National Science Foundation-Opportunities and Resources
Programs of the Division of Undergraduate Education

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Abstract

The programs of the Division of Undergraduate Education (DUE) serve as the focal point for the National Science Foundation's efforts in undergraduate education. These programs and DUE's leadership efforts are directed at strengthening the vitality of undergraduate science, technology, engineering and mathematics (STEM) education for all students, including: majors in STEM disciplines; prospective K-12 teachers; students preparing for the technical workplace; and all students as citizens in a technological society.

The Division's grant programs sponsor projects in the two broad areas of curriculum development and workforce preparation. The scope and objectives of these programs are herein described. Some of these programs are congressionally mandated but administered by the Division. Greater attention is given to the Course, Curriculum and Laboratory Improvement Program that was developed by the Division to provide leadership and resources for the improvement of STEM education. Guidance is provided on how to prepare a successful proposal.

Introduction

DUE's grant programs generally fall into one of two broad categories; i.e., curriculum development or workforce preparation. Of the two, faculty members, particularly new faculty members, have historically shown greater interest in the former. Depending on the type of educational program being served, the Division administers two major programs: Course, Curriculum and Laboratory Improvement (CCLI) and Advanced Technological Education (ATE). These programs are described in detail below.

With two exceptions, the remainder of DUE's grant programs are directed at workforce preparation and expansion. The specific workforce preparation and expansion programs are: Computer Science, Engineering and Mathematics Scholarships (CSEMS); Federal Cyber Service: Scholarship for Service (SFS); Science, Technology, Engineering, and

Mathematics Talent Expansion (STEP); Teacher Professional Continuum (TPC); and Robert Noyce Scholarships. The TPC program is jointly managed by the Division of Elementary, Secondary, and Informal Education (EISE).

The two programs that do not fall exclusively in either the curriculum development and workforce preparation categories are the NSF Director's Award for Distinguished Teaching Scholars (DTS) and the National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL). The former program recognizes and rewards individuals who are both meritorious scholars and exemplary educators. The latter program aims to create, develop, and sustain a national digital library to serve as an online network of learning environments and resources for STEM education at all levels.

For completeness, brief descriptions of the workforce preparation/development programs are provided but with little or no discussion. These descriptions are taken directly from the DUE webpage (1). Detailed attention is given to the curriculum development programs and specific guidance on how to prepare a successful proposal is provided.

Workforce Preparation/Expansion Programs

Computer Science, Engineering and Mathematics Scholarships (CSEMS). This program supports scholarships for academically talented, financially needy students, enabling them to enter the high-technology workforce following completion of an associate, baccalaureate, or graduate-level degree in computer science, computer technology, engineering, engineering technology or mathematics. Academic institutions apply for awards to support scholarship activities and are responsible for selecting scholarship recipients.

Federal Cyber Service: Scholarship for Service (SFS). This program seeks to increase the number of qualified students entering the fields of information assurance and computer security and to increase the capacity of the United States higher education enterprise to continue to produce professionals in these fields. The program has two tracks: (i) the *Scholarship Track* provides funding to colleges and universities to award scholarships in information assurance and computer security fields and (ii) the *Capacity Building Track* provides funds to colleges and universities to improve the quality and increase the production of information assurance and computer security professionals.

Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP). This program seeks to increase the number of students (U.S. citizens or permanent residents) receiving associate or baccalaureate degrees in established or emerging fields within science, technology, engineering, and mathematics (STEM). Two types of proposals are solicited: *Type 1* proposals provide for full implementation efforts at academic institutions and *Type 2* proposals support educational research projects on associate or baccalaureate degree attainment in STEM.

Teacher Professional Continuum (TPC). Jointly managed by the Division of Elementary, Secondary, and Informal Education (ESIE) and the Division of Undergraduate Education (DUE), the TPC program addresses critical issues and needs regarding the recruitment, preparation, enhancement, and retention of science, technology, and mathematics (STM) teachers for grades K-12. Its goals are to improve the quality and coherence of the learning experiences that prepare and enhance STM teachers; to develop innovative resources that prepare and support STM teachers and school and district administrators; to research and develop models and systems that support the teacher professional continuum; to research teacher learning and its impact on teaching practice; and to disseminate this research as well as innovative models and resources to a national audience.

Robert Noyce Scholarship Program. This program seeks to encourage talented science, technology, engineering, and mathematics majors and professionals to become K-12 mathematics and science teachers. The program provides funds to institutions of higher education to support scholarships, stipends, and programs for students who commit to teaching in high-need K-12 schools.

Additional details concerning the scope and objectives of these programs are available through DUE's webpage (1). Deadlines for submission of proposals, program solicitations and related publications are posted on the webpage for each of the programs. Abstracts of previous awards can be accessed through DUE's Project Information Resource System (PIRS) (2). More details on this system and other DUE and NSF search engines will be described in a subsequent section of this paper.

