

Discovery Research PreK-12 (DRK-12)

PROGRAM SOLICITATION NSF 20-572

REPLACES DOCUMENT(S): NSF 17-584



National Science Foundation

Directorate for STEM Education
Research on Learning in Formal and Informal Settings

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

October 07, 2020

October 08, 2021

October 05, 2022

First Wednesday in October, Annually Thereafter

IMPORTANT INFORMATION AND REVISION NOTES

IMPORTANT INFORMATION

Innovating and migrating proposal preparation and submission capabilities from FastLane to Research.gov is part of the ongoing NSF information technology modernization efforts, as described in [Important Notice No. 147](#). In support of these efforts, proposals submitted in response to this program solicitation must be prepared and submitted via Research.gov or via Grants.gov and may not be prepared or submitted via FastLane.

REVISION NOTES

1. Clarified Impact Project Type description
2. Clarified expectations for Design and Development Studies
3. Emphasized a programmatic commitment to supporting research in early childhood and computer science
4. Clarification of the program's interest in funding research and development focused on the integration of computational thinking
5. Synthesis proposals can now request up to \$600,000- and three-years duration

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) ([NSF 22-1](#)), which is effective for proposals submitted, or due, on or after October 4, 2021.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Discovery Research PreK-12 (DRK-12)

Synopsis of Program:

The Discovery Research PreK-12 program (DRK-12) seeks to significantly enhance the learning and teaching of science, technology, engineering, mathematics and computer science (STEM) by preK-12 students and teachers, through research and development of STEM education innovations and approaches. Projects in the DRK-12 program build on fundamental research in STEM education and prior research and development efforts that provide theoretical and empirical justification for proposed projects. Projects should result in research-informed and field-tested outcomes and products that inform teaching and learning. Teachers and students who participate in DRK-12 studies are expected to enhance their understanding and use of STEM content, practices and skills.

The DRK-12 program invites proposals that address immediate challenges that are facing preK-12 STEM education as well as those that anticipate radically different structures and functions of preK-12 teaching and learning. The DRK-12 program has three major research and development strands: (1) Assessment; (2) Learning; and (3) Teaching. The program recognizes the synergy among the three strands and that

there is some overlap and interdependence among them. However, proposals should identify a clear focus of the proposed research efforts (i.e., assessment, learning, or teaching) consistent with the proposal's main objectives and research questions. The program supports six types of projects: (1) Exploratory, (2) Design and Development, (3) Impact, (4) Implementation and Improvement, (5) Syntheses, and (6) Conferences. All six types of projects apply to each of the three DRK-12 program strands.

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.

- Inquiries can be made to, telephone: (703) 292-8620, email: DRLDRK12@nsf.gov

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

- 47.076 --- STEM Education

Award Information

Anticipated Type of Award: Standard Grant or Continuing Grant

Estimated Number of Awards: 50 to 60

It is anticipated that about 12-15 Level I awards, 30-35 Level II awards, 5-7 Level III awards, and 3 Conference/Synthesis awards will be made in FY 2021, pending availability of funds. A Resource Center with a budget of up to \$3,500,000 will also be supported for a duration of 3 years in the 2021 fiscal year.

Anticipated Funding Amount: \$60,000,000 to \$64,000,000

Pending availability of funds, NSF anticipates approximately \$60,000,000 will be available for the FY2021 competition.

Normal limits for funding requests of DRK -12 proposals are as follows: (1) Level I projects up to \$450,000 with a duration of up to three years; (2) Level II projects up to \$3,000,000 with a duration of up to four years; and (3) Level III projects up to \$5,000,000 with a duration of up to five years. Synthesis proposals are up to \$600,000 and three years duration. Conference proposals are up to \$100,000 and one year duration. The level of funding requested should align with the maturity of the proposed work, the size and scope of the empirical effort, and the capacity of the interdisciplinary team to conduct the proposed research.

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. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

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:

There are no restrictions or limits.

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 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:**

Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

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

October 07, 2020

October 08, 2021

October 05, 2022

First Wednesday in October, 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

The goal of the Discovery Research PreK-12 program (DRK-12) is to catalyze research and development of science, technology, engineering, mathematics and computer science (STEM) education innovations or approaches that can serve as models for use within the nation's formal preK-12 STEM education system (e.g., states, districts, schools, and teachers). The intent of the DRK-12 program is to: (1) catalyze new approaches to STEM learning, teaching, and assessment; (2) build knowledge about how to develop preK-12 students' STEM content knowledge, practices, and skills; and (3) provide multiple resources in a variety of STEM learning environments and study the learning process itself. The DRK-12 program is committed to research and development that inform strategies to promote success for all students in all STEM fields of study. The program encourages proposals from a range of institution types and categories including minority-serving institutions (e.g., HBCUs, Tribal Colleges, Hispanic Serving Institutions, Alaska Native-Serving Institutions, and Native Hawaiian-

Serving Institutions), primarily undergraduate institutions and other organizations focused on preK-12 STEM Education. The DRK-12 Program especially welcomes proposals that are consistent with the goal of developing STEM talent and workforce from all sectors and groups in our society (e.g., NSF INCLUDES). Collaborations are encouraged between DRK-12 proposals and existing NSF INCLUDES projects, provided the collaboration strengthens both projects.

Projects in the DRK-12 program build on fundamental research in STEM education and prior research and development efforts that provide theoretical and empirical justification for proposed projects. School leaders, teachers, and students who participate in DRK-12 studies are expected to enhance their understanding and use of STEM content, practices, and skills. The DRK-12 program invites proposals that seek to transform the STEM education landscape of the future by reimagining structures and systems of PreK-12 teaching, learning, and assessment, while also addressing current challenges in PreK-12 STEM research and practice. The projects funded by the program should reflect the needs of the increasingly diverse population and national, state, or district priorities. Projects should contribute to the research base in STEM education by studying how students and teachers learn, through well-articulated STEM education innovations with clear theories of action. DRK-12 projects are expected to contribute to both theory and practice. Therefore, projects are expected to result in innovations or approaches that can be shared with and feasibly implemented by other organizations as well as research shared in peer-reviewed research and practice publications.

