STATEMENT OF WORK – EXTERNAL EVALUATION

Evaluating the Efficacy of the Center for Education at the National Academies

Background

The grant to the Center for Education (CFE) from the National Science Foundation (NSF) provides five years of core support to the CFE, from May 2001 through May of 2006. The grant stipulates that the Center evaluate its activities and impacts in order to: 1) have the information necessary to facilitate continued improvements in CFE operations and 2) allow the NSF to assess the value of its investment in the Center. Thus, there is a need for both formative and summative information from evaluation data.

The CFE evaluation framework is organized around three major components,

1. Evaluation of the Center vis-à-vis the functioning of its board and executive leadership
2. Evaluation of impacts of individual studies
3. Evaluation of impact of the Center as a whole

(See Appendix A for complete framework.) Each of these components requires the assistance of an external evaluator. Specifically, outside assistance is needed to: 1) determine whether and how CFE studies are achieving their desired impacts, 2) fully document the nature and effectiveness of CFE activities and products including summarizing activities and impacts across the varied CFE goals and program strands of work (refer to framework in Appendix A), 3) assess the “value added” of the CFE as an organizational entity in fostering goal attainment, and 4) assess the Center’s internal formative evaluation system and recommend appropriate improvements to that system.

Conducting an External Evaluation of CFE

Commencing in summer 2004, the external evaluator will conduct a six month external evaluation of the CFE following the evaluation framework. The evaluation will consist of five central tasks:

Task 1: Documenting the Impacts of Selected CFE Studies on Target Audiences

Task 1 of the external evaluation, which corresponds directly to the second component in the CFE evaluation framework, will determine for four CFE studies what impacts can be documented from evidence post-hoc. The studies to be examined are *Adding It Up* (2001), *Knowing What Students Know* (2001), *Learning & Understanding* (2002), and *Scientific Research in Education* (2002).

Task 2: Documenting CFE Activities and Products

Task 2, which corresponds to the third component of the CFE evaluation framework, consists of two principal sub-tasks.
Subtask 2.1
The external evaluator will map into an appropriate "Activities Matrix" all formally approved CFE work initiatives since the Center's inception through May of 2004 along with the education initiatives at the Academies conducted under the auspices of the Committee on Science, Mathematics, and Engineering Education (CSMEE) and the Board on Testing and Assessment (BOTA) in the three years preceding the Center's creation. The matrix will be multidimensional allowing for descriptions of CFE and predecessor organization activities and products to be mapped against: a) CFE goals and program strands as outlined in its original proposal to NSF (see Appendix B) and, b) other relevant dimensions such as types of work conducted (e.g., workshops, consensus studies), content focus, publications, funding levels, and sponsorship. (CFE will provide written descriptions of each of these formally approved initiatives to the evaluator).

Subtask 2.2
The evaluator will use the Activities Matrix as the basis for comprehensively describing the CFE portfolio during the first three years of its existence (May '01 through May '04), and through descriptive statistics and accompanying narratives, systematically comparing and contrasting the portfolio with immediately prior education efforts at the Academies.

Task 3: Documenting the "Value Added" of CFE and Impact of Its Work

Task 3, which corresponds to the third component of the evaluation framework, consists of the following three subtasks:

Subtask 3.1
From the Activities Matrix, the evaluator will work with CFE staff to identify a smaller purposeful sample of activities to explore in greater depth. The sample will include a range of activities including sponsored workshops and place special emphasis on more innovative activities and products (e.g., CD compilations, transcript postings, webstreaming).

Subtask 3.2
The evaluator will conduct focused and in-depth examinations of the identified activities, paying particular attention to how intended audiences perceive the quality, relevance, and usefulness of the sampled activity. In these investigations, the evaluator will collate and review available documentation, interview Academies staff, and interview external audiences of CFE work such as a sample of CFE event participants. CFE staff will work closely with the evaluator in securing access to needed individuals and materials to conduct these reviews.

Subtask 3.3
The evaluator will identify and implement specific analytic techniques for documenting the "value added" of the CFE as an organizational entity. The techniques may be implemented as components of previously identified tasks, or as new tasks. An articulated set of hypotheses about the "value-added" of the Center (many specified explicitly in the proposal to NSF) will be investigated such as fostering collaboration among Academies units, providing a home for cross-cutting topical investigations (such as the work of the Committee
on Research in Education and teacher preparation), supporting continuity and long-term development of important lines of research inquiry over time, and increasing the visibility of NRC's education work both within and outside the Academies. Examples of techniques for documenting "value-added" may include specific analyses of changes in the activities portfolio of the CFE compared with predecessor entities (Task 2.2), exploring as part of the in-depth sampled activities investigation (Task 3.2.) the influence of the CFE structure on the nature and effectiveness of the activity, and conducting structured interviews with key individuals from within and outside the organization who can compare and contrast the overall nature of CFE operations and impacts with prior education work at the NRC.

Task 4: Assessing the CFE Internal Formative Evaluation System

Task 4, which corresponds to the first component of the CFE evaluation framework, will describe the nature of CFE’s current internal formative evaluation system and, using the knowledge acquired through the data and evidence-gathering activities described earlier, recommend to the CFE modifications and improvements in the system that would permit the Center to more effectively assess operations and impacts and make needed adjustments on an ongoing basis.

Task 5: Deliverables

The evaluator will provide the following deliverable products to the CFE:

1. A set of Design Deliverables to include:
   a. A Task 1 design document for examining the context in which the findings from the four CFE selected studies entered into and affected the educational research and policy environments.
   b. A Task 2 design document which will contain an activities matrix design and an analysis plan for profiling the CFE portfolio and comparing it to prior education work at the NRC under the auspices of the Committee on Science, Mathematics, and Engineering Education (CSMEE) and the Board on Testing and Assessment (BOTA).
   c. A Task 3 design document which will contain: 1) recommendations of sampled activities that would receive in-depth exploration to assess quality, relevance, and usefulness, 2) a delineation of specific hypotheses to address the "value-added" of the CFE accompanied by plans for their assessment, and 3) all respondent lists and instrumentation that are proposed to be used in Task 3 examinations.

2. Report Deliverables to include:
   a. An outline for the final evaluation report which will include critical findings and insights from each of the four tasks previously specified
   b. The final evaluation report
Schedule

The evaluator will, in their proposal, propose a schedule for the conduct of this work, and the submission of all deliverable products. In preparing this, the evaluator should recognize the following guidelines and constraints:

1. The Final Report will be due no later than March 31, 2005
2. The outline for the Final Report will be no later than February 15, 2005
3. All deliverables will be submitted first as a draft for CFE review and feedback. The evaluator should allow for 10 working days for receiving comments on draft deliverables.

Working with CFE staff

A close working relationship between the CFE and evaluator will be essential for the success of the evaluation. As such, the evaluator will communicate frequently and regularly with CFE staff during the evaluation period via email, conference call, and on-site meetings. CFE staff will provide the evaluator with necessary documentation on activities and products, and, as previously specified, provide other support assistance needed to enable the evaluator to perform their work successfully.
APPENDIX A
The Evaluation Framework

The CFE evaluation framework is grounded in the mission, goals, and program strands that led to The Center’s creation and have been refined through ongoing conversations with NSF and the CFE Board:

- **Mission** – to improve education for all learners, by promoting evidence-based decision making in education policy and practice, enhancing the capacity for educational improvement, and focusing objective, independent, and interdisciplinary attention on education problems and the search for viable solutions.

- **Goals**
  1. **Promote evidence-based decision making** in education policy and practice.
  2. **Enhance capacity** for educational improvement.
  3. **Anticipate and respond to stakeholder needs** through objective, independent, and interdisciplinary attention to education problems and the search for viable solutions.
  4. **Advance equity** in all aspects of education and in all CFE studies.

