



National Science Foundation

Opportunities to Address Barriers and Opportunities for 2-Year and 4-Year STEM Degrees: Systemic Change to Support Students' Diverse Pathways (National Academy of Sciences, 2016)

With funding from NSF's Directorate for Education and Human Resources, the National Research Council Board on Science Education completed a study to understand the barriers to completion of two- and four-year STEM degrees and opportunities for overcoming these barriers. NSF is dedicated to pursuing solutions to existing challenges in undergraduate education by supporting promising research through a variety of programs. A select set of conclusions and recommendations from the report are included in this document, along with NSF programs which can be used to address them.

Conclusion 1: There is an opportunity to expand and diversify the nation's STEM workforce and STEM-skilled workers in all fields if there is a commitment to appropriately support students through degree completion and provide more opportunities to engage in high-quality STEM learning and experiences.

Advanced Technological Education (ATE) – NSF 14-577

ATE focuses on the education of technicians for high-technology fields and encourages proposals from minority-serving institutions and other institutions that support the recruitment, retention, and completion of underrepresented students in technician education programs.

According to the 2015 EvaluATE survey of ATE grantees, 44 percent of students in ATE supported programs are underrepresented minorities and 28 percent are women.

Centers of Research Excellence in Science and Technology (CREST) – NSF 16-525

The CREST program makes resources available to enhance the research capabilities of minority-serving institutions through the establishment of centers that effectively integrate education and research. It promotes research productivity of faculty and an expanded, diverse student presence in STEM disciplines at the graduate level.

CyberCorps®: Scholarship for Service (SFS) – NSF 15-584

SFS addresses cybersecurity education and workforce development and prepares students for cybersecurity professions.

EHR Core Research (ECR) – NSF 15-509

ECR supports research in STEM professional workforce development to address the need to prepare a diverse, highly skilled and motivated workforce who can meet the demands of a dynamic and complex global economy.

Historically Black Colleges and Universities – Undergraduate Program (HBCU-UP) – NSF 16-538

The goal of HBCU-UP is to enhance the quality of STEM education and research at HBCUs as a means to broaden participation in the nation's STEM workforce. HBCU-UP provides awards to develop, implement, and study innovative models and approaches for making substantial improvements in the preparation and success of HBCU undergraduate students so they may participate successfully in STEM graduate programs and/or careers in STEM disciplines.

Louis Stokes Alliances for Minority Participation (LSAMP) – NSF 15-594

LSAMP provides funding to alliances of institutions that implement comprehensive, evidence-based, and sustained strategies that ultimately result in the graduation of well-prepared, highly-qualified students from underrepresented racial/ethnic groups who pursue graduate studies and/or careers in STEM.

Research Experience for Undergraduates (REU) – NSF 13-542

REU projects involve students in meaningful ways in research programs.

CONCLUSION 2: STEM aspirants increasingly navigate the undergraduate education system in new and complex ways. It takes students longer for completion of degrees, there are many patterns of student mobility within and across institutions, and the accommodation and management of student enrollment patterns can affect how quickly and even whether a student earns a STEM degree.

RECOMMENDATION 4: Institutions, states, and federal policy makers should better align educational policies with the range of education goals of students enrolled in 2- and 4-year institutions. Policies should account for the fact that many students take more than 6 years to graduate and should reward 2- and 4-year institutions for their contributions to the educational success of students they serve, which includes not only those who graduate.

Tribal Colleges and Universities Program (TCUP) – NSF 16-531

The goal of the TCUP program is to strengthen Tribal Colleges and Universities and specific other institutions of higher education serving indigenous students by increasing the capacity of the institutions' STEM instructional infrastructure.

Advanced Technological Education (ATE) – NSF 14-577

ATE has an emphasis on supporting two-year colleges. Projects are guided by a coherent vision that recognizes technicians as life-long learners and recognizes the needs of the modern workplace. As a result of ATE facilitation, approximately 1,270 articulation agreements were in place between high schools, two-year institutions, and four-year institutions to help transition students between institutions.

Improving Undergraduate STEM Education: EHR (IUSE: EHR) – NSF 15-585

Research Coordination Networks – Undergraduate Biology Education (RCN-UBE) – NSF 15-527

Part of the Foundation-wide NSF-IUSE initiative, IUSE: EHR and RCN-UBE include support for efforts to integrate research experiences into courses, which extends access to this high impact practice to students unable to participate in extracurricular research.

NSF Scholarships in STEM (S-STEM) – NSF 16-540

S-STEM addresses the challenges facing low-income students by providing funding to institutions to fund scholarships, provide student support, and enhance and study effective curricular and co-curricular activities that support recruitment, retention, student success, and graduation in STEM.



The diagram to the left describes the multiple pathways a person may take to pursue an Engineering Technology occupation. The Florida Advanced Technology Education Center of Excellence (FLATE) at Hillsborough Community College, funded by ATE, has created a uniform system for manufacturing education across Florida which allows students to transfer credits easily when they obtain their education from multiple schools as well as obtain skills relevant to local employers.