II. PROGRAM DESCRIPTION

As a research and development program, DRK-12 contributes to knowledge of how STEM education innovations or approaches are designed, engineered and tested. The emphasis is on what works, for whom, and under what conditions. For DRK-12 proposals, a wide range of potential STEM education innovations or approaches are possible. These include, but are not limited to, policies, instructional or professional development programs, teaching practices, curriculum, formative or summative assessment systems, interventions, instructional technologies, and combinations of approaches that improve STEM learning and learning environments for students in formal preK-12 education settings.

STEM is an acronym for science, technology, engineering, and mathematics and includes computer science. The term is used as shorthand for referring to these domains. The program is receptive to proposals that seek to integrate computing and computational thinking within one or more of the other STEM disciplines as a way to improve teaching and learning in formal education settings. The program welcomes investigators who consider situating their work in the context of a more comprehensive interdisciplinary approach by integrating computing and computational thinking across an entire STEM curriculum to prepare students from early childhood through high school. Proposals are not required to address all STEM domains. However, proposals that have an interdisciplinary focus on two or more of these domains are welcomed.

The DRK-12 program is interested in projects that seek to transform formal education practices and structures through the use of innovative approaches, materials, technologies, and practices. These projects may have a focus on productively disrupting current STEM educational practices by strengthening teaching practices, assessment strategies, and student learning outcomes. In addition, the DRK-12 program contributes to the generation of new knowledge about the nature of STEM learning and learning environments. Research and development plans are integral to every project description. Successful projects will build on, iterate, or apply in novel contexts new innovations or those adapted from prior research and development and study their effects on students, teachers, and educational systems using contemporary and rigorous research designs and analytic techniques.

The DRK-12 program is primarily concerned with the goals and effectiveness of formal education but recognizes that learning is not limited to formal school environments. PreK-12 schools also serve many populations and have varying schedules. The program encourages proposers to draw from knowledge and practice of learning in out-of-school and informal settings to enhance learning and teaching in formal settings. Also, the DRK-12 program includes education in prekindergarten (PreK) through the end of high school, but the connection to college and career-readiness standards ties the work of many projects to post-secondary or adult basic education.

Within the broad DRK-12 mission, there are a number of high priority areas for focused work. Driven by the pressing needs to improve preK-12 STEM teaching and learning for all U.S. students, the program is particularly interested in projects that focus on populations that are underperforming or underserved by current practice. The program is also particularly interested in supporting research and development to promote high quality and innovative STEM education in the early grades. This could include the development of tools and models to support underrepresented students, including girls, in prekindergarten through elementary school in STEM disciplines, particularly computer science. Of particular interest in the area of mathematics education is a focus on improving the teaching, learning, and assessment of statistics and data science, an area of growing need in the future U.S. workforce. Of particular interest in the area of computer science is the integration of computational thinking from the early grades through high school. The program encourages proposals that support computational thinking in ways that reflect real-world, interdisciplinary thinking in computational and data-enabled science and engineering. The program also encourages proposals in the areas of quantum information science and quantum mechanics, in the context of preK through grade 12 formal education.

The DRK-12 program seeks to maintain a balanced portfolio by supporting projects ranging from those with immediate applicability to those that anticipate and provide the foundation for preK-12 STEM education as it could be in future decades. The DRK-12 program is interested in ideas, concepts, theories, practices, and research and development that can challenge existing assumptions and offer promising new approaches to STEM learning, teaching, and assessment. Such proposals could, for example, adapt research-based effective STEM teaching practices in ways that explicitly support the broader and increasingly diverse set of learners who comprise the nation's student population. Proposals that address immediate and pressing challenges typically develop and study STEM education innovations or approaches that could be implemented and used by educators in the relatively near term, albeit in innovative ways. Replication and reproducibility studies related to this range of innovations or approaches are welcomed within the DRK-12 mission.

Each DRK-12 proposal should select a strand that describes the primary focus of the research and development and a project type that describes the type of research study appropriate for the goals and objectives of the project. The DRK-12 program has three research and development strands: (1) Assessment; (2) Learning; and (3) Teaching. For each project, the strand selected should be aligned with the focus of the research and development proposed. The DRK-12 program recognizes that there is some overlap and interdependence among the strands in project activities, but each proposal should have a clear, foregrounded focus on one strand. Collectively, the three strands intend to support the development of a new generation of STEM education innovations or approaches. These innovations or approaches take full advantage of the rich research base on STEM learning, the capabilities of modern technologies to enhance the education of PreK-12 learners and teachers, and emerging scientific and mathematical discoveries.

The program supports six project types: (1) Exploratory, (2) Design and Development, (3) Impact, (4) Implementation and Improvement, (5) Syntheses, and (6) Conferences. The project types describe the nature of the research and development to be completed in support of innovation in the strand defined by the project. The level of funding requested should be appropriate to the work described. Information on current DRK-12 projects can be found at www.cadrek12.org and at NSF Award Search (<https://nsf.gov/awardsearch/>).

DRK-12 Program Strands

There are three strands that guide the focus of DRK-12 projects: (1) Assessment; (2) Learning; and (3) Teaching. All DRK-12 proposals should be well grounded in the findings of STEM education research and be supported by a well-articulated framework that is based on a specific theory of assessment, learning or teaching. Proposals must be guided by specific research question(s) or hypotheses, use appropriate and rigorous research and development designs, include a data collection plan with appropriate descriptions of instruments and measures to be used, include a detailed description of the sample of participants involved in the project, and fully describe the data analytic methods.

(1) Assessment Strand

Innovation in STEM education cannot occur without a rich and growing knowledge base. Research and development in assessment plays a critical and dynamic role in growing this knowledge base because such research and development efforts provide important evidence about changes in teaching and learning. For assessment to be a driving knowledge engine that moves STEM education forward it must be integrated with systems of learning and teaching, with specific attention paid to the needs of practitioner communities and how assessments would be used in formal education settings.