- **Program Strands**
  1. Standards, assessment, and accountability.
  2. Supply, quality, and development of the teaching professions.
  3. Education technology for teaching and learning.
  4. Transitions in education and employment.

**CFE Evaluation Plan**

The CFE evaluation will be organized around three major components:

1. Evaluation of the Center vis-à-vis the functioning of its board and executive leadership
2. Evaluation of impacts of individual studies
3. Evaluation of impact of the Center as a whole

**Evaluation Component 1: Evaluation of the Center Vis-à-vis the Functioning of its Board and Executive Leadership**

**Roles of the Board and Executive Leadership**

The Center’s Board and executive leadership are responsible for providing oversight, direction, and integration of the activities conducted by its standing boards and committees as well as through crosscutting Center-wide projects and activities.
Specific Roles to be Evaluated
1. Guidance and support of agenda setting for the Center as a whole
2. Development of short, intermediate, and long-term strategic plans for the work of the Center.
3. Success in fostering connections among CFE standing boards and committees and with other NRC units
4. Success in fostering effective communication with sponsors, clients, and other outside organizations (i.e., CFE activities and products are reaching the right audiences)
5. Effective management and evaluation of the center’s work

Internal Evaluation Strategy
1. Project level self assessment tools to provide templates for developing and prioritizing project initiatives, designing and managing projects, and communicating results. Because these tools reflect common areas of emphasis/attention across the CFE, they should be applied to all initiatives and projects (i.e., “CFE-wide” activities, as well as activities of each of its standing boards and committees)
2. Project level self assessment tools adapted to shape Center-level evaluation tools and strategies (i.e., ways of assessing the full portfolio of CFE work with respect to missions, goals, and program strands)

Evaluation Component 2: Evaluation of Impacts of Individual Studies

This evaluation component will address the question of whether and how CFE studies are achieving their desired impacts:
1. What specific impacts of the study are expected at the outset, what are the plans for achieving them, and what evidence would need to be collected to determine whether desired impact were in fact met?
2. Consistent with the template established under #1, what impacts from the study can be documented from evidence post-hoc and what factors can explain such impacts (this would include a full examination of the context in which the study’s findings are entering the policy environment)?

Internal and External Evaluation Strategy
1. Internal – self assessment tool to address question 1 for all CFE projects
2. External – component of contracted evaluation of the CFE addressing question 2 with regard to a limited number of bellwether studies representing the range of CFE work under the NSF grant.

Evaluation Component 3: Evaluation of Impacts of the Center as a Whole

This component will consist of two central activities:
1. fully documenting the “reach” of CFE activities and products
2. conducting a “case study” of the CFE
Internal and External Evaluation Strategy

1. Activity 1 would be internal with the possibility of externally contracted assistance if necessary. It would encompass comprehensive descriptions of awareness and subsequent uses of all significant CFE activities and products as gleaned through documenting CFE “reach out and touch” activities (e.g., attendees at workshops and symposiums and report dissemination efforts), scouring of public information retrieval sources for CFE references, documenting web hits, and collating unsolicited feedback/testimonials from consumers on the value of CFE activities and products.

2. Activity 2 would be conducted through contract with an external evaluator. It would fully document the impact of a limited number of bellwether studies (see component 2), but also “add up” and summarize activities and impacts across the CFE goals and program strands with particular attention given to the “value added” of the CFE as an organizational entity in facilitating goal/content strand advancement.
APPENDIX B
Original Proposal to NSF
(Appendices for the proposal available on request)

PROJECT DESCRIPTION

INTRODUCTION

The National Research Council (NRC) requests from the National Science Foundation a five-year continuing grant to support an array of work in the recently expanded Center for Education. With this support the Center will conduct a variety of activities designed to inform education decision makers, build capacity for educational improvement in the U.S., and focus objective, evidence-based attention on solving problems in education. The long-term goal will be improved education for all learners.

This proposal has three sections. Section I presents the context and vision for the Center, including its mission, programmatic strands, operating principles, organization and staffing, and product mix. Section II describes how the Center’s continued emphasis on science, mathematics, engineering, and technology education (SMETE) is central in that broader framework, proposes a set of specific activities and products in SMETE that the Center will conduct in the first two years of the grant, and describes a process by which activities will be developed in the last three years of the grant. Finally, Section III summarizes the significance and expected impacts of these activities and of the Center infrastructure that supports them.

I. THE CENTER FOR EDUCATION

If we are to be effective in spreading an understanding and appreciation for science throughout our society ... our scientists and science leaders must reflect the diversity of this great nation. This means that we must develop an education system that does a much better job of preparing all students...

-Bruce Alberts,
President, National Academy of Sciences, May 2000

Many technological advances are becoming increasingly interdisciplinary ... while we must strengthen math and science education to address the requirements of the new technologies we see on the horizon, we should not lose sight of the advantages of a liberal education.

-Alan Greenspan,
Chairman, Federal Reserve Board of the United States, September 2000

CONTEXT

The interplay between mathematics and science education and general education issues and trends is more important in the U.S. today than ever before. Demographic and socioeconomic trends, changing expectations about the level and content of academic achievement by all students, especially in mathematics, science, and technology (see, e.g., 1*), and emerging knowledge about the cognitive foundations of teaching and learning have profound implications for the future of education at all levels. Consider, for example, that in 1950 the school-age population was 86 percent white, while it is projected that today’s racial and ethnic minorities will constitute the majority of school-age children within the next forty years (2). Linguistic diversity—especially among Asian and Hispanic students—has become commonplace among the school-age population (3). Nearly one in five school-age children live in poverty—and nearly two in five African-American and Hispanic youths do (4). While African-American students have made notable progress in educational attainment and achievement over the last four decades (5, 6), achievement gaps between white students and their non-white peers persist (7). Students with physical and cognitive disabilities face special challenges. Again, though many schools have made strides toward inclusion and appropriate accommodations, problems of defining and implementing high standards for all students remain (8).

* Numbered references throughout this project description correspond to Section D, References Cited.
Awareness of these trends and changing expectations about the academic achievement by all students, as well as evidence of growing economic inequality and its roots in educational disparities (9), have fueled the standards-based education movement, now in its second decade. While there are signs that standards can positively influence achievement (10), it is a movement understood and applied quite differently in different states and localities. Indeed, evidence points to uneven adoption of standards in science, mathematics, and other subjects (11, 12). Fundamental questions about implementation, coupled with evidence of an increasing reliance on high-stakes standardized tests as the performance indicator of choice, have led to a backlash against the tests themselves and concerns about the definition and implementation of standards. Since mathematics and science standards were developed and adopted early relative to other subjects, lessons about the experience with these standards may be of great value in considering issues of policy and practice in the standards movement generally.

Another powerful force in this dynamic landscape is research. For example, advances in cognitive research (e.g., 13) have opened new windows on the nature of human learning, both generally and in specific disciplines, with implications for achievement by all learners. Additionally, the infusion of information technology into education poses new questions about the content and delivery of knowledge, organizational structures, and measures of quality in education.

