provide unconscious bias training for existing managers to raise awareness of how implicit bias can impact performance reviews, hiring, promotion, and access to training and leadership opportunities.
- ✓ Use existing hiring authorities to diversify the Federal STEM workforce at all levels.
- ✓ Develop more flexible hiring pay authorities, particularly for entry level positions.
- ✓ Create authority for Federal scholars and fellows to be hired noncompetitively into Federal service.

Promising and Emerging Practices

- ✓ Adopt or adapt promising and emerging practices to address recruitment, retention, and access challenges.
- ✓ Develop or expand work/life balance efforts.
- ✓ Create a plan for leadership and advancement that addresses barriers impacting groups underrepresented in STEM.

Conclusion

The full benefits of the Nation's STEM enterprise will not be realized until all Americans have lifelong access to high-quality STEM education. While improvements in the participation of individuals in underrepresented racial and ethnic groups in STEM have been made, the STEM enterprise continues to face the same diversity, equity, and inclusion challenges that are present in society. This document provides a summary of best practices for Federal agencies as they implement strategies to promote diversity and inclusion in the STEM workforce.

Appendix 1: Best Practices Solicitation Results

The data in this section was derived from a Best Practices Solicitation (information request) from FC-STEM Interagency Working Groups to FC-STEM agencies, collected in August 2020. Data was provided by 16 FC-STEM agencies. Some agencies provided more than one response, on behalf of a different office, branch, or directorate within the agency.

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Tables 1 and 2 below capture agency responses to questions a and b above, respectively. The numbers for each line denote the number of total mentions of any given best practice. Please note that one agency may have provided more than one best practice. Agencies used different terms when submitting their responses. To the extent possible, the tables below capture original wording in responses to ensure accuracy of interpretation.

Table 3 below captures the specific best practice program names provided by agencies in response to question a above.

Table 1. Best Practices currently utilized by Agencies to Increase Retention, Inclusion, Achievement, and Advancement of Individuals from Groups Historically Underrepresented in STEM

Table 2. Policies or Practices Recommended by Agencies to Drive Positive Change for Diversity and Inclusion in STEM

Table 3. Examples of Best Practice Programs Provided by Agencies

Agency	Office/Directorate/Branch	Program Name
VA		Edith Nourse Rogers STEM Scholarship
NOAA	Office of Education	Jose E. Serrano Educational Partnership Program
NASA	Office of STEM Engagement	NASA Minority University Research and Education Project (MUREP)
		NASA Community College Aerospace Scholars (NCAS)
		NASA National Space Grant College and Fellowship Project
		NASA Technology Infusion Road Tour
DOL	Employment and Training Administration	Industry Intermediaries to Expand Registered Apprenticeship Programs
		TechHire Partnership Grants
		STEM Early College Expansion Partnerships
		Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant
ED	OPEPD	TRIO Program
		Upward Bound Math and Science Program
		Hispanic-Serving Institutions STEM (HSI STEM) and Articulation Program
		Minority Science & Engineering Improvement Program (MSEIP)
		GEAR-UP Program
		STEM Innovation for Inclusion in Early Education (STEMIE) Center
DOD	OASD/M&RA (RI)	DOD STARBASE
DOD	OSD SMART Program	DOD SMART Program
DOD	Air Force AFRL/EN	DOD LEGACY Program
NSF	EHR (HRD)	LSAMP
NSF	EHR (HRD)	CREST
NSF	EHR (HRD)	HBCU-UP
NSF	EHR (HRD)	TCUP
NSF	EHR (HRD)	ADVANCE
NSF	GEO	Significant Opportunities in Atmospheric Research and Science (SOARS)
		REU Program in Geoscience
		U.S. Academic Research Fleet (ARF)
NSF	EHR (DUE)	S-STEM Program
NSF	EHR (HRD/AGEP Program)	AGEP
NSF	EHR (DGE)	National Science Foundation Research Trainee (NRT) Program
		Innovations in Graduate Education (IGE) Program
		CyberCorps Scholarships for Service (CyberCorps SFS)
NSF	CISE	CSfor All Program
		BPC Alliances
		STARS Leadership Corps Program
USDA	Chief Scientist	USDA Pathways Programs
		Forest Service Resource Assistants Program (RAP)
		U.S. Youth Conservation Corps (YCC)
		21st Century Conservation Service Corps (21CSC)
DOE	Oak Ridge Institute for Science and Education	Historically Black Colleges/Universities/Minority Serving Institution Council
DOE	Pacific Northwest National Laboratory	Bridging Opportunities for Leadership and Training in STEM (BOLTS) Program
		Young Women in Science (YWIS) Program
		Student Research Apprenticeship Program (SRAP)
		Diversity Internship for DTRA (DID) Program
		Department of Energy Office of Environmental Management (DOE-EM) Minority Serving Institutions Partnership Program (MSIPP)
DOE	Thomas Jefferson National Accelerator Facility	Becoming Enthusiastic About Math and Science (BEAMS)