The DRK-12 program seeks proposals that address the development of innovations or new approaches with respect to (1) assessment of STEM learning that generates evidence of participants' knowledge or understanding or (2) assessment for STEM learning that is an integrated part of the ongoing learning process. Proposals in this strand must integrate development with the investigation of validity through field-testing new forms of assessment, including technology-enhanced assessments, which have promise for use in classrooms. This promise should be investigated with attention to coherent systems of teaching and learning that account for the intended users of the assessment and the assessment-related needs of states, districts, schools, teachers, and students.

Acknowledging the broad range of definitions of validity, quality proposals must thoughtfully describe and justify how the project will allow for valid and reliable inferences regarding the constructs being assessed. STEM assessment innovations or approaches must be fair and equitable, as well as culturally and linguistically sensitive in addressing the needs of the learners under study.

Quality proposals in the Assessment Strand should carefully specify the STEM constructs being assessed, those being assessed (students, teachers, etc.), and which stakeholders the assessment results can validly inform (e.g., districts, parents, policy makers, schools, students, or teachers). The manner and process of assessing should be appropriately designed and justified. Proposals should address the potential benefits and weaknesses of the chosen strategy or strategies, including a careful articulation in the context of the system of learning, instruction and assessment under study. When multiple strategies are suggested, demonstration of their additional value should be provided. The proposals must describe specifically the intended use of the measure(s) to be developed and the claims that can be made by using the measure(s). As such, the intended users of the instruments should be explicitly considered and incorporated into the research plan activities.

Proposals to this strand should explicitly recognize and address the role the proposed research and development effort plays in furthering an aligned system of assessment, learning and teaching. Proposals in the Assessment Strand may focus on one grade level or across levels. STEM content and practice foci may be within a discipline or across disciplines. Assessments may be of individuals or groups. Assessment research and development efforts in the attitudinal and affective domains should align with a chosen disciplinary domain.

The DRK-12 program encourages proposals that address STEM assessment questions facing the field including, but not limited to, the following:

- a. How does assessment information move across levels of the educational system and with what degree of validity?
- b. How are assessment frameworks related to theories of learning, and in what ways do the resulting assessment innovations or approaches inform and advance the field conceptually?
- c. How do users of STEM assessments (e.g., students, teachers, administrators, districts, parents) interact with, perceive, respond to, and make sense of the assessment information?
- d. How are disciplinary learning progressions and trajectories informing and being informed by and through assessment?
- e. What are effective ways to build capacity in the field for the design, development, implementation, interpretation, and use of assessment in STEM learning settings?
- f. What roles and opportunities do emergent technologies have related to assessment?

(2) Learning Strand

Well-designed STEM education innovations or approaches that enhance student learning of STEM are crucial to excellent preK-12 STEM education. Well-grounded STEM education innovations or approaches are needed for effective implementation of college- and career-readiness standards that provide all students with opportunities to learn recommended concepts and practices. Effective STEM education approaches should prepare students for a wide range of future workforce opportunities, including but not limited to STEM careers and STEM career pathways. At the same time, new and exciting discoveries are being made in the STEM disciplines and large amounts of scientific data are increasingly available for use by the public and learners of all ages. The DRK-12 program is interested in STEM education innovations or approaches that assist preK-12 students in accessing and understanding new data sources and discoveries while leveraging their potential to support learning of important STEM content in the classroom.

The DRK-12 program seeks proposals that consider the ways in which STEM innovations or approaches that enhance student learning could be designed and implemented in a range of learning environments. The DRK-12 program encourages proposals that research and develop STEM education innovations or approaches to student learning that can be implemented in current classrooms, schools, and other learning environments for preK-12 students. Proposals submitted to the Learning Strand should describe how the proposed STEM education innovation or approach aligns with current curricular frameworks and demonstrate how it would be an improvement relative to current practice. In doing so, proposals should provide a compelling argument for why the innovation or approach would lead to improved student learning outcomes.

The DRK-12 program encourages proposals that address important questions facing the learning of STEM including, but not limited to, the following:

- a. How does the innovation or approach challenge and improve upon current practices and standards?
- b. How does the innovation or approach focus on emerging STEM concepts and practices that reimagine or transform existing school curricula?
- c. How does the innovation or approach make use of data and practices from STEM fields to transform existing school curricula?
- d. How is the innovation or approach likely to be transformative for STEM teaching and learning?
- e. How does the innovation or approach increase broader participation in STEM by targeting underserved or disadvantaged groups of learners, such as English language learners, underrepresented minorities, or students with disabilities?

(3) Teaching Strand

The DRK-12 program recognizes that effective STEM learning is built on a well-prepared and knowledgeable STEM teacher workforce, and that STEM teacher development is a part of STEM workforce development. The availability of high-quality resources to address challenges faced by STEM teachers is critically important. Teachers need support to learn about new discoveries in the STEM disciplines and how to integrate contemporary and dynamic content from STEM

fields into classroom practice. Teachers need to be supported in implementing innovative and evidence-based pedagogical techniques to enhance student learning of STEM content and practices. Technology offers opportunities for innovations in classroom content, collection of classroom data to enhance teaching, increasing accessibility for diverse learners, and collaboration around teaching practices with other professionals. Because the student population is becoming increasingly diverse, pre- and in-service teachers need support to teach in ways that make learning accessible and available to all students.

The DRK-12 program seeks proposals to research and develop STEM education innovations or approaches to teacher pre- and in-service education. These innovations or approaches should support career-long learning by preK-12 teachers with the potential for effective implementation, successful diffusion, and future scaling. Proposals submitted to the Teaching Strand should describe how the proposed STEM education innovation or approach aligns with current frameworks and demonstrate how it would be an improvement relative to current practice. In doing so, proposals should provide a compelling argument for why the innovation or approach would lead to improved teaching outcomes and practice.

