CEOSE

THE COMMITTEE ON EQUAL OPPORTUNITIES IN SCIENCE AND ENGINEERING

BIENNIAL REPORT TO CONGRESS 2017-2018

INVESTING IN DIVERSE COMMUNITY VOICES

CEOSE MISSION & BACKGROUND

The Committee on Equal Opportunities in Science and Engineering (CEOSE) advises the National Science Foundation (NSF) on policies and programs to encourage full participation by women, underrepresented minorities, and persons with disabilities within all levels of America's science, technology, engineering, and mathematics (STEM) enterprise.

The Committee on Equal Opportunities in Science and Engineering was established by the United States Congress through the Science and Engineering Equal Opportunities Act of 1980 to address the problems of growth and diversity in America's STEM workforce. The legislation specifically provides that:

> *There is established within the National Science Foundation a Committee on Equal Opportunities in Science and Engineering (hereinafter referred to as the "Committee"). The Committee shall provide advice to the Foundation concerning (1) the implementation of the provisions of sections 1885 and 1885d of this title and (2) other policies and activities of the Foundation to encourage full participation of women, minorities, and persons with disabilities in scientific, engineering, and professional fields [42 U.S.C.§1885(c)].*
>
> *Every two years, the Committee shall prepare and transmit to the Director (of the Foundation) a report on its activities during the previous two years and proposed activities for the next two years. The Director shall transmit to Congress the report, unaltered, together with such comments as the Director deems appropriate [42U.S.C. §1885(e)].*

The CEOSE is composed of between 12 and 16 individuals from diverse STEM disciplines, drawn from diverse institutions in higher education, industry, government, and the non-profit sectors. Its membership also reflects the racial/ethnic and gender diversity of the country's citizenry and includes persons with disabilities. Members of the Committee typically serve a three-year term. A full committee meeting is held three times a year (usually winter, spring, and fall) to review and evaluate policies and program opportunities focused on the state of the participation and advancement of women, underrepresented minorities, and persons with disabilities in education, training, and science and engineering research. On the basis of its findings, the Committee makes recommendations to the Foundation for improving the levels of participation of underrepresented groups in STEM professions.

Committee members also interact with other federal agencies, such as the Department of Defense, National Institutes of Health, Department of Energy, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration, in forging multi-agency collaborations to broaden participation by underrepresented groups in the Nation's STEM workforce.

ACKNOWLEDGMENTS

Members of the Committee on Equal Opportunities in Science and Engineering (CEOSE) are indebted to the following National Science Foundation senior officials and program officers for their technical consultation, collection of critical data, and review assistance and comments that enabled the completion of this Biennial Report to Congress:

DR. FRANCE A. CÓRDOVA
Director (OD)

DR. JOAN FERRINI-MUNDY
Former Operation Officer (OD)

DR. F. FLEMING CRIM
Chief Operating Officer (OD)

DR. SUZANNE IACONO
CEOSE Executive Liaison
and Office Head (OD/OIA)

DR. FAY L. COOK
Former Assistant Director (SBE)

DR. ARTHUR W. LUPIA
Assistant Director (SBE)

DR. KELLINA CRAIG-HENDERSON
Deputy Assistant Director, (SBE)

MS. EMILDA RIVERS
Division Director (SBE/NCSES)

DR. JAMES ULVESTED
Former Acting Assistant Director (MPS)

DR. ANNE KINNEY
Assistant Director (MPS)

DR. DEBORAH LOCKHART
Deputy Assistant Director (MPS)

DR. PRAMOD P. KHARGONEKAR
Former Assistant Director (ENG)

DR. BARRY JOHNSON
Former Acting Assistant Director (ENG)

DR. DAWN M. TILBURY
Assistant Director (ENG)

DR. LINDA BLEVINS
Deputy Assistant Director (ENG)

DR. JAMES F. KUROSE
Assistant Director (CISE)

DR. ERWIN GIANCHANDANI
Deputy Assistant Director (CISE)

DR. JANICE CUNY
Program Director (CISE)

DR. JAMES L. OLDS
Former Assistant Director (BIO)

DR. JOANNE TORNOW
Assistant Director (BIO)

DR. ALLEN TESSIER
Deputy Assistant Director (BIO)

DR. MURIEL POSTON
Former Division Director (BIO)

DR. WILLIAM LEWIS
Former Acting Assistant Director (EHR)

DR. KAREN MARRONGELLE
Assistant Director (EHR)

DR. SYLVIA JAMES
Deputy Assistant Director (EHR)

DR. JOLENE JESSIE
Program Director (EHR)

DR. JESSIE DEARO
Program Director (EHR)

DR. TALITHA WASHINGTON
Program Director (EHR)

DR. REGINA SIEVERT
Program Director (EHR)

DR. CLYTRICE WATSON
Program Director (EHR)

DR. ROGER WAKIMOTO
Former Assistant Director (GEO)

DR. WILLIAM EASTERLING
Assistant Director (GEO)

DR. SCOTT BORG
Deputy Assistant Director (GEO)

DR. BRANDON JONES
Program Director (GEO)

DR. AMANDA ADAMS
Program Director (GEO)

DR. STEPHEN MEACHAM
Section Head (OIA)

DR. ANAND DESAI
Former Section Head (OIA)

DR. CYNTHIA PHILLIPS
Evaluator (OIA)

DR. REBECCA KRUSE
Evaluator (OIA)

DR. JOAN S. BURRELLI
Former Science Resource Analyst (OIA)

MS. RHONDA DAVIS
Office Head (ODI)

MR. ROBERT COSGROVE
Compliance Program Manager (ODI)

MS. JEAN FELDMAN
Head, NSF Policy Office

MR. MICHAEL SIEVERTS
Former Division Director (BFA)

We are grateful for the informative presentations and compelling insights of invited speakers, including: **Dr. Shirley Malcom**, Director of Education and Human Resources Programs (American Association for the Advancement of Science); **Dr. Rodney Hopson**, former Professor and Associate Dean for Research (George Mason University); **Dr. Marcia McNutt**, President (National Academy of Sciences); **Dr. Elizabeth Hillman**, President (Mills College); **Dr. Billy Williams, Director**, (American Geophysical Union); GEO ASPIRE PIs — **Drs. Corey Garza** (California State University) and **Julie Posselt** (University of Southern California).

We also give special thanks to **Dr. Bernice T. Anderson**, CEOSE Executive Secretary and Senior Advisor (OD/OIA) for the technical contributions and oversight role; **Ms. Jolaina Jeff-Cartier**, Staff Associate (OD/OIA); **Ms. Una Alford**, Program Analyst (OD/OIA) and **Mr. Steven Buhneing**, Communication Specialist (OD/OIA) for their administrative and communications coordination support.

Deep appreciation is also extended to **Nicolle Fuller** for designing the report cover, to **Christina Bartlett-Whitcom** for copy editing services and to **Matthew Pepper** for designing the report layout.

TABLE OF CONTENTS

ACRONYMS **3**

EXECUTIVE SUMMARY **5**

I. Introduction and the National Landscape for Broadening Participation 8

II. NSF Efforts to Increase Accessibility, Diversity, Equity and Inclusion in STEM 16

III. CEOSE Ongoing Work to Advance Broadening Participation in STEM 24

IV. CEOSE Recommendation and Plans for the Future 30

Endnotes 34

APPENDICES **37**

Appendix A: NSF Merit Review Process: Selected Tables

Table 2: Competitively Reviewed Proposals, Awards and Success Rates by PI Type

Table 3: Competitively Reviewed Proposals, Awards and Success Rates, by Race and Ethnicity

Appendix B: NSF INCLUDES Awards Directory, FY 2016-2018

Appendix C: Information on HSI Program Awarded Projects in FY 2018 (and the FY 2017 HSI Conference Awards)

Appendix D: HBCU Excellence in Research (EiR) Awards Directory

Appendix E: CEOSE Dear Colleague Letter and 2015-2016 Report Flyer

Appendix F: Examples of NSF-Supported Strategies/Activities/Projects Related to CEOSE's Suggested Practices for NSF's Role in Ensuring Accountability

CEOSE MEMBERSHIP 2017-2018 ..... **64**

ACRONYMS

ADVANCE ..... Increasing the Participation and Advancement of Women in Academic Science and Engineering Program

ADHD ..... Attention Deficit Hyperactivity Disorder

BIO ..... Biological Sciences Directorate

BP ..... Broadening Participation

BPC ..... Broadening Participation in Computing Program

CEOSE ..... Committee on Equal Opportunities in Science and Engineering

CISE ..... Computer and Information Science and Engineering Directorate

DCL ..... Dear Colleague Letter

EAGER ..... Early-concept Grants for Exploratory Research

EiR ..... Excellence in Research

EHR ..... Education and Human Resources Directorate

ENG ..... Engineering Directorate

EPSCoR ..... Established Program to Stimulate Competitive Research

ERC ..... Engineering Research Centers

FY ..... Fiscal Year

GEO ..... Geosciences Directorate

GOLD ..... GEO Opportunities for Leadership in Diversity

GPRA ..... Government Performance and Results Act

HBCU ..... Historically Black Colleges and Universities

HBCU-UP ..... Historically Black Colleges and Universities–Undergraduate Program

HSI ..... Hispanic Serving Institution

INCLUDES ..... Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science

IUSE:EHR ..... Improving Undergraduate STEM Education: Education and Human Resources

LSAMP ..... Louis Stokes Alliances for Minority Participation Program

LSRCE ..... Louis Stokes Regional Centers of Excellence

Mid-Scale RI ..... Mid-Scale Research Infrastructure

MPS ..... Mathematical and Physical Sciences Directorate

MSI ..... Minority-Serving Institution

NAS ..... National Academy of Sciences

NCES ..... National Center for Education Statistics

NCSES ..... National Center for Science and Engineering Statistics

NSB ..... National Science Board

NSF ..... National Science Foundation

ODI ..... Office of Diversity and Inclusion

OIA ..... Office of Integrative Activities

OIRM ..... Office of Information and Resources Management

OISE ..... Office of International Science and Engineering (ISE)

OSTP ..... White House Office of Science and Technology Policy

PI ..... Principal Investigator

REU ..... Research Experiences for Undergraduates

SEA ..... STEM Equity Achievement Project, also known as SEA Change

SBE ..... Social, Behavioral, and Economic Sciences Directorate

SBP ..... Science of Broadening Participation

S&E ..... Science and Engineering

STEM ..... Science, Technology, Engineering, and Mathematics

TEA ..... Tribal Enterprise Advancement

TCUP ..... Tribal Colleges and Universities Program

URM ..... Underrepresented Minority

US ..... United States

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

An inclusive science, technology, engineering and mathematics (STEM) workforce is needed to maintain America's leadership in the scientific enterprise. Increasing the participation of underrepresented groups including African Americans, Hispanic/Latino Americans, American Indians/Alaska Natives, persons with disabilities and women requires national attention to fully engage the nation's citizens in transforming its STEM enterprise. In its last report to Congress, the Committee on Equal Opportunities in Science and Engineering (CEOSE) suggested "future directions for NSF-sponsored research that focused on building inclusive community-engaged STEM communities that would promote STEM participation on the ground and at all ages, as well as reap the scientific benefit of the insights of people from diverse settings, neighborhoods, and circumstances in the innovation cycle." The committee believes providing these new inclusive, community-based or community-focused opportunities will help the nation increase its use of diverse communities to help improve the health and education of our communities; decrease poverty; increase the number and percentage of historically underrepresented groups in STEM; and bring new approaches to the strategic goals of scientific discovery and learning.

INVESTING IN BROADENING PARTICIPATION

The National Science Foundation (NSF) is committed to its investment in broadening participation in STEM science and learning. In fiscal year (FY) 2018, the Foundation awarded slightly over $1 billion[1] to broadening participation programs. NSF's 2018-2022 strategic plan articulates a vision of new opportunities for frontier research with a commitment to ensuring that talented individuals from all sectors of society have access to STEM learning. The plan states, "We endeavor to support outstanding researchers and innovative thinkers from across our Nation's diversity of regions, types of organizations, and demographic groups." NSF has shown this commitment through the NSF 10 Big Ideas, especially the NSF INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science) portfolio, which catalyzes novel approaches to broadening participation in STEM by incentivizing the building of collaborative infrastructures that will proactively seek, and effectively develop STEM talent in academia, government, and the non-profit sectors and groups in the nation.

Other commendable efforts made by NSF include: implicit-bias training for reviewers; the new terms and conditions to address sexual harassment; the Directorate for Geosciences' (GEO) Opportunity for Leadership in Diversity: An Ideas Lab activity;[2] the Directorate for Computer and Information Science and Engineering's (CISE) *Dear Colleague Letter: Pursuing Meaningful Actions in Support of Broadening Participation in Computing* (NSF 17-110);[3] the Directorate for Education and Human Resources' (EHR) Improving Undergraduate STEM Education: Hispanic-Serving Institution (HSI) program;[4] and the Historically Black Colleges and Universities (HBCUs) Excellence in Research (EiR) and Tribal Enterprise Advancement Centers efforts.

CEOSE ACTIVITIES IN 2017 & 2018

Six CEOSE meetings were convened between February 2017 and October 2018 focusing on areas like increasing accountability for broadening participation; addressing sexual harassment; and promoting community engagement in science. CEOSE held discussions with NSF's Director, Chief Operating Officer, Assistant Directors, Deputy Assistant Directors, liaisons from other federal agencies, and outside experts with expertise in diversity and inclusion.

CEOSE RECOMMENDATION

Involving diverse community voices in research projects, especially community-based, community-engaged, and community-focused research projects, has numerous benefits, including serving as a means for increasing broadening participation of underrepresented groups in STEM and improving science and engineering (S&E). However, it requires performing research differently and rejecting the assumption that applied and theoretical research should be distinct. Understanding that application and theory are interconnected and mutually enhancing in place-based research through problem-solving projects such as NSF's Big Idea *Navigating the New Arctic* is fundamental.

CEOSE proposes developing and implementing a recursive, iterative approach that is based on the following propositions: (1) significant societal problems cannot be solved without the unfettered full inclusion of underrepresented populations; (2) full inclusion, in turn, will result in better, more innovative and transformative S&E, as well as a better, more decent and just society; and (3) developing community-based research initiatives that are carried out with community members with a focus on local scientific problems is a promising strategy to help achieve the interrelated goals of full inclusion, better S&E, and a better society.

Based on these perspectives, activities and propositions, CEOSE calls on NSF to increase support for place-based implementation research projects that are grounded in and engage local communities. To realize this more integrative vision for inclusiveness in the STEM enterprise, the 2017-2018 CEOSE recommendation is that **NSF give increased attention to including diverse community voices across its research and education portfolios through community-driven projects.**

I. INTRODUCTION & THE NATIONAL LANDSCAPE FOR BROADENING PARTICIPATION IN STEM

CEOSE is charged by the United States Congress to advise NSF on policies and programs that encourage full participation of women, underrepresented racial and ethnic groups, and persons with disabilities in the scientific enterprise. Every two years, CEOSE prepares a report of its activities during the two-year reporting cycle and plans for the next two years. Past CEOSE reports have included recommendations for how NSF can "move the needle" from incremental progress to achieve demonstrable impact in meeting the increased challenges to improve representation of people from underrepresented groups in STEM disciplines.

In the 2011-2012 report, CEOSE called for a bold new initiative to broaden participation (the initiative resulted in NSF INCLUDES[5]); in the 2013-2014 report, CEOSE specified five components of implementation; and in the 2015-2016 report, CEOSE recommended the development of a shared accountability framework to ensure that investigators, higher education institutions and NSF follow through with proposed programs and/or activities regarding broadening participation, and that the strategies employed are proven and effective. In its 2017 and 2018 meetings, CEOSE focused on the need to broaden the community of voices in various aspects of the scientific enterprise.

The three previous CEOSE reports each pointed to the inclusive research method that is recommended in this 2017-2018 report. Specifically, the 2011-2012 report called for an initiative that "might include several multisite, geographically-based, national experiments of foundational and implementation research involving universities, schools, and communities."[6] Continuing in this vein, the second biennial report (2013-2014) encouraged the use of "field experiments including assessment of interventions and outcomes to understand and mitigate the barriers to broadening participation."[7] Lastly, in the third report (2015-2016), CEOSE suggested future directions for NSF-sponsored research that focused on "building inclusive community-engaged STEM communities that would promote STEM participation on the ground and at all ages, as well as reap the scientific benefit of the insights of people from diverse settings, neighborhoods and circumstances in the innovation cycle."[8] Therefore, NSF would encourage processes that allow researchers to gather input beyond their research domains and communities of colleagues, which could in turn be deployed across a span of research activities and fields of study. This call to action includes frameworks, methodologies, datasets and effective communication of new ideas that are, in part, informed by stakeholder and public communities in the national landscape.

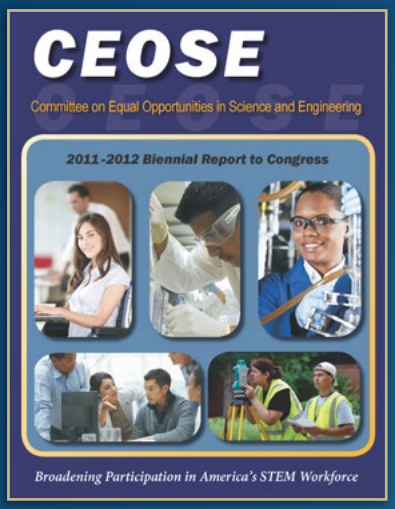
An important goal of broadening participation is to be the means of bringing diversity and intellectual breadth to the transformation of science itself.[9] In the recent reports to Congress, CEOSE emphasized the benefits to education and research that result from broadening participation.[10]

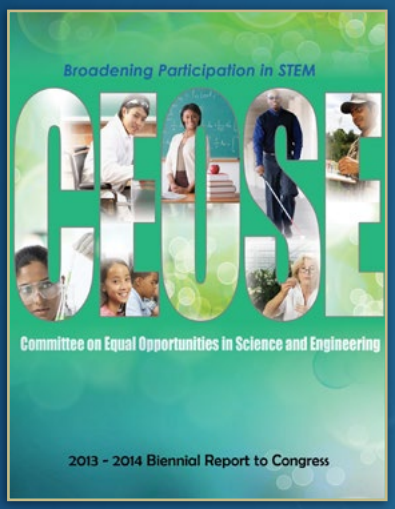
That diversity contributes to better learning, and problem-solving is supported by the work of Patricia Gurin, a distinguished professor of psychology at the University of Michigan (U-M), and her colleagues on the impact of diverse learning environments.[11] It is further supported by Scott Page, a diversity researcher at U-M, who argues that diversity fuels innovation, which enriches the intellectual environment.

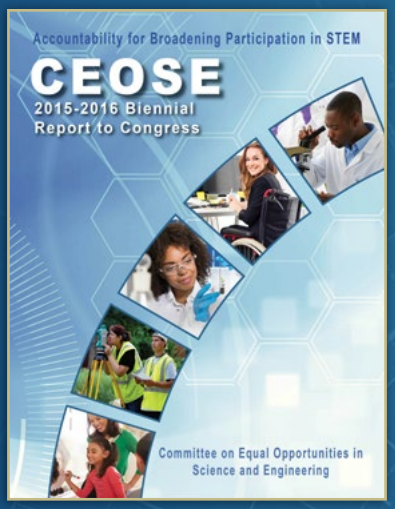
> *Innovation provides the seeds for economic growth and for that innovation to happen depends as much on collective differences as on aggregate ability. If people think alike then no matter how smart they are, they will most likely get stuck at the same locally optimal solutions. That's why diversity of thought powers innovation.*[12]

Page suggests that broad and diverse teams are the most likely to develop the creative solutions needed to solve society's most significant and seemingly intractable problems.[12] This idea is at the core of the argument that the inclusion of diverse community voices will result in both better S&E and empowered societies that contribute value and impact to S&E.

