Informal Science Education Assessment in the Context of the 5-Year Federal STEM Education Strategic Plan

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Informal Science Education in the Federal STEM Education Strategic Plan:

Quality STEM education is important for the nation as a whole and for individual citizens. A robust and capable STEM workforce is crucial to United States competiveness. Multiple reports link improved STEM education to the future security and economic success of the U.S.[1] Federal programs, collectively, spend more than $3 billion per year on STEM education. However, inter-agency coordination and collaboration of these programs has thus far been minimal, leading to repeated questions about the efficiency and effectiveness of these efforts.[2] In addition, there have long been calls for improvements in the STEM education evaluation capacity and practices of federal agencies.[3]

[1] U.S. Department of Commerce (January, 2012). The competitiveness and innovative capacity of the United States. http://www.commerce.gov/sites/default/files/documents/2012/january/competes_010511_0.pdf.
President's Council of Advisors on Science and Technology (September, 2010). Prepare and inspire: K-12 education in science, technology, engineering, and mathematics (STEM) for America's future. http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf.

[2] Federal Coordinating Council for Science, Engineering, and Technology, Committee on Education and Human Resources (1993). Pathways to excellence: A federal strategy for science, mathematics, engineering, and technology education. http://www.eric.ed.gov/PDFS/ED360165.pdf.
GAO (2005). Higher education: Federal STEM programs and related trends. http://www.gao.gov/assets/250/248137.pdf.
U.S. Department of Education (2007). Report of the Academic Competitiveness Council, Washington, D.C.
PCAST (September, 2010). Report to the President: Prepare and inspire: K-12 education in STEM for America's Future. http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf.

[3] NSTC Subcommittee on Education (2008). Finding out what works: Agency efforts to strengthen the evaluation of Federal STEM education programs. http://www.whitehouse.gov/files/documents/ostp/NSTC%20Reports/NSTC_Education_Report_Complete.pdf .

The NSTC Committee on STEM Education (CoSTEM) was created to coordinate federal programs and activities that support STEM education pursuant to the requirements of Sec. 101 of the America COMPETES Reauthorization Act of 2010.[4] The CoSTEM addresses a wide range of education and workforce policy issues including: research and development efforts that focus on STEM education at the PreK-12, undergraduate, graduate, and lifelong learning levels; and current and projected STEM workforce needs, trends, and issues. The CoSTEM is carrying out two specific tasks:

- Develop and implement a 5-year federal STEM education strategic plan to coordinate STEM education activities and programs across federal agencies
- Annually collect and report information on all federal STEM education programs

According to the *Federal Science, Technology, Engineering, and Mathematics (STEM) Education Portfolio*[5], the first report to fulfill the second task described above, the $3.4 billion with which 13 federal agencies support STEM education is a very small piece of the $1.1 trillion in annual U.S spending on education. In addition, of the 252 investments funded in fiscal year 2010, none were identical and only a moderate number shared similar objectives, target audiences, products, and STEM fields of focus.

While the federal STEM education strategic plan is not yet complete, the CoSTEM released a progress report[6] in February that included an overview of the major recommendations under consideration. The progress report indicated that the objectives of federal STEM education programs fall into two broad categories: 1) those that develop and maintain the highly qualified, diverse STEM workforce needed by science mission agencies, and 2) those that increase the

[4] Pub. L. No. 111-358 (http://www.gpo.gov/fdsys/pkg/BILLS-111hr5116enr/pdf/BILLS-111hr5116enr.pdf)

[5] http://www.whitehouse.gov/sites/default/files/microsites/ostp/costem__federal_stem_education_portfolio_report.pdf

[6] http://www.whitehouse.gov/sites/default/files/microsites/ostp/nstc_federal_stem_education_coordination_report.pdf

STEM literacy and proficiency of all citizens. The strategic plan will include four coordination objectives that are designed to improve the efficiency and effectiveness of the federal government's efforts to accomplish these two broad objectives.

1. **Use evidence-based approaches.** Ensure federal STEM education investments incorporate what is known about effective STEM education and use evidence-based STEM education practices.
2. **Identify and share evidence-based approaches.** Conduct STEM education research and evaluation to identify evidence-based practices and assess program effectiveness. Enhance sharing of research and evaluation findings across agencies and with the public.
3. **Increase efficiency and coherence.** Ensure federal STEM education investments are coordinated in order to utilize and leverage federal resources efficiently.
4. **Identify and focus on priority areas.** Align a subset of the federal STEM education investments to focus on federal STEM education priority areas in a coordinated manner. The four priority areas identified are (a) effective K-12 STEM teacher education, (b) engagement[7], (c) undergraduate STEM education, and (d) serving groups traditionally underrepresented in STEM fields.