The DRK-12 program encourages proposals that address important questions facing STEM teaching including, but not limited to, the following:

- a. How does the innovation or approach improve instructional practices and increase students' learning and outcomes?
- b. How does the innovation or approach recruit, certify, induct, and/or prepare STEM teachers better than existing practice?
- c. How do pre- or in-service teachers develop STEM content knowledge and pedagogical content knowledge in ways that improve their instructional practice?
- d. How does the innovation or approach develop teaching expertise and instructional leadership across schools, districts, and the broader national teacher community?
- e. How can we assist teachers in making data-driven instructional decisions to meet the needs of all learners?
- f. How can teachers' capacity and willingness to customize instructional approaches be developed to meet standards and the needs of diverse student populations?
- g. What are effective methods for developing, applying, and testing effective models of professional development that improve STEM teaching and learning?

DRK-12 Project Types

The DRK-12 program invites proposals for six project types: (1) Exploratory, (2) Design and Development, (3) Impact, (4) Implementation and Improvement, (5) Syntheses, and (6) Conferences. The project type describes the type of research and development study that is going to be used to achieve the goals and objectives of the project. The project types are aligned with the Common Guidelines for Educational Research (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf13126).

(1) Exploratory Studies

Exploratory Studies provide investigators with opportunities to investigate STEM education problems that establish the basis for design and development of STEM education innovations or approaches. Exploratory Studies allow researchers to establish initial connections to or among the outcomes of interest related to STEM assessment, learning or teaching. Exploratory Studies must provide evidence of the factors associated with STEM education or learning outcomes to establish the basis for design and development of STEM education innovations or approaches (including potentially moderating or mediating factors). Studies must also provide a well-specified, empirically supported, conceptual framework or theory of action that describes the innovation or approach's assumptions, central design features, anticipated effects that these features elicit, and explanations that relate features to effects. A theory of action may include factors associated with STEM learning outcomes or with moderating or mediating features of the innovation or approach. The theory of action should also provide a basis derived from empirical evidence for pursuing a Design and Development, Impact, or Implementation and Improvement Study, or the need for further research.

DRK-12 Exploratory Study proposals are consistent with the Early Stages and Exploratory types of research and development in the Common Guidelines for Educational Research and Development.

(2) Design and Development Studies

The goal of Design and Development Studies is to research and develop new or improved STEM education innovations or approaches to achieve specific goals related to learning, teaching or assessment. Design and Development proposals build on evidence from prior research and development studies. The proposal should provide a compelling rationale that: specifies the practical problem the project intends to address; justifies the importance of the problem; describes how the proposed STEM innovation or approach differs from existing practice; and explains why the proposed project has the potential to improve learning or education outcomes or increase efficiencies in the education system beyond current practice. The proposal should include a strong theoretical and empirical justification for development and analysis of the proposed innovation or approach. The proposal should provide a compelling rationale for how features or components of a new innovation or approach are expected to achieve the intended outcomes. The proposal should include a description of the initial concept for the planned investigation, including a well-explicated theory of change or logic model. Such a model should identify the key components of the innovation or approach (i.e., the ingredients hypothesized to be critical to achieving the intended results) and should describe their relationships.

Design and Development proposals should describe: the methods for developing the innovation or approach to the point where it can be used by the intended end-users (e.g., iterative development process with students and/or teachers); the methods for collecting evidence on the feasibility that end users will be able to implement the innovation or approach in an authentic education or learning setting (e.g., evidence of feasibility of implementation); and the methods for obtaining pilot data on the promise of the innovation or approach for achieving the expected outcomes (e.g., pilot study).

The program suggests these studies may fall into two major phases of design and development (early stage and late stage). The focus of both kinds of Design and Development studies should include explicit attention to the gathering of evidence as the innovation is designed and the refinement of the innovation over time based on the evidence collected.

Early Stage Design and Development Studies

Early Stage Design and Development Studies seek to research and develop a proof of concept that one can create STEM education innovations or approaches based on a well-specified theory of action. Goals of Early Stage Design and Development Studies must include providing: a prototype or early version of the proposed STEM education innovation or approach. The prototype or early version should be accompanied by a clearly articulated theory of action that describes the innovation or approach's assumptions, central design features, anticipated effects that these features elicit, and explanations that relate features to effects. Anticipated effects can include specific learning outcomes, but may also include other factors that mediate aspects of learning environments such as patterns of discourse or participation evidence related to the theory of action underlying the STEM education innovation or approach.

Late Stage Design and Development Studies

Late Stage Design and Development Studies proposals begin with STEM education innovations or approaches that have already demonstrated promise in small

sets of classrooms, schools, or other learning settings. In these instances, there is already an existing prototype or developed version of the innovation or approach but additional design and development efforts are needed to generate a fully-developed version. Goals of Late Stage Design and Development studies must include providing fully-developed STEM education innovations or approaches that have evidence of feasibility and utility for practice of completed products, ready for implementation by others who request them; and evidence of promise from field studies as indicated by estimates of effect sizes.

DRK-12 Design and Development Study proposals are consistent with the Design and Development type of research and development in the Common Guidelines for Educational Research and Development.

(3) Impact Studies

Impact Studies expand the evidence of promise from previous studies to provide more rigorous evidence of the strength of the STEM education innovation or approach to achieve its intended outcomes. This is accomplished through efficacy or effectiveness studies. An efficacy study examines the impact of a STEM education innovation or approach under ideal conditions, while an effectiveness study examines that impact under normal educational contexts and settings. Proposals for Impact Studies should provide a clear description of the STEM education innovation or approach to be tested and a compelling rationale for examining its impact. The proposal should present a detailed theory of change and describe how the theory influences the selection of appropriate variables to be studied and supports the presentation of a clear set of research questions to be answered. The proposal should describe and document existing evidence that supports the promise of the innovation or approach. Such evidence should go beyond pre-post data to include evidence from experimental or modern quasi-experimental study designs. The proposal should also describe the problem the innovation or approach is attempting to address, how the innovation or approach is an improvement over other approaches to the problem, and why the innovation or approach is appropriate and well-suited for an efficacy or effectiveness study. Impact proposals should include detailed descriptions of the innovation or approach to be implemented, data collection procedures, the measures to be employed and their technical adequacy for the population in the study, the study samples involved and how recruitment will be accomplished, screening and identification procedures if relevant, plans to account for multi-level or nested data structures in the sampling and analysis plans, and adequate justification for the sample sizes proposed (e.g., power analysis) that match the design choices based on the theory of change. For example, an Impact study of an innovation or approach that explicitly targets teachers or schools as the point of intervention should utilize a design that appropriately allows for inferences to be made about the effects on those teachers or schools.

