NATIONAL SCIENCE FOUNDATION

4201 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22230

Directorate for Education and Human Resources
Math and Science Partnership (MSP) Program

May 2005

Dear Colleague:

The Math and Science Partnership (MSP) Program at the National Science Foundation is a major Research and Development (R & D) effort designed to integrate the work of higher education with that of K-12 to reform mathematics and science education at all levels, with particular attention to increasing K-12 student achievement. All aspects of the program, including project- and program-level evaluation, are driven by R & D "habits of mind."

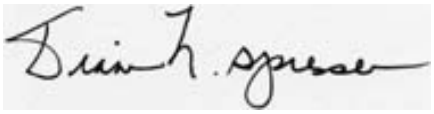
In October 2004, the MSP Program convened a workshop meeting of principal investigators and evaluators of Cohort 1 and 2 projects to formulate a statement that would guide effective project-level evaluation in the context of a national R & D effort, such as the MSP. In recognition of evaluation as an area of expertise and scholarship, the Program sought to bring together this community of evaluators and principal investigators who were experienced in the work of MSP, as well as other experts representing a range of perspectives on evaluation. The Program requested that the leadership of *Building Evaluation Capacity of STEM Projects* -- an MSP-funded project [NSF Grant EHR 0233382] at Utah State University – assume primary responsibility for planning the workshop and for the overall development of any resulting statements and guiding frameworks.

Through the workshop discussions, subsequent discussions by the MSP community at its winter 2005 Learning Network Conference, and a considerable amount of additional work by a team of experienced evaluators, the MSP community has produced the document *Evidence: An Essential Tool – Planning for and Gathering Evidence using the Design-Implementation-Outcomes (DIO) Cycle of Evidence* (NSF 05-31).

On behalf of the MSP program at NSF, I would like to express great appreciation to Drs. Catherine Callow-Heusser, Rosalie T. Torres and Heather J. Chapman, who authored the document, as well as the team of evaluators acknowledged in the introduction to the report. Their expertise, experience and dedication have enabled the MSP program to take an important step forward in project-level evaluation that responds to the ever-deepening nature of an R & D effort. I am especially grateful to Dr. Callow-Heusser for her leadership in this effort. I am also grateful to the broad MSP community of principal investigators and evaluators whose engagement in the development of this document has greatly enhanced its utility.

We ask all MSP Partnership projects to continue their engagement with the *DIO Cycle of Evidence* and to make intelligent use of it as a guiding framework to plan for, gather and use evidence in project-level evaluation. We in the MSP program at NSF also expect to incorporate this framework in the oversight of our projects as we -- and others whom we fund -- engage in the ongoing review of project evaluation commensurate with a major R & D effort.

Sincerely,



Diane M. Spresser
Senior Program Coordinator
National Science Foundation

Evidence: An Essential Tool

Planning for and Gathering Evidence Using the Design-Implementation-Outcomes (DIO) Cycle of Evidence

Prepared for:

The National Science Foundation
Directorate for Education and Human Resources
Math and Science Partnership Program

Prepared by:

The Consortium for Building Evaluation Capacity
2810 Old Main Hill
Utah State University
Logan, UT 84322-2810

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Planning for and Gathering Evidence Using the Design-Implementation-Outcomes (DIO) Cycle of Evidence

Prepared under Grant:
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Catherine Callow-Heusser
Heather J. Chapman
The Consortium for Building Evaluation Capacity

Rosalie T. Torres
Torres Consulting Group

Prepared for The National Science Foundation
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Math and Science Partnership Program

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Introduction and Background

On July 15, 2004, the Math and Science Partnership (MSP) program at the National Science Foundation (NSF) issued a meeting announcement for "principal investigators and evaluators on MSP Cohort 1 and 2 Partnership and RETA projects to consider and formulate a statement of guidance for effective project-level evaluation in the context of a national R & D effort, such as the MSP" (http://hub.mspnet.org/index.cfm/calendar/show/event-168). Specifically, the MSP Program requested a statement about high quality evidence of effectiveness and efficiency, and a guiding framework that would:

- clarify NSF's expectations for gathering and reporting evidence,
- guide current MSP projects in their evaluation activities, and
- guide future MSPs and other who submit proposals to NSF for funding.