THE CENTER AND THE NATIONAL ACADEMIES
Addressing these complex issues systemically will require leadership and decision making from organizations that can bring together the many stakeholders in U.S. education. The National Academies can provide such leadership and a venue for informed discussion. Since its establishment in 1863, the National Academies has provided objective and independent research-based advice to the nation.1 Undertaking analyses of complex and often controversial public policy problems, the NRC (the operating arm of the Academies) brings together members of the National Academies and other experts in activities aimed at harnessing scientific knowledge toward the betterment of decision making and the public welfare. This work is conducted by interdisciplinary and broadly representative ad-hoc committees of volunteer experts, appointed by the NRC’s chair. Working closely with NRC staff, who hold advanced degrees in the relevant scientific disciplines, these committees author consensus reports that are rigorously and independently reviewed to ensure that findings and recommendations are backed by solid evidence. Standing boards and committees, also comprised of volunteers (many of whom are elected members of the National Academies), provide continuity, coherence, and intellectual oversight. The set of procedures for committee appointments, deliberations, and release of reports that has evolved throughout the NRC’s history (see Appendix 1) has given the National Academies a well-deserved reputation for independence, objectivity, and quality.

The National Academies has long been concerned with the promise and problems of education in the U.S. at all levels, particularly in mathematics and science. Hallmark achievements in the improvement of education include workshops, colloquia, convocations, consensus reports, and other products on K-12 science and mathematics education (14 - 19); science education standards (20 - 23); undergraduate science and mathematics (24 - 26); measurement of ability and achievement (27, 28); uses and misuses of educational assessment (29 - 31); international comparisons of achievement, teaching, and curricula in mathematics and science (32 - 36); and cognition, learning, and assessment (37).

Under the leadership of Presidents Bruce Alberts, William Wulf, and Kenneth Shine, the National Academies has strengthened its commitment to improved education for all learners. This commitment is manifest in recent decisions to reorganize and better integrate the NRC’s education programs. In fall 1999, the NRC established the Center for Education (the Center) by bringing together several standing boards and committees that had been responsible for much of the education work in the institution: the Mathematical Sciences Education Board (MSEB), the Committee on Science Education K-12 (COSE K-12), the Committee on Undergraduate Science Education (CUSE), which together had comprised the former Center for Science, Mathematics and Engineering Education (CSMEE); and the Board on Testing and Assessment (BOTA), the Committee on Educational Excellence and Testing Equity (CEETE), and the Board on International Comparative Studies in Education (BICSE).2 The main

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1 The National Academies now encompasses four organizations: the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), the Institute of Medicine (IOM), and the National Research Council (NRC). Established in 1916, the NRC is the chief operating and research arm of the NAS and the NAE.

2 Prior to becoming parts of the new Center for Education, BOTA, BICSE, and CEETE were units within the NRC's Commission on Behavioral and Social Sciences and Education (CBASSE). Beginning in January 2001, CBASSE and the
goals of this reorganization were to take advantage of the strengths of the separate units, seek new synergies in SMETE, and advance a more integrated national discourse about teaching, learning, assessment, and the complexities of education from kindergarten through higher education and lifelong learning.

With a grant from the National Science Foundation, the Center empanelled a Strategic Planning Advisory Group (SPAG - see Appendix 2 for membership and biographical sketches) and began a year of strategic thinking about its expanded mission, priorities, products, and organizational structure. This proposal grows directly out of that strategic planning exercise, discussions with members of the Center’s standing boards and committees, and the wise counsel of NRC staff and other experts with whom the Center regularly interacts.

THE CENTER’S VISION AND MISSION
We believe that what the historian Lawrence Cremin called “the radical ideal” in American education (38)—the twin goals of excellence and universal opportunity—is still the ideal. The Center can provide intellectual resources, leadership, and a venue for consensus building to make that commitment possible. Our mission is

to improve education for all learners, by promoting evidence-based decision making in education policy and practice, enhancing the capacity for educational improvement, and focusing objective, independent, and interdisciplinary attention on education problems and the search for viable solutions.

The Center works at the nexus of education policy, practice, and research, and derives one of its comparative advantages from the combined expertise of its principal units. While continuing the historic emphasis on science and mathematics education of CSME, the expanded Center provides a broader context of expertise in general educational areas such as the cognitive, measurement, and psychometric sciences that can inform specific science and mathematics education projects. Conversely, science and mathematics can provide disciplinary foci and enrichment to general studies of educational issues in the Center. For example, the mathematics and science education communities have made substantial efforts toward greater equality for traditionally underrepresented groups, and important advances in research on learning and information processing have begun with studies in mathematics, science, and technology.

PROGRAM STRANDS: THE CENTER’S PRIORITIES
The Center will strategically focus its program by addressing critical problems in education most likely to benefit from the strengths of the Center in convening experts with diverse knowledge and perspectives and in producing objective, evidence-based studies. The four programmatic strands described below reflect a strong consensus among the SPAG, the Center’s standing boards and committees, NRC staff, and others for how the Center should focus its work. Though work in each strand is necessary to strengthen policy, practice and research, the Center’s principal goal is to find synergies among them.

Standards, Assessment, and Accountability (“Standards”)
Several prominent educational leaders have called for a mid-course review of the standards movement (e.g., 39). Now is the time to engage in a comprehensive review of efforts by school districts and states to align their systems with high academic standards, and to learn from similar efforts abroad. Tapping the substantial expertise in and accomplishments of MSEB, COSE K-12, and BOTA in these areas (40 - 43), the Center plans to undertake work that would frame many of the central and corollary questions for such a review: What are the effects on learning of standards-based curriculum and instruction? How can accountability systems promote greater academic achievement for all students? Can data from external and classroom assessments together be used to improve instruction, inform decision making, promote equitable access to educational opportunities, and shape professional development?

Although the language and rhetoric of K-12 standards-based reform is not yet prevalent in postsecondary policy and practice discussions, both sectors share a number of concerns: course content and emphasis, instruction and the development and use of instructional materials, and an increasing emphasis on enhancing and assessing student

Center will comprise the new Division of Behavioral and Social Sciences and Education. This new arrangement will permit the Center to take fuller advantage of rapidly developing basic research in neurology and cognitive science as well as emerging knowledge in demography, economics, psychology, and anthropology.
learning. Thus, the Center will build on its significant expertise in postsecondary education issues, particularly in STEM, to address the following kinds of questions within this strand: How can academic departments and institutions of higher education best assess the effectiveness of their programs in STEM? What are the opportunities, incentives, and barriers to change in undergraduate and graduate STEM programs?

**Supply, Quality, and Development of the Teaching Professions ("Teaching")**
Efforts to improve the quality of K-12 teachers and teaching have often collided with the realities of current and projected shortages of teachers, especially in science, mathematics and special education (44, 45). At the same time, university leaders are grappling with how to integrate the responsibilities of their institutions for research, teaching, and service. Relying on a growing body of work, including the recently released report of the Glenn Commission (46) and its own publications (47–49), the Center is developing a project (to be supported initially by internal funds) that will suggest an integrated framework to continue the legacy of the Glenn Commission’s efforts and to explore a number of key questions: What does it mean for a teacher to be "qualified," both generally and in mathematics and science? What are indicators of effective teaching and how do content knowledge and pedagogy interact to enhance learning? What support systems are critical? What can be learned from other countries about enhancing the effectiveness of teachers? How can more teachers be recruited from traditional and alternative sources and educated to become competent professionals?

**Education Technology for Teaching and Learning ("Technology")**
As educational software, video, Internet connections, and graphing calculators become nearly ubiquitous in educational settings, attention is turning to how the use of these tools might alter traditional conceptions of content, pedagogy, and professional development. The Center has produced several reports in this area, including work related to the development of a National Digital Library for STEM (50, 51). The U.S. Department of Education has recently funded a new Center project (in collaboration with several other units of the Academies) to explore how best to integrate new computing paradigms, knowledge about learning processes, and new approaches to curriculum and teaching. A major outcome of this effort will be the establishment of a roundtable of experts with diverse backgrounds to monitor these trends and help educators make more informed decisions about the acquisition, use, professional development requirements, and maintenance of education technology. This project will be a springboard for future Center activity in this critical area.