Impact studies should also appropriately justify the choice of counterfactual and the relevant features of the chosen counterfactual, as well as whether aspects of the innovation or approach occur in the counterfactual and to what extent. Investigating similarities and differences between the two conditions is important in the construction of an argument with respect to the effect of the innovation or approach. Potential findings of Impact Studies must include reliable estimates of the average treatment effect of the education innovation or approach through reporting that is consistent with expectations of making causal claims. Such estimates should include appropriate standard errors and confidence intervals.

Impact studies should be described in sufficient detail so that other researchers can replicate the research as discussed in the recently released Companion Guidelines on Replication and Reproducibility in Education Research (https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf19022). The sharing of data from Impact studies should allow for others to reproduce the results when conducting the same or similar analyses, which should be addressed in the Data Management Plan of the proposal. Impact study proposals should include plans for pre-registration in an appropriate publicly available registry.

DRK-12 Impact Study proposals are consistent with the Efficacy and Effectiveness Studies type of research and development in the Common Guidelines for Educational Research and Development.

(4) Implementation and Improvement Studies

Implementation and Improvement Research aims to strengthen the capacity of an organization to reliably produce valued STEM education outcomes for diverse groups of students, educated by different teachers in varied organizational contexts. The focus is more broadly on making STEM education innovations or approaches succeed when implemented at scale. These studies have less prescriptive research designs and methods, with research occurring in rapid, iterative, and context-expanding cycles. Implementation and Improvement Studies require deep engagement of researchers and practitioners during the collaborative research on problems of practice that are co-defined and of value to researchers and education agencies, such as a school district or community of schools. Implementation and Improvement Research seeks to: study implementation in the local context; employ rapid changes in implementation with short-cycle methods; capitalize on variation in educational contexts to address the sources of variability in outcomes to understand what works, for whom, and under what conditions; address organizational structures and processes and their relation to innovation; employ measurement of change ideas, key drivers, and outcomes to continuously test working theories and to learn whether specific changes actually produce improvement; and reform the system in which the approach is being implemented as opposed to overlaying a specific approach on an existing system.

Implementation and Improvement Studies must include strategies for improvement or implementation that address the shared goal of the researcher/practitioner collaborators; conceptual frameworks that address issues of scale, human capacity, and technical support for implementation and improvement in educational systems; measures of organizational learning that assess the progress of implementation and improvement; sustainable communities that can support implementation and improvement in the targeted educational system; and documented practices with an ongoing forum for continued engagement of collaborators from various levels of the educational system.

(5) Syntheses

Synthesis proposals can be funded for up to \$600,000 and may be up to three years in duration. Proposals should focus on a question, issue, or topic of critical importance to K-12 STEM education and to the DRK-12 program. DRK-12 supports capacity building through literature reviews, syntheses, qualitative metasyntheses, and meta-analyses directly related to the goals of the DRK-12 program. Applicants should be clear about which type of Synthesis proposal they are submitting.

Proposals should demonstrate a command of the breadth and depth of the literature on the question, issue, or topic. This background should be used to make a case for the amount, type, and relevance of available literature in conducting the synthesis. For all review types, the literature search procedures, selection procedures (methods, search criteria, etc...), inclusion criteria (population, treatment and comparison groups, measures, publication types, etc...) and screening methodologies should be discussed.

For meta-analysis proposals, authors should discuss all aspects of the quantitative synthesis, including, but not limited to effect size estimation, data transformations, meta-analytic models, moderators, and sensitivity analyses. Proposals should be sufficiently detailed and explicit with respect to methods such that the proposal can serve as a review protocol or pre-analysis plan in addition to allowing for replication and reproducibility by others. Applicants should also discuss how the relevant data will be stored after the conclusion of the project and what statistical analysis packages will be used.

Investigators interested in Synthesis proposals are strongly encouraged to contact a program officer prior to submission to discuss proposal idea(s).

(6) Conferences

Conference proposals can be funded for up to \$100,000 and are usually for one year in duration. Investigators are strongly encouraged to contact a program officer prior to submission to discuss their idea(s). For general guidance about conferences, follow the PAPPG guidance under for preparing Conference Proposals (PAPPG II.E.9), in addition to the DRK-12-specific guidance below. The "Conference" type of proposal should be selected in Research.gov or Grants.gov.

Conference proposals should demonstrate a command of the literature and/or practice on the question, issue, or topic. Participant expertise and selection should be discussed. Conference proposals should include a conceptual framework for the conference, draft agenda, possible participant list, and the outcomes or products that will result.

All proposals in this category should address the need for the work, why it is timely, and the expected contributions to understanding or advancing the question, issue, or topic. All projects should generate a product usable by researchers and/or practitioners and indicate how these product(s) serve the DRK-12 program priorities described earlier in this document. The program is particularly interested in conferences that bring together actively funded researchers to advance critical research agendas of broader importance to preK-12 STEM education.

DRK-12 Resource Center Proposal

The DRK-12 program intends to support one or more projects to fulfill the activities described below for the DRK-12 Resource Center. These project(s) will provide technical support for all DRK-12 projects, to organize meetings and topical webinars, to facilitate national dissemination of project outcomes, and to further develop expertise in the preK-12 STEM education research and development community to enhance the learning and teaching of preK-12 STEM. The Resource Center should engage the multiple communities that carry out the STEM education research funded in the DRK-12 program and/or that benefit from the products and outcomes of DRK-12 projects.