The changing landscape of science as expressed within NSF's 10 Big Ideas, especially *Navigating the New Arctic* and *Future of Work at the Human Technology Frontier*, provides invaluable opportunities for emphasizing the need to include community members who are experiencing the very problems of interest to scientists and engineers involved in the research projects. Community members, in effect, have information and resources and possess knowledge essential for developing the methods, approaches, findings and theories necessary for solving the problem at hand.







www.nsf.gov/od/broadening participation/bp.jsp

Supported by NSF's Division of Engineering Education and Centers, this REU site is directed by NSF Faculty Early Career Development Program awardee Dr. Arash Zaghi to provide undergraduate students with Attention Deficit Hyperactivity Disorder (ADHD) with interdisciplinary research experience in the cyber and physical security aspects of critical infrastructure resilience. These students are severely underrepresented and underserved in engineering programs and at risk of academic failure. This REU site at the University of Connecticut benefits the participating students by providing a positive research and education experience that cultivates their highly desirable assets (e.g., creative problem-solving and risk-taking abilities) and encourages them to continue in engineering careers. This effort is changing the education paradigm from deficit–based to strength–based and make engineering education more inclusive of diverse learning and thinking styles. The effort also engages K-12 teachers and high school students with ADHD (who are at a higher risk for dropping out) in a two-week summer program that actively involves them in engineering research and development activities.

(ENG/EEC–1653854)

The challenge goes beyond increasing the representation of historically underrepresented groups in S&E education and employment. Diverse groups of learners should be included in STEM-based experiential learning, even at early ages. Students should be included in STEM environments that allow them to demonstrate their strengths not only in terms of understanding principles, but also in experimentation alongside established scientists and engineers, who can embolden them to express their own unique perspectives regarding diversity and STEM. This could have mutual benefits -- both to the early learners and to the seasoned scientists, who may learn how youth consume and produce "science."

One pillar of diversity is neurodiversity; for example, those with learning disabilities (dyslexia) and learning differences due to Attention Deficit Hyperactivity Disorder (ADHD), executive function disorder or autism. The inclusion of neurodivergent individuals, as such, and underrepresented groups allow leveraging of their unique abilities to solve intractable problems in different ways. Engineering ways to deliberately embed and integrate these learners early on in experiences that provide frequent, small successes and allow STEM leaders and researchers to gain experience working with, and inspiring, such promising future scientists will enhance research outcomes and experiences for all involved.

Therefore, new opportunities must be provided to help the nation increase its use of diverse communities to help solve highly complex, real-world problems. Moreover, the talent of all Americans is needed to improve the health and education of communities; decrease poverty; increase the number and percentage of historically underrepresented groups in STEM; and bring new approaches to the strategic goals of scientific discovery and learning.

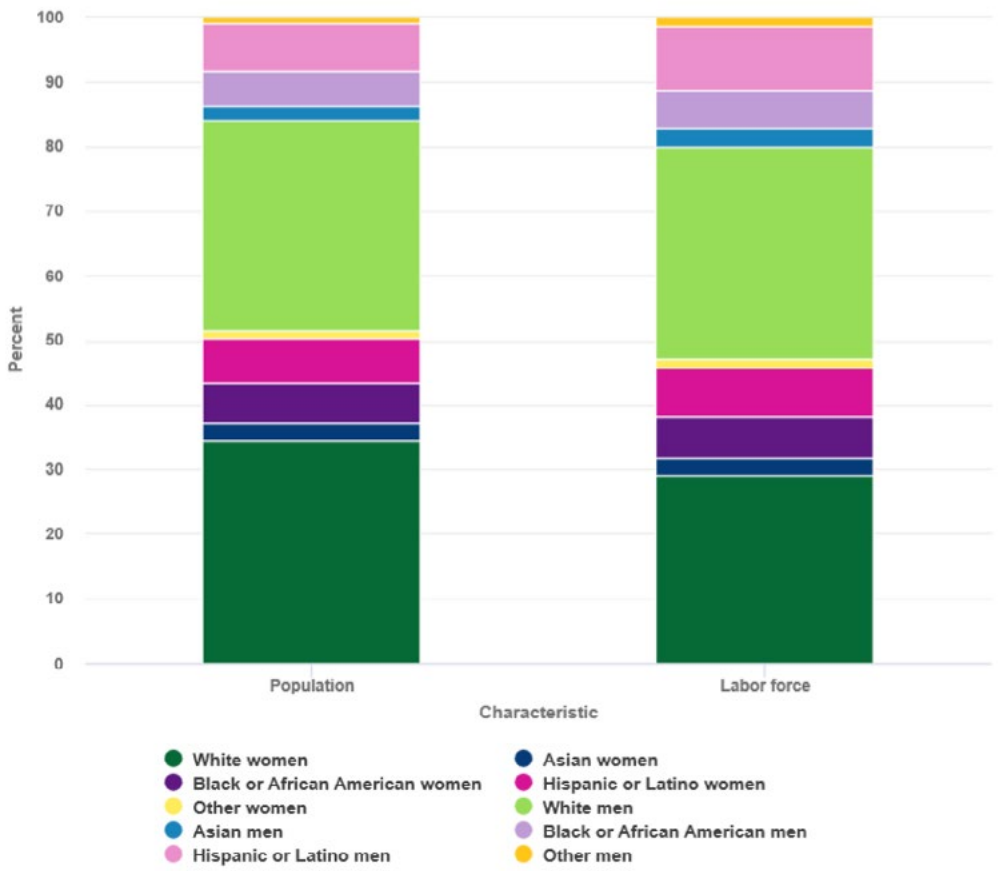
To realize this more integrative vision for inclusiveness in the STEM enterprise, the 2017-2018 CEOSE recommendation is that **NSF should give increased attention to including diverse community voices across its research and education portfolios through community-driven projects.** In other words, including diverse community voices must be seen as an innovative and valued strategy for both advancing knowledge and broadening participation in STEM. The urgency and need for this recommendation can also be supported by 2017 Census data in Figure A, which shows that women and underrepresented racial/ethnic groups constitute a substantial portion of the nation's population, ages 18 to 64 years. Additionally, 11% of the U.S. population has some disability, as shown in Figure B; however, the proportion varies by age. The committee wants to ensure that broadening participation in STEM means greater participation of the diverse communities of learners at all levels in formal and informal learning environments, including K-12 (see Figure C).

The People with Disabilities Achieving Career Employment (PACE) program, centered at the University of Pittsburgh Human Engineering Research Laboratories, designs, develops and delivers an experiential curriculum tailored for veterans and people with disabilities. It also offers guidance to academic institutions and employers about making accommodations for individuals with disabilities in their advanced manufacturing programs. PACE's curriculum prepares students with orthopedic, neurological or cognitive impairments to become manufacturing technicians. Each module is taught by a different instructor. This exposes students to various instruction and management styles as well as workplace expectations.

(EHR/DUE–1406757)

FIGURE A.

Noninstitutionalized resident population of the U.S. and civilian labor force of the U.S. by age, ethnicity, race and sex: 2017.

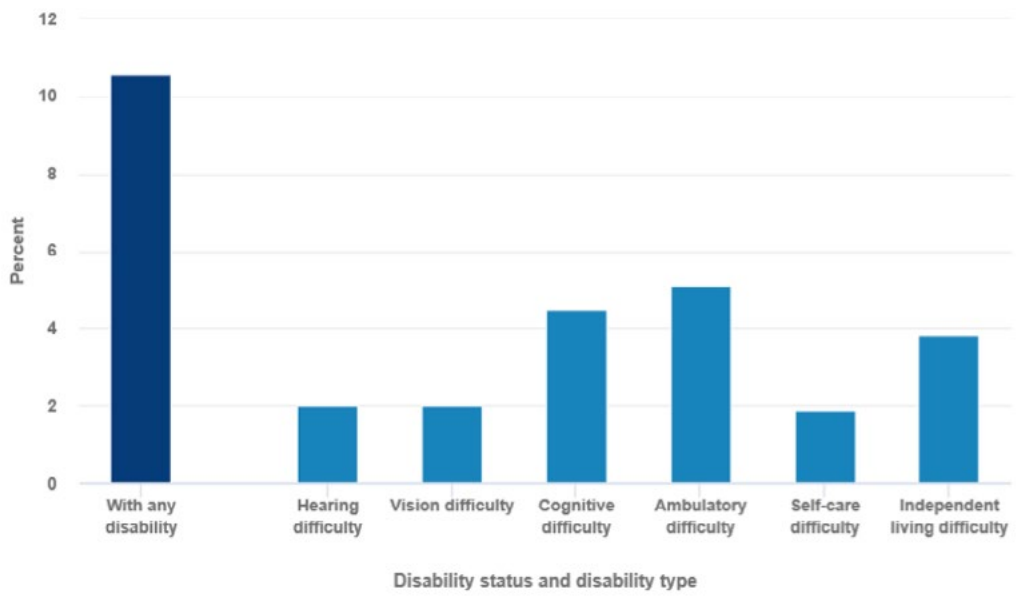


Note(s):
Hispanic or Latino may be any race. Other includes individuals not of Hispanic ethnicity who reported more than one race or a race not listed separately.

Source(s):
U.S. Census Bureau, Population Division, Annual Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States: April 1, 2010 to July 1, 2017, table PEPASR6H (June 2018), https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml, accessed 2018 June 29. Bureau of Labor Statistics, labor force statistics from the Current Population Survey, 2017, https://www.bls.gov/cps/. Related detailed data: WMPD table 1-2 and table 9-4.

FIGURE B.

U.S. population, ages 18-64, with a disability and type of disability: 2016.

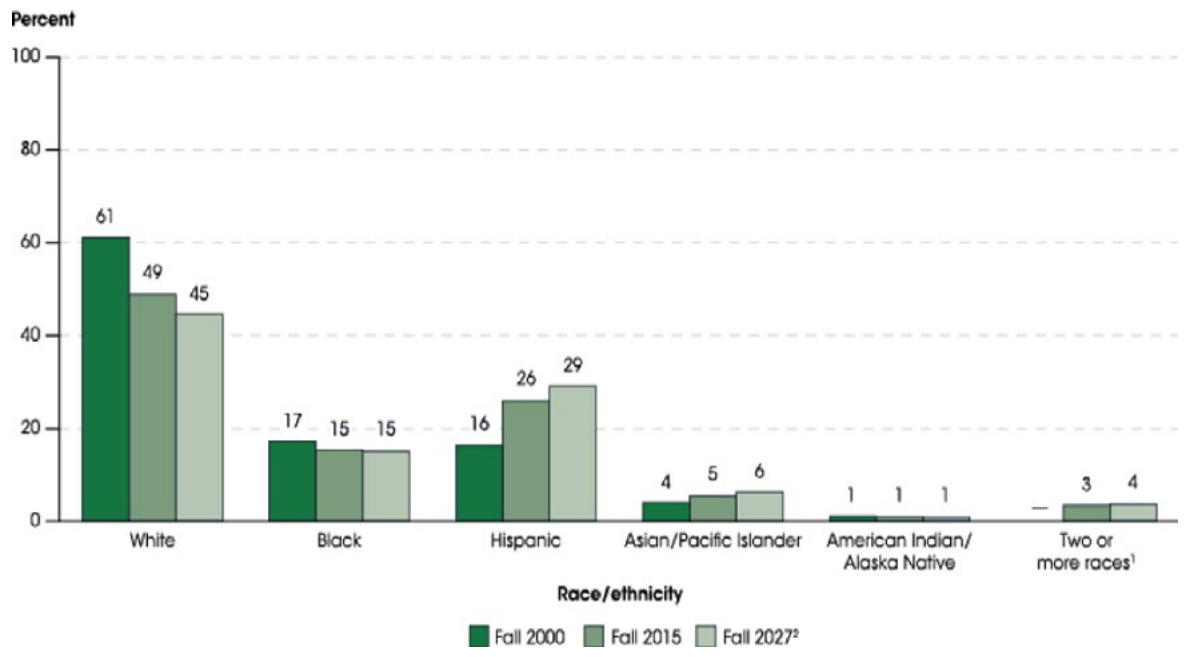


Note(s):
Respondents can report more than one disability. Age categories drawn from published Census tables.

Source(s):
U.S. Census Bureau, 2016 American Community Survey, tables B18101–B18107, 1-Year Estimates, https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml, accessed 2018 July 3. Related detailed data: WMPD table 1-3.

FIGURE C.

Distribution of public-school students enrolled in prekindergarten through 12th grade, by race/ethnicity: fall 2000, fall 2015 and fall 2027.



[1] In 2000, data on students of Two or more races were not collected.

[2] Projected.

NOTE: Race categories exclude persons of Hispanic ethnicity. Although rounded numbers are displayed, the figures are based on unrounded estimates. Detail may not sum to totals because of rounding.

SOURCE: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "State Nonfiscal Survey of Public Elementary and Secondary Education," 2000-01 and 2015-16; and National Elementary and Secondary Enrollment Projection Model, 1972 through 2027. See *Digest of Education Statistics 2017*, table 203.50.

IES/NCES: Status and Trends in the Education of Racial and Ethnic Groups, https://nces.ed.gov/programs/raceindicators/indicator_rbb.asp

CEOSE encourages NSF to continue to provide leadership in increasing the participation of underrepresented groups in the STEM enterprise by partnering with other federal agencies, education institutions, STEM professional associations/societies and other partners, including the communities and stakeholders who can collaborate in the co-production of knowledge. The next section of this report highlights accomplishments of NSF in broadening participation with specific attention to the foundation's recently initiated efforts. The latter part of this report focuses on the activities of CEOSE during 2017-2018 that informed the recommendations and advice to NSF in this report, as well as future direction for the committee.

The Louisiana School for the Visually Impaired (LSVI) presents a seminar series where faculty bring a tactile item relating to their research. The Consortium for Innovation in Manufacturing and Materials has also coordinated with two female engineering students at Louisiana State University to work with the staff of LSVI in training them on a curriculum to utilize their 3D printer to print eyeglass frames for the students. The student's proposal, "Procedural Study of Additive Manufacturing Eyeglasses for Visually-Impaired Students," was awarded an NSF Summer Undergraduate Research Experience grant sponsored by the Louisiana Established Program to Stimulate Competitive Research and the Louisiana Board of Regents.

(OIA/EPSCoR–1541079)

II. NSF EFFORTS TO INCREASE ACCESSIBILITY, DIVERSITY, EQUITY & INCLUSION IN STEM

NSF promotes broadening participation in several ways, from non-discriminatory policies and fair employment practices to inclusive research practices/strategies and the funding of broadening participation programs. Selected accomplishments in these areas during the 2017-2018 reporting period are highlighted in this section.

BROADENING PARTICIPATION-RELATED POLICIES & PRIORITIES

Mitigating the impact of bias is critical to the growth and diversification of the scientific workforce. NSF provides a summary statement on its broadening participation webpage[13] about increasing diversity in the STEM workforce by reducing the impact of bias. The statement calls attention to efforts to eliminate underrepresentation of racial/ethnic groups and women in the federal workforce; innovative strategies to remove participation barriers in the merit review process for grantmaking; implicit bias training for staff and reviewers; and annual reporting requirements that help the foundation monitor its commitment to an environment free of harassment and discrimination. Additionally, NSF is one of a few federal agencies investigating potential bias in the scientific review process. Moreover, through its Science of Broadening Participation activity, the foundation is funding research to better understand the contexts and consequences of implicit barriers, as well as identify best practices for reducing the impact of bias in the scientific community.

NSF sent a clear message in Important Notice No. 144[14] that the foundation does not tolerate sexual harassment within the agency or at awardee organizations, field sites or anywhere NSF-funded science and education are conducted. The foundation also consolidated the agency's policies and procedures, information on filing complaints and other resources to improve the community's understanding of Title IX and sexual harassment.[15] More recently, the foundation published a requirement that awardee organizations must notify the agency of: (1) any findings or determinations that an NSF-funded principal investigator (PI) or co-principal investigator (Co-PI) committed harassment, including sexual harassment or sexual assault; (2) the placement of the PI on administrative leave; or (3) the imposition of any administrative action relating to a harassment or sexual assault finding or investigation.

In response to Public Law 111-353, NSF's new strategic plan for FY 2018-2022[16] articulates a vision of new opportunities for frontier research with a commitment to ensuring that talented individuals from all sectors of society have access to STEM learning. Inclusion is identified as a core value, guiding how the foundation sets priorities, addresses challenges, and recruits and develops personnel: "We endeavor to support outstanding researchers and innovative thinkers from across our Nation's diversity of regions, types of organizations, and demographic groups."[14]

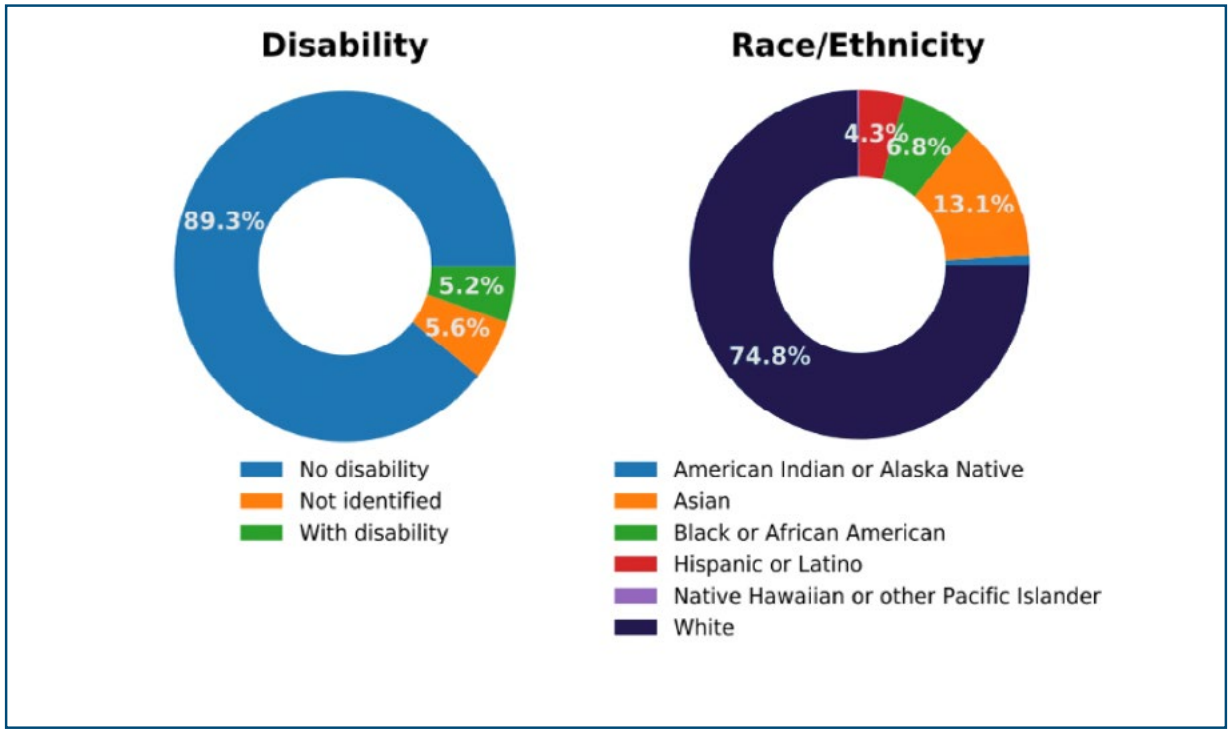
NSF submitted a statement of priorities to the White House Initiatives on Historically Black Colleges and Universities (WHI-HBCUs) about key areas of support to facilitate partnering efforts with HBCUs that are aligned with the agency's commitment to inclusion and mission of promoting the progress of science. Priority activities for FY 2018 included conducting outreach to the HBCU community for recruiting reviewers, panelists, expert consultants and Intergovernmental Personnel Act assignments from HBCUs; providing tailored technical assistance linked to programmatic competitiveness and/or the infrastructure for innovation and fundamental research; and developing a portfolio of projects that enable STEM and STEM education faculty at HBCUs to conduct research and have increased access to cutting-edge equipment for research and training.