Appendix 2: Examples of Agency Operationalizations of the Terms "Underrepresented" and "Underserved"

Department of the Interior (DOI)

The agency does not have an operationalized definition of "underrepresented" "diversity" or "inclusion." However, in common usage in DOI programs, "underrepresented" is used for personnel to refer almost exclusivity to gender, ethnicity, or race, and to mean at a level lower than the US population. "Diversity" is largely undefined. At USGS, our Diversity and Equal Opportunity Office defines diversity as underrepresented groups, women, and persons with disabilities. Inclusion is just beginning to be discussed, mostly in the context of workplace culture. DOI is implementing bystander training and generational sensitivity training to begin to tackle inclusion.

Department of Education (ED)

The Department of Education does not have a specific way it operationalizes the term "underrepresented" and it would generally be up to the individual programs or authorizing legislation to indicate what this means in a specific context. The Department often uses terms like underrepresented minorities as an informal term to include African Americans, Hispanics/Latinos, Native Americans, and Asian/Pacific Islanders. Underrepresented might also reference children with disabilities, special education students, low-income children or families (sometimes this becomes students who qualify for free/reduced price lunch), women, or English language learners. Increasingly, there are attempts to ensure the representation of rural students and schools as well.

The Department also uses the term somewhat interchangeably with references to disadvantaged (which could mean low-performing or economically disadvantaged), underserved, "high need" students, or students "at risk."

The Every Student Succeeds Act (ESSA) requires states to collect and report data on student "subgroups" including: economically disadvantaged students; students from each major racial/ethnic group; children with disabilities as defined under IDEA; and English learners.

Language from ED's Institute of Education Sciences (IES) Training Programs: IES encourages recruitment of fellows from groups underrepresented in education research (for example, racial/ethnic minorities, first in their families to graduate college, veterans, individuals from low-income backgrounds, and individuals with disabilities). IES usage of underrepresented/underserved: English learners, free or reduced lunch recipients (low-income families), and Hispanic and Black students.

Food and Drug Administration (FDA)

FDA operationalizes "underrepresented" as the NIH does at
https://www.edi.nih.gov/data/demographics

National Aeronautics and Space Administration (NASA)

NASA Office of STEM Engagement (OSTEM) assessed its "diversity" Performance Goal (PG) and Annual Performance Indicator (API) highlighted below which included:

- Analysis of historical performance data to determine overall performance of NASA's OSTEM Higher Education investments (internships, fellowships and other student engagement opportunities) in achieving the PG and API
- Literature Review and Benchmarking other Federal Agencies
- Convened experts to review assessment findings and develop recommendations for future diversity metrics (Expert Panel Review - ERP)

The assessment noted that although NASA OSTEM has achieved this goal historically, the trend analysis indicated no significant change in closing the gap of any diversity category (flat). Additionally, the Expert Review Panel recommended keeping this PG and API but to further explore this topic. In FY2020, NASA OSTEM is conducting a "Diversity Deep Dive" study to evaluate "How have NASA STEM Engagement investments broadened participation of historically underrepresented and underserved groups in STEM fields in NASA STEM Engagement activities?" and annually we assess NASA OSTEM performance in achieving PGs and APIs and determine if they need to enhanced or retired.

Performance Goal (PG) 3.3.3: Provide opportunities for students, especially those underrepresented in STEM fields to engage with NASA's aeronautics, space, and science people, content, and facilities in support of a diverse future NASA and aerospace industry workforce.	Annual Performance Indicator (API)/Success Criteria: Meet or exceed the national average in two of the four categories of student diversity for NASA STEM enrollees in internships, fellowships, or other student engagement opportunities. Diversity Categories: (1) students across all institutional categories and levels (as defined by the U.S. Department of Education), (2) racially or ethnically underrepresented students (Hispanics and Latinos, African Americans, American Indians, Alaska Native, Native Hawaiians and Pacific Islanders), (3) women, and (4) persons with disabilities at percentages that meet or exceed national averages for science and engineering enrollees, as determined by the most recent, publicly available data from the U.S. Department of Education's National Center for Education Statistics.

National Institutes of Health (NIH)

NIH encourages institutions to diversify their student and faculty populations to enhance the participation of individuals from groups identified as underrepresented in the biomedical, clinical, behavioral, and social sciences, such as:

- Individuals from racial and ethnic groups that have been shown by the National Science Foundation to be underrepresented in health-related sciences on a national basis (visit nsf.gov to see data and the report "Women, Minorities, and Persons with Disabilities in Science and Engineering"). The following racial and ethnic groups have been shown to be underrepresented in biomedical research: Blacks or African Americans, Hispanics or Latinos, American Indians or Alaska Natives, Native Hawaiians, and other Pacific Islanders. In addition, it is recognized that underrepresentation can vary from setting to setting; individuals from racial or ethnic groups that can be demonstrated convincingly to be underrepresented by the

grantee institution should be encouraged to participate in NIH programs to enhance diversity. For more information on racial and ethnic categories and definitions, see the OMB Revisions to the Standards for Classification of Federal Data on Race and Ethnicity.