This request arose out of needs to: (a) provide guidance for evaluation planning and evaluation activities to NSF's MSP projects and other projects, and to groups submitting proposals to NSF programs; (b) have a consistent framework by which to assess project-level evaluation; and (c) develop a document about project-level evaluation, grounded in the expertise and experience of the scholarly community having that expertise, that would be an important component of NSF's response to the 2004 Inspector General's Audit of NSF's Math and Science Partnership Program. Both the document and the process by which it was developed are critical components of that response.

The resulting statement and guiding framework—the Design-Implementation-Outcomes (DIO) Cycle of Evidence—described in the following sections were initially outlined by a team of experienced evaluators who have long been involved in evaluations of complex, large-scale projects, particularly mathematics and science projects. This document is based upon work supported by the NSF under supplemental funding to grant EHR-0233382, with the guidance and support of Elizabeth VanderPutten. The developers included (alphabetically)

Catherine Callow-Heusser, Ph.D. Candidate (ABD)
James Dorward, Ph.D., USU's Building Evaluation Capacity MSP-RETA[1]
Joy Frechtling, Ph.D., Westat, consultant for USU's NETA[2]
Frances Lawrenz, Ph.D., U-MN, member of USU's MSP-RETA Advisory Committee
Sean Smith, Ph.D., Horizon Research
Rosalie Torres, Ph.D., Torres Consulting Group, consultant for USU's NETA
Norm Webb, Ph.D., U-WI-Madison

[1]USU: Utah State University; RETA: Research, Evaluation, and Technical Assistance project

[2] NETA: USU's Network for Evaluation Technical Assistance consists of expert evaluators who provide technical assistance to some MSP projects as part of USU's RETA funding

Iris Weiss, Ph.D., Horizon Research, member of USU's MSP-RETA Advisory Committee

Additional input was provided by other members of the MSP-RETA project team at Utah State University (Heather Chapman, Steve Lehman, and Scott Bates), other members of USU's MSP-RETA Advisory Committee (James Altschuld, Frank Davis, Arlen Gullicksen, Donna Mertens, Tom Romberg), and other professional evaluators at Horizon Research. An initial version of the DIO Cycle of Evidence was presented at a meeting of MSP principal investigators (PIs) and evaluators, titled "Evidence: An Essential Tool" and held on October 21-22, 2004, in Arlington, VA. At that meeting, PIs and evaluators reviewed the framework, applied it to activities within their own projects, and provided recommendations for revising and improving the framework. MSP project teams (i.e., PIs, Co-PIs, evaluators, stakeholders) provided additional feedback at the MSP Learning Network Conference held in Washington, DC, January 31-February 1, 2005.

One major theme in the feedback was the need for a common language—a language known to evaluators but also familiar to Science, Technology, Engineering, and Mathematics (STEM) faculty and professionals involved in planning, implementing, and evaluating MSP projects. The DIO Cycle of Evidence addresses this need for a common language, and provides a framework for considering projects and project activities at multiple levels, from the global "big picture" view of projects to the most detailed perspective of individual project activities designed to produce specific outcomes. Overall, the evidence gathered through applying this framework can help increase knowledge, provide evidence for accountability, improve projects, and support the value and feasibility of projects and activities.

The remainder of this document includes the following major sections:

(a) A statement about high quality evidence of project effectiveness and efficiency.

(b) A description of the DIO Cycle of Evidence as a guiding framework for planning, gathering, and using evidence.

(c) The relationship of the DIO Cycle of Evidence to other frameworks used in evaluating projects.

(d) The role of context in establishing evidence of project effectiveness.

(e) Resources to help projects learn more about planning, gathering, and using evidence.

(f) A glossary of terms and abbreviations used throughout this document.