DIVERSITY OF NSF STAFF

A diverse staff of scientists and engineers at NSF demonstrates the foundation's commitment to its core value of inclusion. NSF is striving to maintain a STEM workforce that has representation reflective of the broader STEM community, as seen in the following two charts. CEOSE encourages NSF to continue to promote diversity within all of its research and education units, modeling the importance of broadening participation in supporting better science.

FIGURE D.

Scientists and engineers employed at NSF, characterized by categories of disability and racial and ethnic groups: FY 2017.



Source: NSF, Internal Communications, Fall 2018

Through Northern Michigan University's Center for Native American Studies, the Indigenous Women Working within the Sciences (IWWS) project seeks to improve the performance of American Indian high school students in STEM by advancing indigenous knowledge, instructional pedagogy and practices. The project team works to pilot activities and coursework to train K-16 STEM educators about American Indian inclusive methods and materials; provides American Indian and Alaska Native (AIAN) high school students with STEM college preparatory experience using inclusive STEM practices; and provides a cohort of female AIAN high school students with additional university experiences and mentors as these students transition to postsecondary education. Activities include a summer educators institute and workshops for K-16 STEM educators; a summer STEM academy for AIAN high school students; a STEM workshop for female AIAN high school students; and a mentoring program for AIAN high school students.

(EHR/HRD–1649082)

BROADENING PARTICIPATION UPDATES/ ACCOMPLISHMENTS RELATED TO RESEARCH PRACTICES

In the course of evaluating competitive research ideas, reviewers contribute to the diversity of current and future scientists and engineers across the U.S. Review panels are designed to be broadly inclusive of race/ethnicity, gender, disability status and geographic location. In recent years, the use of virtual panels has helped NSF's efforts to improve career-life balance and broaden the participation of individuals in the merit review process. For example, gender information was available for 79.3% of the 16,187 panelists in FY 2016; among those panelists 32.5% on in-person panels and 33.3% on virtual panels were women.[17] NSF continues to provide training to increase the awareness of and sensitivity to implicit bias in the review process. More specifically, NSF recently developed a reviewer orientation video, to be viewed before reviews are written, that contains tips on writing analytical reviews, broader impacts, and how to mitigate cognitive bias. CEOSE encourages NSF to continue its vigilance regarding the merit review process, selection and training of reviewers, and outreach to identify and include reviewers who represent the stakeholders, partners and communities discussed in this report.

Key findings about the demographic diversity of PIs submitting proposals, as reported in the *FY 2016 Report on the NSF's Merit Review Process*,[17] were:

- The proportion of proposals from females was 26.9% and the funding rate was 28.8%.
- The proportion of proposals from PIs of underrepresented racial or ethnic groups was 8.3% and the funding rate was 23%.
- The proportion of proposals from PIs identifying themselves as having a disability was 1.4% and the funding rate was 22%.

The detailed tables in Appendix A revealed that women submitted fewer proposals than men but the success rate for female PIs was slightly higher than for male PIs. The proportion of proposals for researchers from underrepresented racial or ethnic groups remained low and their success rate was lower than the average success rate for all PIs. The proportion of proposals from researchers with disabilities remained relatively steady and their success rate was comparable to the overall success rate for all PIs.[17]

PROGRAM HIGHLIGHTS FOR BROADENING PARTICIPATION

Current information about the NSF Broadening Participation portfolio can be found on the NSF website.[18] The funding profile for programs to broaden participation in FY 2018, according to the recent NSF budget request, was:

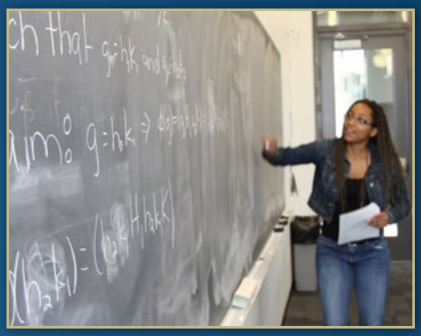
- $258.18 million for focused programs or programs that have an explicit broadening participation goal.
- $575.31 million for emphasis programs or programs that have broadening participation as one of several emphases, but not the explicit goal of the program.
- $170.59 million for geographic diversity programs (see "NSF Programs to Broaden Participation" in the FY 2020 Budget Request to Congress[19]).

During this reporting period, CEOSE requested information about NSF's newer investments to address the agency's STEM workforce strategic objective 2.2, to "foster the growth of a more capable and diverse research workforce and advance the scientific and innovation skills of the Nation."[20] Newer efforts are highlighted below.

NSF INCLUDES is a comprehensive initiative to catalyze novel approaches in broadening participation in STEM by incentivizing the building of collaborative infrastructures that will proactively seek and effectively develop STEM talent from all sectors and groups in the nation. NSF INCLUDES is especially interested in broadening participation for those groups traditionally underrepresented in STEM fields and persons from economically disadvantaged backgrounds. In FY 2017, the initiative supported a second cohort of design and development launch pilots to lay the foundation for larger scale partnerships. NSF also received reports from the FY 2016 conference awardees to inform the FY 2018 solicitation for the NSF INCLUDES Coordination Hub (NSF 17-591) to "provide increased communication, interoperability, coordination, support, and accountability" for the NSF INCLUDES Network. The expanded or new opportunities in FY 2018 also included the "Dear Colleague Letter" 17-111, calling for three types of proposals: Early-concept Grants for Exploratory Research (EAGER), conference and supplemental funding,[21] and a solicitation for the NSF INCLUDES Alliances (NSF 18-529).[22]

These expanded opportunities in FY 2018 resulted in funding a five-year coordination hub and a significant investment in the first cohort of five-year alliances. The five new NSF INCLUDES Alliances represent a $46,958,593 investment. The Coordination Hub has launched the National Network website.[23] More than 10 solicitations across NSF include language on NSF INCLUDES. For example, this is an insert from the Improving Undergraduate STEM Education: Education and Human Resources (IUSE:EHR) solicitation:

> "IUSE:EHR also seeks to support projects that have high potential for broader societal impacts, including improved diversity of students and instructors participating in STEM education, professional development for instructors to ensure adoption of new and effective pedagogical techniques that meet the changing needs of students, and projects that promote institutional partnerships for collaborative research and development. IUSE:EHR especially welcomes proposals that will pair well with the efforts of NSF INCLUDES to develop STEM talent from all sectors and groups in our society. Collaborations are encouraged between IUSE proposals and existing INCLUDES projects, provided the collaboration strengthens both projects."[24]



The goal of the WATCH:US project is to increase and diversify the number of professional mathematicians in the U.S. by identifying and proliferating best practices and known mechanisms for increasing the success of women in mathematics graduate programs, particularly women from underrepresented groups. In addition to the WomenDoMath website, the project supports mini-grants for local programs, as well as both exploratory and effectiveness research. Members of the project's advisory board are affiliated with premier professional societies: the Association for Women in Mathematics, the American Mathematical Society, the Mathematical Association of America, the American Statistical Association, the Society for Industrial and Applied Mathematics, the National Association of Mathematicians, and the Society for Advancement of Chicanos/Hispanics and Native American in Science.

(MPS/OMA–1649365)

The NSF INCLUDES investments are already contributing to new collective knowledge related to broadening participation of underrepresented groups in STEM. For example, the three most commonly used collaborative change strategies by the NSF INCLUDES community are Collective Impact, Network Improvement Communities and Participatory Action Research. Common across these collaborative strategies is the NSF INCLUDES framework of five core elements: vision, partnerships, goals and metrics, leadership and communication, and expansion, sustainability and scale. More interesting is that the first annual report to the nation (NSF 18-040) revealed that NSF INCLUDES is engaging 760 partnering organizations working to broaden participation in STEM through collaborative change, including 10 private foundations, 11 museums and observatories, 52 professional organizations and their affiliates, 57 community colleges/community college districts, 68 corporations, 96 K-12 schools/school districts, and 254 colleges and universities. Within the context of the shared accountability, the agency is working closely with NSF INCLUDES technical assistance, evaluation contractors and project-level evaluators to find answers to: What are we learning? What do we need to do more of, less of, or differently for catalytic impact? The NSF INCLUDES directory of launch pilots, conference grants, EAGERS, coordination hub and new alliances is included in Appendix B.

On July 3, 2017, the CISE Directorate issued a Dear Colleague Letter: ***Pursuing Meaningful Actions in Support of Broadening Participation in Computing* (BPC)** (NSF 17-110) announcing a pilot effort to enhance the community's awareness of and barriers to broadening participation in computing. The goals of Phase I of the pilot included: (1) increase PI awareness and understanding of BPC, and (2) provide information, resources and encouragement so that PIs develop interest, skills and meaningful activities in support of BPC. This letter emphasized that broadening participation in computing required sustained efforts that must be innovative, varied and welcoming of multiple pathways that eliminate or overcome barriers, as well as provide resources that can develop interests, skills and activities in support of BPC at all levels (K-12, undergraduate, graduate and postgraduate). This effort builds on CISE's long history of support for BPC. It also aligns with prior recommendations of the CISE advisory committee (see "CISE Advisory Committee's Strategic Plan for Broadening Participation"[25])

The ***GEO Directorate's Opportunities for Leadership in Diversity (GOLD): An Ideas Lab Activity*** (NSF 16-516) pointed out that diversity is vital for promoting innovation, strengthening the community's ability to tackle complex geoscience research problems, and engendering widespread public Earth and environmental science literacy.[26] The aim of GOLD is to facilitate the design, pilot implementation and evaluation of innovative professional development curricula that can unleash the potential of geoscientists with interests in broadening participation to become impactful leaders in the community. GEO has funded five pilot projects as a result of an Ideas Labs meeting that was held in March 2016. Each team was required to include a geoscientist and a social scientist. The GOLD portfolio includes:

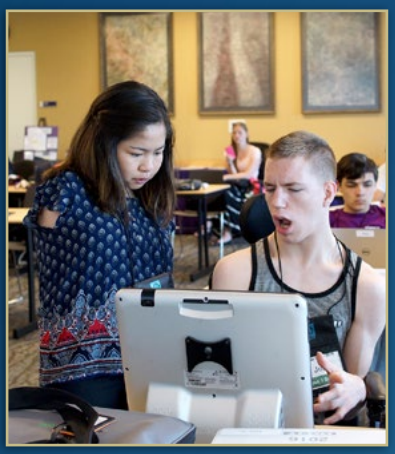
- *Hearts of GOLD* (Fort Hays State University with the National Center for Atmospheric Research, Virginia Polytechnic Institute and State University, National Oceanic and Atmospheric Administration, and Florida International University), using the influence of respected geoscientists to create champions for diversity in the geosciences.

- *Sparks for Change* (Arizona State University), aiming to create inclusive geoscience departments and support early career minority faculty by using small groups to facilitate departmental culture change.

- *FIELD: Fieldwork Inspiring Expanded Leadership and Diversity* (Colorado State University, Ohio State University, South Dakota School of Mines and Technology, and University of Southern California), creating more equitable and accessible cultures of geoscience fieldwork to maximize diversity, inclusion and equity.

- *GeoDES: Geoscience Diversity Experiential Simulations* (College of William and Mary, University Corporation for Atmospheric Research, University of Wisconsin-Madison, American Geological Institute, Yale University, Cornell University and Michigan State University), providing professional development that empowers faculty to recognize and respond to prejudice in workplaces.

- *ASPIRE: Active Societal Participation in Research and Education* (University of Washington, University of Southern California, University Corporation at Monterey Bay, and University of Maryland Center for Environmental Sciences), cultivating ethical models of community-based geoscience research by using place-based science as a vehicle to bridge long-standing divides that impede access to and inclusion in the geosciences.



AccessCSforAll works to increase the successful participation of students with disabilities in K-12 computing. K-12 students with disabilities enrolled in computing courses may encounter tools and curricula that are inaccessible to screen readers used by students who are blind or have reading-related disabilities such as dyslexia. Content embedded in images without text-based alternatives accessible by screen readers also creates barriers. Students who are deaf require captions or transcriptions of audio content and students with disabilities can benefit from curricular features that facilitate access to them. Access CSForAll provides real-time support to teachers nationally who encounter a student with a disability when teaching AP Computer Science Principles or any other computer science course.

(CISE/CNS–1738259)

On June 6, 2017, the foundation issued DCL 17-092[27] to seek community input to inform a new HSI program via conference proposals to identify challenges and opportunities regarding undergraduate STEM education at two-year and four-year HSIs. NSF also made 11 conference awards. In addition to the conference DCL, NSF released a program solicitation in FY 2018, ***Improving Undergraduate STEM Education: Hispanic-Serving Institutions (HSI) Program*** (NSF 18-524[28]). The program is designed to enhance the quality of undergraduate STEM education at HSIs and to increase retention and graduation rates of undergraduate students pursuing degrees in STEM fields at HSIs. In addition, the HSI program seeks to build capacity at HSIs that typically do not receive high levels of NSF grant funding. In FY 2018, NSF spent $30 million to support grants in two tracks: (1) Building Capacity, and (2) HSIs New to NSF. (See Appendix C for the listing of HSI awards, including the conference grants.)

On Sept. 19, 2017, NSF released the *Dear Colleague Letter:* ***Historically Black Colleges and Universities Excellence in Research Program*** (DCL 17-138) announcing the HBCU EiR funding opportunity to promote sustainable improvements to the research and development capacity and competitiveness of HBCUs. HBCU EiR was implemented in FY 2018 as part of the solicitation (NSF 18-522) for the Historically Black Colleges and Universities-Undergraduate Program (HBCU-UP),[29] designed to support projects that enable STEM and STEM education faculty at HBCUs to conduct research and, thus, further develop research capacity at HBCUs. In FY 2018, the program spent $20 million to support research conducted by individual PIs at HBCUs and research projects that aimed to stimulate research capacity and competitiveness through interdisciplinary collaborations across universities. (Appendix D has a listing of the 44 EiR awards made in FY 2018.)

Tribal Enterprise Advancement (TEA) centers represent a new component in the Tribal College and Universities Program (TCUP). In FY 2018, NSF supported four new centers that are addressing environmental, social, educational and economic challenges and promoting community-relevant STEM opportunities:

- *Tribal Enterprise Advancement Center for Community Marine Research* (Northwest Indian College), focusing on research and education outreach regarding the marine ecosystem.

- *Navajo Technical University's Advanced Manufacturing Center*, developing four new degrees and certificate programs (i.e., a bachelor's degree in mechanical engineering, an associate degree in metal additive manufacturing technician II, and certificates in quality control inspection and metal additive manufacturing technician).

- *United Tribes Technical College's and Intertribal Research and Resource Center*, utilizing a coordinated interdisciplinary approach to research, outreach, teaching and education in serving the tribes in the Northern Plains.

- *Aaniih Nakoda Nic'-Mni' (Water) Center* (Aaniih Nakoda College), integrating water research studies to provide community members with the knowledge, skills, experiences and credentials needed to address local water issues effectively.

In FY 2018, NSF announced awards for six **Louis Stokes Regional Centers of Excellence** (LSRCEs) that will support recruitment and retention of minority undergraduate and graduate students studying STEM disciplines.

- The *Louis Stokes Midwest Regional Center of Excellence in Broadening Participation* is a five-year award that serves as a hub for STEM educational research, dissemination and professional development activities.

- The *Louis Stokes Florida-Caribbean Regional Center of Excellence in Broadening Participation (FL-C-LSRCE)* is a three-year award with emphasis on investigating and disseminating evidence-based practices that contribute to student success in STEM within the undergraduate STEM pathway, including community college matriculation and transfer to four-year STEM programs.

- The *Fisk-Vanderbilt Bridge Program Regional Center of Excellence in Broadening Participation (FVBP LSRCE)* is a three-year project designed to generate and disseminate new knowledge in the science of broadening participation at the STEM graduate education level.

- *Louis Stokes Regional NSF International Center of Excellence in Broadening Participation (LSAMP-NICE)* is a five-year center that investigates and disseminates international research experiences and persistence in STEM for traditionally underrepresented minority students.

- *Louis Stokes Center for Promotion of Academic Careers through Motivational Opportunities to Develop Emerging Leaders in STEM (LS-PAC MODELS)* is a five-year mentoring focused, data-driven center, in collaboration with IBM, aimed at developing a national model from undergraduate to STEM doctoral degree to attract, prepare and retain traditionally underrepresented minorities in the STEM workforce.

- *Southeastern Coalition for Engagement and Exchange in Nanotechnology Education Louis Stokes Regional Center of Excellence in Broadening Participation (SCENE-LSRCE)* serves as a three-year pilot disciplinary institute designed to strengthen skills and knowledge in nanoscience through outreach, informal science, curriculum improvement, and dissemination activities at the K-12 to undergraduate STEM pathways.

The goal of the Sparks for Change project is to build a network of leaders in broadening participation, a collection of tested strategies for improving departmental support for broadening participation efforts, and geoscience departments that are better equipped to attract and retain underrepresented faculty and students. Ultimately, the program aims to foster a more diverse geoscience workforce. The Sparks for Change Institute supports and builds diversity for geoscience departments using small groups as change agents who enact departmental-level culture change that supports broadening participation. The institute holds workshops that bring together different institution types. Participants are provided with the leadership skills necessary to lead departmental culture change; opportunities for sharing broadening participation strategies; and support in developing individualized departmental plans for enacting change. Ongoing support, including personalized evaluation of efforts, development of resources and alliance building, will continue to empower the participants to enact change upon returning to their institution.

(GEO/AGS–1645453)

III. CEOSE ONGOING WORK TO ADVANCE BROADENING PARTICIPATION IN STEM

The 2017-2018 CEOSE activities included meetings of the full committee; disseminating the 2015-2016 CEOSE report, as well as monitoring the responses to shared accountability recommendations; and preparing this report. The work of the committee was aligned with the plans proposed in the prior report. This section is a brief overview of the committee's work in this reporting period.

CEOSE MEETINGS

Six CEOSE meetings were convened between February 2017 and October 2018 that covered a wide range of topics. Highlights of some of the presentations, followed by a summary of the discussions with the NSF Director, Chief Operating Officer and other senior leaders, are presented below. It is important to note that agency liaisons from the Department of Education, Environmental Protection Agency, National Institutes of Health, National Institute of Standards and Technology and Smithsonian Institution regularly updated the committee on efforts these agencies were planning and/or implementing to broaden participation in STEM.

CEOSE received presentations on seven of NSF's 10 Big Ideas and expects updates on the other three in upcoming meetings.[30] An update on *NSF INCLUDES* was provided at each meeting, articulating how the effort has expanded and how evaluation ensures accountability of the initiative. In addition to sharing "lessons learned" documents, a portfolio analysis of the NSF INCLUDES investment was updated to reflect the diversity of projects in terms of discipline, focus, geography and type of institution. The committee encouraged NSF to reach out to NSF center directors and to leverage the network of NSF-funded centers and comparable NSF large-scale science initiatives. NSF responded by hosting the "NSF INCLUDES Center Summit: Broadening Participation through Center-Scale Research Activities" in January 2018.

NSF BIG IDEAS

- *Future of Work at the Human-Technology Frontier* has four goals: (1) to understand and build human-technology partnerships, (2) to design new technologies to augment human performance, (3) to illuminate the emerging socio-technical landscape, and (4) to foster lifelong and pervasive learning. The effort emphasizes thinking about design-use-impact feedback loops, convergent research and interdisciplinarity. Discussion by CEOSE members included: how technology could increase the participation of underrepresented groups; how broadening participation can be a core part of research rather than an add-on; the need for training or guidance in convergence research; the need to help people understand the pros and cons of advances in technology, especially in the workplace; and the need to create humane workplaces.

