

OneNSF INVESTMENTS

E²: EXPEDITIONS IN EDUCATION

OVERVIEW

Expeditions in Education (E²) is an NSF initiative to infuse cutting-edge science, engineering, and innovation into the preparation of a world-class scientific workforce for the twenty-first century, and to ensure that all of NSF's education and workforce investments are drawing on the latest educational theory, research, and evidence. The initiative will draw in new ideas on the best and most exciting of NSF-supported scientific advances and knowledge.

The resources committed to E² in FY 2013 will be used to develop pilot activities among all NSF directorates and offices to engage, empower, and energize learners in science, technology, engineering, and mathematics (STEM). This initiative is planned to last five years with planning beginning in FY 2012; pilot activities will be launched in FY 2013; and further shaping and definition will occur in FYs 2014-2017. Additional focus areas may emerge over time.

Goals

E² activities will integrate STEM education research and development to improve learning in science and engineering disciplines and capitalize on the scientific assets across NSF to bring engaging new evidence-based practices, content, knowledge, and real-world applications to more learners.

Scope

The E² initiative brings the educational and research missions of NSF together to consolidate, leverage, and focus efforts to “move the dial” towards achieving important national goals in STEM education and human capital development. E² encompasses all of the science and engineering fields that NSF funds to develop approaches to engaging all citizens in STEM in both formal and informal settings. As such it involves multiple directorates and offices in each of the three focus areas: Transforming Undergraduate STEM Learning through Science and Engineering, Learning and Understanding Sustainability and Cyberlearning, Data and Observations of STEM Education. E² is a research-intensive activity and the goal for all components must be to address a challenge in STEM learning or education using current or emerging areas of science. This will require disciplinary and interdisciplinary collaboration among cognitive scientists, STEM education researchers, and disciplinary researchers.

Organizational Structure

The E² initiative will be managed jointly, with the research directorates/offices leading areas in their disciplines and EHR providing coordination, evidence-based practices, and evaluation expertise. Research directorates and offices will participate in E² by providing funds to jointly support the R&D projects and by re-defining ongoing R&RA-based education efforts to fit within E² and consolidating efforts where appropriate and advantageous. To facilitate its coordination and evaluation role, EHR will make available expert staff liaisons to link to other directorates, divisions, and offices.

A Dear Colleague Letter will be issued in FY 2013 to invite proposals for each of the three focus areas, calling attention to the programs across NSF that are part of the portfolio. Within each program announcement for this set, the E²-specific expectations and language will be included. Review and award decisions will be undertaken as a joint effort among all participating directorates and offices. EHR will match financial and staffing commitments made by the other directorates and offices for FY 2013 E² activities. All projects funded across the Foundation within the E² initiative in FY 2013 will become part of a phase-one E² portfolio that will be managed jointly.

This portfolio will be subject to a set of common metrics, common data collection and reporting standards, and a comprehensive rigorous evaluation. A set of E² draft guiding principles is under development in FY 2012 to define what will constitute an E² activity. These principles will be refined over time as the E² activity matures, and will be central to the Dear Colleague Letter.

Approach

The Nation's capacity for innovation and global competitiveness depends on a science and engineering workforce well prepared for the twenty-first century and a citizenry that is science-literate. This means ensuring that learners have access to current science and opportunities to glimpse the frontiers. E² investments will leverage two important assets of NSF:

- Research that is transforming the frontiers of science and engineering and leading to innovation for society; and
- Research and development to improve STEM teaching and learning for the twenty-first century.

The E² vision is to *engage, empower, and energize* America's populace with STEM and to help create tomorrow's STEM leaders. *Engagement*, in part through the exciting content of NSF-funded research programs, will bring learners at all levels, in both formal and informal settings, into evidence-driven educational environments and settings. There they can be *empowered* through evidence-based instruction, and innovative curricular offerings. NSF-wide educational programs will provide tested models for potential national-scale transformation to *energize* tomorrow's STEM workforce, creating deeper levels of knowledge and more dynamic pathways to economic innovation across U.S. society.

Over time, E² will transform NSF's education portfolio into a coordinated and strategic set of investments spanning: basic research and theory about STEM learning; design, implementation, and assessment of models for STEM learning and workforce development; evidence-based models for building institutional and human capacity; and innovative approaches to adaptation and scale-up. Collaboration and coordination among all directorates and offices will lead to a systemic and coherent NSF approach to improved learning in the science and engineering disciplines that capitalizes on the scientific assets across NSF. In addition to the programmatic activity of E², the re-envisioning of the EHR Directorate proposed for FY 2013 is intended to provide a full set of core investments in STEM education R&D.