(g) Appendices that contain supplemental resources.

Statement on High Quality Evidence of Effectiveness

The NSF's MSP program is "recognized as a research and development effort for building capacity and integrating the work of higher education - especially its disciplinary faculty in mathematics, the sciences and engineering - with that of K-12 to strengthen and reform science and mathematics education" (NSF, 2005). As with any research and development effort, a focus on high quality evidence of effectiveness and efficiency helps to ensure intellectual rigor and broad impact. To accomplish this, scientifically based evaluation methods for gathering and analyzing evidence must be implemented to determine the effectiveness and efficiency of programs or projects, and to assess the relationship between project implementation and outcomes. Additionally, formative evidence collected along the way should be used to guide ongoing decisions, improve projects and activities, and increase opportunities for successfully attaining project goals.

The MSP program seeks to improve student outcomes in mathematics and science for all K- 12 students. Within the context of MSP, the purpose of evaluation is to provide scientific insights grounded in evidence to

(a) establish the need for MSP projects and activities,
(b) document how the projects are implemented,
(c) improve projects and make data-based decisions about changes for improvements through ongoing formative evaluation, and
(d) determine the impact of projects and activities and demonstrate how impacts were determined.

Using an evaluation framework, and as part of the research and development (R&D) effort integral to the MSP program, MSP partners explore, research, and evaluate methods that best accomplish MSP goals in relation to the five MSP Key Features:

(a) partnerships that effectively engage science, technology, engineering and mathematics (STEM) disciplinary faculty
(b) teacher quality, quantity and diversity
(c) challenging courses and curricula
(d) evidence-based design and outcomes
(e) institutional change and sustainability

High Quality evidence that is both reliable and valid is crucial to determining the degree to which MSP goals are reached. Given the R&D nature of MSPs, methods for gathering the needed evidence must be matched to four main evaluation purposes (Mark, Henry, & Julnes, 2000; Weiss, 1998): (a) oversight and accountability, (b) program improvement involving mid-course corrections, (c) overall assessment of merit and worth, and (d) generating knowledge. Sound evaluation practices, starting with needs assessment (which should be ongoing and continuous), are encouraged to prioritize and conduct evaluation activities to gather evidence for these purposes.

While randomized controlled trials might be best to answer some evaluation questions, most questions within an R&D setting will require alternative or mixed methods (both quantitative and qualitative data gathering and analysis), including interviews, observations, case studies, surveys, and other strategies to understand causality and to provide the information needed to improve educational experiences and outcomes for K-12 students. Applied appropriately, the scientific rigor of these methods can be established. In 2002, in H.R. 3801 included the following definition for scientifically valid educational evaluation:

> The term "scientifically valid education evaluation" means an evaluation that:
> (a) adheres to the highest possible standards of quality with respect to research design and statistical analysis;
> (b) provides an adequate description of the programs evaluated and, to the extent possible, examines the relationship between program implementation and program impacts;
> (c) provides an analysis of the results achieved by the program with respect to its projected effects;
> (d) employs experimental designs using random assignment, when feasible, and other research methodologies that allow for the strongest possible causal inferences when random assignment is not feasible; and
> (e) studies program implementation through a combination of scientifically valid and reliable methods.

The American Evaluation Association (AEA, 2003) proposed that this definition be adopted as it "calls attention to the need for more rigorous methodologies in the context of the function of evaluation to assess and inform. In addition, it illuminates the relationship between program implementation and program impact."[3] Within the MSP, scientifically based evaluation methods for gathering and analyzing evidence can be implemented according to this definition to determine the effectivenss of the MSP program and projects, and to assess the relationship between project implementation and project impact.

While rigorous evaluation designs and appropriate data collection methods are crucial, the evidence gathered and reported forms the foundation for project accountability, project improvement and mid-course corrections, and claims of project impact. *Evidence* is an essential tool for establishing project effectiveness and efficiency.

[3] AEA's statement regarding scientifically based evaluation methods is available at http://www.eval.org/doestatement.htm.