**Transitions in Education and Employment ("Transitions")**
The mobility of students and workers is increasing, and pathways among conventional education settings and workplaces are much less linear than in the past. The decentralized U.S. educational system and its separation from the workplace make it difficult for many students to move among institutions of learning, from formal schooling to work, and from work to further education and training. The changing nature of work (see, e.g., 52, 53); a growing reliance on competencies rather than credentials (54); the emergence of informal and industry-based centers for learning and training (55); and the influence of science and technology raise questions about the development and delivery of instruction in K-12 and beyond. Building on initiatives recently begun in the Center, future work would address questions such as: How can the skills that are required in current and evolving workplaces and the education provided in our schools and colleges be better aligned? How are other countries adapting their educational institutions to new workplace demands? How can community colleges, four-year colleges and universities, graduate schools, and postdoctoral programs collaborate with each other and K-12 districts to smooth transitions for all learners?

**OPERATING PRINCIPLES**
Given the mission of the Center and its program strands, our strategic planning effort has identified a number of operating principles that will guide the work of the Center, including the specific projects that are proposed for funding by the NSF in Section II of this proposal. These operating principles follow.

**To interact closely with the National Academies and its members**
The elected members of the National Academies are an invaluable resource—providing expertise in the natural, social, and behavioral sciences, mathematics, engineering, and medicine—and a critical audience for the Center’s products. The Center will draw on these members to serve on boards and committees, review committee reports, and offer general advice. In turn, the members will be one of the target audiences for the Center’s products, so that the results of research-based investigations into educational problems can inform individual Academy members, their institutions, and their professional constituencies.
To be responsive and anticipatory
In accordance with the historic charter of the National Academies, the Center will promote evidence-based decision making by responding to critical questions in education policy and practice, as framed by requests for studies from government agencies (at federal, state, and local levels) and other sponsors. At the same time, the Center will develop heightened capacity to anticipate challenges and opportunities in education, and fulfill the NRC's mission of advising government and other stakeholders proactively. These goals reinforce one another: building the long-term intellectual infrastructure to anticipate emergent problems will enable the marshalling of resources and expertise to respond effectively to ad-hoc requests and needs of the education community.3

To focus on access and equity
Ensuring that all aspects of the Center’s work address issues of equity and access derives from its mission to promote decision making that can improve education for all learners. During the initial development of new projects, study questions will be refined to ensure that the work explicitly addresses equity. As literature and evidence are reviewed over the course of projects, emphasis will be placed on the ways different groups may be affected by various policy decisions. Procedurally, an operating principle for the entire NRC is to ensure that the composition of committees, as well as staff, reflects the nation’s diversity.

To rely upon and advance the use of evidence
What constitutes evidence in education is an unresolved and hotly debated question (see, e.g., 56, 57). As an NRC priority, the Center will focus on evidence in several ways. We will rely upon objective evidence from a range of theoretical perspectives and methodologies, as they are used in the U.S. and abroad, and ensure that Center reports and other products are grounded in valid and appropriate inferences. This focus will enable us to identify gaps in extant data and recommend appropriate remedies. Moreover, the Center will seek to advance the use of evidence in education decision making by considering the norms, methods of inquiry, and standards of quality applicable to educational problems.4

To convene experts, forge partnerships, and build capacity
The Center will build upon the NRC’s capacity to convene diverse groups of experts, to provide a neutral venue for discussing issues and developing recommendations, to foster clarity and consensus about complex issues, and to develop intellectual resources for problem-solving. A key activity of the Center will be a series of “roadmapping” exercises designed to help the NRC and other education communities identify crucial problems, gaps, and overlaps in initiatives and expertise, including those in other countries. Based on these roadmapping activities (the metaphor is borrowed from business organizations that engage in intensive scanning of their environments as a basis for planning and strategic decision making) the Center will forge partnerships—national and international—and help build capacity both within and outside the Academies to improve education for all learners.

To disseminate its products effectively to target audiences
The Center will explicitly identify target audiences for its array of products (see Appendix 3), and use this information as a base for developing comprehensive dissemination plans for each of its projects. In this we will benefit from a larger NRC effort underway to disseminate its products widely and more effectively. Our dissemination strategy will likely entail relying more on the internet and development of interactive websites; writing popular versions of consensus reports (e.g., see 58); preparing brochures and reports for target audiences; partnering with disciplinary and trade associations; and including Center report briefs and/or articles in publications for members of the National Academies and in trade and professional journals. We anticipate that convening and roadmapping activities will enhance our dissemination efforts and provide a basis for outreach to—and engagement with—multiple stakeholder communities.

3 A recent example illustrates this point. The capacity of the Board on Testing and Assessment to respond to three simultaneous requests for studies relating to the Voluntary National Test, in 1997-1998, was an important return on the Department of Education’s prior investments in the Board’s intellectual and organizational infrastructure.
4 Procedurally, a critical standard applied in external reviews of all NRC reports is whether findings, conclusions, and recommendations are supported by evidence. Our commitment to this principle is reflected in a new project that will explore the scientific principles of research in education and implications for the federal role in supporting education research.
To engage in ongoing evaluation of the Center’s efforts and impacts
Just as the impacts of educational interventions are usually difficult to measure, so too are the impacts of activities of a Center such as this one. We plan to rely on a variety of measures to provide a multidimensional picture of strengths and weaknesses that can feed into continuous improvement of the Center’s work. As such, we will develop and implement several streams of evaluative activities. For example, we see formative evaluation as one of the most important mechanisms for adjusting, correcting, and measuring progress in our work. Therefore, a key activity of our standing boards and committees will be to review projects and their impacts. We also recognize the desirability and value of external summative evaluation. We plan to work closely with our volunteer experts and sponsors to develop a comprehensive evaluation strategy that will likely include: seminars or conferences to showcase the Center’s accomplishments and engage scholars and practitioners in discussions of their usefulness, quality, and timeliness; development of a model and instruments for external evaluation; and engagement of independent outside evaluators.

ORGANIZATION AND STAFFING
Appendix 4 illustrates the Center’s organizational structure. Hundreds of scholar-experts volunteer their time to serve on the Center’s Advisory Board, standing boards, and ad-hoc committees. Working closely with Center staff, they form the intellectual base for the Center’s work. The Advisory Board will provide oversight and guidance for the development of the Center’s priorities and projects; promote collaborations and synergies within the Center and with other organizations within and outside the NRC; develop and refine strategies for disseminating the Center’s products; and participate in the development of an evaluation strategy for its work. While the membership of the Advisory Board has not yet been established, we expect that it will be similar in breadth, expertise, and stature to the NSF-supported SPAG (see Appendix 2), and will include members of the National Academies. The Advisory Board will meet formally 2-3 times per year. It will include chairs of the Center’s standing boards and committees as well as at-large members who can infuse other perspectives into the Center’s planning and work. Members will serve staggered terms.

Program officers of the Center (see Section E for biographical sketches of senior staff personnel) include scientists, policy researchers, former and current K-12 teachers and college faculty members, and other experts. They have been selected for their substantive knowledge, prior experience at the intersection of policy and research, and ability to work effectively with committees of volunteer experts from academe, industry, practice, and policy organizations. They cover a wide range of knowledge and skills relevant to the Center’s mission: education practice and theory (including content expertise in science and mathematics); related science, mathematics, and social science disciplines (e.g., computer science, cognitive psychology, economics, and public policy); and research methodology (e.g., measurement, statistics, and evaluation). A high priority is to hire additional staff to bolster this expertise.

The Center has begun to establish mechanisms to enable integration and synergy among staff. The primary mode of collaboration is through the development of teams organized around the program strands, that will manage projects, foster cross-fertilization, and support the Advisory Board and standing boards and committees. Even in cases where projects are managed by a single unit of the Center, they will benefit from regular consultations with colleagues from other units in and out of the Center.