- *Navigating the New Arctic* focuses on problems of climate change experienced in the Arctic, emphasizing the valuable knowledge that indigenous residents of the Arctic can contribute to the STEM enterprise. Changes in the Arctic affect the everyday lives not of scientists, but of residents

of Arctic communities. Motivated by this presentation, CEOSE members discussed defining and addressing these and similar problems through problem-driven implementation research, conducted by a diverse and expanded community, as a strategy for both advancing knowledge and broadening participation. The discussions that followed led CEOSE to focus its 2017-2018 report on inclusion of diverse community voices as a particularly promising strategy to significantly increase participation in STEM by women, underrepresented minorities and persons with disabilities throughout the school system and across communities.[31] Importantly, the approach highlighted by *Navigating the New Arctic* places broadening participation as part-and-parcel of the research enterprise since including diverse community voices is necessary to help solve highly complex, real-world problems with general implications and theoretical significance.

- Other Big Ideas briefings included the overview and progress of the 2018 launch of "NSF 2026 Idea Machine," a prize competition for the next set of Big ideas for future investment; the details of the *Dear Colleague Letter: Mid-Scale Research Infrastructure (Mid-scale RI) Opportunities* (NSF 19-013), designed to address the need for contemporary research infrastructure to support the advancement of S&E research, as well as STEM education research; and the update of the awards portfolio of *Growing Convergence Research* (23 awards in FY 2017 and seven in FY 2018) that integrates knowledge, methods and expertise from different disciplines and forms novel frameworks to catalyze scientific discovery and innovation.

BROADENING PARTICIPATION DATA AND ACCOUNTABILITY

Four presentations provided additional context for CEOSE's push for increased accountability for broadening participation. The presentation on the *2017 Women, Minorities, and Persons with Disabilities in Science and Engineering Digest* (NSF 17-310)[32] provided important trend data in five topical areas: enrollment, field of degree, occupation, employment status and early career doctorate holders. While there was an appreciation of data showing progress over time, CEOSE was concerned about fields with low participation of women and the decline in degree attainment for underrepresented racial/ethnic groups. For example, despite increases in the number of women earning degrees in physics, the proportion of women in physics is the lowest of all the physical sciences. Another concern is that while African Americans have increased their share of degrees in psychology, social sciences and biological sciences, there have been notable declines in mathematics and statistics.

The Chicago Alliance For Equity in Computer Science (CAFECS) ensures that all Chicago Pubic School students have access to inclusive, high-quality, introductory computer science education in high school. CAFECS provides sufficient support to teachers and holds all schools accountable for offering high-quality computer science across the entire district. CAFECS empowers at least 25,000 Chicago teens with the foundational practices of computer science. Woven into the ECS curriculum are activities that address ethical issues, critical analysis of data and connection with community, issues that all contribute to developing informed citizens of this increasingly digital society.

(CISE/CNS–1738572)

The presentation on the ADVANCE program, Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers,[33] provided evidence of the success of the program, using both quantitative and qualitative metrics. For example, over 75% of the funded Institutional Transformation awardees made policy changes at their institutions in the areas of recruitment, hiring, research support, tenure criteria, standards for promotion to full professor, and work-life balance. A 2012 ADVANCE program evaluation reported that from 2001 to 2008, accomplishments included a 40% increase in new STEM hires of women and a 64% increase in women in STEM leadership. A few exemplary projects were highlighted, showing how ADVANCE institutions are held accountable for equitable STEM structures, utilization of research-based inclusive practices, and a STEM culture that supports a diverse STEM academic workforce.

NSF is supporting the STEM Equity Achievement project, or SEA (STEM Equity Achievement) Change. Developed by the American Association for the Advancement of Science, SEA Change is a "LEED-like" certification for diversity and inclusion in STEM higher education.[34] SEA Change promotes an institutional self-assessment of mission, policies, structures, leadership, culture and institutional makeup in the context of institutional transformation for equity, diversity and inclusion. The self-assessment process fosters awareness, understanding, action and reflection by having institutions undertake the following steps: (1) collect data, (2) critically analyze data, (3) use data to identify problem areas and understand why they're problematic, (4) develop a five-year action plan to address problem areas, and (5) show progress over time. Criteria have been established for recognition at the bronze, silver and gold levels of certification. CEOSE is very supportive of this innovative effort, which is highly responsive to CEOSE's suggested practices for demonstrating broadening participation accountability at the institutional level.

The learning agenda presentation outlined how NSF INCLUDES has become a case study for implementation of a performance improvement model. A learning agenda is defined as a set of broad questions directly related to the work an agency conducts that, when answered, enables the agency to work more effectively and efficiently. NSF has been engaging the NSF INCLUDES community in the following learning agenda actions: (1) identify stakeholders, (2) identify and prioritize questions, (3) develop a plan to answer questions, (4) implement a plan to answer questions, and (5) disseminate and use findings.

SEXUAL HARASSMENT

CEOSE received a briefing from the National Academy of Science, Engineering, and Medicine (NASEM) on the recent study "Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Science, Engineering, and Medicine."[35] Dr. Marcia McNutt, President of NAS, described the magnitude of the problem and the need for meaningful change. The report noted that changes in climate and culture can reduce, deter and address harassment. CEOSE was particularly interested in the findings that sexual harassment undermines research integrity, reduces the talent pool, and is disproportionately experienced by women of color and sexual- and gender-minority people.

The recommendations emphasized the importance of addressing gender harassment as the most common form of sexual harassment; moving beyond legal compliance to address culture and climate; and creating diverse, inclusive and respectful environments. CEOSE members were especially interested in the following three recommendations: (1) diffuse the hierarchical and dependent relationship between trainees and faculty, (2) improve transparency and accountability, and (3) make the entire academic community responsible for reducing and preventing sexual harassment.

The NSF Office of Diversity and Inclusion (ODI) and the NSF Policy Office provided an overview of Title IX and specific details about NSF's new terms and conditions to address sexual misconduct in its awardee community (described in Section 2, pages 10-11). In particular, the NSF Director stressed the commitment of NSF to ensuring the safety and security of the people its awards support.

DISCUSSIONS WITH NSF LEADERSHIP

At each meeting, CEOSE stressed the key role that broadening participation plays in strengthening the research enterprise and generating the diversity of ideas that innovative science requires. The committee emphasized the need to integrate broadening participation and accountability into all of NSF's Big Ideas.

Other areas discussed included updates of broadening participation activities in the NSF directorates and offices, such as:

- The Directorate for Biological Sciences' (BIO) effort to document evidence of broadening participation within the Research Experiences for Undergraduates (REU) program and updating the broadening participation brochure to include links to accountability resources for the BIO community.
- CISE's emphasis that broadening participation is an expected component of its research and education awards portfolios, including an expectation of reporting on broadening participation activities in annual reports.
- EHR's plans to collect comparable data to strengthen the capacity for broadening participation learning at the program, division and directorate levels and the request for all of EHR's programs to find ways to connect to NSF INCLUDES.
- The Directorate for Engineering's convening of project teams in the RED program (Revolutionizing Engineering and computer science Departments) focusing on revolutionizing training and preparation of a diverse engineering workforce and making available case studies and models for change.
- GEO's work related to countering implicit biases and cultural barriers in order to promote more diversity and inclusion in fieldwork.
- The Directorate for Mathematical and Physical Sciences' (MPS) internal assessment of broadening participation issues in the mathematical and physical sciences and its broadening participation working group to discuss and share best practices across MPS programs.
- The Office of Integrative Activities' call for grand challenge questions for future research via the "NSF 2026 Idea Machine."[36]
- ODI's new sexual harassment Federal Register Notice and upcoming roundtable.
- The Office of International Science and Engineering's plans for a broadening participation track within its International Research Experiences for Students program and a workshop focused on using international research experiences to recruit and retain diverse populations in S&E.
- The Directorate for Social, Behavioral and Economic Sciences' investment to convert a research activity to a program to further the development of the science of broadening participation by supporting projects that advance the understanding of barriers that hinder diversity in STEM fields and/or the factors that enhance broadening participation.

Researchers at Gallaudet University's Visual Language and Visual Learning Science of Learning Center (VL2) have developed story book apps in American Sign Language (ASL). The apps include English translations and ASL dictionaries that allow deaf and hard-of-hearing children and their parents to read and learn together. The apps are also used by daycares and preschools to provide fun and engaging opportunities for children to improve their language learning whether deaf or hearing. Young and emerging deaf readers can watch stories in ASL or start reading it in English. At any point throughout the story in English, children can tap the screen to watch that part of the story in ASL. Children can also touch specific English words to see them finger-spelled, as well as being signed in ASL. Research suggests that visual language learning early in childhood leads to many cognitive and social benefits later. VL2 story apps can be downloaded from the Apple App Store.

(SBE/SMA–0541953)

The NSF Director expressed deep appreciation for the CEOSE biennial reports. She commented that the 2015-2016 report is consistent with the foundational framework of NSF's mission and accountability requirements. She encouraged CEOSE to work closely with NSF to operationalize the recommendations and suggestions outlined in the 2015-2016 report, underscoring that it will take time to design and implement a shared accountability framework at the agency level.

CEOSE shared with the NSF Director that the next CEOSE report will focus on community engagement in science and noted that researchers need to better understand broadening participation barriers and challenges so that they can successfully interact with underserved or underrepresented communities. CEOSE stressed that inclusive science leads to better science. CEOSE member Nancy Cantor noted that problem-solving teams should be interdisciplinary, cross-generational and cross-gender. "Diverse cognitive complexity on a team leads to better solutions. Inclusive, deeply respectful community-based science creates the next generation in a much broader way and may be a tool for broadening participation," said Cantor.

DISTRIBUTION OF & REACTIONS TO THE 2015-2016 CEOSE REPORT

Over 130 STEM organizations received full copies of the 2015-2016 CEOSE report. The report was also distributed to NSF advisory committees and in several instances was the source of presentations given by the CEOSE liaisons to the NSF advisory committees. CEOSE also prepared a letter to accompany a report summary for broad dissemination to, for example, former CEOSE members, organizations such as the Association of Public and Land-grant Universities, Pennsylvania State University's Dean and Executive Directors, the National Organization of Research Development Professionals, and many others. The response from the field has been positive, including several recent proposals that reference the *CEOSE 2015-2016 Biennial Report to Congress*. (See Appendix E)

Three levels of shared accountability for broadening participation were emphasized in the previous report: the project level, the institutional level and the agency level. There is evidence that NSF is providing leadership and support, such that the recommendation for shared accountability can be addressed at all levels; for example, as implemented in NSF INCLUDES (e.g., the requirement and merit review of project level evaluation plans; institutional acceptance of agency accountability policies and compliance with data reporting requirements; NSF-funded developmental evaluation as well as evaluation capacity building efforts for PIs, evaluators and STEM leaders/practitioners; PI engagement with the technical assistance provider and the coordination hub for developing metrics and sharing assessment tools and promising/proven broadening participation practices; guidance for PIs for project reports submitted to and approved by NSF; periodic internal and external portfolio reviews; and the agency's annual NSF INCLUDES Report to the Nation). The foundation's actions related to the suggested practices that CEOSE outlined for "NSF's Role in Ensuring Accountability" can be found in Appendix F.

The Teaching Through Technologies (T3) Alliance engages precollege students from underrepresented minority groups in after-school and intensive summer programs to teach them three emerging technologies – Raspberry Pi coding, 3D printers and autonomous systems (air, land and water). T3 is a hands-on curriculum led by the University of Alaska Fairbanks in close partnerships with the Council for Opportunities in Education, Educating4Leadership and Thrive Design Enterprises programs across the country supporting these technologies through curriculum adoption, growth mindset and design thinking. Using these newly acquired technologies and processing skills, the students identify and design a solution to a community issue.

(OIA/EPSCoR–1740991)

IV. CEOSE RECOMMENDATION & PLANS FOR THE FUTURE — INVESTING IN DIVERSE COMMUNITY VOICES

AN INNOVATIVE STRATEGY FOR ADVANCING KNOWLEDGE AND BROADENING PARTICIPATION

It's funny what's happened to this word knowing…The actual act of apprehending, of making sense, of pulling together, from what you have, the significance of where you are – this [now] oddly lacks any really reliable, commonly used verb in our language…[one] meaning the activity of knowing…[Yet], every culture has not only its own set body of knowledge, but its own ways of [knowing].

-Sir Geoffrey Vickers

An inclusive epistemology that involves the knowledge possessed "on the ground" by community members is required for the effective solution of locally manifested universal problems. This epistemology expands the definition of expertise and knowing to include other voices — those that are not necessarily steeped in professional credentials or academic knowledge, but in lived experience of the conditions and actualities under examination. What is called for is a movement away from a narrow definition of "expert" to a community of experts, a broadening of context to include indigenous place-based knowledge.[37] Community members with that knowledge must also be actively involved when the problem is defined and remain involved through the development and implementation of solutions.[38]

In describing the set of assumptions involved in participatory action research, a form of research particularly appropriate for place-based academic community partnerships, William Foote Whyte, in "Action Research for the 21st Century: Participation, Reflection, and Practice," argues that "the standard model does not represent the one and only way to advance scientific knowledge." Instead, he encourages a "research strategy that maximizes the possibility of encountering creative surprises [which] are most likely to occur if we get out of our academic morass and seek to work with practitioners whose knowledge and experience is quite different from our own."[39] Furthermore, there is a significant difference between researching as a detached observer versus as an active participant, whose work genuinely matters to the local population. As participants, researchers are much more likely to develop trusting relationships with community members, which is a requisite for having access to insider knowledge.[40]

Creative surprises are not the only benefit that results from inclusion of community voices in research. Engaging underrepresented populations to solve meaningful, community-identified scientific problems is a promising strategy to engage those populations in STEM. The Government Performance and Results Act (GPRA) advisory committee came to that conclusion in its 2009 report, which specifically highlights projects demonstrating that "students, particularly those from underrepresented populations in STEM, are more attracted to, and retained in, STEM if their studies and research have social meaning and real, immediate impact."[41] This idea has roots in John Dewey's

theories of learning and instrumental intelligence that are outlined in his book *How We Think*[42] and resonates with more recent literature on the relationship of relevance to motivation and student learning. Educator and philosopher Paulo Freire's work on adult education also supports this practice as well.[43]

The GPRA advisory committee also supports a P-20+ systemic approach to STEM education, wherein an integrated research team includes prekindergarten through 12th-grade students and teachers working with university faculty and college students (and other partners as needed) in a research-based inquiry. Such inclusive teams are improving both teaching and learning across all levels of education, exposing students to career paths they may not have thought possible. The advisory committee specifically highlights the value of combining a P-20+ approach with a research project and a place-based community focus: "Connecting a major research project with a highly successful community program and outreach efforts to school children is extraordinarily innovative, creative and significant."[44]

Although involving diverse community voices in research projects, especially place-based research projects, has numerous benefits, including serving as a means for increasing broadening participation of underrepresented groups in STEM and improving S&E, it is not easy to do. It requires performing research differently and rejecting the assumption that applied and theoretical research should be distinct. Understanding that application and theory are interconnected and mutually enhancing in place-based, problem-solving projects, such as *Navigating the New Arctic*, is fundamental. This integrative approach can be usefully described as "implementation research."

Implementation research, as stated, involves the integration of theory and practice.[45] The primary test of the effectiveness of place-based implementation research is whether it contributes to the solution of locally manifested universal problems, such as poor schooling, educational attainment gaps, eroding environments, inadequate health care, poverty and high levels of economic inequality. This approach assumes that human beings "learn by doing," and from and through implementation. It also assumes that research designed to realize large societal goals through developing and implementing programs on the ground with community partners, refining these programs, and engaging in an iterative process leads to significant learning, high-level theoretical advances, rigorous and replicable methodologies, and improved practices. The core rationale for implementation research is perhaps best expressed in a well-known maxim attributed to psychologist Kurt Lewin: "If you want to truly understand something, try to change it."

The mission of the BioBus initiative is to help minority, female and low-income K-12 and college students in New York City discover, explore and pursue science. The BioBus brings top-tier science education to the doorstep of students, with a focus on under-resourced and high-poverty communities. Equipped with over $100K in research-grade microscopes and a troop of Ph.D. scientists, the BioBus has completed over 1,000 active teaching days, worked with over 150,000 students and engaged over 500 schools and community organizations. Through this work, BioBus has made a marked difference in the lives of students, parents and educators, bringing enthusiasm for discovery, heightened academic engagement and increased interest in STEM career paths. Survey results and conversations with parents confirm that many students experience a dramatic positive shift in their attitudes towards science as a result of participating in BioBase courses.

(BIO–0086392)

Active Societal Participation In Research and Education (ASPIRE) cultivates a generation of geoscientists with the leadership knowledge and skills to reframe the geosciences as socially relevant and thereby broaden participation in these fields. This generation of geoscientists will do so by using place-based science as a vehicle to bridge long-standing divides that impede access to and inclusion in the geosciences. To bring about change, the project draws upon, refines and institutionalizes the working group model as the Mobile Working Group (MWG), directly referencing the need to move outside of the "ivory tower" and into the community. Led by a geoscientist with one foot in the academy and the other in the community - the Gate-opener - each MWG focuses on a single issue linked to a single community. ASPIRE supports multiple MWGs working across the geographic, ethnographic and "in practice" community space, as well as across the body of geoscience research and application.

(GEO/AGS–1645515)

Identifying populations to engage in implementation research vary based on the problem space to be considered. Research on climate science, variability and change has long embraced the practice of engaging stakeholders in the co-production of knowledge around the changing environment. Dr. Alison Meadow and her colleagues[46] provide a review of co-production practices, including Stephen Biggs's resource synthesis[47] discussing modes of stakeholder engagement, and devise a more extensive set of approaches to collaboration with stakeholders with guidance for researchers and required resources. For investigators new to the idea of implementation research or co-production of knowledge, these works represent an accessible approach that easily translates beyond climate science.

Fundamentally, regardless of whether these engagement practices are called participatory action research, co-production of knowledge, place-based knowledge or implementation research, the practices include an integrated collaborative approach to the production of new knowledge and solutions. At the time of this report, NSF has just released a new solicitation for the Engineering Research Centers (ERC). In this fourth generation of ERCs, emphasis is placed on *Convergent Research and Innovation through Inclusive Partnerships and Workforce Development.*[48] From the solicitation:

> "Convergent research approaches require the deep integration of knowledge, tools, and ways of thinking beyond engineering (for example, from the physical, mathematical, life/health sciences, computational sciences and social sciences, among others). Purposeful team formation is needed for the convergent approach, supported by diversity and a culture of inclusion where all participants are recognized and derive mutual benefits. The convergent approach supports the strong societal impact expected of each ERC."

ERC teams, responding to the requirement for convergent research approaches, could include community partners while crafting the "integrated, holistic ERC vision and strategic plan." In fact, throughout the ERC program model, there are many opportunities to include community experts and voices from outside of traditional STEM research expertise. CEOSE members recognize the opportunities provided by programs like the new ERC. Equally important is the ability of NSF program staff, reviewers and applicants to notice that these programs enable innovative approaches to implementation research and inclusion of perspectives from underrepresented groups.

RECOMMENDATION

To advance knowledge and broaden participation, CEOSE proposes developing and implementing a recursive, iterative approach that is based on the following propositions:

1. Significant societal problems cannot be solved without the unfettered full inclusion of underrepresented populations.

2. Full inclusion, in turn, will result in better, more innovative and transformative S&E, as well as a better, more decent and just society.

3. Developing community-based research initiatives that are carried out with community members with a focus on local scientific problems is a promising strategy to help achieve the interrelated goals of full inclusion, better S&E and a better society.

Based on the above propositions, CEOSE calls on NSF to increase support for place-based implementation research projects that are grounded in and engage local communities. **CEOSE recommends that NSF give increased attention to including diverse community voices across its research and education portfolios through community-driven projects.** Such portfolios could, for example, emphasize community-driven and community-led projects, projects in which community members are PIs and Co-PIs, and projects in which community members and stakeholders are critical knowledge- and relationship-brokers across a network of project contributors. NSF is well positioned to support the implementation of this recommendation that involves multiple partners along the entire P-20+ pathway. Doing so will result in broader participation and better S&E.