- Individuals with disabilities, who are defined as those with a physical or mental impairment that substantially limits one or more major life activities, as described in the Americans with Disabilities Act of 1990, as amended. See NSF data here.

Individuals from disadvantaged backgrounds, defined as those who meet two or more of the following criteria:

- Were or currently are homeless, as defined by the McKinney-Vento Homeless Assistance Act (Definition: https://nche.ed.gov/mckinney-vento/);
- Were or currently are in the foster care system, as defined by the Administration for Children and Families (Definition: https://www.acf.hhs.gov/cb/focus-areas/foster-care);
- Were eligible for the Federal Free and Reduced Lunch Program for two or more years (Definition: https://www.fns.usda.gov/school-meals/income-eligibility-guidelines);
- Have/had no parents or legal guardians who completed a bachelor's degree (see https://nces.ed.gov/pubs2018/2018009.pdf);
- Were or currently are eligible for Federal Pell grants (Definition: https://www2.ed.gov/programs/fpg/eligibility.html);
- Received support from the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) as a parent or child (Definition: https://www.fns.usda.gov/wic/wic-eligibility-requirements).
- Grew up in one of the following areas: a) a U.S. rural area, as designated by the Health Resources and Services Administration (HRSA) Rural Health Grants Eligibility Analyzer, or b) a Centers for Medicare and Medicaid Services-designated Low-Income and Health Professional Shortage Areas (qualifying zip codes are included in the file). Only one of the two possibilities listed can be used as a criterion for the disadvantaged background definition.

Students from low socioeconomic status (SES) backgrounds have been shown to obtain bachelor's and advanced degrees at significantly lower rates than students from middle and high SES groups (see https://nces.ed.gov/programs/coe/indicator_tva.asp), and are subsequently less likely to be represented in biomedical research. For background see Department of Education data at, https://nces.ed.gov/; https://nces.ed.gov/programs/coe/indicator_tva.asp; https://www2.ed.gov/rschstat/research/pubs/advancing-diversity-inclusion.pdf.

Literature shows that women from the above backgrounds face particular challenges at the graduate level and beyond in scientific fields. (See, e.g., "From the NIH: A Systems Approach to Increasing the Diversity of Biomedical Research Workforce")

Appendix 3: IWGIS Academic Discussion on Language and Use of the Term "Underrepresented Groups"

The IWGIS also held scholarly conversations to examine the use of inclusive language, specifically, the use of the phrase "underrepresented groups" to better understand how race and ethnicity are depicted in publications and the media. Below is a brief summary of our findings and some general recommendations that will be incorporated into IWGIS documents.

Summary of Findings

- The STEM education community has attempted to move away from deficit language in education (*economically disadvantaged, at-risk, vulnerable, high crime, urban)*
- Language referring to groups that are underrepresented is also evolving.[159]
- Consequently, there is no uniform agreement about what terms to use
    - Scholarly literature uses *underrepresented groups* to refer to numbers related to the representation in the STEM workforce; it not intended to be derogatory. This term is used in international literature as well.[160]
    - *Underrepresented groups* is preferable to "underrepresented minorities" or "historically underrepresented"[161]; the latter infers that that parity has been achieved when it has not
    - Scholarly literature does not typically use "people of color"; the US Commission on Civil Rights also refrains from using umbrella terms like this because they hide individual groups; instead, they promote a people-first approach
    - Government reports use the term *racial and ethnic minorities*
    - The term *minority* or *minorities* places a value judgment and infers that those labeled as minority are 'less than'.[162]
    - The term "*underrepresented*" is primarily interpreted to refer to African Americans and Hispanics and therefore overlooks or reduces the importance of the other racial and ethnic groups that are underrepresented in STEM
    - Professional organizations use underrepresented as well: NOBCCHE.org, APS, National Academies of Science, Engineering and Medicine (Diversity, Equity and Inclusion reports; although recent reports refer to the "underrepresentation of" specific groups).

Options/Possible Recommendations

- Be more sensitive when referring to underrepresentation in STEM
- Underrepresented is a relative term and the context should be clearly defined – underrepresented with respect to what?