PRODUCT MIX
Written output from workshops, symposia, and convocations can be in the form of proceedings, summaries, transcripts, and collections of papers. In addition, the NRC’s long track record with such convening activities has proven that sponsors and other participants also benefit from their participation in discussions held in open sessions (as allowed under NRC policy). Such venues allow sponsors and other stakeholder communities to share important information about progress, obstacles, and findings from their respective work and to make connections with experts in many fields. These activities accumulate in an intellectual infrastructure that enable the Center to be responsive and anticipatory, consider requests for in-depth studies of selected questions, and work closely with sponsors on the development of the Center’s agenda.

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5 This proposal itself is a product of intensive staff and volunteer collaboration.
II. High Quality Science, Mathematics, Engineering, and Technology Education For All Learners: The Center’s NSF-Supported SMETE Portfolio

The remainder of this proposal details a two-part plan for developing a portfolio of work focusing on high quality SMETE for all learners, to be supported by the NSF. The first part of the plan outlines ten specific activities that we propose to initiate during the first two years of the grant. We deliberately have not specified activities for the final three years because we feel it is critical for the Center to be flexible and adaptive, and to accommodate NSF’s evolving needs and priorities. However, the second part of the plan does describe a process by which the Center and NSF can build on these initial activities and jointly develop a plan for the Center’s work and focus in the last three years of the grant period.

PROPOSED NSF-SUPPORTED SMETE ACTIVITIES: THE PORTFOLIO FOR YEARS 1 AND 2

Table 1 of Appendix 5 provides a helpful summary of ten activities proposed for the first two years of the grant. The table also outlines the leadership, liaison, and oversight activities that will provide the infrastructure to support these activities. The proposed activities have been developed collectively by the Center’s standing boards and committees, the SPAG, Center staff, and other NRC staff. Some activities reflect ongoing work of standing boards and committees and thus have well-defined frameworks and research questions. Others are at earlier stages of development and require further deliberation to frame the issues, review relevant evidence, determine appropriate stakeholders, and formulate study questions. Approximately half of these activities will include publications that go through the NRC’s formal internal report review process (see Appendix 1); the remainder will result in other kinds of output such as commissioned papers, meeting transcripts, or monographs that frame research and policy options. Table 1 also includes information about target audiences; the Center unit responsible for the activity; the Center program strand to which the activity most closely aligns (see Section I); collaborating or consultative units within the Center or elsewhere in the National Academies; and outcomes and deliverables.

Table 2 of Appendix 5 shows in greater detail how the activities align with and contribute to the Center’s program strands, and include references to Center work in progress. These references, coupled with the many publications cited in the proposal and the biographies of senior staff and volunteers, are evidence of a strong intellectual foundation for this endeavor.

Center-wide Activities

The expanded Center provides many new opportunities for collaboration and synergy. One area of special interest is the role of assessment in SMETE, for which the collaboration among MSEB, COSE K-12, and BOTA will provide the basis for a “signature” Center project. A second Center-wide project focuses on procedural issues for which the NRC as a whole has significant experience, and will address specifically the expert panel process used to evaluate curriculum programs that NSF funds in mathematics and science.

CFE-1 Roles and Relationships of Classroom Assessments and High Stakes Tests

Primary Program Strand: Standards, Assessment, and Accountability

Educational assessments serve various purposes. Effective teachers use assessment as part of instruction to monitor learning and provide feedback. Education researchers are paying increasing attention to the potential benefits of classroom assessments for improving learning, particularly for low achievers (59). Moreover, national standards in science and mathematics recognize this type of assessment as a fundamental part of teaching and learning (60). At the same time, educational decision makers who are external to the classroom rely on large-scale tests to measure summative achievement of individuals and programs. Much of the accountability movement is based on the idea that external tests have value for changing school and classroom practices (61, 62). Ideally, learning outcomes assessed in the classroom would be compatible with (though not necessarily the same as) the targets for the large-scale external tests. In reality, they are often out of alignment with each other, causing tensions among different classroom expectations, external expectations, and student learning (63, 64). Furthermore, classroom and large scale assessment practices can have unintended consequences for different groups, raising important equity issues. Thus, a central question is:

➢ How might better links be made between external standardized tests and classroom assessments used by teachers?
The Center proposes to address this question by focusing on mathematics and science and exploring implications for general educational assessment and policy issues. The initiative will involve dialogue among national and international experts in classroom and large-scale assessment and mathematics and science education, resulting in a proceedings and report that will examine the tensions between classroom and large scale assessment and identify promising research and practice directions for strengthening the ties between them.

CFE-2 Evaluation of Expert Panel Review Processes
Primary Program Strand: Standards, Assessment, and Accountability

For nearly a decade NSF has funded standards-based curriculum and assessment development projects in mathematics and science. As materials from these projects are used questions arise about their efficacy in improving mathematics and science education. In recent years, NSF and the U.S. Department of Education have established expert panels to review such materials using criteria such as the coherence of the materials, the nature and quality of materials provided to support teachers in their use of the materials, and the strength of the research base about the impact of the materials on student learning (65). The Center proposes to address the question:

- Is the expert panel review process fair and effective?

This activity will be conducted by a small ad-hoc committee and overseen by the Center’s Advisory Board. The committee will examine processes by which NSF review panels operate, evaluate the composition and expertise of the panels, and advise NSF about its review process and its responsiveness to concerns raised by the field. The outcome of this effort will be a letter report.

Mathematical Sciences Education Board (MSEB) Activities
Established in 1985, the mission of the Mathematical Sciences Education Board is to provide national leadership and guidance for policies, programs, and practices supporting the improvement of mathematics education at all levels and for all members of society. MSEB supports this mission through the publication of documents such as Everybody Counts (66) and High School Mathematics at Work (67) and by holding a variety of convening activities such as the “Symposium on the Nature and Role of Algebra” (68) and “Mathematics Education in the Middle Grades” (69). MSEB members represent the broad community of those involved in mathematics education, including mathematicians, administrators, researchers, two- and four-year college faculty and administrators, and K-12 teachers (see Appendix 6).

Recent MSEB work has emphasized teacher development, drawing on both national and international research, and has included several workshops related to the content knowledge needed by mathematics teachers in elementary and middle school, as well as a joint U.S./Japan workshop that focused on how teaching itself can be a medium for professional development. MSEB’s current agenda is centered on understanding the impact of standards-based efforts to improve mathematics education. That agenda includes plans to continue work in teacher development, consider assessment issues informed by international experiences, explore links between standards and the role of assessments in classrooms, and consider articulation issues from secondary to postsecondary work in mathematics.

MSEB-1 Effects of NSF-Supported Mathematics Curriculum Materials
Primary Program Strand: Standards, Assessment, and Accountability

NSF has funded a series of 13 initiatives to develop curriculum materials in mathematics at the elementary, middle, and high school levels that are consistent with the changes called for in the NCTM Standards (see the K-12 Mathematics Curriculum Center at http://www.edc.org/mcc/). As these materials have appeared, NSF also focused its teacher enhancement programs on systemic efforts to support the reform of instruction with an explicit requirement that "standards-based" materials be adopted. Although efforts to implement the new materials are currently widespread, a basic question is:

- What has been the effect of these standards-based materials on achievement of all students in mathematics?