The primary goal of the Resource Center is to advance activities that have the potential to improve the rigor and quality of research and development in STEM education. These activities include but are not limited to promoting innovations in STEM teaching and learning, knowledge building and dissemination, and networking within the STEM education research community.

Institutions: It is anticipated that the institutions most well-suited for the DRK-12 Resource Center will be service-oriented educational organizations or institutions with demonstrated capacity to plan, develop, and manage a national center that provides technical support for a diverse portfolio of projects nationwide. It should have demonstrated expertise in targeting STEM disciplines, rigorous education research methodologies including measurement, and STEM teacher professional development.

Capacity Building: The DRK-12 Resource Center is expected to facilitate discussions and professional connections across the network of DRK-12 projects through Principal Investigator convenings, topically-focused meetings, webinars, and other appropriate means to advance capacity for high-quality STEM research and development activities. The Center is also expected to collaborate with other resource centers supported by EDU for a) broadening awareness of the diverse funding programs in STEM education and their resources, b) promoting synergistic efforts among resource centers to advance the knowledge base and broader participation in STEM education, and c) identifying common areas of interest with respect to research methods, measurement, and data analysis techniques.

Broadening Participation: The DRK-12 Resource Center is expected to facilitate broadening participation in STEM education by targeting outreach and capacity building activities to geographic regions, community types (rural, suburban, or urban), and institutions (such as community colleges, high-need school districts, and minority serving institutions) that are less well represented in the DRK-12 portfolio.

Technical Support: The DRK-12 Resource Center is expected to monitor DRK-12 projects during the various stages of project implementation and provide technical research assistance appropriate to those projects. Support may include, but is not limited to, facilitating the emergence and development of communities of practice, identifying promising practices and resources (both print and electronic) that may be of help to projects in meeting their goals, or providing prospective Principal Investigators with access to information about DRK-12 program projects, outcomes, and resources.

Dissemination: The DRK-12 Resource Center is expected to facilitate the broad dissemination of project outcomes, findings, and evidence of promising practices to the various STEM education communities. In addition to providing comprehensive reports of DRK-12 program activities and outcomes to NSF, the Center is expected to implement a dissemination plan that will inform STEM education professionals, industry and policy stakeholders, and STEM education research communities of program resources, outcomes, and projects. This implementation plan should include topically oriented synthesis reports that summarize findings from funded or completed DRK-12 projects (e.g., early science learning, early numeracy instruction, or algebra).

The DRK-12 program may support a single entity or multiple entities to fulfill the range of Resource Center activities outlined above. The DRK-12 Resource Center will be supported for 3 years with total funding not to exceed \$3,500,000. The size of the request should be appropriate to the scope of work proposed. Recognizing that the activities are quite wide ranging and that applicant institutions may have varying capacities to realize the goals described above, more than one Resource Center proposal may be supported. The "Center" type of proposal should be selected in Research.gov or Grants.gov.

Selected Resources

DRK-12 and other programs (described below) fund resource and infrastructure centers to provide technical assistance to their current and prospective PIs.

The mission of the Community for Advancing Discovery Research in Education (CADRE) is to support and connect researchers and developers in K-12 STEM education. CADRE is the current resource network for the DRK-12 program. To explore the resources made available by CADRE to the STEM education research community, see <http://cadrek12.org/>.

The resources on the CADRE website may be most pertinent to proposal preparation for the DRK-12 program. However, these additional centers may also be useful:

The Center for Advancement of Informal Science Education (CAISE) works in collaboration with the NSF AISL program to strengthen and advance the field of informal STEM education and its infrastructure by providing resources for NSF principal investigators, ISE professionals, and STEM researchers. See <http://www.informalscience.org/> for more information.

The STEM Learning and Research Center (STELAR) is supported by the ITEST program. STELAR's mission is to build capacity and magnify the results of ITEST projects in order to deepen the impact of the ITEST program. For more information see <http://stelar.edc.org/>

NSF INCLUDES is one of the NSF 10 Big Ideas. For the U.S. to remain the world leader in STEM innovation and discovery, it must identify and develop talent from all sectors to become STEM professionals. For more information, see the NSF INCLUDES Coordination Hub and National Network: <http://www.includesnetwork.org/home>

About EDU and DRL

DRK-12 is one of six programs in the Division of Research on Learning in Formal and Informal Settings (DRL) in the Directorate for STEM Education (EDU). The other five programs in EDU/DRL are: Advanced Technological Education (ATE) · Advancing Informal STEM Learning (AISL) · Computer Science for All (CSforAll) · Innovative Technology Experiences for Students and Teachers (ITEST) · EDU Core Research (ECR) · Each program can be accessed from the DRL Web Page <https://www.nsf.gov/dir/index.jsp?div=DRL>.

Investments by EDU/DRL contribute to the three categories that together form the foundation for EDU's strategic framework toward the fulfillment of the EDU mission. Within each of these categories, EDU/DRL will continue to build and emphasize its research and development activities.

Learning and learning environments: Investments in this category seek to develop understanding of the cognitive, affective, and non-cognitive foundations of STEM learning; to study emerging contexts and tools for learning STEM concepts and skills; and to build environments that promote new, high-impact learning opportunities for tomorrow's scientists and engineers, as well as the public (publics) and students living in an increasingly technology-oriented society.

Broadening participation in STEM: Programs in this category capitalize on the Nation's diversity in order to increase the scientific workforce by engaging and building capacity in all people in STEM learning and professional training, particularly those from groups that have been traditionally underrepresented in STEM fields.

STEM workforce: Workforce investments are intended to improve the education and preparation of a STEM workforce that will be ready to capitalize on unprecedented advances in technology and science, and to address future global, social, and economic challenges.

