This solicitation has been archived and replaced by NSF 20-612.

Cyberlearning for Work at the Human-Technology Frontier

PROGRAM SOLICITATION
NSF 17-598

REPLACES DOCUMENT(S):
NSF 17-520

National Science Foundation

Directorate for Computer & Information Science & Engineering

Directorate for Education & Human Resources

Directorate for Engineering

Directorate for Social, Behavioral & Economic Sciences

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

January 08, 2018

Second Monday in January, Annually Thereafter

IMPORTANT INFORMATION AND REVISION NOTES

Please note that the solicitation has been substantially revised. The main revisions are:

- New added focus for cyberlearning within the context of work at the human-technology frontier;
- The Exploratory (EXP) category is no longer relevant as all proposals should be exploratory in nature;
- Projects will be funded up to a total of $750,000 per project;
- All proposals must have innovations in both technology and learning;
- Advisory boards are optional and no longer required;
- There are fewer required sections in the Project Description;
- Special award conditions are no longer specified; and
- Solicitation-specific review criteria are no longer specified.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 19-1), which is effective for proposals submitted, or due, on or after February 25, 2019.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Cyberlearning for Work at the Human-Technology Frontier

Synopsis of Program:

The purpose of the *Cyberlearning for Work at the Human-Technology Frontier* program is to fund exploratory and synergistic research in learning technologies to prepare learners to excel in work at the human-technology frontier. This program responds to the pressing societal need to educate and re-educate learners of all ages (students, teachers and workers) in science, technology, engineering, and mathematics (STEM) content areas to ultimately function in highly technological environments, including in collaboration with intelligent systems. Innovative technologies can reshape learning processes, which in turn can influence new technology design. Learning technology research in this program should be informed by the convergence of multiple disciplines: education and learning sciences, computer and information science and engineering, and cognitive, behavioral and social sciences. This program funds learning technology research in STEM and other foundational areas that enable STEM learning.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of

contact.

- For program inquiries please contact, telephone: N/A, email: Cyberlearning-WHTF@nsf.gov

- Tatiana Korelsky, co-lead CISE, CISE/IIS, telephone: (703) 292-8930, email: tkorelsk@nsf.gov

- Amy L. Baylor, co-lead EHR, EHR/DRL, telephone: (703) 292-5126, email: abaylor@nsf.gov

- John Cherniavsky, Senior Advisor, EHR/DRL, telephone: (703) 292-5136, email: jchernia@nsf.gov

- Dan R. Cosley, Program Director, CISE/IIS, telephone: (703) 292-8491, email: dcosley@nsf.gov

- Soo-Siang Lim, Program Director, SBE/BCS, telephone: (703) 292-7878, email: slim@nsf.gov

- Julie Martin, Program Director, ENG/EEC, telephone: (703) 292-8657, email: julmarti@nsf.gov

- Robert Russell, Program Officer, EHR/DRL, telephone: (703) 292-2995, email: rlrussel@nsf.gov

- Chia Shen, Program Officer, EHR/DRL, telephone: (703) 292-8447, email: cshen@naf.gov

- Maria Zemankova, Program Officer, CISE/IIS, telephone: (703) 292-7348, email: mzemanko@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.041 --- Engineering
- 47.070 --- Computer and Information Science and Engineering
- 47.075 --- Social Behavioral and Economic Sciences
- 47.076 --- Education and Human Resources

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 20

Contingent upon availability of funds.

Anticipated Funding Amount: $15,000,000

Each project will be funded for a duration of 2 to 3 years and up to a total funding amount of $750,000.

Eligibility Information

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

An individual may participate as PI or co-PI in **no more than a total of two (2)** proposals in response to this solicitation. In the event that an individual exceeds the limit for this solicitation, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e. the first two proposals received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required

- **Preliminary Proposal Submission:** Not required

- **Full Proposals:**

  - Full Proposals submitted via FastLane: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

- Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
- Full Proposals submitted via Grants.gov: *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov* guidelines apply (Note: The *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

  Not Applicable

- **Other Budgetary Limitations:**

  Not Applicable

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  January 08, 2018

  Second Monday in January, Annually Thereafter

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria apply.

Award Administration Information

Award Conditions:

Standard NSF award conditions apply.

Reporting Requirements:

Standard NSF reporting requirements apply.

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I. INTRODUCTION

New and emerging technologies have the potential to expand and transform learning and educational opportunities and outcomes for learners and workers of all ages, making it possible to adapt to their interests, needs, prior knowledge and available resources. This program responds to the pressing societal need to educate and re-educate learners of all ages to ultimately function in highly technological environments, including in collaboration with intelligent systems (see [1], [2], [3], [4], [5]). New skills are necessary for successful collaborative work in new industrial and commercial environments, including working with technologies that augment human capabilities.