As a first step toward addressing this complex question, MSEB proposes to convene a steering committee of experts in assessment, curriculum development, and implementation to identify and analyze known studies about the effectiveness of the NSF-supported materials, and to establish initial criteria for review of those studies. A workshop with researchers and practitioners who have been involved with the implementation of these programs will provide an important input to the steering committee’s work. Addressing this question adequately
also will require consideration of several related questions, such as: Have students of diverse populations had access to these materials? Which teachers have been supported in their adoption and use and how has this support been carried out? The framework Understanding the Influence of the Standards in Mathematics, Science, and Technology Education (70), developed under the leadership of MSEP and COSE K-12, will guide and inform the development of this work. MSEP will produce a letter report to NSF summarizing the results of the workshop and subsequent deliberations.

MSEP-2 Next Steps in Mathematics Teacher Development
Primary Program Strand: Supply, Quality, and Development of the Teaching Professions

Extending previous work on the content knowledge needed by elementary and middle school teachers of mathematics, the MSEP proposes to conduct a two-part activity that builds on these efforts. First, it will focus on the content needed by mathematics teachers in grades 9-12. Informed by the outcomes of these activities in the elementary, middle, and high school levels, MSEP will then look broadly at the role of the university in mathematics teacher preparation.

Many experts agree that reforming teacher professional development is central to sustaining and deepening efforts to provide quality mathematics education for all students (71-73). However, many professional development opportunities for practicing teachers lack coherence and a systemic approach. Further, while many high school mathematics teachers have adequate content knowledge, others, especially those in schools with high concentrations of minority and low income students, lack appropriate preparation (74, 75). MSEP will focus on two overarching questions:

➤ What is the mathematical content knowledge high school mathematics teachers need to teach well?
➤ How do high school teachers come to know the mathematics they need to teach well?

To address these questions, MSEP proposes to convene a workshop designed around what teachers actually do (e.g., videos of practicing teachers, samples of student work, curriculum materials), what we know about how students learn (76), and teachers' beliefs about how students should learn mathematics and expectations about which students should learn what kind of mathematics (77). A summary of the workshop will be useful for college-level educators of practicing and prospective high school teachers in mathematics wishing to re-examine their approaches to teacher education.

This work will also set the stage for a second phase of activity. The responsibility of universities for the development of K-12 mathematics teachers is diffuse, and little is known about what it might mean for universities to take teacher education as a priority. The proceedings of the grades 9-12 teacher content workshop, MSEP’s earlier work in this area, and the internal Center work in response to the Glenn Commission report will together provide a platform from which to consider a larger question of how mathematics teachers are prepared:

➤ Who is ultimately responsible for the preparation of mathematics teachers?

This initiative will consist of a series of small symposia, bringing together deans of arts and sciences, deans of education, education department chairs, mathematics department chairs, and other participants to consider the implications and challenges if community colleges and universities were to take seriously the charge of preparing mathematics teachers. The symposia will review current literature on preparation of teachers, encourage participants to consider the relationship between content and competence, and build on work of MSEP in rethinking the education of mathematics teachers. Summaries of these symposia will be made available for the participants and circulated widely to the field.

Committee on Science Education K-12 (COSE K-12) Activities
COSE K-12 was created as a standing board in 1996, in large part to promote the findings of the National Science Education Standards (NSES) (78). Its mission is to broaden the definition of science education to include not only what is known in the sciences but also how it is known; how the disciplines relate to one another; and the impacts of science and technology on the human condition. Members include science educators from classrooms, informal and higher education institutions, district and state administrators, education researchers, professional development specialists, and scientists. Several members of the NAS have served as members of COSE K-12 (see Appendix 6).
COSE K-12 reaches diverse audiences through its efforts. Its publications range from Inquiry and the National Science Standards (79) for teachers and teacher educators, to Designing Curriculum Programs (80) and Selecting Instructional Materials (81) for school boards, and district and state committees responsible for implementing standards. It has convened hundreds of science education leaders from across the country for symposia on such topics as "Improving Teacher Preparation and Credentialing Consistent with the National Science Education Standards" (82) and "Learning from TIMSS" symposium (83); and it has authored a two-volume analysis of TIMSS for practitioners and professional developers (84, 85). This year and next it is releasing addenda to the NSES to provide further guidance on classroom assessment and on science and technology.

COSE-1 Taking Stock of the National Science Education Standards
Primary Program Strand: Standards, Assessment, and Accountability

Since the publication of the NSES, science educators and leaders in school districts, states, government agencies, corporations, teacher education institutions, and non-profit organizations have focused efforts and resources on standards-based initiatives. However, few systematic attempts have been made to reflect on these efforts and understand their influence. COSE K-12 proposes to take stock of the NSES by examining two related questions:

➢ Based on the research, what do we know about the influence of the NSES on various facets of the educational system, on opportunities for all students to learn, and on student learning?

In early 2001, the Center will release its NSF-funded report A Framework for Research: Understanding the Influence of Standards in Science, Mathematics, and Technology Education, paving the way for this effort. COSE K-12 proposes to address this question by commissioning researchers to use the framework to search the literature and create an annotated bibliography of relevant studies. Then, papers will be drafted focusing on the implications, gaps, and other themes revealed by this bibliography. These products will frame an open workshop hosted by COSE K-12 where findings from existing research and implications for future research will be discussed and analyzed. A report will summarize the workshop proceedings. From the perspective of practice, related questions are:

➢ Will the vision for science education articulated in the NSES, and supplements that interpret those standards, be sufficient to guide states and school districts as they continue their efforts to improve science education for all? Is it time to begin planning a revision to the NSES?

COSE K-12 will explore these questions from the vantage point of practice. The National Science Teachers Association, American Association for the Advancement of Science, Council of State Science Supervisors, Eisenhower National Clearinghouse, and the National Science Education Leadership Association have agreed to work closely with us on efforts to engage practitioners in a series of collaborative outreach efforts. First, a workshop with regional, state, and district leaders who are responsible for science education will generate an initial set of reactions and needs. Themes and suggestions from this workshop will be used to frame a series of focus groups at regional and national NSTA conferences and design an interactive web site. The focus groups will elicit the views of teachers, teacher-leaders, professional developers, and teacher educators from diverse settings. The web site will highlight the input gathered through the workshop and focus groups, and will use mechanisms such as threaded discussions to allow an even wider range of stakeholders to provide their views and extend these conversations. Based on this information, and with input from the research-based study of the influence of NSES described above, COSE K-12 will collaborate with governmental agencies that supported the creation of the NSES to assess whether a revision of the NSES is needed and/or whether additional products or initiatives to clarify and interpret the standards are advisable.

COSE-2 Framing Science Teacher Education as a Career Continuum
Primary Program Strand: Supply, Quality, and Development of the Teaching Professions

A growing body of research suggests that teacher quality is the strongest single influence on student achievement in science and other subjects; at the same time, school systems encounter formidable obstacles to recruiting and retaining well-prepared teachers for all students, especially in high minority, low income areas (86). Further, teacher preparation, induction, mentoring, and ongoing professional development activities are rarely, if ever, implemented holistically. This lack of coordination can result in a set of fragmented activities that do not build on one another to improve teachers' content knowledge, pedagogy, and skills for working with their colleagues across their careers. As reports from the Glenn Commission (87) and the NRC (88) emphasize, systematic attention to the education of science teachers across their careers will be required if we are to improve their knowledge and skills, and, in turn, increase access to science learning for all students. Building on prior work, COSE K-12 proposes to initiate work that could lead to the development of a research-based continuum of teacher professional development
that recognizes those aspects of teacher education that are best developed at different stages of teachers' careers and makes provisions for their coordination. Key initial questions include:

- On what research evidence should such a continuum be based?
- What are its characteristics at critical points and along various pathways?