FUTURE PLANS

In the future, CEOSE will continue to work with NSF to integrate the community-driven/community-based broadening participation strategy within the design and implementation of NSF's Big Ideas. Also, CEOSE will continue to provide advice/suggestions on how best to address accountability challenges in the NSF INCLUDES portfolio (e.g., qualitative approach to diversity, equity and inclusion for the assessment of impact), and how to advance broadening participation in the context of emerging research practices that value broadening participation for better science. In future CEOSE discussions and activities, more attention will be given to the themes of inclusion and intersectionality; effective policy development and implementation for increasing STEM employment of individuals with disabilities; and the robust engagement of minority-serving institutions in groundbreaking research.

END NOTES

1. NSF, *FY 2020 Budget Request to Congress*, https://nsf.gov/about/budget/fy2020/pdf/13_fy2020.pdf.

2. NSF, *GEO Opportunities for Leadership in Diversity (GOLD) Program Solicitation*, NSF 16-516, https://www.nsf.gov/pubs/2016/nsf16516/nsf16516.htm.

3. NSF, *Dear Colleague Letter: Pursuing Meaningful Actions in Support of Broadening Participation in Computing (BPC)*, NSF 17-110, https://www.nsf.gov/pubs/2017/nsf17110/nsf17110.jsp.

4. NSF, I*mproving Undergraduate STEM Education: Hispanic-Serving Institutions Program Solicitation*, NSF 18-524, https://www.nsf.gov/pubs/2018/nsf18524/nsf18524.htm.

5. NSF INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science), https://www.nsf.gov/news/special_reports/nsfincludes/index.jsp.

6. *Broadening Participation in America's STEM Workforce: CEOSE 2011-2012 Biennial Report to Congress*, pg. 21.

7. *Broadening Participation in STEM: CEOSE 2013-2014 Biennial Report to Congress*, pg. 1.

8. *Accountability for Broadening Participation in STEM: CEOSE 2015-2016 Biennial Report to Congress*, pg. 24.

9. David B. Spencer and Sharon Dawes, *Report of the Advisory Committee for GPRA Performance Assessment FY 2009*, NSF 09-068 (Arlington, VA: National Science Foundation, 2009), https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf09068.

10. Committee on Equal Opportunities in Science and Engineering, *2011-2012 Biennial Report to Congress: Broadening Participation in America's STEM Workforce* (Arlington, VA: National Science Foundation, 2013).

11. Patricia Gurin, Jeffrey S. Lehman, and Earl Lewis, with Eric L. Dey, Gerald Gurin, and Sylvia Hurtado, *Defending Diversity: Affirmative Action at the University of Michigan* (University of Michigan Press, 2004): 97-188, https://www.press.umich.edu/pdf/0472113070-ch3.pdf.

12. Scott E. Page, "Diversity Powers Innovation," Center for American Progress (Published January 26, 2007, http://www.americanprogress.org/issues/economy/news/2007/01/26/2523/diversity-powers-innovation/.

13. NSF, Broadening Participation website, https://www.nsf.gov/od/broadeningparticipation/bp.jsp.

14. NSF, Important Notice No. 144: Harassment, https://nsf.gov/pubs/issuances/in144.jsp.

15. NSF, Office of Diversity and Inclusion, Sexual Harassment webpage, https://www.nsf.gov/od/odi/harassment.jsp.

16. NSF, *Building the Future-Investing in Discovery and Innovation: NSF Strategic Plan for Fiscal Years (FY) 2018-2022*, https://www.nsf.gov/pubs/2018/nsf18045/nsf18045.pdf.

17. NSF, Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2016, NSB 2017-26, https://www.nsf.gov/nsb/publications/2017/nsb201726.pdf.

18. NSF, Broadening Participation website, www.nsf.gov/od/broadeningparticipation/bp.jsp.

19. NSF, section "NSF Programs to Broaden Participation FY 2020 Budget Request to Congress" from *NSF FY 2020 Budget Request*, www.nsf.gov/about/budget/fy2020/pdf/13_fy2020.pdf.

20. NSF, *NSF Strategic Plan for Fiscal Years (FY) 2018-2022*, www.nsf.gov/about/performance/strategic_plan.jsp.

21. NSF, *Dear Colleague Letter: Announcement of an Effort to Expand the NSF INCLUDES National Network*, NSF 17-111, https://www.nsf.gov/pubs/2017/nsf17111/nsf17111.jsp.

22. https://www.nsf.gov/pubs/2018/nsf18529/nsf18529.htm.

23. NSF, *Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES) Program Solicitation*, NSF 18-529, https://www.includesnetwork.org/home.

24. NSF INCLUDES Special Report, www.nsf.gov/news/special_reports/nsfincludes.

25. https://www.nsf.gov/cise/oad/cise_bp.jsp

26. NSF, *GEO Opportunities for Leadership in Diversity (GOLD) program solicitation*, NSF 16-516, https://www.nsf.gov/pubs/2016/nsf16516/nsf16516.htm

27. NSF, *Dear Colleague Letter: Improving Undergraduate STEM Education in Hispanic Serving Institutions*, NSF 17-092, www.nsf.gov/pubs/2017/nsf17092/nsf17092.jsp.

28. NSF, *Improving Undergraduate STEM Education: Hispanic-Serving Institutions program solicitation*, NSF 18-524, www.nsf.gov/pubs/2018/nsf18524/nsf18524.htm.

29. NSF, *Historically Black Colleges and Universities Undergraduate Program solicitation*, NSF 18-522, www.nsf.gov/publications/pub_summ.jsp?WT.z_pims_id=5481&ods_key=nsf18522.

30. NSF's 10 Big Ideas Special Report, www.nsf.gov/news/special_reports/big_ideas/.

31. CEOSE, NSF, *February 9 - 10, 2017 Meeting Minutes* (Accessed May 1, 2018), www.nsf.gov/od/oia/activities/ceose/minutes/CEOSE_MeetingMinutes_Feb2017_Final.pdf.

32. NSF, *Women, Minorities, and Persons with Disabilities in Science and Engineering*, NSF 17-310, www.nsf.gov/statistics/2017/nsf17310/.

33. NSF, ADVANCE program brochure, NSF 17-70, www.nsf.gov/ehr/Materials/ADVANCEBrochure.pdf.

34. AAAS, "SEA Change Program Aims to Transform Diversity Efforts in STEM" (news release), www.aaas.org/news/sea-change-program-aims-transform-diversity-efforts-stem.

35. NASEM, *Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine*, www.nap.edu/read/24994/chapter/1.

36. NSF 2026 Idea Machine website, www.nsf.gov/ideamachine.

37. Nancy Cantor and Peter Englot, "Beyond the 'Ivory Tower': Restoring the Balance of Private and Public Purposes of General Education," *The Journal of General Education: A Curricular Commons of the Humanities and Sciences* 62, no. 2-3 (2013): 121.

38. William F. Whyte, Davydd J. Greenwood, and Peter Lazes, "Participatory Action Research: Through Practice to Science in Social Research," in "Action Research for the 21st Century: Participation, Reflection, and Practice," ed. William F. Whyte, special issue of *American Behavioral Scientist* 32, no. 5 (May 1989): 513-551.

39. William F. Whyte, "Advancing Scientific Knowledge through Participatory Action Research," *Sociological Forum* 4, no. 3 (September 1989): 383-384.

40. Eugene J. Webb, Donald T. Campbell, Richard D. Schwartz, and Lee Sechrest, *Unobtrusive Measures: Revised Edition* (Thousand Oaks, CA: Sage Publications, 2000).

41. Spencer and Dawes, *Report of the Advisory Committee for GPRA Performance Assessment FY 2009*, 31.

42. John Dewey, *The Child and the Curriculum* (University of Chicago Press, 1902); John Dewey, *The School and Society*, (University of Chicago Press, 1900); John Dewey, *How We Think* (Lexington, MA: D.C. Heath, 1910/rev. ed., 1933); Jeffrey R. Albrecht and Stuart A. Karabenick, "Relevance for Learning and Motivation in Education," *The Journal of Experimental Education* 86, Issue 1 (2018)

43. Paulo Freire, *Pedagogy of the Oppressed* (New York: Herder and Herder, 1972).

44. Spencer and Dawes, *Report of the Advisory Committee for GPRA Performance Assessment FY 2009*, 35.

45. The intellectual benefit of integrating theory and practice is succinctly captured by Paul Lazarsfeld and Jeffrey Reitz in *An Introduction to Applied Sociology* (New York: Elsevier Publishing, Co., 1975), 10: "Nothing is more conducive to innovation in social theory than collaboration on a complex practical problem."

46. Alison M. Meadow, Daniel B. Ferguson, Zack Guido, Alexandra Horangic and Gigi Owen, "Moving Toward the Deliberate Coproduction of Climate Science Knowledge," Weather, Climate and Society (2015), 7(2), 179-191. https://journals.ametsoc.org/doi/full/10.1175/WCAS-D-14-00050.1

47. Stephen D. Biggs, *Poor Farmer Participation in Research: A Synthesis of Experiences from Nine National Agricultural Research Systems*, International Service for National Agricultural Research (1989) http://ebrary.ifpri.org/cdm/ref/collection/p15738coll11/id/92

48. Gen-4 Engineering Research Centers (ERC) (NSF 19-503), https://www.nsf.gov/pubs/2019/nsf19503/nsf19503.htm

APPENDICES

A-F

APPENDIX A

NSF MERIT REVIEW PROCESS

TABLE 1 | Competitively Reviewed Proposals, Awards and Success Rates by PI Type[1]

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All PIs	Proposal	42,352	44,577	44,428	45,181	55,542	51,562	48,613	48,999	48,051	49,620	49,285
	Awards	10,425	11,463	11,149	14,595	12,996	11,192	11,524	10,829	10,958	12,007	11,877
	Funding Rate	25%	26%	25%	32%	23%	22%	24%	22%	23%	24%	24%
Female PIs	Proposal	8,510	9,197	9,431	9,727	11,903	11,488	10,795	11,152	11,142	11,444	11,598
	Awards	2,233	2,493	2,556	3,297	2,982	2,602	2,775	2,556	2,669	3,007	3,032
	Funding Rate	26%	27%	27%	34%	25%	23%	26%	23%	24%	26%	26%
Male PIs	Proposal	31,482	32,650	32,074	32,091	38,695	35,211	32,932	32,866	31,625	32,411	31,528
	Awards	7,765	8,451	7,986	10,437	9,080	7,739	7,816	7,316	7,286	7,810	7,512
	Funding Rate	25%	26%	25%	33%	23%	22%	24%	22%	23%	24%	24%
PIs from Under-represented Racial or Ethnic Groups	Proposal	2,608	2,798	2,762	2,945	3,613	3,441	3,291	3,303	3,268	3,383	3,331
	Awards	638	713	670	889	812	735	718	651	681	788	778
	Funding Rate	24%	25%	24%	30%	22%	21%	22%	20%	21%	23%	23%
New PIs[2]	Proposal	15,877	16,445	16,483	16,840	21,545	19,238	17,943	17,635	17,405	18,276	18,348
	Awards	2,842	3,151	3,132	4,174	3,620	2,976	3,063	3,013	3,108	3,320	3,510
	Funding Rate	18%	19%	19%	25%	17%	15%	17%	17%	18%	18%	19%
Prior PIs	Proposal	26,172	27,660	27,424	28,341	33,997	32,324	30,670	31,364	30,646	31,344	30,937
	Awards	7,475	8,202	7,892	10,421	9,376	8,216	8,461	7,816	7,850	8,687	8,367
	Funding Rate	29%	30%	29%	37%	28%	25%	28%	25%	26%	28%	27%
PIs with Disabilities	Proposal	434	434	448	470	545	543	483	488	468	562	496
	Awards	107	107	109	149	108	107	134	122	99	120	110
	Funding Rate	25%	25%	24%	32%	20%	20%	28%	25%	21%	21%	22%

Source: NSF Enterprise Information System, 10/01/16 and 11/02/16.

[1] Some of the awards in FY 2009 and FY 2010 were funded with a special appropriation made under the American Recovery and Reinvestment Act (ARRA). See the FY 2015 Merit Review Report for additional details.

[2] In FY 2009, in conjunction with NSF's implementation of the ARRA, NSF revised its definition of a new PI: "A new PI is an individual who has not served as the PI or Co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or post-doctoral fellowships, research planning grants, or conferences, symposia and workshop grants)." This definition is used here. Previously, a new PI was considered to be any individual who had not previously been a PI on any NSF award.

TABLE 2 | Competitively Reviewed Proposals, Awards and Success Rates, by PI Race and Ethnicity[1]

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
American Indian/ Alaska Native	Proposals	112	97	91	88	118	129	83	113	103	104	99
	Total Awards	32	32	23	29	28	36	18	28	36	25	29
	Omnibus				20	28						
	ARRA				9	0						
	Funding Rate	29%	33%	25%	33%	24%	28%	22%	25%	35%	24%	29%
Black/ African American	Proposals	915	1,034	997	1,022	1,280	1,201	1,154	1,124	1,123	1,102	1,134
	Total Awards	201	240	246	298	270	243	263	203	204	233	264
	Omnibus				233	262						
	ARRA				65	8						
	Funding Rate	22%	23%	25%	29%	21%	20%	23%	18%	18%	21%	23%
Native Hawaiian/ Pacific Islander	Proposals	28	26	30	23	38	42	40	32	30	30	41
	Total Awards	9	6	8	8	10	11	6	5	5	2	7
	Omnibus				5	8						
	ARRA				3	2						
	Funding Rate	32%	23%	27%	35%	26%	26%	15%	16%	17%	7%	17%
Asian	Proposals	7,916	8,801	8,952	9,550	11,626	10,829	10,382	10,511	10,538	11,148	11,623
	Total Awards	1,530	1,801	1,780	2,465	2,124	1,907	1,914	1,887	1,925	2,256	2,168
	Omnibus				1,691	2,071						
	ARRA				774	53						
	Funding Rate	19%	20%	20%	26%	18%	18%	18%	18%	18%	20%	19%
White	Proposals	29,861	30,676	30,217	29,975	36,153	33,200	30,596	30,766	29,624	30,099	29,031
	Total Awards	7,885	8,499	8,153	10,499	9,306	7,826	8,020	7,372	7,390	7,902	7,748
	Omnibus				7,144	8,958						
	ARRA				3,355	348						
	Funding Rate	26%	28%	27%	35%	26%	24%	26%	24%	25%	26%	27%
Multiracial	Proposals	301	279	284	337	512	433	448	439	425	495	508
	Total Awards	78	81	76	112	118	99	113	110	114	151	124
	Omnibus				80	112						
	ARRA				32	6						
	Funding Rate	26%	29%	27%	33%	23%	23%	25%	25%	27%	31%	24%
Hispanic or Latino	Proposals	1,525	1,639	1,611	1,755	2,092	2,019	1,934	1,956	1,921	2,053	1,950
	Total Awards	378	433	382	533	476	438	412	401	411	495	459
	Omnibus				373	465						
	ARRA				160	11						
	Funding Rate	25%	26%	24%	30%	23%	22%	21%	21%	21%	24%	24%

Source: NSF Enterprise Information System, 10/01/16.

[1] This table differs from a similar one included in reports for years up to FY 2011. Before FY 2012, individuals who identified a race and indicated that they were Hispanic or Latino were only counted in the Hispanic or Latino category. Beginning in FY 2012, such individuals are included in both the appropriate racial group and in Hispanic or Latino. Previously, except for those who were Hispanic or Latino, individuals who identified multiple races were not included in the table. A "multiracial" category has been added to the table.

APPENDIX B

NATIONAL SCIENCE FOUNDATION INCLUDES AWARDS DIRECTORY | FY2016-2018

PROGRAM OVERVIEW

In 2013, CEOSE recommended that NSF undertake a bold new initiative in broadening participation in STEM. In response, NSF established NSF INCLUDES, a comprehensive national initiative designed to enlarge the pool of innovators and thereby leverage the benefits of diversity in the U.S. population to make substantial improvements in the nation's leadership in STEM discovery and education.

Recognizing the opportunity for significant impact, NSF INCLUDES is situated as one of NSF's Ten Big Ideas for Future NSF Investments at the frontiers of science and engineering. As a Big Idea, NSF INCLUDES is investing in pilot projects and funding alliances and partnerships that use research-based, collaborative change strategies meant to unite a wide variety of partners to solve a common broadening participation problem.

To achieve national impact, NSF INCLUDES shifts away from single-project efforts and recognizes that complex problems are best addressed through collaborative approaches and shared resources among varying institutions, industry, professional societies and the scientific community at large.

FY 2016 COHORT 1 AWARDS: NSF INCLUDES DESIGN & DEVELOPMENT LAUNCH PILOTS (DDLPS)

1649082: *Indigenous Women Working Within the Sciences (IWWS)*, Northern Michigan University, MI; PI April Lindala.

1649095: *Project in Partnership with HBCUs and TCUs*, Quality Education for Minorities Network, DC; PI, Ivory A. Toldson.

1649142: *STEPs to STEM*, Princeton University, NJ; PI Jannette Carey.

1649161: *Alliance to Strengthen the STEM Tapestry (ASSisT): Motivating Critical Identity Shifts to Weave the STEM Disenfranchised into Science and the Sustainability Workforce*, University of Utah, UT; PI Nalini Nadkarni.

1649192: *A Networked Improvement Community for Broadening the Participation of Black and Latino Youth in Computational Careers*, New York Hall of Science, NY; PI Margaret Honey

1649199: *CIRTL INCLUDES - Toward an Alliance to Prepare a National Faculty for Broadening Success of Underrepresented 2-Year and 4-Year STEM Students*, University of Wisconsin-Madison, WI; Iowa State University, IA; University of Pittsburgh, PA; University of Texas at El Paso, TX; Michigan State University, MI; University of Georgia, GA; University of California-Los Angeles, CA; PI Robert D. Mathieu.

1649201: *Creating Academic Pathways in STEM (CAPS): A Model Ecosystem for Supporting Two-Year Transfer*, University of Colorado at Boulder, CO; PI Sarah M. Miller.

1649206: *Georgia STEPS (Science, Technology and Engineering Partners for Success)*, Wiregrass Georgia Technical College, GA; PI Shawn Utley.

1649210: *Coastal Almanac*, University of Washington, WA; Western Washington University, WA; Oregon State University, OR; PI Julia K. Parrish.

1649214: *A Collective Impact Approach to Broadening Participation in the STEM Professoriate*, Association of Public and Land-Grant Universities, DC; PI Howard J. Gobstein.

1649224: *WeC4Communites (We Compute for our Communities): Community-Focused Computing for Minoritized Youth*, University of Delaware, DE; PI Lori L. Pollock

1649226: *An Integrated Approach to Retain Underrepresented Minority Students in STEM Disciplines*, University of Georgia, GA; Florida International University, FL; Savannah State University, GA; Clark Atlanta University, GA; Fort Valley State University, GA; PI Suzanne E. Barbour.

1649228: *Redefining Potential: The Upstate NY Design and Development Pilot for Diverse Student Populations*, University of Rochester, NY; PI Beth Olivares.

1649231: *Early STEM Engagement for Minority Males through a Network of Minority Serving Institutions*, Morgan State University, MD; SRI International, CA; Jackson State University, MS; Kentucky State University, KY; North Carolina Agricultural & Technical State University, NC; PI Jumoke O. Ladeji-Osias.

1649240: *STEM^3: Scaling STEM^2*, California State University-Fullerton Foundation, CA; PI Mark S. Filowitz.

1649263: *Building Diverse and Integrative STEM Continua Using Socio-environmental Systems In and Out of Neighborhoods (DISCUSSION)*, North Carolina Agricultural & Technical State University, NC; North Carolina Central University, NC; PI Gregory D. Goins.

1649271: *Building upon CAHSI's Success to Establish a Networked Community for Broadening Participation of Hispanics in Graduate Studies*, University of Texas at El Paso, TX; PI Ann Q. Gates.

1649277: *Computing for All Levels & Learners (SF CALL)*, San Francisco State University, CA; PI Eric S. Hsu.

1649289: *A Program Designed to Recruit, Retain, and Train Hispanic Women in STEM Disciplines*, Randolph-Macon College, VA; PI April H. Marchetti.