This framework positions the directorate to respond to emerging opportunities created by new technologies, improvements in the STEM education evidence base, administration priorities, and other national or societal needs. For more information on EDU see: <https://www.nsf.gov/dir/index.jsp?org=EDU>

Other Funding Opportunities

The programs listed below may also be of interest; see individual solicitations for due dates:

Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES) https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505289

Faculty Early Career Development (CAREER) https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503214

Cyberlearning and Future Learning Technologies (Cyberlearning) https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504984

Improving Undergraduate STEM Education (IUSE) https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505082&org=DUE&from=home

Robert Noyce Teacher Scholarship Program (Noyce) https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5733&org=DUE&from=home

Research Coordination Networks (RCN) https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=11691

The goal of the RCN program is to advance or create new directions in research and practice by funding investigators with diverse expertise yet who share a common interest in an important question, issue, or topic.

RCN awards do not directly support research or development activities. RCNs fund the development of networks and relationships, such that researchers and practitioners discuss and advance their research and practice activities across theoretical frameworks, methodological approaches and/or disciplinary, organizational, geographic, and international boundaries. The question, issue, or topic provides relevance and coherence to the network.

The DRK-12 program welcomes submissions of RCN proposals that advance DRK-12 goals through the sharing of ideas, knowledge, and practices. RCNs are an additional avenue for considering strategic impact, advancing effective collaborations, and broadening participation. See the RCN solicitation for further details and speak to a DRK-12 program officer if considering this proposal mechanism.

III. AWARD INFORMATION

It is anticipated that about 12-15 Level I awards, 30-35 Level II awards, 5-7 Level III awards, and 3 Conference/Synthesis awards will be made in FY 2021, pending availability of funds. A Resource Center with a budget of up to \$3,500,000 will also be supported for a duration of 3 years in the 2021 fiscal year.

Pending availability of funds, NSF anticipates approximately \$60,000,000 will be available for the FY2021 competition.

Normal limits for funding requests of DRK-12 proposals are as follows: (1) Level I projects up to \$450,000 with a duration of up to three years; (2) Level II projects up to \$3,000,000 with a duration of up to four years; and (3) Level III projects up to \$5,000,000 with a duration of up to five years. Synthesis proposals are up to \$600,000 and three years duration. Conference proposals are up to \$100,000 and one year duration. The level of funding requested should align with the maturity of the proposed work, the size and scope of the empirical effort, and the capacity of the interdisciplinary team to conduct the proposed research.

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* (PAPP), Chapter I.E. Unaffiliated individuals are not eligible to submit proposals in response to this solicitation.

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:

There are no restrictions or limits.

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 Research.gov or Grants.gov.

- 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) 292-8134 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) 292-8134 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 Research.gov. 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.

COVER SHEET PAGE

Mark the Human Subjects box as pending, approved, or exempted (with exemption subsection 2 indicated). This box should not be left blank. The Human Subjects box should be marked as pending if an IRB is either (1) reviewing the project plan and has not yet determined a ruling of "approved" or "exempt", or (2) the project plan has not yet been submitted to an IRB for review.

To avoid delays in processing award recommendations, it is strongly recommended that PIs begin the process of obtaining appropriate Institutional Review Board (IRB) approvals or exemptions as needed for projects involving human subjects. No awards will be made without such approvals or exemptions.

Select the DRK-12 solicitation number.

Project Summary. The first sentence of the Project Summary should specify the type of proposal (e.g., Exploratory; Design and Development; Impact Studies; Implementation and Improvement Studies; Conference; and Synthesis) and the Strand (Assessment, Learning or Teaching) addressed. The second sentence should state the discipline or disciplines being addressed and grade level(s), if appropriate.

Proposals that do not contain a Project Summary, including an overview and separate statements on intellectual merit and broader impacts, will not be accepted or will be returned without review as outlined in the most current PAPPG.

Project Description. The Project Description is limited to 15 pages and must comply with all formatting requirements of the most current PAPPG. Proposals funded under this solicitation must focus on research questions or hypotheses about PreK-12 STEM assessment, learning or teaching.

Proposals must address the following elements in the 15-page project description, in any order:

1. Importance:

The proposal must clearly show how the proposed project addresses critical STEM educational needs, and has the potential for broad impact. The proposal should provide a rationale for how the project will improve STEM education for students and advance knowledge, and it should explain how products or findings might ultimately be implemented in schools, even if in the long term. The proposal should address how the proposed STEM education innovations or approaches differ from existing practice and why the proposed project has the potential to improve learning or education outcomes beyond what current practice provides.

2. Results from prior NSF support

The proposal must describe results of prior NSF support for related educational projects in which the PI or co-PI have been involved, as outlined in the PAPPG

(NSF20-1).

3. Research and Development Design

The design of any DRK -12 proposal begins with hypotheses or research questions about how some aspect of STEM education can be improved based on theories of learning, teaching and development and prior empirical work. The proposal should articulate a plan of work that describes research and development strategies appropriate for attaining the project's goals consistent with the type of study proposed. Proposals must demonstrate how the work is related to similar research and development. The proposal should address how the major design iterations and resulting evidence will be developed to support or question key assumptions underlying the research and development plan. The proposal should identify all measures to be developed or employed in generating evidence of the project's success and provide evidence of or plans to establish the technical quality (e.g., validity and reliability) of each measure. The proposal should include detailed descriptions of the study goals, design and implementation processes, data collection and quality, as well as specific plans for analysis of the data collected and the methods for producing findings.

4. Mechanisms to Assess Success of the Project

All DRL projects are subject to a series of external, critical reviews of their designs and activities (including their theoretical frameworks, data collection plans, analysis plans, and reporting plans). Peer review of the proposed project and ongoing post-award monitoring by NSF staff are two types of external critical review that apply to all DRL projects. A proposal must describe appropriate mechanisms to assess success through project-specific external review and feedback processes. These mechanisms might include an external review panel or advisory board proposed by the project or a third-party evaluator. The external critical review should be sufficiently independent, rigorous, and timely as to influence the project's activities and improve the quality of its findings. Successful proposals will (1) describe the expertise of the external reviewer(s); (2) explain how that expertise relates to the goals and objectives of the proposal; (3) identify a specific set of questions that frames the evaluation; and (4) specify how the PI will report and use results of the project's external, critical review process.

