

National Science Foundation Programs that Support Engineering Education Research

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Abstract— The goal of this session is to increase the participants' knowledge of current funding opportunities at the National Science Foundation (NSF) to support projects with potential significant impacts on science, technology, engineering, and mathematics (STEM) education. In particular, the discussion will focus on new and current funding opportunities in the Division of Undergraduate Education (DUE) in the Directorate of Education and Human Resources (EHR) and the Division of Engineering Education & Centers (EEC) in the Directorate of Engineering. During the session, we will provide examples of project activities that support STEM education research opportunities. The session will use a highly interactive format (i.e., team-based activities and discussion) to engage the participants, to clarify misconceptions, and to potentially initiate and share new ideas pertinent to engineering education research and innovations in classroom implementations. This session facilitates idea sharing and interaction amongst peers.

Keywords—*funding opportunities; engineering education; National Science Foundation; student learning; student learning environments; curriculum development; faculty development.*

I. GOALS

The four overarching goals of this session are to:

- (1) enhance the participants' knowledge of current funding opportunities at the National Science Foundation (NSF) to support research and implementation towards excellence in undergraduate science, technology, engineering, and mathematics (STEM) education;
- (2) discuss current and new funding opportunities as well as share examples of project activities that support STEM education research opportunities;
- (3) present a framework to ground STEM education research efforts based on research type; and
- (4) share and discuss potential project ideas for feedback from NSF program officers and participants.

The session uses a highly interactive format, consisting of team-based activities and discussion, to engage the participants and to foster sharing of ideas, to clarify misconceptions, and to potentially initiate new ideas in engineering education research

and innovative implementations. This session supports the goals of the Frontiers in Education (FIE) conference through providing a setting for sharing of ideas and interaction amongst peers; and it informs participants about current NSF funding opportunities in STEM education.

II. SESSION TOPICS

The intended audience for the session includes those eligible to submit proposals to NSF and other project stakeholders, such as:

- 2-year and 4-year college and university faculty members in STEM and STEM education
- 2-year and 4-year college and university administrators
- STEM industry representatives
- Institutional, educational, discipline-based educational, and social / behavioral science researchers.

The tentative session agenda is as follows:

- (1) Brief NSF Program Descriptions – 30 mins
- (2) Common Education Research Framework – 15 mins
- (3) Small Group Discussions – 30 mins

III. DIRECTORATE FOR EDUCATION & HUMAN RESOURCES: DIVISION OF UNDERGRADUATE EDUCATION

NSF Division of Undergraduate Education (DUE)'s current programs constitute a comprehensive approach to strengthening STEM education at two- and four-year colleges and universities by improving curricula, instruction, laboratories, infrastructure, assessment, diversity of students and faculty, and collaborations. Several DUE programs are of particular interest to engineering educators. These are described briefly below and will be discussed in the session.

A. *Improving Undergraduate Stem Education (IUSE:EHR)*

The Improving Undergraduate STEM Education (IUSE) program was introduced in 2013 and includes the goals of past DUE programs (Transforming Undergraduate Education in STEM (TUES), WIDER, and STEM Talent Expansion Program (STEP)), among other goals. Recognizing that the preparation of a globally-competitive workforce, including future teachers, and a scientifically literate populace requires excellent STEM education. IUSE supports the improvement of the undergraduate STEM education enterprise through funding research on design, development, and wide-spread implementation of effective STEM learning and teaching knowledge and practice, as well as foundational research on student learning. IUSE supports projects that build on both fundamental research and development in undergraduate STEM education that provide theoretical and empirical justification for the proposed efforts. Proposals should describe projects that build on available evidence and theory, and that will generate evidence and further the state-of-the-art.

B. *Advanced Technological Education Program (ATE)*

The Advanced Technological Education Program involves partnerships between academic institutions and employers to promote improvement in the education of technicians at the undergraduate and secondary school levels. The ATE program supports curriculum development, professional development of college faculty and secondary school teachers, career pathways to two-year colleges from secondary schools and from two-year colleges to four-year institutions, and similar workforce development activities. The ATE program also supports targeted research on technician education, the changing role of technicians in the workplace, and other topics that advance the knowledge base needed to make technician education programs more effective and more forward-looking.