1649296: *Northern New Mexico STEM Mentor Collective*, Northern New Mexico College, NM; PI Steven J. Cox.

1649297: *A National Network for Access and Inclusion in Physics Graduate Education*, American Physical Society, MD; PI Monica J. Plisch.

1649298: *A Community Centered Approach to Improving STEM Pathways for Underrepresented Students*, University of Illinois at Chicago, IL; PI Kimberly A. Lawless.

1649300: *Changing the Face of STEM in the U.S. Virgin Islands through Targeted Interventions to Expand Opportunities and Broaden Participation*, University of The Virgin Islands, VI; Southern Utah University, UT; Pennsylvania State University-University Park, PA; PI Kristin R. Wilson Grimes.

1649310: *Early Engagement in Research: Key to STEM Retention*, Columbia University, NY; PI Robert Newton.

1649312: *Mississippi Alliance for Women in Computing (MAWC)*, Mississippi State University, MS; PI Sarah B. Lee.

1649320: *Consortium of Minority Doctoral Scholars (CMDS)*, University of Florida, FL; University of Wisconsin-Madison, WI; PI Juan E. Gilbert.

1649323: *FIRST TWO: Improving STEM Persistence in the First Two Years of College - Associated Universities*, Inc/National Radio Astronomy Observatory, DC; PI Sue A. Heatherly.

1649338: *Integrating Indigenous and Western Knowledge to Transform Learning and Discovery in the Geosciences*, University Corporation for Atmospheric Research, CO; Michigan State University, MI; University of Arizona, AZ; PI Carolyn Brinkworth.

1649342: *Expanding STEM to INCLUDE the Bottom Quartile of the Nation's K-12 Graders Through the Teaching and Learning of Mathematics*, The Algebra Project, MA; PI Robert P. Moses.

1649344: *NSF INCLUDES: South East Alliance for Persons with Disabilities in STEM (SEAPD-STEM)*, Auburn University, AL; Alabama State University, AL; Tuskegee University, AL; Vanderbilt University, TN; PI Overtoun M. Jenda.

1649346: *Creating a Diverse STEM Pathway with Community Water Research*, University of Maine, ME; PI Mohamad T. Musavi.

1649355: *Increasing Degrees Awarded to African American, Hispanic,* Native American and Women Students in Engineering (50K Coalition), National Society of Black Engineers, VA; PI Karl Reid.

1649361: *UTAH PREP*, Utah Valley University, UT; PI Daniel Horns.

1649365: *WATCH US (Women Achieving Through Community Hubs) in the United States*, University of Nebraska-Lincoln, NE; PI Judy L. Walker.

1649367: *Engaging Local Communities in Geoscience Pathways*, Carleton College, MN; PI Cathryn A. Manduca.

1649377: *Supporting Women Advancing Through Technology*, University of California-Irvine, CA, PI Linda Christopher.

1649378: *Enhancing the New Mexico STEM Pipeline*, New Mexico State University, NM; PI Steven Stochaj.

1649380: *Bay Area Regional Collaboration to Expand and Strengthen STEM (RECESS)*, University of California-San Francisco, CA; PI Renee Navarro.

1649381: S*TEM Core Initiative*, Saddleback College, CA; PI Jim Zoval.

1649384: *LEVERAGE, Strengthening the ASSIST Collaborative to Illuminate Engineering Faculty Pathways*, Great Minds in STEM, CA; PI Anna M. Park.

FY2016 NSF INCLUDES CONFERENCES

1650289: *Envisioning Impact*, National Opinion Research Center, IL; TERC, MA; PI Kevin Brown.

1650390: *Conference on Multi-Scale Evaluation in STEM Education*, University of Tennessee Knoxville, TN; PI Louis J. Gross.

1650433: *NextLivesHere: Social Change Innovation Summit*, University of Cincinnati, OH; PI Kathie Maynard.

1650452: *Bridging Engineering Science and Technology (BEST)*, University of Akron, OH; PI Brian Davis.

1650490: *Accelerating Data-Driven Collaboration for Large-Scale Progress*, University of Missouri-Kansas City, MO; PI Alexis N. Petri.

1650508: *High-Leverage Problems, Useful Data*, Formative Evaluation, Effective Communication, SRI International, CA; PI Timothy Podkul.

1650509: *The Technical and Human Infrastructure to Support Collective Impact of the INCLUDES Program at the Alliance and Network Levels*, American Association for the Advancement of Science, DC; PI Shirley M. Malcom.

1650510: *Informing the Design of the INCLUDES Alliances and National Network: An Intersectionality Approach*, National Alliance for Partnership in Equity, PA; PI Mimi E. Lufkin.

1650516: *The Atlanta Backbone Organization Design Workshop: Computer Science Education Collective Impact Initiatives*, Georgia Department of Education, GA; PI Caitlin Dooley.

1650533: *Supporting a Collective Impact Approach from the Bottom Up*, The Algebra Project, MA, PI Robert P. Moses.

1650548: *Collective Impact as a Pathway to Reinvigorate Broadening Participation in STE*M, University of California-San Diego, CA; PI Kim E. Barrett.

1650570: *California STEM INCLUDES Conference and Network,* University of California-Irvine, CA; PI Michael B. Dennin.

1650575: *Conference to Advance the Collective Impact of Retention and Continuation Strategies for Hispanics and Other Underrepresented Minorities in STEM Fields*, University of California-Merced, CA; PI Marjorie S. Zatz.

FY 2017 COHORT 2 DDLPS & SPECIAL AWARDS

1744411: *Water Network for Team STEM (WaNTS)*, Pacific Resources for Education and Learning, HI; PI Ming Wei Koh.

1744431: *Aligning for Impact: Computer Science Pathways Across Contexts*, Georgia Department of Education, GA; PI Caitlin Dooley.

1744436: *Growing STEM engagement and participation in Native Pacific Islander Communities*, University of Guam, GU; PI John A. Peterson.

1744440: *Southeastern Compact for Inclusive Student Transitions in Engineering and Physical Sciences (SCI-STEPS)*, Vanderbilt University, TN; PI Keivan G. Stassun.

1744445: *BEST BET: Broadening Experiences in Scientific Training-Beginning Enhancement Track*, Boston University, MA; PI Linda Hyman.

1744446: *Diversifying Access to Urban Universities for Students in STEM Fields*, University of Pittsburgh, PA; PI Alison Slinskey Legg.

1744455: *American STEM Alliance Network Improvement Community*, American Institutes for Research in the Behavioral Sciences, DC; PI Melissa Dodson.

1744460: *Sustainability Teams Empower and Amplify Membership in STEM (S-TEAMS)*, Montclair State University, NJ; PI Amy R. Tuininga.

1744463: *Building on Strengths – A Design and Development Launch Pilot to Broaden Participation in Mathematics*, Iowa State University, IA; PI Michael Young.

1744467: *The Alabama Alliance for an Inclusive Middle Grades Computer Science Preparation through Makerspaces in the Alabama Black Belt Region*, Tuskegee University, AL; PI Shaik Jeelani.

1744472: *IM STEM, National Alliance for Partnerships in Equity*, PA; PI Mimi E. Lufkin.

1744474: *Indigenous Math Circles Communities*, Kansas State University, KS; PI David R. Auckly.

1744477: *EMERGE in STEM: Education for Minorities to Effectively Raise Graduation and Employment in STEM*, North Carolina Agricultural & Technical State University, NC; PI Gregory H. Monty.

1744479: *Capacity Building in Disaster Research for Scholars from Under-Represented Groups*, University of Nebraska at Omaha, NE; PI DeeDee Bennett.

1744483: *American Indian Traditional Science Experience*, University of Montana, MT; PI Aaron M. Thomas.

1744490: *Leadership and iSTEAM for Females in Elementary School (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM*, New Jersey Institute of Technology, NJ; PI Bruce G. Bukiet.

1744491: *Advanced Manufacturing Partnerships (AMP): Broadening Participation in New Hampshire's Workforce*, University of New Hampshire, NH; PI Palligarnai T. Vasudevan.

1744497: *Statewide Consortium: Supporting Underrepresented Populations in Precalculus by Organizational Redesign toward Engineering Diversity*, Clemson University, SC; PI Anand K. Gramopadhye.

1744499: *Diversifying Future Leadership in the Professoriate in Computing at Research Universities*, Texas A&M Engineering Experiment Station, TX; PI Valerie E. Taylor.

1744500: *Increasing Minority Presence within Academia through Continuous Training (IMPACT)*, Georgia Tech Applied Research Corporation, GA; PI Comas I. Haynes.

1744501: *Ecology Plus (Ecology+): Broadening Pathways to Ecological Careers Through a Collective Impact Approach*, Ecological Society of America, DC; PI Teresa M. Mourad.

1744502: *Expanding Diversity in Energy and Environmental Sustainability Through the Creation of Learning Opportunities for Minority Students in the Mid-Atlantic Region*, Delaware State University, DE; PI Aristides Marcano.

1744506: *Wabanaki Youth in Science (WaYS) Program to Bridge inclusion in Post-Secondary Education Through the Sciences*, University of Maine, ME; PI Darren Ranco.

1744523: *Project SYSTEMIC (A Systems-Thinking Approach to STEM Ecosystem Development in Chicago)*, Project Exploration, Chicago, IL; PI Natasha Smith-Walker.

1744524: *Building a Network for Education and Employment in Environmental Stewardship of Indigenous Lands*, University of Colorado at Denver, CO; PI Timberley M. Roane.

1744526: *SPICE (Supporting Pacific Indigenous Computing Excellence) Data Science Program for Native Hawaiians and Pacific Islanders*, University of Texas at Austin, TX; PI Kelly P. Gaither.

1744539: *Fostering Engineering Identity and Support Structures to Promote Entry and Persistence in Engineering for First-Generation Students*, Arizona State University, AZ; PI Kyle D. Squires.

1744541: *Math FACESS (Families & Communities Empowering Student Success in Mathematics)*, Explora, NM; PI Joseph L. Hastings.

1744543: *Sustaining Workforce Diversity in Emerging STEM Economies*, University of Nevada at Reno, NV; PI David K. Shintani.

1764404: *ACCEYSS: Association of Collaborative Communities Equipping Youth for STEM Success*, Texas State University, San Marcos, TX; PI Shetay Ashford.

1748345: *SPECIAL AWARD — The NSF INCLUDES Open Forum: A Platform for Collective Impact and Knowledge to Advance Broadening Participation in STEM*, American Association for the Advancement of Science, DC; PI Shirley M. Malcom.

FY 2018 AWARDS

Alliances

1834540, 1834528, 1834516, 1834545: *NSF INCLUDES Alliance: Inclusive Graduate Education Network*, American Physical Society, MD; PI Theodore Hodapp.

1834601, 1834569, 1834586, 1834575, 1834595: *NSF INCLUDES Alliance: Expanding the First2 STEM Success Network*, Associated Universities Inc/ National Radio Astronomy Observatory; PI Sue Heatherly.

1834518, 1834522, 1834526, 1834513, 1834510, 1834521: *NSF INCLUDES Alliance: National Alliance for Inclusive and Diverse STEM Faculty (NAIDSF)*, Association of Public and Land-Grant Universities, Washington DC; PI Howard Gobstein.

1834620: *NSF INCLUDES Alliance: Computing Alliance of Hispanic-Serving Institutions*, University of Texas at El Paso, TX; PI Ann Gates.

1834628, 1834608: *NSF INCLUDES Alliance: STEM Core Expansion*, Saddleback College, CA; PI Plum Zoval.

Coordination Hub

1818635: *NSF INCLUDES Coordination Hub*, SRI International, CA; PI Timothy Podkul.

EAGERS

1812428: *DCL: INCLUDES: Early Stage Empirical Research (EAGER): Data and the Future of an Empirically Grounded Research Community for Broadening Participation in STEM*, Arizona State University, AZ; PI Kimberly Scott.

1834978: *DCL: NSF INCLUDES EAGER: A Study of Online Scientific and Scholarly Communities for Broadening Participation in STEM*, Rochester Institute of Tech, NY; PI Lisa Elliot.

1835055: *DCL: NSF INCLUDES: Leveraging Field-Campaign Networks for Collaborative Change*, Colorado State University, CO; PI Emily Fischer.

1834897: *DCL: NSF INCLUDES: EAGER: Examining Collective Impact in a Community-University Partnership to Broaden Girls' Participation in Science from Middle School to High School Graduation*, University of Massachusetts Amherst, MA; PI Ezekiel Kimball.

Conferences

1812795: NSF INCLUDES Conference: A Convening on Community-Engaged Assessment, University of Cincinnati, OH; PI Kathie Maynard.

1812997: *DCL NSF INCLUDES: Bringing Conversations on Diversity and Inclusion in Data Science to the Ecological and Environmental Sciences*, Battelle Memorial Institute, OH; PI Alycia Crall.

1813017: *NSF INCLUDES Symposium for ADVANCING STEM Latin as in Academic Careers*, The University of Texas Rio Grande Valley, TX; PI Ala Qubbaj.

1834924: *AccessINCLUDES: Linking the knowledge and results of NSF disability-related projects and projects within the NSF INCLUDES National Network*, University of Washington, WA; PI Sheryl Burgstahler.

1835082: *DCL: NSF INCLUDES: A National Summit to Survey and Stimulate Broadening Participation Research at Historically Black and Tribal Colleges/Universities*, QUALITY EDUCATION FOR MINORITIES NETWORK, DC; PI Ivory Toldson.

Supplements

1813084: Collaborative Research: NRT-IGE: Deploying Holistic Admissions and Critical Support Structures to Increase Diversity and Retention of US Citizens in Physics Graduate Programs, Rochester Institute of Technology, NY; PI Casey Miller.

1835099: Management and Operations of the IceCube Neutrino Observatory 2016-2021, University of Wisconsin-Madison, WI; PI Francis Halzen.

1835100: American Institute of Mathematics Research Conference Center: A Model for Collaboration, American Institute of Mathematics, CA; PI J. Brian Conrey.

1835174: NSF Nanosystems Engineering Research Center for Nanotechnology Enabled Water Treatment Systems (NEWT), William Marsh Rice University, TX; PI Pedro Alveraz.

Co-Funding

1820984, 1820975, 1820971, 1820975, 1820974, 1820983: The AGEP Alliance State System Model to Transform the Hiring Practices and Career Success of Tenure Track Historically Underrepresented Minority Faculty in Biomedical Sciences, University of Maryland Baltimore County, MD; PI Renetta Tull.

1821083, 1820997, 1821005: *Collaborative Research: An AGEP Alliance Model to Advance Underrepresented Minority STEM Faculty at Predominately Undergraduate Institutions*, Stony Brook University, NY; PI Charles Taber.

1821298, 1821008, 1821019, 1821052: *Collaborative Research: The AGEP Engineering Alliance: A Model to Advance Historically Underrepresented Minority Postdoctoral Scholars and Early Career Faculty in Engineering*, Georgia Tech Research Corp, GA; PI Comas Haynes.

1826532, 1826543: *Collaborative Research: Florida-Caribbean Louis Stokes Regional Center of Excellence*, Santa Fe College, FL; PI Stefani Waschull.

1826735: *Collaborative Research: Louis Stokes Regional Center of Excellence: Broadening Participation of Underrepresented Students in STEM Education Using Nanotechnology*, Norfolk State University, VA; PI Michael Keeve.

1826755: *Louis Stokes Regional Centers of Excellence in Broadening Participation*, Fisk University, TN; PI Arnold Burger.

1826824: *Louis Stokes Regional Center of Excellence: LSAMP – NSF International Center of Excellence (NICE)*, Salish Kootenai College, MT; PI Steven Dupuis.

1826826: *Louis Stokes Regional Center of Excellence: Center for Promotion of Academic Careers through Motivational Opportunities to Develop Emerging Leaders in STEM (LS-PAC MODELS)*, Louisiana State University & A&M College, LA; PI Isiah Warner.

1840644: *NCWIT Participation in BPCNet (Broadening Participation in Computing Network)*, University of Colorado at Boulder, CO; PI Lucinda Sanders.

1841271: *EAGER: CRA-W Programs for Partnerships in the BPCnet Pilot*, Computing Research Association, DC; PI Margaret Martonosi

APPENDIX C

INFORMATION ON HSI PROGRAM AWARDED PROJECTS FY 2018

The Improving Undergraduate STEM Education: Hispanic-Serving Institutions (HSI) Program aims to enhance undergraduate STEM education and build capacity at HSIs. Projects supported by the HSI program will also generate new knowledge on how to achieve these aims. Complete project abstracts can be found at: https://www.nsf.gov/awardsearch.

RESOURCE HUB

1832338, 1832345: *NSF National Resource Hub for STEM Education at Hispanic-Serving Institutions*

This collaborative project at New Mexico State University, Dona Ana Community College and California State University, Northridge, will advance the aims of the HSI Program by establishing the NSF National Resource Hub for STEM Education at Hispanic-Serving Institutions. (PI Elba Serrano, New Mexico State University; PI Mariaelena Zavala, The University Corporation, Northridge)

TRACK 1: BUILDING CAPACITY

1832237: *The Dominican University STEM Success Model to Support Students through Critical Transitions*

This project will advance the goals of the HSI Program by implementing teaching and student support practices that can increase the success of undergraduates in early STEM courses. (PI Christopher Anderson, Dominican University)

1832282: *Institute for Interdisciplinary Science: Preparing Students for the 4th Industrial Revolution*

This project aims to create the Institute for Interdisciplinary Science. (PI Andrea Holgado, Saint Edward's University)

1832335: *STEM Faculty Professional Learning in the Zone of Proximal Development*

This project, a collaboration between California State University, Sacramento, and the University of California, Irvine, will support efforts to improve the teaching effectiveness of STEM faculty and to advance knowledge about strategies that lead to increased use of evidence-based and equity-minded teaching strategies. (PI Lynn Tashiro, University Enterprises, Incorporated)

1832348: *An Intervention to Improve Success of Biology Majors in Mathematics*

This project at Los Angeles Mission College will advance the aims of the HSI Program by developing a student-centered intervention to support the success of undergraduate biology students. (PI Parvaneh Mohammadian, Los Angeles Mission College)

1832357: *Guiding Critical Transitions to the Baccalaureate*

This project at Riverside City College will advance the aims of the HSI Program by developing and analyzing the impact of six interventions for Riverside College Promise Program students who have declared STEM majors. The interventions include a summer bridge program from high school to college, home courses, college and career workshops, research experiences, near-peer mentoring and cross-enrollment courses. (PI Virginia White, Riverside Community College District/Riverside City College)

1832388: *Transforming STEM Undergraduate Education through Academic Literacy, Mentoring, and Professional Development*

This project at the University of Texas at San Antonio will advance the aims of the HSI Program by developing new curricula and methods of instruction that increase student persistence and success. (PI Heather Shipley, University of Texas at San Antonio)

1832405: *Polytechnic for All: STEM Undergraduate Success via an Inclusive Institution*

This project at California State Polytechnic University, Pomona, will advance the aims of the HSI Program by developing and implementing a multifaceted approach to enhance student learning and success in STEM. (PI Paul Beardsley, Cal Poly Pomona Foundation, Inc.)