[159] Castania, K. (2003) The Evolving Language of Diversity *Cornell Cooperative Extension*.
[160] Pearson, W. and Fechter, W. (1994) Who will do science? Educating the next generation *Johns Hopkins University Press.*
[161] Mukherji, B.R., Neuwirth, L.S., & Limonic, L. (2017) Making the Case for Real Diversity: Redefining Underrepresented Minority Students in Public Universities *SAGE* 7.
[162] Castania, K. (2003) The Evolving Language of Diversity *Cornell Cooperative Extension*.

- Recognize that there are differences between language used in lay publications versus scholarly/peer reviewed publications
- Communicate that "underrepresented groups" is an acceptable term in scholarly literature
- Use the term *underrepresentation* to refer to what is occurring in fields of science or the participation of specific racial and ethnic groups in STEM fields
- Spell out the racial and ethnic groups being discussed; perhaps avoid the use of the acronym "URM"

Appendix 4: Demographics of the Federal STEM Workforce Infographic

Demographics of the Federal STEM Workforce

The federal government relies on its scientific and technical workforce to perform critical functions in an array of areas, including space exploration, national security and information technology, management and protection of the environment, and transportation. Of the 2.1 million federal employees, more than 330,000 (16%) people comprise the federal STEM workforce. This study considered the more than 280,000 (~14%) people who occupy engineering, information technology and mathematics, physical science and natural resources and life science careers. While women and traditionally underrepresented racial and ethnic groups (UREG*) comprise about 43% and 38% of the total federal workforce, respectively; they only comprise 29% and 10% of the federal STEM workforce. This data analysis was conducted to shed light on the demographics of the federal STEM workforce.

Federal STEM workforce is **16%** of the total federal workforce.

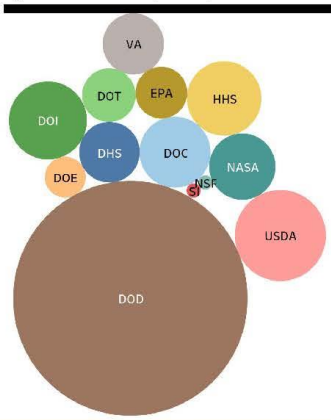
Women are **29%** of the federal STEM workforce

UREG are **10%** of the federal STEM workforce.

*UREG includes African American, Hispanic, Native American, Native Alaskan, Native Hawaiian and Pacific Islander, but does not include Asian Americans as they are not underrepresented in STEM. UREG women count as both UREG and women in STEM.

ABOUT THIS STUDY

Two of the goals of the Federal five-year strategic plan were to "Increase diversity, equity and inclusion in STEM" and to "Prepare the STEM workforce for the future". As a result, this study was compiled to assess the current status of the federal STEM workforce and serve as a point of reference for recommendations to address the Plan's goals. The data reported here are from OPM FedScope (fedscope.opm.gov; June 2019). This analysis focuses on the STEM workforce for job tracks: 04xx Natural Resources and Life Sciences, 13xx Physical Science, 08xx Engineering & Architecture, and 22xx Information Technology, 15xx Math, and 12xx Patent Examiner fields. This analysis does not include STEM employees in occupations such as sociology, psychology, management analyst, etc. or STEM workers in management or administrative positions (e.g. NSF). The Health fields are also not included in this report (~196,000 employees reported in Health Occupations). Data reported here includes the pay banding systems for GS, excepted service, SES, and agency-specific systems. Approximately 25% of STEM employees are in special pay systems at DOC, DOE, NSF and other agencies.

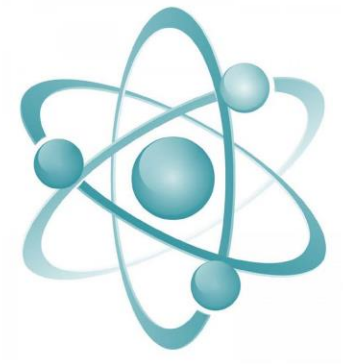


TOP STEM EMPLOYERS

The Department of Defense (DOD) is the largest employer in the federal government and its employees make up 47% of the federal STEM workforce. Individually, the other federal agencies represent smaller fractions (0.18-7%) of the total federal STEM workforce, however when specific career fields are considered their contribution to accomplishing the federal government's mission as it relates to STEM is evident.

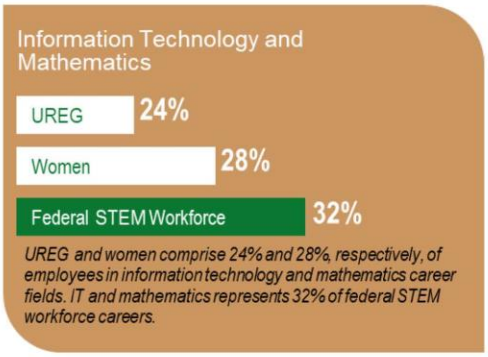
Racial and ethnic diversity demographics and employment of women by the top STEM employers varies by agency and career field. VA, EPA, HHS and DOD have the highest representation of UREG in their total STEM workforce. HHS, EPA, NSF, and VA have the highest percentages of women in their total STEM workforce.