Informal science education constitutes a significant portion of federal investments in STEM education, particularly at science mission agencies and the National Science Foundation. The exact amount of federal funding for informal STEM education is difficult to determine because individual STEM education programs often support both formal and informal STEM education. However, an estimate can be calculated from the data collected to write the NSTC STEM education portfolio report. Information on programs is divided into two categories in the data set:

[7] STEM education engagement activities are what most agencies would call informal or non-formal education

1. Programs that address agency mission specific workforce issues (e.g., Short Courses in Integrative and Organ Systems Pharmacology, Nuclear Education Curriculum Development , a University Nano Satellite Program) and
2. Programs that address broader STEM education issues.

The primary objective of about 32 percent ($157 million) of funding from science mission agencies that targeted toward broader STEM education issues was "engagement."[8] Robust assessment and evaluation of these informal STEM education programs will be a key aspect in implementing the strategic plan. However, the informal science education assessments and evaluations currently in use are inadequate to make a strong case for the value of these investments.

The Need for Better Assessment and Evaluation of Informal Science Education:

The impact of informal science education is unclear because of the difficulty in defining measurable outcomes and assessing impact for these programs. The NRC report *Learning Science in Informal Environments*[9] includes an in-depth review of the factors that make assessment and evaluation of outcomes particularly difficult. The report also provides a basic framework that could potentially be used to move the field of informal science education assessment and evaluation forward.

The CoSTEM is hopeful that this summit and similar efforts will lead to recommendations for how federal agencies and stakeholders funded by federal agencies can better assess and evaluate informal STEM education in order to

- Justify federal expenditures on informal science education;

[8] The NSTC survey on federal STEM education did not ask whether a program was primarily focused on formal or informal education.
[9] http://www.nap.edu/catalog.php?record_id=12190

- Support continuous improvement of informal science education programs; and
- Identify and test different models of informal science education programs.

To accomplish these goals, it will be necessary to be able to show short-, intermediate-, and long-term outcomes, and test the links and their theoretical underpinnings between each stage of foundational research to scaling up programs. Such work will require the development of theories of action and/or logic models.

Defining Metrics, Measures and Outcomes:

The CoSTEM is looking for research on informal science education to support the development of clear and measurable program outcomes and to identify methods and metrics to assess these outcomes. federal agencies represented on the CoSTEM have stated that their goals are to attract more people to STEM careers related to their missions and to improve public interest and proficiency in STEM. Thus, CoSTEM is actively seeking guidance regarding how to assess the impact of informal STEM education on career choice and on all six strands of science proficiency identified by the NRC. However, CoSTEM is particularly interested in identifying strategies to assess the impact of informal STEM education environments on the two outcomes that these environments are particularly well suited to accomplish[10]: 1) increasing interest in and identification with STEM, and 2) increasing participation of learners from underserved groups.

The CoSTEM progress report calls for the development of evidence standards that all agencies could adopt to inform their funding award process and the evidence that funded projects should collect. The goal of these evidence standards is to improve the quality and pace of R&D at all stages (from foundational research to scale-up studies) by ensuring that

[10] According to the NRC report *Learning Science in Informal Environments*

- program models are chosen based on sufficient evidence for the level of the funding and scale of the project, and
- evidence collected indicates whether a project is effective and if so, what aspects of the project made it successful.

The CoSTEM is seeking guidance to inform its choice of evidence standards for informal science education projects.

One particular evaluation issue that federal agencies struggle with is how to identify and measure outcomes that are appropriate for the size and maturity of the project. STEM education projects funded by the federal government cover a wide range, from the relatively small ($300 thousand), to the relatively large ($20 million) and from the relatively immature (originating in 2010), to the relatively mature (originating in 1995). The CoSTEM is interested in creating capacity to support robust evaluation designs across the federal government by exploring whether it is possible to create common evaluation frameworks, tools, and metrics that could be used by all projects and align evaluation standards to project size and maturity. CoSTEM is seeking input into whether this strategy is plausible given the current state of informal science education research and evaluation; and guidance on how to develop common models, tools, and metrics. For example, is it possible to identify a single common evaluation framework with tools and metrics to track the impact of after-school programs, and what would such a model look like?

The 5-year federal STEM education strategic plan is scheduled to be completed this spring. Input prior to the completion of the report from this meeting and from other stakeholders will inform the final report. In addition, the CoSTEM will seek further support from the informal science education community to guide and support implementation of the strategic plan after it its release.