1832421: *Addressing Critical Transitions of First-Year STEM Students*

This project at Northeastern Illinois University, an HSI, aims to increase retention of students by engaging them in a supportive, research-based learning community called Agua en Comunidades Experimentales (ACE), which means Water in Research Communities. The ACE learning community will include social support, scientific training and research experiences relate`d to water science. (PI Laura Sanders, Northeastern Illinois University)

1832425: *Infusing Research as Pedagogy*

This project at Union County College will advance the aims of the HSI Program by integrating research into undergraduate STEM courses. The project plans to embed course-based undergraduate research experiences (CUREs) into STEM gateway courses, support independent research experiences during the academic year and develop a summer research academy. (PI Liesl Jones, Union County College)

1832436: *STEM Student Success from Two-year to Four-year Institutions through Classroom-Based Undergraduate Research Experiences*

This project will advance the aims of the HSI Program by adding course-based undergraduate research experiences (CUREs) to introductory algebra, biology and chemistry courses, which serve as gateways into STEM majors. The project is a collaboration between Miami Dade College, the largest two-year HSI in the nation; the University of Florida; and the University of Miami. (PI Pablo Sacasa, Miami Dade College)

1832446: *Engaging Stem Transformative Experiences for Early Momentum*

This project at Hartnell College will advance the aims of the HSI Program by creating transformative early experiences in STEM research that will help equip students to overcome obstacles to success in STEM programs. (PI Mohammed Yandi, Hartnell College)

1832450: *Catalyzing Change in Calculus*

This project at Florida International University will advance the aims of the HSI Program by increasing the success of students in calculus. Leveraging a partnership with Broward College, the project will implement Modeling Practices in Calculus, a student-centered curriculum in which students learn calculus by engaging in the authentic practices of mathematicians. (PI Laird Kramer, Florida International University)

1832457: *Enhancing Undergraduate STEM Education by Enhancing Transfer Success*

This project will advance the aims of the HSI Program by increasing the number of students from community colleges who transfer to four-year STEM programs and by accelerating their baccalaureate degree completion. The partners include the Borough of Manhattan Community College, Bronx Community College, Guttman Community College, Hostos Community College, Kingsborough Community College and LaGuardia Community College. (PI Pamela Brown, CUNY New York City College of Technology)

1832464: *STEM Transformative Experiences Project*

This project at Saint Peter's University will advance the aims of the HSI Program by providing 45 high-impact, off-campus internship experiences each year to low-income undergraduate students who are pursuing STEM degrees. (PI Jeanette Wilmanski, St Peter's University)

1832468, 1832427: *A Collaborative Undergraduate STEM Program in Resilient and Sustainable Infrastructure*

This project will advance the aims of the HSI Program by increasing the number of students who complete baccalaureate degrees in engineering or related degrees in resilient and sustainable infrastructure. This collaborative project between the University of Puerto Rico (UPR) Mayaguez, UPR Rio Piedras and UPR Ponce will develop an interdisciplinary Resilient Infrastructure and Sustainability Program to educate undergraduate STEM students in engineering and related skills needed to respond to natural disasters. (PI Carla Lopez del Puerto, University of Puerto Rico Mayaguez; PI Humberto Cavallin, University of Puerto Rico-Rio Piedras)

1832472: *Building Capacity of Women in STEM*

This project at Mount Saint Mary's University will advance the aims of the HSI Program by increasing retention in STEM and preparing students for research and other opportunities in STEM. (PI Jennifer Chotiner, Mount Saint Mary's University)

1832507: *A Faculty Development Program to Increase Students' Quantitative Reasoning Skills*

This project will advance the aims of the HSI Program by improving the ability of STEM faculty to teach quantitative reasoning skills to undergraduates. The project is a collaboration between three colleges in the City College of New York (CUNY) system: Lehman College, Baruch College and LaGuardia Community College. (PI Esther Wilder, CUNY Herbert H. Lehman College)

1832511: *Positive Learning Opportunities and Research Experiences to Promote Success in STEM*

This project at Saint Xavier University will advance the aims of the HSI Program by increasing retention and graduation rates of undergraduates in STEM fields. To this end, the project will create a STEM Studio that will provide students with ongoing community, social and academic supports. (PI Bindhu Alappat, Saint Xavier University)

1832523: *Transforming Undergraduate Education in STEM Through Culturally Relevant Pedagogy and Community Engagement*

This project at the University of Texas Rio Grande Valley will advance the aims of the HSI Program by increasing the retention and graduation of undergraduate students in science and mathematics. The project plans to achieve its goals by offering well-designed, high impact STEM courses that build upon culture, community engagement and regionally relevant research. (PI Alexis Racelis, The University of Texas Rio Grande Valley)

1832528: *Undergraduate STEM Transitions, Experiences, and Mobility*

This project at San Diego State University will advance the aims of the HSI Program by transforming the pathways taken by STEM undergraduate students. Specifically, the project will identify mechanisms of support for students' transitions between two- and four-year colleges, in addition to the multiple movements that might occur prior to this critical transition. (PI Felisha Herrera Villarreal, San Diego State University Foundation)

1832534: *Integrated Interventions to Improve Undergraduate Student Success in STEM*

This project at the University of Houston will advance the aims of the HSI Program by improving retention of students from first-year courses to higher level courses, and through completion of their bachelor's degree. The project will analyze student motivation and desire for obtaining a STEM degree. It will also implement and test the effectiveness of academic interventions, such as a summer bridge program, on student success. (PI Donna Stokes, University of Houston)

1832536: *Advancing Student Success in Undergraduate Engineering and Computer Science*

This project at California State University-Fullerton will advance the aims of the HSI Program by increasing retention and graduation rates in computer science and engineering, and reducing high repetition rates in lower-division STEM courses. The project seeks to generate new knowledge about the role of social support mechanisms in helping students overcome these challenges. (PI Sudarshan Kurwadkar, California State University-Fullerton Foundation)

1832538: *Improving the Undergraduate Chemistry Experience by Green Chemistry, Active-learning, and Peer-led Experiences*

This project at the University of California, Merced, will advance the aims of the HSI Program by increasing undergraduate student interest and success in chemistry. The project will redesign laboratory courses to use student-guided inquiry and green chemistry; develop a peer-learning environment that builds a sense of community; and develop short videos to complement lower-division chemistry courses. (PI Erik Menke, University of California, Merced)

1832543: *Integrating Research, Mentoring, and Industry Collaborations to Improve STEM Recruitment and Retention*

This project at Phoenix College will advance the aims of the HSI Program by incorporating multidisciplinary Course-Based Undergraduate Research Experiences (CUREs) into STEM curricula in colleges throughout the district. (PI Robin Cotter, Maricopa County Community College District)

1832553: *Building Bridges into Engineering and Computer Science*

This project at Wilbur Wright College will advance the aims of the HSI Program by enabling talented, underprepared, low-income students to pursue and complete a bachelor's degree in engineering or computer science. The project aims to develop and implement pathways, practices and interventions to support student success in engineering or computer science at two critical transitions: from high school to community college and from community college to four-year universities. (PI Doris Espiritu, City Colleges of Chicago Wilbur Wright College)

1832558: *Collaboration for Inclusive and Engaging Curriculum, Instruction, and Achievement*

This project at the California State University-Stanislaus (Stanislaus State) will advance the aims of the HSI Program by improving STEM student retention, graduation and success by developing a STEM faculty culture of evidence-based teaching and student-centered learning environments. (PI Matthew Cover, California State University-Stanislaus)

1832567: *City College of New York STEM Communities*

This project at the City University of New York (CUNY) City College will advance the aims of the HSI Program by building a social media platform designed specifically for students entering, continuing or transferring into STEM majors. The platform will be designed as a "one-stop" location for academic support, tutoring and social interaction. (PI Joseph Barba, CUNY City College)

TRACK 2: HSIs NEW TO NSF

1832243: *Los Futuros de STEM (STEMFutures): Building Student Success in STEM*

The project will create a STEM professional development program, enhance student support and develop co-requisite supplemental instruction. (PI Jeffrey Alexander, Pueblo Community College)

1832545: *Using Ocean Plastic Research to Increase Student Engagement and Persistence in Biology*

This project at National University will advance the aims of the HSI Program by adding research experiences to undergraduate biology courses. Through a collaboration with the Scripps Institution of Oceanography, the project will incorporate course-based undergraduate research (CURE) biology courses for biology majors and for non-majors. The research topics will focus on plastic pollution in the ocean. (PI Ana Barral, National University)

1832433: *Recruiting and Retaining Students into Computing*

This project at Texas A&M University-San Antonio will advance the aims of the HSI Program by increasing the retention and completion rates of students in computer science and to better equip them to achieve careers in cybersecurity. The project also plans to increase the number of transfer students who transfer from two-year colleges into computer science programs at the university. The project plans to integrate cybersecurity topics throughout the entire computer science curriculum, so that students will obtain an NSA Cyber Defense Education certificate upon graduation. (PI Jeong Yang, Texas A&M University-San Antonio)

Conference Awards (4) from July 6, 2017 DCL deadline

1748199: *HSI Conference: Hispanic-focused STEM Ideas for Inspiration and Innovation*, Nova Southeastern University, FL; PI Meline Kevorkian

1748526: *HSI Conference: Transforming STEM Education in Hispanic Serving Institutions - Regional Insights from the Southwest*, University of Arizona, AZ; PI Guadalupe Lozano

1748533: *HSI Conference: Understanding and Improving Readiness and Student Transitions*, University of Houston, TX; PI Andrew Hamilton

1748570: *HSI Conference: Pathways for Hispanic Students in STEM*, University of California-Irvine, CA; PI Michael Dennin

Conference Awards (7) from Sept. 20, 2017, DCL deadline

1800200: *HSI Conference: URBANO-Increasing Access and Success in Urban STEM Programs*, CUNY City College, NY; PI Jorge Gonzalez.

1802552: *HSI Conference: Accelerating the Impact of HSI STEM Education and Research on Innovation Ecosystems*, University of Puerto, PR; PI Rodolfo Romanach.

1764268: *HSI Conference: Stakeholder Perspectives on Challenges and Opportunities for Improving Undergraduate STEM Education at HSIs*, Texas A&M Engineering Experiment Station, TX; PI William Kitch.

1759134: *HSI Conference: PROMISE: Providing Resources and Opportunities for Minorities in STEM Education*, Laredo Community College, TX; PI Nora Garza.

1764378, 1764166, and 1764249: *Collaborative HSI Conference: Co-Designing an Engineering Education Research Agenda*, University of Texas-El Paso, TX; PIs Meagan Kendall, Alexandra Strong and Ines Basalo.

1759566: *HSI Conference: Catalyzing Progress in Undergraduate STEM Education with Insights from Midwestern HSIs*, Northeastern Illinois University, IL; PI Laura Sanders.

1764323: *HSI Conference: Dissecting the STEM Education Ecosystem in Hispanic Serving Institutions (HSIs): Regional Insights from Southern California*, California State University Fullerton Foundation, CA; PI Yusheng (Chris) Liu.

APPENDIX D

HBCU EXCELLENCE IN RESEARCH (EIR) AWARDS DIRECTORY

Award #	Title	Institution	PI
1832022	Excellence in Research: Crosstalk between the STK4/ Hippo and NF-Kappa B pathway in mammalian cells	Clark Atlanta University	Bekir Cinar
1832163	Excellence in Research: Investigation of RECQ1 helicase in DNA transactions upon oxidative stress	Howard University	Sudha Sharma
1832140	Excellence in Research: Contribution of Terrestrial Bacteria to Iodine Biogeochemical Cycling	Howard University	Courtney Robinson
1832026	Excellence in Research: Involvement of MEF-2 transcription factor in mitochondrial stress response through SOD2	Howard University	Atanu Duttaroy
1831958	Excellence in Research: Genome Evolution of Amoebozoa: Resolving the deep phylogeny of Amoebozoa through genomic and proteomic features	Spelman College	Yonas Tekle
1831988	EiR: Functional Study of the Rapidly Evolving Interferon Complex in Amphibians	Tennessee State University	Yongming Sang
1830866	Excellence in Research in Spectroelectrochemical Measurements in Intact Microorganisms	Xavier University	Robert Blake
1827091	Excellence in Research: Teaching Problem-Solving and Deductive Skills to K-12 Students Through a Forensics Course Based on Mobile Devices	Jackson State University	Frances Dancer
1831964	Excellence in Research: Evaluating the Use of Virtual Mentoring for HBCU Undergraduates in Computer Science	Morehouse College	Kinnis Gosha

Award #	Title	Institution	PI
1831969	Excellence in Research: Human Factors Approach to Facilitate Ambient Assisted Living Accessible and Usable to People with Visual Impairments: Loneliness Self-Monitoring System	North Carolina A&T State University	Hyung Nam Kim
1832110	Excellence in Research: Developing a Robust, Distributed, and Automated Sensing and Control System for Smart Agriculture	North Carolina A&T State University	Ali Karimoddini
1832034	Excellence in Research: Collaborative Research: Strengthen the Foundation of Big Data Analytics via Interdisciplinary Research among HBCUs	Prairie View A&M University	Lei Huang
1831980	Excellence in Research: Collaborative Research: Strengthen the Foundation of Big Data Analytics via Interdisciplinary Research among HBCUs	Texas Southern University	Yunjiao Wang
1832041	Excellence in Research: Tolerance of Ambiguity and Academic Success	Tuskegee University	Mohammad Khan
1832141	Excellence in Research: Navigating the Double Bind: Assessing the Development and Contribution of Identity Shifting to the Recruitment & Retention of Black Women in STEM Education	Spelman College	Danielle Dickens
1831282	Excellence in Research: Skin Tissue Regeneration using Smart Scaffolds	Alabama State University	Komal Vig
1831332	Excellence in Research: Investigation of Enhancer-Free Photogenerated Singlet Oxygen	Delaware State University	Aristides Marcano
1832068	Excellence in Research: Integrated Hazard and Traffic Modeling for Massive Evacuation in Florida Under Uncertainty of Hurricane Track	Florida A&M University	Wenrui Huang
1831559	Collaborative Proposal: EiR: Understanding Interactions of Gold and Silver Nanoparticles with Proteins to Achieve Optimum Surface Plasmon Effect	Howard University	Tao Wei

Award #	Title	Institution	PI
1831548	Collaborative Proposal: EiR: Understanding Interactions of Gold and Silver Nanoparticles with Proteins to Achieve Optimum Surface Plasmon Effect	Winston-Salem State University	Xiuping Tao
1831954	EiR: Doping cubic boron nitride, an extreme material for power electronics and radiation detection	Morgan State University	Michael Spencer
1832117	Excellence in Research: GaAsSb/GaAs Nanowires based Avalanche Photodetectors on Si	North Carolina A&T State University	Shanthi Iyer
1831962	Excellence in Research: Fast Functional Imaging of Neural Networks with Nanoelectrode Arrays	Norfolk State University	Hargsoon Yoon
1832134	Excellence in Research (EiR): Radical Scavenging Interactions of Carbon Nanodots and Smart Polymer-Carbon Nanodots Systems	North Carolina Central University	John Bang
1831133	Excellence in Research: Engineering Two-dimensional Transition Metal Dichalcogenide Nanomaterials for Sweat Sensing	North Carolina Central University	Fei Yan
1832011	HBCU-Excellence in Research: Vertical Profiles of Aerosols and Their Radiative Impacts	Howard University	Siwei Li
1832065	Identification of Urban Flood Impacts Caused by Land Subsidence and Sea Level Rise for the Houston-Galveston Region	Morgan State University	Jiang Li
1832121	HBCU-Excellence in Research: Understanding Atmospheric Moist Convection and Organization Using Automatic Feature Identification and Tracking	Morgan State University	Xiaowen Li
1832089	HBCU: Excellence in Research: Analysis and Modeling of the Ocean Spray Effects on Tropical Cyclone Dynamics	North Carolina A&T State University	Yevgeniy Rastigeyev

Award #	Title	Institution	PI
1831013	HBCU-Excellence in Research: Radiative Effects of Biomass Burning Aerosols Laboratory and Field Measurements and Modeling of Climate and Health Impacts	North Carolina A&T State University	Solomon Bililign
1832126	Excellence in Research: Numerical Analysis of Quasiperiodic Topology	Howard University	Roberto De Leo
1831950	Excellence in Research: Numerical Algorithms for Fluid Poroelastic Structure Interaction Models	Morgan State University	Mingchao Cai
1830886	Excellence in Research: Control of Electric and Magnetic Light with Plasmonic Nanostructures	Norfolk State University	Natalia Noginova
1832031	Excellence in Research: Single Crystal Growth and Investigation of Novel Exotic Fermion Materials	Norfolk State University	Doyle Temple
1830874	Excellence in Research: Quantum Nanophotonics with Periodic Carbon Nanotube Arrays	North Carolina Central University	Igor Bondarev
1831979	Excellence in Research: Constraining the symmetry energy in nuclear equation of state for neutron rich systems: A study of Isovector Giant Quadrupole Resonance by Compton Scattering	North Carolina Central University	Mohammad Ahmed
1832098	Excellence in Research: Development of High Resolution Coherent 2D Rovibrational Spectroscopy	Spelman College	Peter C. Chen
1831977	Excellence in Research: Dynamics of High-L States of Rydberg Atoms	Texas Southern University	Daniel Vrinceanu
1831682	Excellence in Research: Time Domain Astronomy in the Caribbean: Detecting and Characterizing the Fastest Astrophysical Transient Events	University of the Virgin Island	Antonino Cucchiara

Award #	Title	Institution	PI
1831339	Excellence in Research: Unlocking the Synthetic Power of Regioselective and Stereoselective Carbon Carbon Bond Formations for Multicomponent Reactions in Heterocycle Synthesis	Winston-Salem State University	Fenghai Guo
1831020	Excellence in Research: Evaluating Thiol-Peptides with Auxiliary Binding Groups as Chelators of Mercury(II)	Winston-Salem State University	Maria Ngu-Schwemlein
1832167	Excellence in Research: Investigation of Small Molecule Adsorption and Conversion on the Semiconductor/Ionic-Liquid Interface and Application to Sensing and Catalysis	Xavier University of Louisiana	Zhe Wang
1832064	Excellence in Research: A Comparison of Educational Outcomes at Institutions of Higher Education	Howard University	Omari Swinton
1831983	Excellence in Research: A Comparison of Educational Outcomes at Institutions of Higher Education	Jackson State University	Nicholas Hill
1832144	Excellence in Research: The Impact of Online Comparison Websites on the Remittance Industry	Spelman College	Angelino Viceisza
1832090	Excellence in Research: Pathways to Academic Success in African American Children	Spelman College	A. Nayena Blankson
1831205	Excellence in Research: Analyzing the Impact of Landscape Change on the Watershed Dynamics of a Flood-Prone Urban Region	Texas Southern University	Maruthi Sridhar Balaji Bhaskar

APPENDIX E

Committee on Equal Opportunities in Science and Engineering (CEOSE)

www.nsf.gov/od/oia/activities/ceose

Established by Congress to advise the National Science Foundation concerning the implementation of the Science and Engineering Equal Opportunities Act and other policies and activities to encourage the full participation of women, underrepresented minorities, and persons with disabilities in scientific, engineering, and professional fields.

CEOSE Members, 2017

Ira Harkavy
(CEOSE Chair)
University of Pennsylvania

Louis A. Martin-Vega
(Vice-Chair)
North Carolina State University

Mary Monroe Atwater
University of Georgia

Nancy Cantor
Rutgers University - Newark

Garikai Campbell
Morehouse College

Peter Eden
Landmark College

Jose Fuentes
Pennsylvania State University

C. Michael Gooden
Integrated Systems Analysts, Inc.

Charles Isbell
Georgia Institute of Technology

Robert J. Jones
University of Illinois at Urbana-Champaign

Alicia Knoedler
The University of Oklahoma

Daniela Marghitu
Auburn University

Robert Eugene Megginson
University of Michigan

Loretta Moore
Jackson State University

Lydia Villa-Komaroff
Massachusetts Life Science Center

Nai-Chang Yeh
California Institute of Technology

CEOSE Executive Liaison
Suzi Iacono
National Science Foundation

CEOSE Executive Secretary
Bernice Anderson
National Science Foundation

November 13, 2017

Dear Colleague:

The Committee on Equal Opportunities in Science and Engineering (CEOSE) is charged by the United States Congress to advise the National Science Foundation (NSF) on policies and programs that encourage full participation by women, underrepresented racial and ethnic groups (African Americans, Hispanics/Latinos, and Native Americans), and persons with disabilities within all levels of the United States' science, technology, engineering, and mathematics (STEM) enterprise and to transmit to the Director of NSF every two years a report on its activities during the previous two years and proposed activities for the next two years.