Department of Agriculture (USDA), Department of Commerce (DOC), Department of Defense (DOD), Department of Energy (DOE), Department of Homeland Security (DHS), Department of Interior (DOI), Department of Transportation (DOT), Environmental Protection Agency (EPA), Heath and Human Services (HHS), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), Smithsonian Institution (SI), Veterans Affairs (VA).

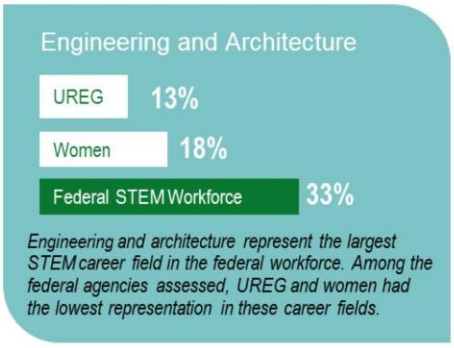


280,000+

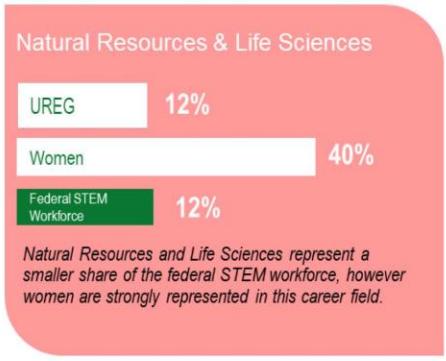
Federal STEM employees in career fields assessed in this study. *Cumulatively, engineering, information technology and mathematics careers are the largest career fields in the federal STEM workforce. The Department of Defense, as the largest STEM employer, drives this trend. Natural resources and physical science careers represent a smaller share of the federal STEM workforce, however women are more highly represented in those career fields. UREG are largely underrepresented in each of the career fields at all agencies assessed.*



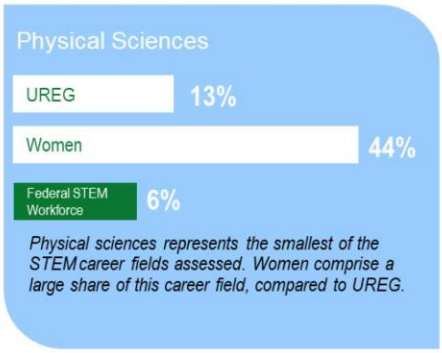
DOD, VA, and DOC are the top employers of IT and mathematics careers. More than 30% of the DOD STEM workforce is IT and mathematics and within these career fields, women and UREG represent 23% and 21% of the workforce, respectively. IT and mathematics careers are 37% and 28% of the VA and DOC STEM workforce, respectively.



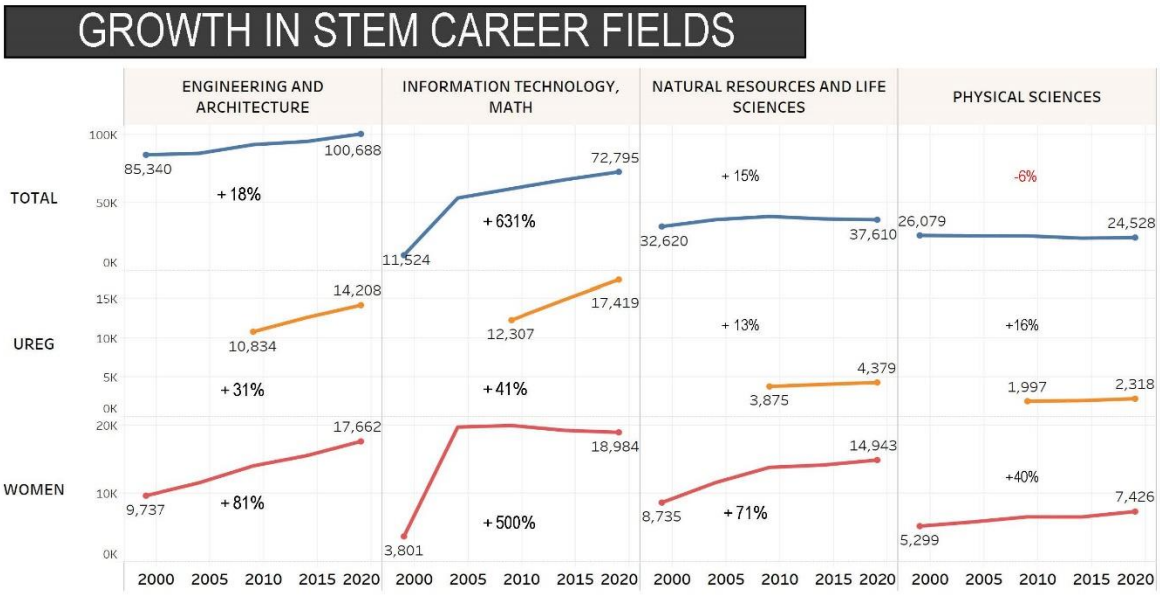
NASA, DOD, and DOC are the top employers of engineering and architecture careers. These career fields represent 85% of NASA's workforce. Women and UREG represent 23% and 15% of the employees in these career fields. For DOD and DOC, engineering and architecture represent 48% and 33% of the STEM workforce, respectively.