The goal of *Cyberlearning for Work at the Human-Technology Frontier* program is to support transformative advances of technologies for learning to educate a new generation of students, teachers, and workers to excel or re-engage in highly technological and collaborative environments that require foundational STEM content knowledge. An important direction of this program is to foster lifelong learning with and through technology, particularly in preparation for and within the context of the work setting. This program invites transformative proposals that integrate advances in what is known about how people learn (individually and in groups) with the opportunities offered by new and emerging technologies such as artificial intelligence (AI) and virtual or augmented environments to prepare future learners and workers across the lifespan, in formal and informal settings.

[1] National Academies of Sciences, Engineering, and Medicine. 2017. *Information Technology and the U.S. Workforce: Where Are We and Where Do We Go from Here?*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24649.

[2] *Preparing for the Future of Artificial Intelligence*, CreateSpace Independent Publishing Platform, ISN-10: 1544643136, ISBN-13: 978-1544643137.

[3] *Artificial Intelligence, Automation, and the Economy*, CreateSpace Independent Publishing Platform, ISBN-10:1544643535, ISBN-13: 978-1544643533.

[4] National Academies of Sciences, Engineering, and Medicine. 2017. *Building America's Skilled Technical Workforce.* Washington, DC: The National Academies Press. https://doi.org/10.17226/23472.

[5] National Academies of Sciences, Engineering, and Medicine. 2016. *Promising Practices for Strengthening the Regional STEM Workforce Development Ecosystem*. Washington, DC: The National Academies Press. https://doi.org/10.17226/21894.

II. PROGRAM DESCRIPTION

The *Cyberlearning for Work at the Human-Technology Frontier* program supports learning technology (or cyberlearning) research that integrates both learning and technological goals to enable radical improvements in learning within educational and work environments. Cyberlearning research in this program should be informed by the convergence of multiple disciplines: education and learning sciences, computer and information science and engineering, and cognitive, behavioral and social sciences.

This program solicits projects that are **exploratory and experimental** in nature. These projects should explore proof-of-concept or feasibility of a novel or innovative learning technology. We encourage projects that try out new ideas, especially risky ones.

A primary goal of the program is to investigate innovative technologies for **STEM learning and teaching** within the educational and work settings, to include pervasive lifelong learning with technology. Within this program, the scope of projects span across:

- *Content area:* STEM and other foundational areas supported by NSF that enable STEM learning (e.g., self-regulation, literacy, communication, collaboration and social skills).

- *Population and context*: learners, teachers and workers in formal or informal settings (e.g., workplace, online, classroom, museums); and individual, collective, and collaborative learning across the lifespan.

In the **context of work**, we encourage projects that: (1) design and develop future learning environments to educate or re-educate workers for new work environments and experiences in collaboration with advanced technology; (2) develop relevant formal and informal learning experiences as well as just-in-time training on the job; (3) support the needs of diverse workers from a broad set of backgrounds and experiences; and (4) support the future work of teachers in classrooms and other related settings.

All projects must address a learning need or opportunity within the educational or work context and must have integrated learning and technology goals (see below), convergent with the computer and information sciences, engineering, and/or social sciences. Innovative technologies can reshape learning processes, which in turn can influence new technology design.

Learning and educational goals: to investigate learning processes and principles (e.g., cognitive, neurobiological, behavioral, affective, cultural, social, volitional, epistemological, developmental and other perspectives) relevant for the proposed learning technology innovation. The learning goals should advance education and learning sciences.

Technology goals: to introduce new or emerging technologies within the learning or work context (e.g., intelligent tutoring and other AI technologies, virtual or augmented environments, human-technology partnerships, socio-technical integration within learning environments, multimodal modeling and sensing of cognitive or emotional states, natural language and multimodal interfaces, embodiment, and learning analytics). The technology goals should advance the fields of computer science, information science, and/or engineering.

Incremental advances in existing technologies will not be funded through this program; rather, proposals must aim to lay the foundations for designing or refining new and emerging learning technology innovations.

Additionally, projects that are **not** a fit for this program include those:

- That simply focus on making teaching easier;

- That aim simply to implement and evaluate a software application or technology in support of a specific course;

- That are primarily technology-enabled teaching or technology-enabled research on learning;

- Where students learn to use technology; and

- That are primarily about educational impact in the here and now (implementation projects).