To address these questions, COSE K-12 proposes to convene a workshop of national and international experts in teacher preparation and professional development. A small planning group, including members from COSE K-12 and CUSE, will identify participants who represent diverse perspectives, select specific issues to be addressed, and plan workshop activities. The outcome of the workshop will be a refined set of questions related to the identified topics and a plan for further work. We expect that this activity will yield greater understanding of the continuum and aid teacher educators in their efforts to integrate their work to support high quality science teaching for all.

**Committee on Undergraduate Science Education (CUSE) Activities**

The Committee on Undergraduate Science Education is charged with promoting and sustaining improvement in undergraduate science education for all students. Since its inception in 1993, CUSE has identified, developed, and promoted implementation of programs that enrich the understanding and appreciation of scientific knowledge and improve the skills necessary for continued learning, productive living, and informed decision making. Membership on the committee includes members of the National Academies of Sciences and Engineering, higher education faculty and administrators from two- and four-year colleges and universities, K-12 science teachers, mathematicians, and representatives from science- or technology-based industries (see Appendix 6).

CUSE has produced two reports on ways to improve science teaching for K-12 and undergraduate students. Following the NRC/NSF national convocation, *From Analysis to Action: Undergraduate Education in Science, Mathematics, Engineering, and Technology* (89), CUSE, MSEB, and the Board on Engineering Education (BEEd) organized a series of forums across the U.S. to discuss ways to improve undergraduate SMETE. Those discussions led to the publication of CUSE's *Transforming Undergraduate Education in Science, Engineering, and Technology* (90). Those reports, along with NSF's *Shaping the Future* (91) have served as guides for subsequent National Academies' projects aimed at improving undergraduate SMETE in the U.S. Building on these themes, a study committee under the oversight of CUSE is currently preparing a report on ways to recognize, evaluate, and reward effective teaching in undergraduate SMETE. CUSE will focus its next series of activities on institutions of higher education and their relationships to the organizations that support them, faculty, and students.

**CUSE-1 Criteria and Benchmarks for Evaluating Undergraduate SMETE Program Effectiveness**

**Primary Program Strand: Standards, Assessment, and Accountability**

After the CUSE report on evaluating and rewarding effective undergraduate teaching is released, a next logical step will be to identify criteria, benchmarks and metrics to enable departments and institutions to assess their SMETE programs and plan for ongoing improvements. These tools also could inform the decision making of prospective students, parents, and guidance counselors. To commence the development of such measures, CUSE proposes to work with MSEB, COSE K-12, BOTA, and the NAE’s Committee on Engineering Education (CEE) to organize a workshop to address questions such as these:

- What are appropriate and available measures of undergraduate SMETE learning that could be used as criteria and benchmarks for such a framework?
- How could such criteria and benchmarks be used to develop a comprehensive instrument for evaluating the effectiveness of undergraduate SMETE programs in promoting learning for all students?

Workshop proceedings will summarize this activity. We anticipate that this work also could lead to the development of a comprehensive initiative involving science, mathematics, engineering and technology departments.

**CUSE-2 Transitions from Graduate Learning to Undergraduate Teaching in SMETE**

**Primary Program Strand: Transitions in Education and Employment**
Improving teaching in undergraduate SMETE requires attention to both current and future faculty. In *Transforming Undergraduate Education* (92), CUSE called on graduate schools and postdoctoral programs to better prepare their students—future faculty members—to facilitate learning among an increasingly diverse undergraduate student population. The report recommended that undergraduate institutions must also develop hiring and professional development policies that reinforce their commitments to teaching and encourage new faculty members to continue to improve their knowledge and skills about teaching and learning. Efforts by NSF, the Pew Charitable Trust, Council of Graduate Schools, and the American Association of Colleges and Universities through the *Preparing Future Faculty* initiative reflect these ideas. CUSE, in consultation with BOTA, Committee on Engineering Education, the Government-University-Industry Research Roundtable (GUIRR), the Committee on Science Engineering and Public Policy (COSEPUP), and other experts proposes to oversee the development of a series of structured discussions that would address various aspects of the following two questions:

- How can undergraduate and graduate institutions in SMETE coordinate to improve teaching skills and knowledge during the critical transition years between graduate school and the first two years of a faculty member’s appointment?
- What institutional policy changes might be required to sustain such coordination?

Summaries of these discussions will be published. Ideas for next steps of implementation and further research that derive from the discussions also will be articulated and circulated.

CUSE-3 Promoting Inquiry-Based Science Education for Undergraduates

*Primary Program Strand: Standards, Assessment, and Accountability*

“Inquiry” describes the myriad ways by which scientists study nature and propose explanations for natural phenomena based on the evidence derived from their work. Inquiry also can refer to approaches and strategies for teaching and learning that enable learners to master scientific concepts as a result of carrying out scientific investigations. Although this approach to teaching and learning is emphasized in national (93, 94) and many state science standards, few non-scientists understand the nature or process of inquiry in science. To help teachers in Grades K-12 use inquiry-based approaches to teaching, the Center recently produced *Inquiry and the National Science Education Standards* (95). A similar emphasis on inquiry-based approaches to teaching science at the undergraduate level, particularly in introductory and lower division courses, could improve science education for all students (e.g., 96 - 99). Though many science faculty employ inquiry in their research, this perspective may not always find its way into their teaching. Accordingly, CUSE proposes to address the question:

- How can inquiry-based instruction be better integrated into undergraduate science programs to enhance learning and understanding of science for all students?

CUSE proposes to convene a panel of scientists and science educators to design the framework for a document that would use *Inquiry and the National Science Education Standards* (100) as a guide, and decide how it might be adapted for instructors of undergraduate students.

**Board on Testing and Assessment (BOTA) Activities**

BOTA was created in 1993 to advise policymakers and the public on critical issues of testing and assessment in education, the workplace, and the armed services. Among the issues BOTA considers are: the uses of tests as policy tools, civil rights implications of tests, and innovative methods of assessment. BOTA members include educators, assessment experts, statisticians, economists, lawyers, industrial/organizational psychologists, and others (see Appendix 6). Members of the Academies have served on BOTA since its inception. Informed by earlier NRC work (101), BOTA has engaged in a number of activities related to the development and assessment of workplace skills, including analyses of how skills are measured, developed and used on the job (102). Although much of BOTA’s work has focused on K-12 assessment issues, BOTA staff and members have over the past year drawn on these activities and collaborated with other units of the NRC to prepare a new report on the future of the information technology workforce (103).

**BOTA-1 Technical Skills for Work**

*Primary Program Strand: Transitions in Education and Employment*
A large pool of unemployed and under-employed individuals in the U.S. today could potentially contribute to the economy if their skills and knowledge required for today's more technical workplace were upgraded. However, there is little agreement among experts about how skills are measured, developed, and applied. In one view (104, 105), formal education can increase an individual's skills, which can be measured by assessments and transferred to different contexts (for example, from college to a job). In contrast, a "situational" perspective views skills as being an integral part of a social system (106). In this perspective (107 - 109), formal knowledge is acquired through all kinds of schooling, and informal knowledge is developed in the workplace through experience and collaboration with other workers; skills learned and used in one context may be difficult to transfer to another context.

BOTA, in collaboration with MSEB, CUSE, and a new Center steering committee on the impact of the economy on education, proposes to convene experts in anthropology, engineering, economics, labor relations, and industrial psychology for a workshop on technical skills. This workshop will assess what is known about formal and informal learning of technical skills from research in both the U.S. and abroad, the possible relationship between these two modes of learning, and the role of science and mathematics as essential building blocks for learning. Workshop participants will discuss questions such as:

- What is the state of research about situated learning, job performance, and organizational effectiveness?
- What is known about the extent to which skills learned through formal education and training transfer to enhance individual and organizational effectiveness?
- What is known about the relationship between formal education and training and informal learning at work?