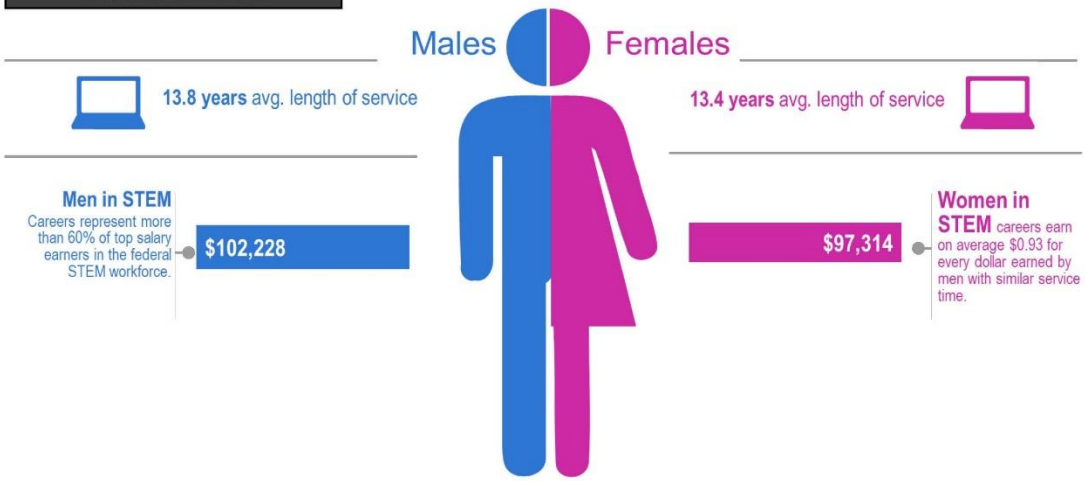
USDA, DOI and HHS are the top employers of natural resources and life sciences careers. More than 65% of the USDA STEM workforce are natural resources and life sciences careers. Women comprise 36% and UREG are 13% of USDA careers in these fields. For DOI and HHS, these career fields are 45% and 37% of their STEM workforce, respectively.



DOC, DOD and DOI are the top employers in the physical science career field. This career field constitutes 25% of the DOC STEM workforce, with women and UREG representing 25% and 11%, respectively. Physical science careers are only 3% of the DOD STEM workforce and represent 18% of the DOI STEM workforce.



Growth in STEM careers has been consistently positive in engineering and technology career fields over the past 20 years. Both women and UREG have had overwhelmingly positive growth in engineering and technology, likely due to increased dependence on technology and increased investments in education by federal agencies to increase representation in these areas. Growth in natural resources and life sciences was positive, particularly for women; while an over all decrease in physical sciences was observed. Data on race and ethnicity was not collected by FedScope prior to 2009.