In the recently completed 2015-16 report, CEOSE recommended the development of an accountability framework for assessing the bold new initiative advocated in the first two reports as well as the overall broadening participation portfolio: "**NSF should adopt a framework based on the information and principles in this report that ensures true shared accountability for PIs, for institutions, and for NSF itself in promoting participation and excellence in science and engineering by deliberately and fully utilizing all the talent and potential the Nation has to offer.**" Additionally, in the report, CEOSE's advice to the Foundation includes guiding principles and suggested practices for the three basic levels of accountability—the principal investigators of projects; institutions awarded grants, especially higher education institutions; and the agency level of NSF itself.

In her letter transmitting the report to Congress, NSF's Director, France A. Córdova, wrote: **"This report provides valuable insights as NSF and the research community continue to explore and implement innovative approaches to broadening participation in STEM."** Echoing Director Córdova, the Committee hopes our 2015-2016 report spurs innovative ways to promote and increase diversity and inclusion in STEM.

The enclosed summary provides an overview of Accountability for Broadening Participation in STEM -the 2015-2016 CEOSE Biennial Report to Congress. The full report can be found at the CEOSE website at www.nsf.gov/od/oia/activities/ceose.

Best regards,

The CEOSE Advisory Committee

CEOSE

Committee on Equal Opportunities in Science and Engineering

AN ACCOUNTABILITY FRAMEWORK FOR ASSESSING EFFORTS TO BROADEN PARTICIPATION IN STEM

Progress in broadening participation has been insufficient to meet increased challenges despite decades of efforts to improve representation of people from underrepresented groups (women, African Americans, Hispanics/Latinos, American Indians/Alaska Natives and persons with disabilities) in science, technology, engineering, and mathematics (STEM). Therefore, in its previous two reports, CEOSE focused its recommendations to NSF on ways to "move the needle" to achieve demonstrable progress in broadening participation.

In its 2011-2012 report, CEOSE focused on a single recommendation calling for a bold new initiative to broaden participation. That recommendation resulted in the establishment of an NSF initiative "Inclusion Across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science" (NSF INCLUDES) launched in FY 2016, which CEOSE members recognized as a promising initial response.

CEOSE's 2013-2014 report reiterated the recommendation for a bold new initiative and proposed five specific components of a plan for implementation (i.e., develop and implement an effective preK-20+ system of STEM pathways; provide stable and sufficient direct support for individuals; support the further development of a science of broadening participation grounded in empirical research; conduct field experiments to understand and mitigate the barriers to broadening participation; and recognize the field-specific nature of the broadening participation challenge).

In this 2015-16 report, CEOSE recommends developing an accountability framework for assessing the full development of the bold new initiative advocated in the first two reports as well as the overall broadening participation portfolio:

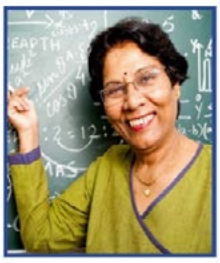
"NSF should adopt a framework based on the information and principles in this report that ensures true shared accountability for PIs, for institutions, and for NSF itself in promoting participation and excellence in science and engineering by deliberately and fully utilizing all the talent and potential the Nation has to offer."

2015-2016 Biennial Report to Congress

An accountability framework for broadening participation must have a set of clear assumptions, definitions, goals, and metrics, as well as a strategy for change and it must adhere to several clear principles:

- The framework should take into account local conditions, context and history;
- The framework must encourage success by requiring accountability from the beginning;
- The framework must require evaluation systems that allow periodic feedback to modify practice;
- The framework must encourage learning from and through implementation of programs and projects; and

And, accountability, in the context of NSF's broadening participation efforts, must be addressed at three basic levels:



- The first is at the level of the individual project, where PIs are accountable for using grants to the best of their ability to accomplish the project's goals, as well as reporting and disseminating the outcomes of their projects.
- The second level is the level of the institution (particularly higher education institutions), where they are jointly held accountable with PIs for monitoring grant expenditures and meeting reporting requirements.

- The third is at the level of NSF itself, where NSF is accountable for using its funding vehicles effectively to further the U.S. scientific endeavor and having the data available to demonstrate that it is doing so.

CEOSE recognizes and applauds NSF's efforts across the Foundation to broaden participation, including embracing the challenge of implementing a bold new initiative around broadening participation. NSF has an important role to play among federal funding agencies and can lead the way in building an accountability system that provides incentives to principal investigators and institutions of higher education to move with urgency toward the goal of broadening participation. The recommendation and suggested practices in the report are meant to strengthen activities/practices that allow NSF, its constituents, and its partners: to understand their collective progress on their shared goals around broadening participation, to adjust as necessary to achieve those goals; and to, above all, be accountable to those goals.

2015-2016 Biennial Report to Congress

APPENDIX F

EXAMPLES OF NSF-SUPPORTED STRATEGIES/ ACTIVITIES/PROJECTS RELATED TO CEOSE'S SUGGESTED PRACTICES FOR NSF'S ROLE IN ENSURING ACCOUNTABILITY

ACKNOWLEDGE GRANTEE INSTITUTIONS FOR POSITIVE PAST AND PRESENT CONTRIBUTIONS TO BROADENING PARTICIPATION

- The **ADVANCE program** is supporting the American Association for the Advancement of Science STEM Equity Achievement Project to design and implement a certification for diversity and inclusion in STEM higher education.

- The **Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM)** program recognizes the exemplary mentoring work of individuals and organizations to broaden participation in STEM. In summer 2018, the Office of Science and Technology Policy and NSF honored 27 individual recipients and 14 organizational recipients for their mentoring contributions to broadening participation (NSF 18-043).

FACILITATE CHANGING CULTURE THROUGH THE POWER OF CONVENING

- The ***NSF INCLUDES Summit: Broadening Participation through Center-Scale Research Activities***, a first-of-its-kind gathering, is expected to result in NSF's centers, institutes and other center-scale activities joining in the NSF INCLUDES National Network. The summit, along with the 2018 NSF INCLUDES PI meeting, provided the opportunity to: (a) share information about their diversity activities, strategies and outcomes; (b) identify ways in which the community might use collaborative change strategies in their broadening participation initiatives; (c) identify opportunities to mobilize and act together through team activities; and (d) leverage projects that produce webinars and other large-scale training activities focused on various aspects of cultural change.

- **Transforming Undergraduate Education in Engineering (TUEE), Phase III: Voices on Women's Participation and Retention** was a convening of individuals from academia, professional societies, selected federal agencies and industry to address the chronic problem of low female participation and success in U.S. engineering undergraduate programs. The workshop developed an action agenda that is currently being implemented by engineering colleges and other relevant stakeholders (see http://tuee.asee.org/phase-iii/).

PROVIDE MULTIPLE LEVELS OF LEARNING AND NETWORKING OPPORTUNITIES

- The **NSF INCLUDES Technical Assistance** team has employed various learning opportunities about accountability for broadening participation, such as:
  - *Crafting NSF INCLUDES Annual Report* webinar.
  - *Using Evaluation for Advocacy* webchat.
  - *Culturally Responsive Evaluation* webinar.
  - *Sustainability and Scale* webinar.
  - *In-person and virtual meetings of the Evaluation Affinity Group.*
  - *Virtual learning about and access to social network analysis tools.*
  - *Series about Launch Pilot Journeys: Discoveries and Detours.*

- **OIA** provided funding for ***Shared Accountability and Higher Education: A Compact Guide for Broadening Participation in STEM*** (see full report at https://www.nettercenter.upenn.edu/sites/default/files/HE_STEM_Accountability_Brochure_Final.pdf

- The **ADVANCE** community has access to the **StratEGIC Toolkit** that includes Change *Strategy Brief 7: Strengthened Accountability Structures* (see https://www.colorado.edu/eer/sites/default/files/attached-files/7_accountabilitystructuresbrief123015.pdf).

FURTHER ELEVATE THE VALUE OF BROADENING PARTICIPATION AND DIVERSITY OF PERSPECTIVES AS CRUCIAL TO EXCELLENCE IN THE RESEARCH PROCESS

- NSF Program Officers receive **Merit Review training** that includes information about broadening participation, implicit bias, etc.

- In addition to constructing diverse NSF INCLUDES (or other broadening participation program) review panels, the panelists/reviewers have access to an **implicit bias briefing**.

- The **CISE Broadening Participation in Computing (BPC)** pilot is investigating the inclusion of meaningful BPC plans in proposals submitted to a subset of CISE research programs.

- Accountability expectations are frequently included in the solicitation of the focused broadening participation programs. For example, see the following excerpt from the **Centers of Research Excellence in Science and Technology (CREST)** program announcement (NSF 18-509):
  - **CREST:** *"...Evaluation plans for research projects could include activities related to project integrity and usefulness/utilization and dissemination of findings. Evaluation activities could include such activities as documenting and describing the operation of the project through all phases and oversight related to appropriate selection of participants, fidelity, and integrity of research design and measures (formative); and assessing the extent to which findings contribute to the knowledge base in the field and are disseminated to those researchers and practitioners who will utilize the findings (summative)."*

PROMOTE, DEVELOP AND IMPLEMENT AN EFFECTIVE STRATEGY FOR LONG-TERM LONGITUDINAL DATA COLLECTION

- **NSF Research Experiences for Undergraduates (NSF REU) Longitudinal Monitoring and Evaluation System:** In 2015, NSF contracted with Mathematica Policy Research to: (1) develop a framework for evaluating the REU Sites program, and (2) build, pilot test and present findings for a web-based longitudinal data collection system. The purpose of this longitudinal system is to track the application process; improve the collection and analysis of student demographic and other basic characteristics important to the knowledge base for broadening participation; and measure participant outcomes (matriculation, graduation and career trajectory) over time to comply with the "America Competes Reauthorization Act of 2010."

- **Monitoring Longitudinal Career Outcomes of NSF Graduate Research Fellowship (NSF GRFP) recipients.** The purpose of this project, started in 2015, is to develop and pilot a monitoring and evaluation approach that may be used as a permanent longitudinal monitoring system to assess program outcomes. The short-term goal is to develop the instrument, conduct the survey, and assess the feasibility of this method to track the careers of the fellows. The intermediate goal is to implement a permanent system that will enable NSF to follow cohorts of fellows over time. The long-term goal is to use the data collected as one component of a larger evaluation of the GRFP.

UTILIZE COMMITTEES OF VISITORS (COV) TO EVALUATE THE NEW BROADENING PARTICIPATION INITIATIVE

- The advice of the committee regarding COV will be considered when the **NSF INCLUDES** COV is scheduled.

- Currently, **NSF INCLUDES** has a third-party developmental evaluation. The evaluation questions are:
  - In what ways and to what extent is NSF INCLUDES responding to the broadening participation challenge?
  - What are the key ingredients, facilitators and inhibitors for achieving STEM and broadening participation outcomes?
  - What progress has been made and what mid-course corrections/adjustments are needed?
  - What have we learned about what works?
  - How, and with whom, should knowledge gained be transferred and used?

PROMOTE AND SUPPORT THE FURTHER DEVELOPMENT OF A SCIENCE OF BROADENING PARTICIPATION

- **EHR** has a ***Broadening Participation Research Track and/or Broadening Participation Research Centers Tracks*** in several programs (LSAMP, HBCU-UP and TCUP). Broadening Participation Research proposals in STEM education may investigate behavioral, cognitive and affective learning and social differences, as well as organizational, institutional or systemic processes that may impact participation and success in STEM education.

- **SBE** has a **Science of Broadening Participation (SBP) program** to support research proposals that employ the theories, methods and analytic techniques of the social, behavioral, economic and learning sciences to better understand the factors that enhance, as well as the barriers that hinder, the ability to expand participation of underrepresented/underserved populations in STEM education and the scientific workforce.

CEOSE MEMBERSHIP 2017-2018

Dr. Mary Monroe Atwater
Professor of Mathematics and African American Studies
Department of Mathematics and Science Education
The University of Georgia
Athens, GA 30602

Dr. Gilda Barabino*
Dean and Berg Professor
Grove School of Engineering
The City College of New York
New York, NY 10031

Dr. Suzanne Barbour*
Professor and Dean of the Graduate School
Department of Biochemistry and Molecular Biology
University of Georgia
Athens, GA 30602

Dr. Garikai Campbell
Provost and Senior Vice President
Office of the Provost
Morehouse College
Atlanta, GA 30314

Dr. Nancy Cantor
Chancellor
Rutgers University – Newark
Newark, New Jersey 07102

Dr. Peter Eden*
President
Landmark College
Putney, Vermont 05346

Dr. Jose D. Fuentes*
Professor of Meteorology
Department of Meteorology
Pennsylvania State University
State College, PA 16801
Chair: 06/01/2018 -01/31/2022

Dr. Juan Gilbert*
The Banks Preeminence Chair in Engineering
Dept. of Computer & Information Science and Engineering
University of Florida
Gainesville, FL 32611

Mr. Michael Gooden
Chief Executive Officer
Integrated Systems Analysis, Inc.
Alexandria, VA 22311

Dr. Ira Harkavy (Former Chair)
Associate Vice President
University of Pennsylvania
Philadelphia, PA 19104
Vice Chair: 10/01/2014-01/31/2016}
Chair: 02/01/2016-05/31/2018

Dr. Charles Isbell*
Professor and Senior Associate Dean
School of Interactive Computing
Georgia Institute of Technology
Atlanta, GA 30332

Dr. Kaye Husbands Fealing*
Professor and Chair
Ivan Allen College of Liberal Arts
Georgia Institute of Technology
Atlanta, GA 30318

Dr. Robert Jones
President

University at Albany
Albany, NY 12222

Dr. Alicia Knoedler *(Vice Chair)
Director of Team Innovation

Exaptive, Inc.
Oklahoma City, OK 73103
Vice Chair: 06/01/2018-01/31/2020

Dr. Louis Martin-Vega (Former Vice-Chair)
Professor and Dean

College of Engineering
North Carolina State University
Raleigh, NC 27695
Vice Chair: 02/01/2016-05/31/2018

Dr. Daniela Marghitu*
Professor of Computer Science and Software Engineering

Department of Computer Science and Software Engineering
Auburn University
Auburn, AL 36849

Dr. Robert Eugene Megginson*
Arthur F. Thurman Professor

Department of Mathematics
University of Michigan
Ann Arbor, MI 48109

Dr. Loretta Moore
Professor of Computer Science

Department of Electrical and Computer Engineering and Computer Science
Jackson State University
Jackson, MS 39217

Dr. Lydia Villa-Komaroff*
Consultant

Chestnut Hill, MA 02467

Dr. Nai-Chang Yeh*
Professor

California Institute of Technology
Pasadena, CA 91125

NSF CONTACTS

Dr. Suzanne Iacono
Office Head and CEOSE Executive Liaison

Office of Integrative Activities (OIA)
Office of Director, NSF

Dr. Bernice T. Anderson
Senior Advisor and CEOSE Executive Secretary

Office of Integrative Activities (OIA)
Office of Director, NSF

* Current Members

NOTES

IMAGE CREDITS

COVER

Artwork: Designed by Nicolle R Fuller, www.sayostudio.com

FIGURES

Figure A: Noninstitutionalized resident population of the United States ages 18-64, by race, ethnicity, and sex: 2017

Figure B: U.S. civilian noninstitutionalized population ages 18-74, by disability status: 2016

Figure C: Percentage distribution of public-school students enrolled in prekindergarten through 12th grade, by race/ethnicity, Fall 2000, Fall 2015, and Fall 2027

Figure D: Scientists and engineers employed at NSF, characterized by categories of disability and racial and ethnic groups: FY 2017.

PHOTOS

Page 9: Previous CEOSE Covers designed by Steven Buhneing

Page 10: Arash Zaghi, University of Connecticut

Page 11: ATE Impacts 2018-2019

Page 15: Heather Lavender, Louisiana State University

Page 18: NMU Center for Native American Studies

Page 20: The EDGE Foundation, Claremont, CA

Page 21: "DO-IT, University of Washington"

Page 23: University Corporation for Atmospheric Research

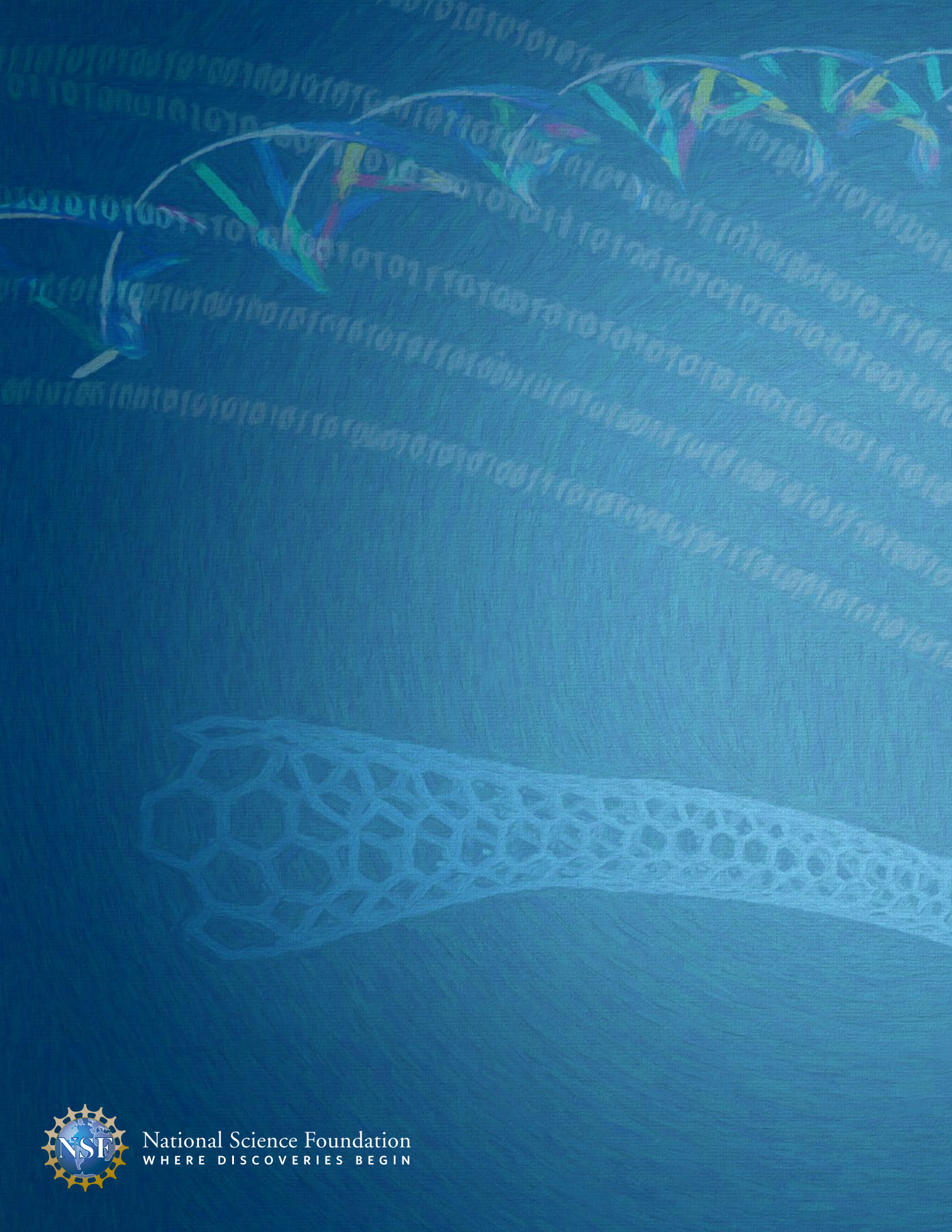
Page 25: Don Yanek, Office of Computer Science, Chicago Public Schools

Page 28: Matthew Kohashi, Visual Language and Visual Learning Center, Gallaudet University

Page 29: John Monahan, University of Alaska

Page 31: Purugganan Lab, New York University, National Science Foundation Tumblr, https://nationalsciencefoundation.tumblr.com/post/176777522624/all-aboard-the-biobus/amp

Page 32: Corey Garza, California State University, Monterey Bay



National Science Foundation
WHERE DISCOVERIES BEGIN