5. Dissemination

A proposal must include a creative communication strategy for reaching a broad audience for the findings of the project, including, where appropriate, scholars, practitioners, policymakers and public audiences. While the potential results of the proposed research are expected to be of sufficient significance to merit peer-reviewed and widely-distributed publications, approaches that reach broader audiences or practitioners, policymakers, and the general public in dynamic ways are also strongly encouraged. Proposals should identify the key elements of a communication plan (e.g., target audiences and identification of the channels/media/technologies appropriate for reaching specific audiences).

6. Expertise

DRK-12 proposals generally involve interdisciplinary teams. Projects typically include STEM education researchers, development experts, school district personnel, experienced teachers, STEM researchers, statisticians, psychometricians, learning scientists and informal learning experts, and policy researchers, as appropriate. When feasible, proposals should include new researchers and developers (e.g., beginning scholars, postdoctoral associates, and graduate students) as part of the project team as a means of building a more diverse community of researchers, designers, and developers. The proposal should include a brief narrative describing the expertise of personnel and their contributions to the proposed work, including those responsible for the external review.

7. Broader Impacts

Please note that per guidance in the most current PAPPG, the Project Description must contain, as a separate section within the narrative, a section labeled "Broader Impacts". Proposers can decide where to include this section within the Project Description.

Supplementary Documentation:

Supplementary documents should include **Letters of Collaboration** from project partners, the **Postdoctoral Mentoring Plan** (*if applicable*) and the **Data Management Plan** as described in the PAPPG. Letters of support from persons endorsing the project but not making a substantial commitment to the project are not allowed. Inclusion of any other information in the supplementary documents or as an appendix will result in the proposal being returned without review.

Data Management Plan: All data collected for DRK-12 projects must accord with the revised EDU Data Management Guidance, which may be found here: <https://www.nsf.gov/bfa/dias/policy/dmpdocs/ehr.pdf>. Data Management Plans will be reviewed by panelists and program directors and should be written with sufficient clarity and detail to support proposal processing and the merit review process. Generic Plans should be avoided. The Data Management Plan (not to exceed two pages) should describe the data, metadata, samples, software, curricula, documentation, publications, and other materials generated during the proposed research. The Data Management Plan should reflect the best practices and standards for the proposed research and types of data being generated, whether experimental, computational, text-based, media or physical materials. DRK-12 expects its awardees to describe how data and related materials are generated to allow others to reproduce the findings and/or replicate the study. Further the Plan should support the sharing of data, products and methods in such a way that others can understand, validate, and replicate the research findings.

Postdoctoral Mentoring Plan: Each proposal that requests funding to support postdoctoral researchers must upload under "Mentoring Plan" in the supplementary documentation section, a description of the mentoring activities that will be provided for such individuals. In no more than one page, the mentoring plan must describe the mentoring that will be provided to all postdoctoral researchers supported by the project.

In addition to guidance provided in the PAPPG on required Special Information and Supplementary Documents, please provide a **list of all project personnel** in the Supplementary Document section. Include 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 reviewer selection. The list should include all PIs, co-PIs, senior personnel, paid/unpaid consultants or collaborators, subawardees, postdoctoral researchers (if known), and project-level advisory committee members. This list should be numbered and include (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 Smith; XYZ University; PI
2. John Jones; University of PQR; Senior Personnel

Appendix: Not permitted. The 15 pages of the Project Description should contain all the information needed to describe the project. Proposals submitted with an Appendix will be returned without review.

Collaborators and Other Affiliations Information: Collaborators & Other Affiliations (COA) information specified in the PAPPG should be submitted using the instructions and spreadsheet template found at <https://nsf.gov/bfa/dias/policy/coa.jsp>.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

Budget Preparation Instructions:

DRK -12 generally does not fund equipment that is normally found in schools, universities, and research and development organizations, such as computers. Requests for equipment must be accompanied by justification for its importance to the operation of the project.

The budget should include a request for funds to cover the cost of attendance of the Principal Investigator at a biennial awardees meeting in the Washington, DC area.

DRK -12 does not provide scholarships for undergraduate, pre-service, or other students.

C. Due Dates

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

October 07, 2020

October 08, 2021

October 05, 2022

First Wednesday in October, Annually Thereafter

D. Research.gov/Grants.gov Requirements

For Proposals Submitted Via Research.gov:

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 Research.gov user support, call the Research.gov Help Desk at 1-800-673-6188 or e-mail rgov@nsf.gov. The Research.gov Help Desk answers general technical questions related to the use of the Research.gov system. 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: <https://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 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 *Leading the World in Discovery and Innovation, STEM Talent Development and the Delivery of Benefits from Research - NSF Strategic Plan for Fiscal Years (FY) 2022 - 2026*. 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 other underrepresented groups 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 or the Division of Acquisition and Cooperative Support 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 an NSF Grants and Agreements Officer. 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) 292-8134 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.

Administrative and National Policy Requirements

Build America, Buy America

As expressed in Executive Order 14005, *Ensuring the Future is Made in All of America by All of America's Workers* (86 FR 7475), it is the policy of the executive branch to use terms and conditions of Federal financial assistance awards to maximize, consistent with law, the use of goods, products, and materials produced in, and services offered in, the United States.

Consistent with the requirements of the Build America, Buy America Act (Pub. L. 117-58, Division G, Title IX, Subtitle A, November 15, 2021), no funding made available through this funding opportunity may be obligated for an award unless all iron, steel, manufactured products, and construction materials used in the project are produced in the United States. For additional information, visit NSF's [Build America, Buy America](#) webpage.

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:

- Inquiries can be made to, telephone: (703) 292-8620, email: DRLDRK12@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 <https://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 (FASSED) 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) 292-8143
- **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 [System of Record Notices](#), NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." 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
Policy Office, Division of Institution and Award Support
Office of Budget, Finance, and Award Management
National Science Foundation
Alexandria, VA 22314

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