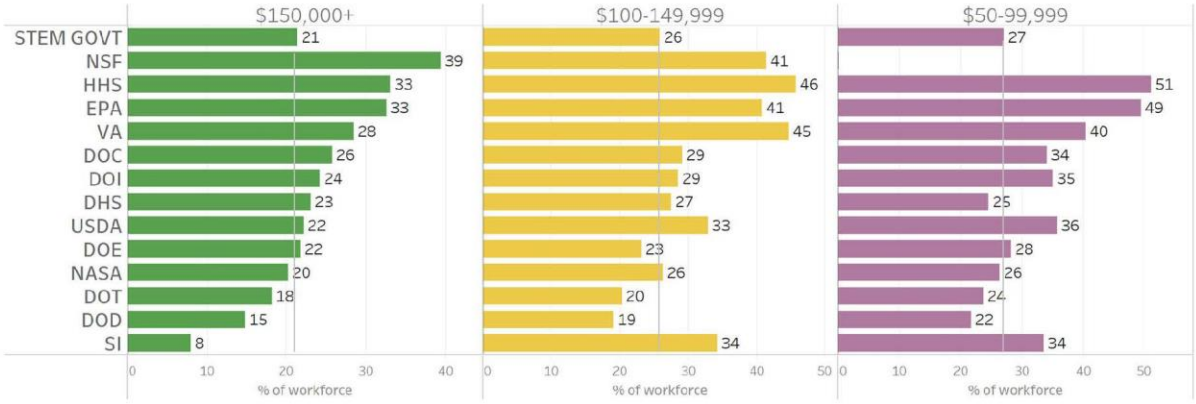


A recent report by the US Government Accountability Office revealed that the gender pay gap among federal employees decreased by 12 cents on the dollar from 1999 to 2017(GAO-21-67, 2020). Though varied, pay disparities also existed among women from different racial and ethnic groups with the widest gaps (9-12 cents) existing for Hispanic and Latina, Black, American Indian and Alaska Native women. An assessment of salary data in the current study aligned with that reported by GAO, showing that women earned 93 cents for every dollar earned by men.

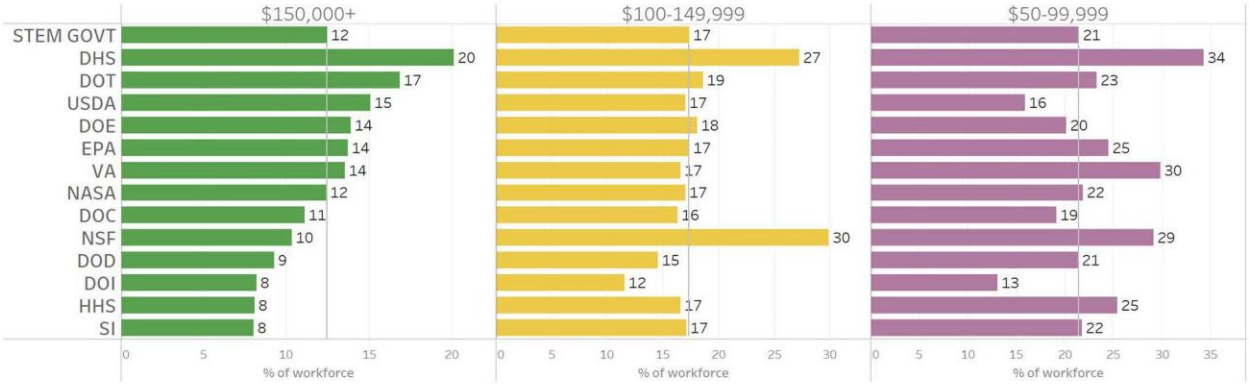
Salary as a Proxy for GS Level

Due to variances in pay scales (i.e. GS vs. pay banding) this study considers salary as a proxy for GS level. The figures below show the percentage of earnings by STEM employees for each federal agency compared to the total STEM workforce (STEM GOVT). Salaries were classified as entry-level ($50-99,999), mid-career ($100-149,999) and late career ($150,000+).

In general, women earned more than the average STEM salary at most of the STEM agencies analyzed for this study. Most women are at entry to mid-level salaries in STEM fields with roughly a third of the women in the STEM workforce earning high-level salaries. UREG salaries vary widely across STEM agencies at entry level salaries and are at average with all STEM employees at mid-level salaries. About half of the STEM agencies UREG employees meet the average high-salary levels in STEM.



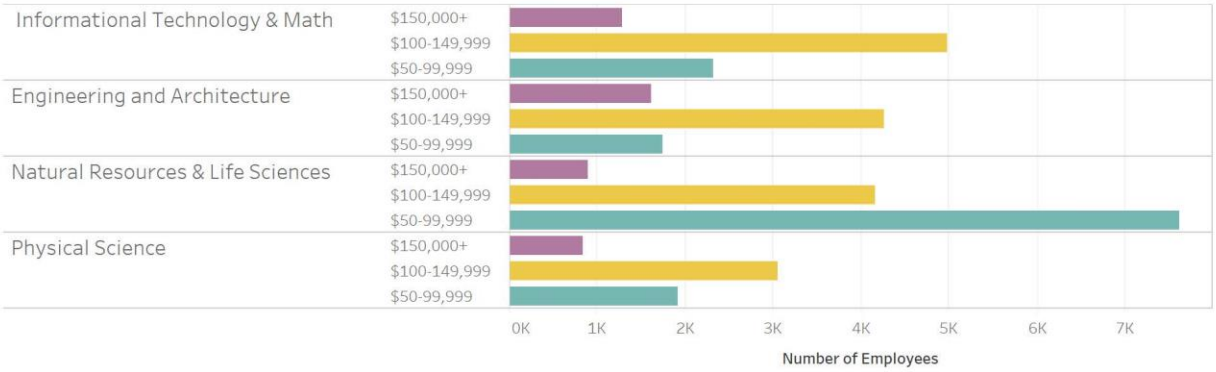
Women's salaries in STEM career fields. Data points represent percentages of women's earnings and are not meant to equal 100% when all salary categories are added together. The percentage of women earning less than $150K were generally lower for most agencies, however earnings were consistently equal to or greater than the average for the federal STEM workforce.