For such projects, please see NSF programs within the Directorates for Computer and Information Science and Engineering (CISE) https://www.nsf.gov/funding/pgm_list.jsp?org=CISE and Education and Human Resources (EHR) https://www.nsf.gov/funding/pgm_list.jsp?org=EHR.

III. AWARD INFORMATION

Approximately $15 million is anticipated to fund proposals for durations of 2 to 3 years and up to a total funding amount of $750,000 per project.

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

The categories of proposers eligible to submit proposals to the National Science Foundation are identified in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG), Chapter I.E.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 2

An individual may participate as PI or co-PI in **no more than a total of two (2)** proposals in response to this solicitation. In the event that an individual exceeds the limit for this solicitation, proposals received within the limit will be accepted based on earliest date and time of proposal submission (i.e. the first two proposals received will be accepted and the remainder will be returned without review). **No exceptions will be made.**

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via FastLane, Research.gov, or Grants.gov.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal & Award Policies & Procedures Guide*

(PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full Proposals submitted via Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the *NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov*. The complete text of the *NSF Grants.gov Application Guide* is available on the Grants.gov website and on the NSF website at: (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.C.2 for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the PAPPG instructions.

The following information SUPPLEMENTS (does not replace) the guidelines provided in the NSF Proposal & Award Policies & Procedures Guide (PAPPG) and the NSF Grants.gov Application Guide.

Project Description: Project Descriptions must include the following content:

1. A description of the vision and cyberlearning innovation, including the:
   - Learning need or opportunity within the educational or work context;
   - Technological state-of-the-art; and
   - Ultimate vision and justification for the cyberlearning innovation.
2. A description of the proposed methodology, including:
   - Research questions based on the interdisciplinary foundations, to include the learning and computer and information sciences;
   - A research plan articulating the research design, measures, data collection, and analysis methods;
   - A formative evaluation (note that a formative evaluation is encouraged; a summative evaluation is not required); and
   - Up to five diagrams or screen shots in Special Information/Supplementary Documentation (see below) to illustrate the learner or worker experience with the technology.
3. A separate section describing Results from Prior NSF Support, as per the PAPPG.
4. A separate section describing Broader Impacts, as per the PAPPG.

Special Information/Supplementary Documentation: *The following supplementary documents **are required** and should be uploaded into the Supplementary Documentation Section. **No other supplementary materials are allowed.**

1. *List of Project Personnel and Partner Institutions (Note - In collaborative proposals, only the lead institution should provide this information):* Provide current, accurate information for **all personnel and institutions involved in the project.** NSF staff will use this information in the merit review process to manage conflicts of interest. The list should include all PIs, Co-PIs, Senior Personnel, paid/unpaid Consultants or Collaborators, Subawardees, and Postdocs. This list should be numbered, in alphabetical order by last name, and include for each entry (in this order) Full name, Organization(s), and Role in the project, with each item separated by a semi-colon. Each person listed should start a new numbered line. For example:

   1. Mary Adams; XYZ University; PI
   2. John Brown; University of PQR; Senior Personnel
   3. Jane Green; XYZ University; Postdoc
   4. Bob Jones; ABC Inc.; Paid Consultant
   5. Tim White; ZZZ University; Subawardee

2. *Documentation of Collaborative Arrangements of Significance to the Proposal through Letters of Collaboration:* There are two types of collaboration, one involving individuals/organizations that are included in the budget, and the other involving individuals/organizations that are not included in the budget. Collaborations that are included in the budget should be described in the Project Description. Any substantial collaboration with individuals/organizations not included in the budget should be described in the Facilities, Equipment and Other Resources section of the proposal (see PAPPG Chapter II.C.2.i). Whether or not the collaborator is included in the budget, a letter of collaboration from each named participating organization other than the submitting lead, non-lead, and/or subawardee institutions must be provided at the time of submission of the proposal. Such letters simply confirm the commitment to collaborate, as illustrated in the recommended format provided in the PAPPG. They must explicitly state the nature of the collaboration, appear on the organization's letterhead and be signed by the appropriate organizational representative. These letters must not otherwise deviate from the restrictions and requirements set forth in PAPPG Chapter II.C.2.j.

Please note that letters of support may not be submitted. Such letters do not document collaborative arrangements of significance to the project, but primarily convey a sense of enthusiasm for the project and/or highlight the qualifications of the PI or co-PI. Reviewers will be instructed not to consider these letters of support in reviewing the merits of the proposal.

3. *Diagrams and/or screen shots:* Up to five (5) diagrams or screen shots that will help readers grasp the envisioned experiences of learners or workers interacting with the proposed technological innovation may be submitted. Short captions that name the diagram or screen shot and point to its essential elements are allowed; **additional textual material is not allowed with the diagrams**.