The E² approach will evolve in three stages: conceptualization and planning (underway in FY 2012); pilot effort in three focus areas (FY 2013); longer-term structure, evaluation, and expansion to enhance NSF encouragement of cross-disciplinary science in STEM education and learning (FYs 2013-2017).

INVESTMENT FRAMEWORK

FY 2012

In FY 2012 planning efforts are underway, beginning with establishing the baseline portfolio of NSF investment in the three E² focus areas (undergraduate STEM education, sustainability, and cyberlearning/data). Town hall meetings, focus groups, and webinars will be held internally and with the PI community to determine interest and capacity in the field and the agency to sharpen the focus areas. An investment framework and operational roadmap for E² in FY 2013 will be developed by a committee of program officers.

Evaluation planning also will begin in FY 2012.

FY 2013 Request

In FY 2013, E² will comprise three initial focus areas:

1. Transforming Undergraduate STEM Learning through Science and Engineering

This focus area will bring evidence-based practices in teaching, learning, assessment, and research to undergraduate science and engineering education across disciplines, and will enrich the undergraduate curriculum so that all students can have access to inspiring and authentic science learning opportunities. Goals include actively engaging students in the science and engineering enterprise to prepare them either as practitioners or science-savvy citizens, and the initiative will emphasize undergraduate student research and preparation for graduate studies in STEM. As solicitations are developed, principal investigators (PIs) will be asked to frame a major question that they will pursue through their research, such as “How can introductory courses in the physical sciences (both disciplinary and interdisciplinary) be effectively re-imagined and re-designed to put undergraduate research experiences at the center, as a means of enabling more students to continue in STEM and perhaps consider graduate school?” Parallel efforts by STEM education researchers will build theory and knowledge about the impact of such experiences on learners and faculty. An emphasis will be placed on programs that have the potential to be scaled up nationally and potentially affect national statistics for STEM student retention and other important outcome indicators. This will build on several core programs in EHR, such as Transforming Undergraduate Education in STEM (TUES), STEM Talent Expansion Program (STEP), and other learning programs across the agency. For example, the Directorate for Biological Sciences (BIO) will develop a portfolio of investments to catalyze and support the implementation of improvements in undergraduate biology education through the Transforming Undergraduate Biology Education (TUBE) program.

2. Learning and Understanding Sustainability

In this focus area we will build on current investments in Science, Engineering and Education for Sustainability (SEES) about sustainability. SEES programs, including the Sustainability Research Network (SRNs), are creating new interdisciplinary learning experiences for graduate and undergraduate students as well as literacy programs. The ongoing Climate Change Education program (CCE) that is directed toward K-12 levels will be included in this portfolio beginning in FY 2013. Within this E² focus we will draw in new ways on the assets and science underway in NSF facilities and centers to bring meaningful data and current scientific practice to learners. Participating programs will reframe solicitations to ask PIs to identify a major learning question that they will pursue in the area of sustainability education (e.g., How do students develop systems thinking skills? Does undergraduate student participation in sustainability research lead to greater interest in STEM careers? Can research centers that focus on sustainability effectively integrate education and public outreach components and demonstrate impact on learning?). This element will place particular emphasis on the role of interdisciplinary science and engineering in transforming learning outcomes at the national scale, with strong partnership between EHR and participating research directorates and offices.

3. Cyberlearning, Data, and Observations for STEM Education

Modern research in science and engineering generates substantial volumes of data. Increasingly, these data are dynamic and are delivered in real-time through observatories, such as the Ocean Observatories Initiative (OOI) and the National Ecological Observatory Network (NEON), and many other large facilities and major research centers supported by NSF. Most of these facilities and centers invest in education and outreach, but the activities are not always fully integrated into NSF education efforts. NSF-funded Research in cyberlearning, funded in several NSF directorates, is advancing learning using tools for networking, visualization, and other capabilities. For example,

BIO will likely support this focus area to increase its investment in education/workforce development activities at its Centers for Analysis and Synthesis, NEON and in major Advances in Biological Informatics (ABI) investments. Leveraging the data generated by major facilities and centers with the advancements being made in cyberlearning research has the potential to greatly enhance the STEM learning experience. For example, cyber-enabled simulation and data-intensive virtual labs at the secondary and undergraduate level could be developed with the integration of data from major NSF facilities. Additionally, mechanisms could be developed for the submission of samples gathered in K-12 or informal science education settings by scientists with the data processed using instruments based at NSF-funded facilities and university labs. The overall goal of this activity is to address the many questions associated with how STEM learning can be enhanced and how new content can be introduced using these new cyberlearning resources and tools. For example, "what are the premier approaches to pedagogy and faculty development for the "connected" age, and how can these technologies be used to advance a diverse workforce for science and engineering, build a science-savvy populace, or derive value from citizen science?"