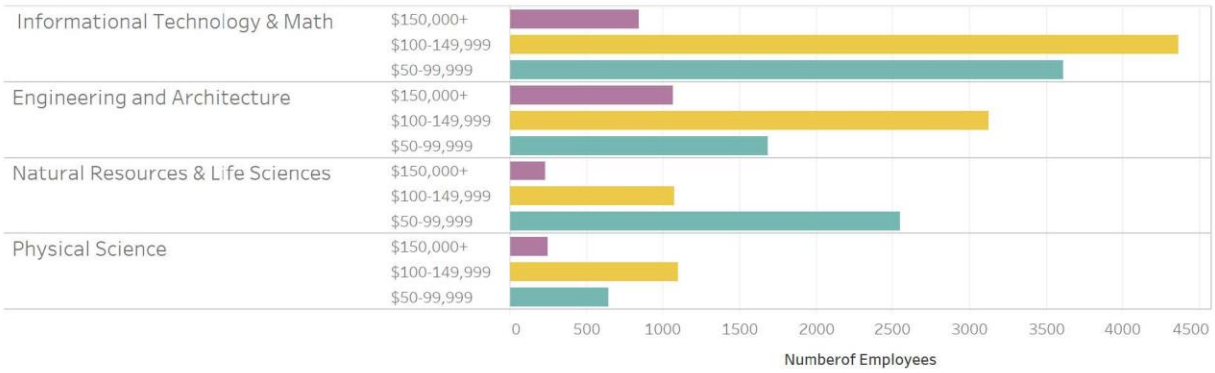
UREG salaries in STEM career fields. Data points represent percentages of earnings by UREG and are not meant to equal 100% when all salary categories are added together.

Salary by STEM Career

The greatest number of women by salary occur in the Natural Resources & Life Sciences (~12,976) where the majority of employees are at entry level salaries ($50-99,999). In the other STEM fields the majority of women earn mid-level salaries ($100-149,000), in particular in the fields of Information Technology and Math. The greatest number of UREG are employed in Information Technology & Math fields where most employees earn mid-level salaries ($100-149,000). STEM fields in the Natural Resources & Life Sciences report the majority or UREG employees at entry level salaries ($50-99,999).



Women's salaries by STEM career category. Data points represent the number of women earning entry-, mid-, and high-level salaries.



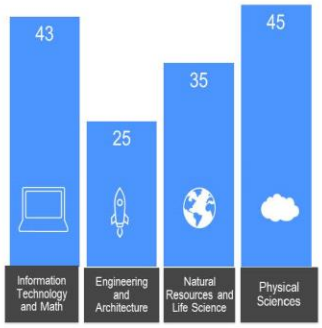
UREG salaries by STEM career category. Data points represent the number of individuals from UREG earning entry-, mid-, and high-level salaries.

AGING STEM WORKFORCE

AGE GROUP	GOVT	DOD	DHS	DOC	DOE	DOI	DOT	EPA	HHS	NASA	NSF	SI	USDA	VA
20-34	50,658	33,782	1,158	3,643	551	2,295	966	800	1,215	1,598	0	36	3,057	885
35-49	101,279	48,675	3,865	9,804	1,480	6,440	2,169	2,160	5,843	3,250	164	190	8,599	3,600
50-64	115,471	53,450	3,799	7,999	1,949	6,101	3,772	3,310	5,904	5,736	259	220	8,438	4,567
65+	14,423	5,274	620	1,031	315	763	454	605	1,251	683	148	78	1,161	587

Employees aged 50+ account for 46% of the federal STEM workforce, while those less than 35 account for only 18%. The 35-49 year old age group accounts for 36% of the federal STEM workforce. Trends for all federal agencies included in this study consistently revealed that the federal STEM workforce, much like the federal workforce in general, is aging. If current hiring trends persist, the federal workforce may face a deficit in qualified STEM employees.

47.5% Average percent of individuals over age 50 for top STEM employers in the 4 federal career tracks.



Of the career categories considered in this study, physical sciences and IT and Math have the highest percentage of employees over age 50. This analysis includes the entire population of employees in those career areas.

Resources:
Data Sources: Unless otherwise noted below, all data are from FedScope (fedscope.opm.gov) from the Office of Personnel Management, for all full-time, non-seasonal, permanent employees (June 2019)

GAO, Gender pay differences: The pay gap for federal workers has continued to narrow, but better quality data on promotions are needed, GAO-21-67 (Washington, DC: December 2020.

This study was compiled by the Interagency Working Group for Inclusion in STEM Workforce Subcommittee. December 2020. Authors: Natasha White (NOAA), Sheree Watson (USGS), Avital Percher (NSF), and Marlene Kaplan (OSTP)