C. *NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM)*

A program is also available related to building student cohorts and organizational infrastructure in order to support degree attainment of meritorious STEM students. NSF's Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) Program makes grants to institutions of higher education to support scholarships for academically talented students demonstrating financial need, enabling them to enter the STEM workforce or STEM graduate school following completion of an associate, baccalaureate, or graduate-level degree in science, technology, engineering or mathematics disciplines. S-STEM projects can contribute to the knowledge base of scholarly research in education by carrying out research on factors that affect associate and baccalaureate degree attainment.

D. *Education Core Research (ECR) - EHR*

The Education and Human Resources (EHR) Core Research (ECR) program seeks proposals that will help synthesize, build and/or expand research foundations in the following core areas: STEM learning, STEM learning environments, workforce development, and broadening participation in STEM. ECR is an EHR directorate-wide

program. It accepts proposals with implications for and research with K-12, undergraduate and graduate student populations, of both formal and informal learning settings.

VII. NSF DIRECTORATE FOR ENGINEERING – DIVISION OF ENGINEERING EDUCATION AND CENTERS

Engineering Education and Centers (EEC) integrates disciplinary basic research and education into strategic frameworks critical to address societal grand challenges and to promote innovation. Also included are formal scholarly studies in engineering education and on how people learn, and investments in faculty, graduate and undergraduate students, post-doctoral scholars, and K-12 teachers. Current programs of particular interest to the engineering education community that will be addressed in the workshop are described below.

A. *Research Initiation in Engineering Formation (PFE:RIEF)*

The NSF Engineering (ENG) Directorate has launched a multi-year initiative, the *Professional Formation of Engineers*, to create and support an innovative and inclusive engineering profession for the 21st Century. Professional Formation of Engineers (PFE) refers to the formal and informal processes and value systems by which people become engineers. It also includes the ethical responsibility of practicing engineers to sustain and grow the profession. The engineering profession must be responsive to national priorities, grand challenges, and dynamic workforce needs; it also must be equally open and accessible to all.

The Professional Formation of Engineers: Research Initiation in Engineering Formation program enables engineering faculty who are renowned for teaching, mentoring, or leading educational reform efforts on their campus to initiate collaborations with colleagues in the social and/or learning sciences to address difficult, boundary-spanning problems in the professional formation of engineers.

B. *Research in the Formation of Engineers (RFE)*

The Research in the Formation of Engineers (RFE) program welcomes proposals that consider the construction of engineering knowledge, engineering identity, and the engineering profession, as well as interventions that expand the boundaries of each of these. Ultimately RFE aims to transform the engineering formation system, and thus the impact of proposed projects on this system must be described. PIs should provide a roadmap detailing how they envision the proposed research will eventually broadly impact practice within the engineering formation system, even if these activities are not within the scope of the submitted proposal.

C. *Education Broadening Participation in Engineering (BPE)*

The broadening participation in engineering program seeks to create a more inclusive engineering environment. It is well recognized that several groups are under-represented in the

engineering profession. Recognizing the value of diverse perspectives, BPE funds projects that support the increased participation of individuals who are members of under-represented populations. Examples of funded projects include workshops to explore the inhibitors to broadening participation, funding to support participation of diverse groups in professional conferences, and activities that provide mentoring to early career faculty.

VII. CROSS-DIRECTORATE PROGRAMS

A. *Faculty Early Career Development Program (CAREER)*

The CAREER Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations. Such activities should build a firm foundation for a lifetime of leadership in integrating education and research. NSF encourages submission of CAREER proposals from junior faculty members at all CAREER-eligible organizations and especially encourages women, members of under-represented minority groups, and persons with disabilities to apply.

B. *IUSE / Professional Formation of Engineers: REvolutionizing engineering and computer science Departments (RED)*

The Directorates for Engineering (ENG), Computer and Information Science and Engineering (CISE) and Education and Human Resources (EHR) are continuing a program aligned with the Improving Undergraduate STEM Education (IUSE) framework: *REvolutionizing engineering and computer science Departments (herein referred to as RED)*. This funding opportunity enables engineering and computer science departments to lead the nation by successfully achieving significant sustainable changes necessary to overcome longstanding issues in their undergraduate programs and educate inclusive communities of engineering and computer science students prepared to solve 21st-century challenges.