4. *Collaboration and Management Plan:* A Collaboration and Management Plan is required for all proposals. **Proposals missing a Collaboration and Management Plan will be returned without review.** Up to 3 pages are allowed for this plan. The plan must describe the interdisciplinary project team that reflects the convergent disciplines represented in the project. This may include paid or unpaid consultants or collaborators. For proposals that address learning within the work context, we encourage including a relevant industry participant or consultant. Information should include:

   1. The collaborators, their expertise, and the specific roles of each in the proposed project; and
   2. Coordination mechanisms that will enable scientific integration across the multi-disciplinary project team.

5. *Postdoctoral Researcher Mentoring Plan:* Proposals that include funding to support postdoctoral researchers must include a Postdoctoral Researcher Mentoring Plan as supplementary documentation. See Chapter II.C.2.j of the PAPPG for further information about the implementation of this requirement. **Proposals that require this plan and do not include it will be returned without review.**

6. *Data Management Plan:* All proposals must include a Data Management Plan or assert the absence of the need for such a plan. A Data Management plan specifies the procedures you will use for keeping, storing, and sharing ***data*** with other researchers. Data Management Plans should also include the method for making the data anonymous. FastLane will not permit submission of a proposal that is missing a Data Management Plan. The Data Management Plan will be reviewed as part of the intellectual merit or broader impacts of the proposal, or both, as appropriate. See Chapter II.C.2.j of the PAPPG for further information about the implementation of this requirement. For Directorate specific guidance on Data Management Plans see https://www.nsf.gov/bfa/dias/policy/dmp.jsp.

Single Copy Documents:

Collaborators and Other Affiliations Information: Proposers should follow the guidance specified in Chapter II.C.1.e of the NSF PAPPG. Grants.gov Users: The COA information must be provided through use of the COA template and uploaded as a PDF attachment.

Note the distinction to the list of Project Personnel and Partner Institutions specified above under Supplementary Documents: the listing of all project participants is collected by the project lead and entered as a Supplementary Document, which is then automatically included with all proposals in a project. The Collaborators and Other Affiliations are entered for each participant within each proposal and, as Single Copy Documents, are available only to NSF staff.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

Budgets must include funding for the PI to attend a two-day PI meeting every year during the lifetime of the award in the Washington, DC, area.

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

  January 08, 2018

  Second Monday in January, Annually Thereafter

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: http://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane or Research.gov may use Research.gov to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is 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.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of

knowledge.

- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (PAPPG Chapter II.C.2.d(i). contains additional information for use by proposers in development of the Project Description section of the proposal). Reviewers are strongly encouraged to review the criteria, including PAPPG Chapter II.C.2.d(i), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
   a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
   b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- For program inquiries please contact, telephone: N/A, email: Cyberlearning-WHTF@nsf.gov

- Tatiana Korelsky, co-lead CISE, CISE/IIS, telephone: (703) 292-8930, email: tkorelsk@nsf.gov

- Amy L. Baylor, co-lead EHR, EHR/DRL, telephone: (703) 292-5126, email: abaylor@nsf.gov

- John Cherniavsky, Senior Advisor, EHR/DRL, telephone: (703) 292-5136, email: jchernia@nsf.gov

- Dan R. Cosley, Program Director, CISE/IIS, telephone: (703) 292-8491, email: dcosley@nsf.gov

- Soo-Siang Lim, Program Director, SBE/BCS, telephone: (703) 292-7878, email: slim@nsf.gov

- Julie Martin, Program Director, ENG/EEC, telephone: (703) 292-8657, email: julmarti@nsf.gov

- Robert Russell, Program Officer, EHR/DRL, telephone: (703) 292-2995, email: rlrussel@nsf.gov

- Chia Shen, Program Officer, EHR/DRL, telephone: (703) 292-8447, email: cshen@naf.gov

- Maria Zemankova, Program Officer, CISE/IIS, telephone: (703) 292-7348, email: mzemanko@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188

  FastLane Help Desk e-mail: fastlane@nsf.gov.

  Research.gov Help Desk e-mail: rgov@nsf.gov

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at http://www.grants.gov.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at https://www.nsf.gov

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314

- **For General Information** (NSF Information Center)**:** (703) 292-5111

- **TDD (for the hearing-impaired):** (703) 292-5090

- **To Order Publications or Forms:**

    Send an e-mail to: nsfpubs@nsf.gov

    or telephone: (703) 292-7827

- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and NSF-51, "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Office of the General Counsel
National Science Foundation
Alexandria, VA 22314

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