NSF Director's Award for Distinguished Teaching Scholars (DTS)

The NSF Director's Award for Distinguished Teaching Scholars recognizes and rewards individuals who have contributed significantly to the scholarship of their discipline and to the education of students in science, technology, engineering, or mathematics (STEM), and who exemplify the ability to engage productively in both research and education.

This award is part of NSF's efforts to promote an academic culture that values a scholarly approach to both research and education. The Director's Award is the highest honor bestowed by NSF for excellence in both teaching and research in STEM fields, or in educational research related to these fields.

DTS awardees serve as excellent career models for young STEM educators. Names and disciplines along with links to project abstracts and other relevant publications can be accessed through the DUE webpage (1).

National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL)

Building on work supported under the multi-agency Digital Libraries Initiative, this program aims to establish a national digital library that will constitute an online network of learning environments and resources for science, technology, engineering, and mathematics (STEM) education at all levels. The program is organized into three tracks: (i) *Collections* projects are expected to aggregate and manage a subset of the library's content within a coherent theme or specialty. (ii) *Services* projects are expected to develop services that support users, collection providers, and the Core Integration effort and which enhance the impact, efficiency, and value of the library. (iii) *Targeted Research* projects are expected to explore specific topics that have immediate applicability to collections, services, and other aspects of the development of the digital library.

The NSDL Portal (3) provides links to a variety of resources that can assist STEM educators with their efforts in both teaching and research. Further, STEM students can benefit from the resources available via the portal.

Curriculum Development Programs

Advanced Technological Education (ATE). Jointly managed by the Division of Undergraduate Education (DUE) and the Division of Elementary, Secondary, and Informal Education (ESIE), the ATE program promotes improvement in technological education at the undergraduate and secondary school levels by supporting curriculum development; the preparation and professional development of college faculty and secondary school teachers; internships and field experiences for faculty, teachers, and students; and other activities. With an emphasis on two-year colleges, the program focuses on the education of technicians for the high-technology fields that drive our nation's economy. The program also promotes articulation between programs at two-year colleges and four-year colleges and universities--in particular, articulation between two-year and four-year programs for prospective teachers (with a focus on activities and disciplines that have a strong technological foundation) and between two-year and four-year programs in science, technology, engineering, and mathematics (also with a focus on disciplines that have a strong technological foundation).

Course, Curriculum, and Laboratory Improvement (CCLI). The CCLI program seeks to improve the quality of science, technology, engineering, and mathematics (STEM) education for all students, based on research concerning the needs and opportunities that exist and effective ways to address them. It targets activities affecting learning environments, course content, curricula, and educational practices, with the aim of contributing to the relevant research base. The program has four tracks:

1. **Educational Materials Development (CCLI-EMD)** projects are expected to produce innovative materials that incorporate effective educational practices to improve student learning of STEM. Projects to develop textbooks, software or laboratory materials for commercial distribution are appropriate. Two types of EMD projects are supported: those that intend to demonstrate the scientific and

educational feasibility of an idea, a "proof of concept" or prototype and those based on prior experience with a prototype that intend to fully develop and test the product or practice. Such materials are expected to be disseminated nationally for adoption and adaptation.

2. **National Dissemination (CCLI-ND)** projects are expected to provide faculty with professional development opportunities to enable them to introduce new content into undergraduate courses and laboratories and to explore effective educational practices to improve the effectiveness of their teaching. Projects should be designed to offer workshops, short courses, or similar activities on a national scale in single or multiple disciplines.

3. **Adaptation and Implementation (CCLI-A&I)** projects are expected to result in improved education in STEM at academic institutions through adaptation and implementation of exemplary materials, laboratory experiences, and/or educational practices that have been developed and tested at other institutions. Proposals may request funds in any budget category supported by NSF, or may request funds to purchase only instrumentation.

4. **Assessment of Student Achievement (CCLI-ASA)** projects are expected to develop and disseminate assessment practices, materials (tools), and measures to guide efforts that improve the effectiveness of courses, curricula, programs of study, and academic institutions in promoting student achievement, particularly in STEM. This program track also promotes the full integration of assessment with these educational efforts. Projects may be integrated with research on learning, particularly research focused in the STEM disciplines. Three types of ASA projects are supported: (i) *Development:* developing and validating new assessment materials (tools) and practices for use in single or multiple undergraduate disciplines; (ii) Adaptation*:* adapting assessment materials and practices that have proven effective for one setting or audience for use in a new setting or with a different audience; and (iii) *Dissemination:* spreading the use of effective assessment practices through workshops or Web-based materials that have been validated and are thoroughly documented with detailed instructions.

Guidelines for Proposal Preparation

New engineering educators are most likely to be successful by proposing "proof of concept" projects in the CCLI Engineering Materials Development track or the CCLI Adaptation and Implementation track projects. NSF program officers often conduct proposal preparation workshops at the Annual ASEE and Frontiers in Education Conferences. Participation in such a workshop greatly enhances the likelihood of success. Serving on a NSF panel to review proposals for any of the previously described programs will also provide first-hand insight into what constitutes a successful proposal. Individuals who would like to serve as a panelist should send an email request with an attached one or two page biographical sketch to an appropriate program officer in the Division of Undergraduate Education.