C. *NSF Innovation Corps (I-Corps)*

The NSF Innovation Corps (I-Corps™) involves a set of activities and programs that prepare researchers to extend their focus beyond the laboratory or classroom and broaden the impact of select NSF-funded projects. All NSF-funded projects are eligible for consideration in I-Corps, including education projects. I-Corps program provides support for teams of innovators to accelerate and scale up novel effective practices in a sustainable manner. Help for teams can take the form of workshops, mentoring, and participation in a cohort of like-minded innovators.

D. *Research Experiences for Undergraduates (REU)*

The Research Experiences for Undergraduates program supports active research participation by undergraduate students in any of the areas of research funded by the National Science Foundation. REU projects involve students in

meaningful ways in ongoing research programs or in research projects specifically designed for the REU program.

VII. COMMON GUIDELINES FOR EDUCATION RESEARCH AND DEVELOPMENT

The National Science Foundation and the Institute of Education Sciences in the U.S. Department of Education have released a collaborative publication, *Common Guidelines for Education Research and Development* [1]. The *Common Guidelines* document broadly describes six types of research studies. These research types include those that generate the most fundamental understanding related to education and learning; examinations of associations between variables; iterative design and testing of strategies or interventions; and assessments of the impact of a fully-developed intervention on an education outcome. For each research type, there is a description of the purpose and the expected empirical and/or theoretical justifications, types of project outcomes, and quality of evidence. The *Common Guidelines for Education Research and Development* offers guidance on building the evidence base in STEM learning. A set of Frequently Asked Questions (FAQs) regarding the *Common Guidelines* is available [2]. Grant proposal writers and principal investigators are encouraged to familiarize themselves with both documents and use the information therein to help in the preparation of proposals to NSF. The workshop will highlight essential aspects of these new guidelines.

VII. QUALIFICATIONS OF PRESENTERS

All the presenters in this session are program directors at the National Science Foundation. Each presenter has extensive experience in leading engineering education and research projects as well as engaging with students in and out of the classroom. The presenters work very closely in developing the STEM education funding programs at NSF. In particular, they are directly involved in writing the program solicitations, reviewing proposals, making funding recommendations, communicating expectations to principal investigators, and interacting with potential principal investigators.

VIII. INTENDED AUDIENCE

The anticipated audience of this session includes STEM educators who are interested in developing high-impact projects in STEM undergraduate education. This includes instructors, faculty members, and administrators at U.S. colleges and universities in the engineering, computing, and engineering education disciplines. The content of this session would be of interest to the broad FIE audience.

IX. KNOWLEDGE ATTENDEES WILL ACQUIRE

At the end of the session, participants will have extended their knowledge about NSF funding opportunities for undergraduate STEM education. In particular, the participants should be able to:

- Describe the goals, objectives, and scopes of the programs discussed;
- Identify the program(s) that fit their needs and interests;
- Develop high-impact project activities that support the goals of the opportunities; and
- Apply knowledge of revisions to the proposal preparation guidelines, review process, and project reporting requirements to develop responsive proposals.

Through the highly interactive and engaging activities, participants will have opportunities to increase their knowledge about NSF programs in STEM education, initiate new ideas in engineering education innovations and

research, clarify questions and misconceptions related to the opportunities discussed, and share ideas.

REFERENCES

- [1] NSF 13-126, Common Guidelines for Education Research and Development, A Report from the Institute of Education Sciences, U.S. Department of Education and the National Science Foundation, August 2013, <http://ies.ed.gov/pdf/CommonGuidelines.pdf> [accessed May 3, 2016].
- [2] NSF 13-127, Frequently Asked Questions (FAQs) for NSF 13-126, *Common Guidelines for Education Research and Development*, <http://www.nsf.gov/pubs/2013/nsf13127/nsf13127.jsp> [accessed May 3, 2016].