Following the workshop, BOTA will prepare workshop proceedings, synthesizing the presentations and discussions and outlining additional research needs. It will also develop a framework and vision for next steps in better understanding the relationship between formal education and training and informal learning at work.

**Board on International Comparative Studies in Education (BICSE) Activities**

BICSE was established in 1988 to give NSF and the National Center for Education Statistics advice on U.S. participation in large-scale, cross-national education assessments. Best known for its guiding work on the Third International Mathematics and Science Study, in 1998 BICSE broadened the scope of its work to include smaller scale comparative education studies. The board's current and future activities include a major symposium and upcoming book on advances in methodology for large scale, cross national education studies since 1960; a workshop and publication on comparative perspectives on teacher quality and development; a report on the use of video in classroom assessment; and priorities for future U.S. participation in international education studies.

Although BICSE does not seek specific project funds from NSF under this proposal, the Center will draw on BICSE's wealth of expertise (see Appendix 6) to add an international dimension to Center activities. In addition to maintaining ties with international organizations such as the Center for Educational Research and Innovation (part of OECD) and UNESCO, BICSE will help the Center's standing boards and committees network with counterpart organizations and researchers in educational research and policy in other countries. Potential counterpart organizations include the UK's National Foundation for Educational Research and the Australian Council for Educational Research. Ties with such organizations will help the Center broaden its research base, as well as provide prototypes for research designs and alternative models for organizing education systems.

**Leadership, Liaison, and Oversight**

In addition to the specific project activities outlined above, this proposal requests funding to support leadership, liaison, and oversight activities that will enable the Center to develop and carry out its work. As shown in Table 1, these activities include support for the Center's Advisory Board, standing boards and committees, dissemination and outreach, and evaluations. NSF support would partially fund regular meetings of the Center's Advisory Board, enabling this group of experts to provide oversight for the Center's work, to interact with its counterpart in the Division on Behavioral and Social Sciences and Education (DBASSE), to coordinate and promote synergy across the Center's standing boards and committees, and to guide the development of the Center's dissemination and evaluation strategies. Similarly, NSF funds would support regular meetings of MSEB, COSE K-12 and CUSE to review projects, discuss emerging issues in SMETE, conduct "roadmapping" exercises, and plan future projects. A

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6 Internal NRC funds would be used to pay for one of the two annual meetings of this Advisory Board.
small portion of the award also would contribute to the ability of MSEB, COSE K-12, and CUSE to collaborate with BOTA and BICSE. Finally, NSF funds would be used to support the ongoing development of the Center’s dissemination and evaluation strategies, which would be conducted in close collaboration with the NSF. This support is essential to the fulfillment of the Center’s commitment to foster synergy across disciplines and intellectual traditions, blend research with practice, and maintain the highest standards of quality control.

MECHANISM FOR DEVELOPING THE CENTER’S PORTFOLIO IN YEARS 3-5

While we also plan to seek support for this portfolio from other sources, we believe that NSF will continue to be the lead agency for the Center. To ensure that we accommodate the needs of both the SMETE communities and the NSF for the long-term, we propose to establish a process to develop a similar set of activities in years 3, 4, and 5 of the grant period in close consultation with NSF.

The Center’s Advisory Board and the EHR leadership will be the key partners in this effort. As the central mechanism for establishing priorities in the Center, the Advisory Board will coordinate and integrate input from a variety of internal and external sources. Advisory Board members who are also chairs of standing boards and committees will regularly report on lessons and findings from projects under their purview as well as emerging issues they see in their respective subject areas. The Advisory Board will develop a list of priorities, emerging issues, and suggested project ideas that align closely with the Center’s mission, priorities, and strengths. Insights and input from the Center’s convening and partnering activities also will ensure that the Advisory Board is fully apprised of the needs of the field.

We expect to develop a schedule for regular interactions between NSF program staff and Center staff. In addition, NSF program staff will be invited routinely to open sessions of board and committee meetings. A comprehensive electronic database is being developed that will allow the Center’s staff to exchange information about ongoing projects and to share that information with NSF to promote ongoing and reinforcing development of ideas and plans. Finally, we plan to organize a joint Center-EHR meeting, most probably in the beginning of year 2 of the grant, to plan the Center’s agenda for years 3 and 4. A second joint meeting would likely follow in year 3 to finalize plans for the remainder of the grant.

Although we wish to emphasize the importance of flexibility and adaptability, we also are ready to discuss preliminary ideas for projects we would undertake in the later years of the grant. Examples include COSE K-12’s plans to focus on K-16 articulation issues in science, and MSEB’s intentions to develop a better understanding of how various educational technologies can support mathematics learning in the classroom. Other ideas center on the uses of educational technology to improve teaching and learning, and links to ongoing work on the Digital National Library for SMETE. In the area of methodology and evidence, we expect that the maturing Interagency Education Research Initiative will soon provide lessons about replicability in complex learning environments. Regular discussions with NSF staff during the first two years of the award would help mold future projects that are both responsive and anticipatory.
III. **Significance and Expected Impact of Proposed Activities**

Ultimately, the goal of the proposed portfolio is to promote high quality SMETE for all learners. The Center can uniquely advance progress toward this goal by harnessing the expertise of its prominent volunteer experts in this service. Of course, there are countless intermediaries between the Center (a unit of the NRC, which is a nationally based scientific organization) and the learners it aims to impact in classrooms, lecture halls, and training facilities across the country. Thus, the Center must forge strong connections throughout the SMETE policy, practice, and research communities to maximize its effects. These communities can act as critical conduits for dissemination to ensure that the Center’s products reach their intended target audiences. Further, the proposed work can build the capacity of these communities to promote high quality SMETE in three interrelated ways:

Convening diverse communities

The convening activities embedded in the proposed activities would provide a forum for diverse groups of experts to foster clarity about complex issues and problems in SMETE. At the same time, the proposed collaborations among the Center’s standing boards and committees would serve a similar function within the institution itself. Both sets of discussions would build interdisciplinary connections between science and mathematics education and related social and behavioral sciences that could significantly strengthen SMETE improvement efforts.

Addressing problems using evidence

The Center’s objective, independent assessment of problems and possible solutions in SMETE would provide an important source of advice for the SMETE communities to inform their decision making. Its products and related activities would in turn enhance the capacity of the SMETE communities to approach problems and catalyze change in science and mathematics education based on credible evidence.

Anticipating emerging problems and trends

The standing boards and committees of the Center would perform their critical role of anticipating future needs and issues in their respective disciplines, enabling them to be more responsive to the needs of NSF and other sponsors (e.g., see footnote 4, page 5). Importantly, this function would also serve to alert the SMETE communities about emerging problems, encouraging proactive rather than reactive improvement efforts.

Overall, we expect that the impact of NSF’s investing in the Center and its standing boards and committees would significantly advance reform efforts in the critical area of SMETE for all learners.

**Federal Advisory Committee Act (FACA)**

The Academy has developed interim policies and procedures to implement Section 15 of the Federal Advisory Committee Act, 5 U.S.C. App. § 15. Section 15 includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a Federal agency. In accordance with Section 15 of FACA, the Academy shall submit to the government sponsor(s) following delivery of each applicable report a certification that the policies and procedures of the Academy that implement Section 15 of FACA have been substantially complied with in the performance of the contract/grant/cooperative agreement with respect to the applicable report.

**Public Information About the Project**

In order to afford the public greater knowledge of Academy activities and an opportunity to provide comments on those activities, the Academy may post on its website (http://www.nas.edu) the following information as appropriate under its procedures: (1) notices of meetings open to the public; (2) brief descriptions of projects; (3) committee appointments, if any (including biographies of committee members); (4) report information; and (5) any other pertinent information.