In preparing a proposal, it is vital to recognize the criteria upon which proposals will be judged. NSF has established two primary criterions for judging the quality of proposals. These are termed the NSF Merit Review Criteria (4) and are listed below. Following each criterion are potential considerations that reviewers may employ in their evaluation. These are suggestions and not all will apply to any given proposal. Each reviewer will be asked to address only those that are relevant to the proposal and for which he/she is qualified to make judgments.

Criterion 1: What is the intellectual merit of the proposed activity?
How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

Criterion 2: What are the broader impacts of the proposed activity?
How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

In addition, proposals should address the following elements in their proposal to provide reviewers with the information necessary to respond fully to the above-described NSF merit review criteria. NSF staff gives these elements careful consideration in making funding decisions.

Integration of Research and Education. One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students, and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities.
Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- are essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

Here are some guidelines, which if followed, will result in a more competitive proposal. First, some general suggestions:

- Get started early
- Get acquainted with FastLane
- Read the " Program Announcement/Solicitation" and <u>follow</u> the guidelines
- Determine which program best fits your idea
- Learn about the recent DUE awards & request copies of the proposals from the PIs
- Contact (*e-mail* is best) a program officer to discuss your idea; this often helps you to refine your idea and may prevent you from applying to the wrong program
- Subscribe to Custom News Services at NSF –<u>http://www.nsf.gov/home/cns/</u>

To be competitive, the proposal must:

- Be based on original and/or sound ideas
- Have a clearly defined scope of work and set of measurable outcome objectives
- Have a focused project plan in sufficient detail
- Require a realistic amount of work within budget constraints
- Be cost effective with evidence of potential high impact
- Demonstrate the likelihood that the project will be sustained
- Include a solid assessment and evaluation plan linked to project objectives

In writing a proposal, careful attention should be given to the following considerations:

- Clearly state what you want to do and why
- Identify your audience
- Identify specific tasks and provide a timeline
- Cite similar efforts in the literature
- Provide results from own prior funding (if applicable)
- Address broader impacts in some detail
- Include a dissemination plan

Careful attention to details and completeness can often be the difference between a declination and an award. Here are some matters that should be considered in preparing a proposal.

- Follow the NSF Grant Proposal Guide (GPG)
- Strictly adhere to the page and font-size limits
- Make budget directly reflect work plan
- Provide biosketches for all personnel
- Attach letters of commitment outlining specific contributions-general litters of support without commitment of resources (actual or in-kind) carry little weight

- The project summary must include explicit ***intellectual merit and broader impact*** statements
- Ensure that the "Pending and Current Support" forms are compatible with the budget and budget justification-the forms should list the proposed project as pending

NSF Resources

A tremendous amount of information is made available by NSF that can aid individuals in both their teaching and grantmanship efforts. This information can be accessed through the NSF website (5) and/or the DUE webpage (1). The latter provides users with access to a PIRS search engine (2) referred to earlier in this paper. PIRS serves as a gateway to award abstracts and other information about projects supported by the DUE. Through PIRS, principal investigators (PIs) are able to post up-to-date information about their project activities and results. The PIRS database is searchable by PI name, awardee organization, DUE program, project discipline, abstract keywords, and other criteria. In addition:

- DUE's ***Simple Award Search*** tool will generate lists of awards made in DUE programs. The search can be restricted by NSF award number, start date, expiration date, investigator (PI or co-PI), awardee organization, and program. For CCLI program awards made in the FY2000 competition (proposal deadline June 7, 1999) and later, the search can also be restricted to individual disciplines.

- DUE's ***Simple Award List*** tool will generate a list of awards (sorted by NSF award number) for any DUE program. A list of awards that are currently active in the program, those that were active during a given fiscal year, or those that began during a given fiscal year can be produced.

NSF-wide search engines are also described and accessible through a DUE webpage. These search engines permit the following:

- The ***Quick Search*** tool can perform full-text searches on the award records, including abstracts, in NSF's database.

- The ***Fielded Search*** tool can restrict your search criteria to specific fields in the database, and to use date and numeric ranges.

Conclusions

The Division of Undergraduate Education of the National Science Foundation is a valuable resource for new engineering educators both in terms of information and funds to support curricular development or workforce preparation efforts. To meet the challenges of educating STEM students for the 21st Century, teaching and learning systems need to be more efficient and effective. Therefore, it is important that new

engineering educators view teaching and research as complementary rather than separate activities. The future demands that these activities be integrated both to improve the educational enterprise and student learning. DUE offers programs that can help faculty members achieve this balance in their academic careers.

Bibliography

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Biography

Roger K. Seals, PE, is a Program Director in the Division of Undergraduate Education at the National Science Foundation. He is on an IPA appointment from the Department of Civil and Environmental Engineering at Louisiana State University.