Image credit: FLATE, Hillsborough Community College

CONCLUSION 3: National, state, and institutional undergraduate data systems often are not structured to gather information needed to understand how well the undergraduate education system and institutions of higher education are serving students.

RECOMMENDATION 1: Data collection systems should be adjusted to collect information to help departments and institutions better understand the nature of the student populations they serve and the pathways these students take to complete STEM.

NSF's Project and Program Evaluation (PPE) initiative supports research initiatives and special projects related to evaluation. The Board of Science Education at the National Academy of Sciences, in an effort supported by PPE, is developing a framework and set of indicators that can document the status and quality of undergraduate STEM education at both community colleges and 4-year institutions.



Since its inception in 1993, the statewide California State University LSAMP (CSU-LSAMP) has produced an increasing number of degrees from year to year. In 1993-94, 917 minority students earned B.S. degrees. In 2014, minority STEM baccalaureate degree production across the CSU-LSAMP project was 3,455. The project has served a total of 23,360 students across 23 participating campuses since 1993-94. Of those for whom tracking data are available (18,875 students), 7,999 earned STEM degrees for a completion rate of 42 percent. Project evaluation data show that CSU-LSAMP participants were twice as likely to complete their degree program as non-participants.

Photo credit: CSU-LSAMP

The TCUP program supported the development of a Bachelor of Science in Secondary Science Education (BSSE) at Salish Kootenai College. The institution reports that eight students have graduated from the program to date, seven of whom are employed in secondary STEM education. Six of the graduates are teaching now in reservation schools with high American Indian student enrollment. The project also supports six students currently working toward the BSSE degree. Thirteen of the former or current students are of American Indian heritage.

Photo credit: Regina Sievert, Salish Kootenai College



RECOMMENDATION 2: Federal agencies, foundations, and other entities that fund research in undergraduate STEM education should prioritize research to assess whether enrollment mobility in STEM is a response to financial, institutional, individual, or other factors, both individually and collectively, and to improve understanding of how student progress in STEM, in comparison with other disciplines, is affected by enrollment mobility.

EHR Core Research (ECR) – NSF 15-509

As part of the NSF Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES) priority, the ECR Broadening Participation theme supports the investigation of issues underlying the learning and participation of members of groups underrepresented in STEM.

Historically Black Colleges and Universities – Undergraduate Program (HBCU-UP) – NSF 16-538

HBCU-UP provides funding for Broadening Participation Research studies that would contribute to understanding the participation of and successful outcomes for African-American students in STEM. In addition, funding is available for Broadening Participation Research Centers that will produce work that adds to the research knowledgebase about the barriers that hinder and factors that enhance our ability to broaden participation in STEM.

Louis Stokes Alliances for Minority Participation (LSAMP) – NSF 15-594

Alliances that have been funded 10+ years by the LSAMP Program and seeking continued funding are required to incorporate a knowledge-generating research study that rigorously investigates effective practices or innovations related to their strategies for recruiting, retaining, and graduating students historically underrepresented in STEM.

NSF Scholarships in STEM (S-STEM) – NSF 16-540

S-STEM projects will contribute to the knowledge base of scholarly research in education by carrying out research on interventions which affect associate or baccalaureate degree attainment for academically talented U.S. students demonstrating financial need.

RECOMMENDATION 3: Federal agencies, foundations, and other entities that support research in undergraduate STEM education should support studies with multiple methodologies and approaches to better understand the effectiveness of various co-curricular programs.

EHR Core Research (ECR) – NSF 15-509

ECR supports proposals to conduct foundational research. The learning and learning environments theme encourages the creative use of formal and informal STEM learning environments — including the full array of available and emerging materials, platforms, and learning opportunities — to ensure that all students have access to high-quality, inspiring STEM learning and teaching.

Improving Undergraduate STEM Education: EHR (IUSE: EHR) – NSF 15-585

IUSE: EHR, managed by the Education and Human Resources Directorate, is one component of NSF’s larger Cross-directorate investment in improving undergraduate STEM education. NSF-IUSE serves as the framework for all investments in research and development that are critical for curricular improvement in undergraduate STEM education. IUSE: EHR invites proposals that address immediate challenges and opportunities that are facing undergraduate STEM education, as well as those that anticipate new structures and new functions of the undergraduate learning and teaching enterprise.

Researchers at the University of Wisconsin, Madison are studying factors that affect students at Wisconsin’s two-year colleges who aspire to transfer into science, technology, engineering, and mathematics majors at four-year institutions. The research is funded by the IUSE: EHR program.

Photo credit: Matthew Ammerman, Madison College



NSF’s Directorate for Education and Human Resources

Division of Undergraduate Education (DUE)

Division of Human Resource Development (HRD)

Division of Graduate Education (DGE)

Division of Research on Learning in Formal and Informal Settings (DRL)

Read the NAS report at:

<http://www.nap.edu/catalog/21739/barriers-and-opportunities-for-2-year-and-4-year-stem-degrees>

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