The first phase of investments, totaling \$49.0 million, within the E² frame will begin in FY 2013.

FY 2014 – FY 2017

By FY 2017, as a result of increasing scope and experience with E², the following specific outcomes are anticipated:

- As noted in the EHR chapter, the EHR portfolio is being reframed to have clear emphasis on a set of core research and development (R&D) activities that provide the intellectual foundation for STEM learning and a set of highly-successful and strongly-leveraged E² partnerships with the research directorates and offices.
- EHR's STEM education and workforce development portfolio is distinguished from that of other agencies, particularly the U.S. Department of Education, by an emphasis on the learning opportunities in frontier science and the emerging practice of science for the twenty-first century. The STEM education and workforce programs across NSF are conceptualized and managed in partnership with EHR.
- NSF's scientific staff includes a set of individuals, based both in EHR and in other parts of the agency, with formal expertise, training, or experience at the national level in STEM education learning research.
- The E² initiative will become the agency's signature vehicle for presenting a coherent and exciting set of opportunities in STEM learning investments with an emphasis on well-evaluated learning outcomes for programs that have the potential to operate at the national scale. .

EHR, over the next five fiscal years, will include a stronger and more deliberate infusion of cutting-edge science, engineering, and innovation in all programs designed to prepare a world-class scientific workforce for the twenty-first century. E² also will lead to changes in the education investments made within NSF's research directorates and offices by enabling much stronger connections to the existing base of research and theory about STEM learning and stronger evaluation of STEM education activities lead by EHR.

Expeditions in Education (E²) Funding

(Dollars in Millions)

Directorate/ Office	FY 2011 Actuals	FY 2012 Estimate	FY 2013 Request	Focus Area
BIO	-	-	\$2.00	Transforming Undergraduate STEM Learning through Science and Engineering
CISE	-	-	4.00	Cyberlearning, Data, and Observations for STEM Education
ENG	-	-	1.00	Cyberlearning, Data, and Observations for STEM Education
GEO	-	-	12.00	\$6M- Transforming Undergraduate STEM Learning through Science and Engineering, \$6M- Learning and Understanding Sustainability
MPS	-	-	5.00	\$2M- Transforming Undergraduate STEM Learning through Science and Engineering, \$3M- Cyberlearning, Data, and Observations for STEM Education
SBE	-	-	1.00	Cyberlearning, Data, and Observations for STEM Education
OCI	-	-	1.50	Cyberlearning, Data, and Observations for STEM Education
OISE	-	-	0.50	Cyberlearning, Data, and Observations for STEM Education
OPP	-	-	1.50	Learning and Understanding Sustainability
IA	-	-	-	
EHR	-	-	20.50	\$8M- Transforming Undergraduate STEM Learning through Science and Engineering, \$8.17M- Learning and Understanding Sustainability, \$4.33M- Cyberlearning, Data, and Observations for STEM Education
Total, NSF	-	-	\$49.00	

Totals may not add due to rounding.

EVALUATION FRAMEWORK

A single evaluation and monitoring framework will be developed for the E² activity, with customization as appropriate underneath each focus area. The following are additional details about what activities will be undertaken each year.

FY 2012

- Establish the unifying goal and framework and clarify sub-goals within each focus area;
- Develop roadmaps and a logic model for each focus under the unifying framework;
- Identify metrics to be used in common across focus areas;

- Develop indices to estimate interdisciplinary scope;
- Align evaluation and monitoring processes with E² metrics; and
- Undertake feasibility studies for evaluation planning in **E² Cyberlearning, Data, and Observations for STEM Education** focus area.

FY 2013

- Use roadmaps and logic models to determine implementation plans and activities;
- Establish evaluation contract for all E² activity;
- Assure that baseline data is collected for **E² Transforming Undergraduate STEM Learning through Science and Engineering** focus area;
- Incorporate E² focus on undergraduate transformation in planning for FY 2013 NSF priority goal on undergraduate instruction as the evaluation baseline;
- Determine longer-term goals for E² impact on EHR and R&RA programs;
- Develop baseline data gathering plan for **E² Learning and Understanding Sustainability** focus area; and
- Launch evaluation studies of **E² Cyberlearning, Data, and Observations for STEM Education** focus area.

FY 2014 – 2017

- Launch a comprehensive evaluation of impacts on NSF's undergraduate education investments;
- Continue long-term monitoring and focus area evaluations;
- Create a plan and begin implementation for studying impact on EHR programs and R&RA programs; and
- Refine E² investments based on data; and
- Launch evaluation of **E² Learning and Understanding Sustainability** focus area.