Preface

The National Science Foundation (NSF) has from its beginning been authorized to initiate and support education programs in all of the fields of science and engineering, at all education levels. Our work began with the introduction of graduate research fellowships early in the 1950s and continues today with a rich and complex package of programs that address all aspects of both formal and informal education in science and engineering. We are the only federal agency with such a broad and comprehensive mission in science, technology, engineering, and mathematics (STEM) education. Our goal is straightforward but challenging: to prepare "a diverse, competitive, and globally engaged U.S. workforce of scientists, engineers, technologists, and well-prepared citizens." It is in our nation's interests to serve all learners well—those who have the potential to make original and innovative contributions to our scientific and technical knowledge, those who plan to pursue careers based on a significant knowledge of science and technology, those who choose other fields, and those who will require an understanding of the societal influence of science and technology in order to exercise responsible citizenship.

This overarching vision is built into the Course, Curriculum, and Laboratory Improvement (CCLI) program at NSF. CCLI supports projects that are designed to improve the quality of STEM education for all students, based on educational research and empirical data concerning needs and opportunities in undergraduate education and effective ways to address them. The program targets activities affecting learning environments, course content, curricula, and educational practices, with the aim of improving learning and contributing to the relevant knowledge base that will support future efforts to enhance STEM education.

We are looking for effective ways to prepare and support teachers and faculty who can inspire and challenge students in the STEM disciplines and to provide them with effective materials and strategies to promote and assess learning. Our focus is on the support of innovative and well-warranted approaches to the development of new courses of study and pathways to STEM careers that address contemporary workforce needs and enhance the quality of the STEM workforce. We also want to develop a robust research community that can conduct rigorous research and evaluation that will support excellence in STEM education. We invest in research in the science of learning, facilitating the translation of research into practice, and create supportive learning environments and STEM pathways by developing models of reform/systemic change at both institutional and multi-institutional levels through networking, partnerships, alliances, and collaborations. In pursuing this ambitious agenda, we want to broaden participation (individuals, geographic regions, types of institutions, STEM disciplines), close achievement gaps in all STEM fields, and conduct research on ways to support the participation of women, minorities, and persons with disabilities in STEM education and the STEM workforce. This is an ambitious agenda that requires the energy and imagination generated by the over 1,750 projects we have supported throughout the history of the CCLI program and the insights and discoveries of the many investigators at over 600 institutions across the country who are contributing to our knowledge about how people learn science, engineering, and mathematics; how technology contributes to learning; and how to measure what students have learned.

CCLI has an impressive history and record of accomplishment that will be documented and interpreted in the chapters that follow. NSF has supported many of the most productive contributors to the enhancement of undergraduate education. Many of the leaders in the field got their start as researchers and developers with help from us. We are proud of this tradition and the part we have played in creating the capacity that this nation must depend on as it seeks to prepare the next generation of scientists and engineers as well as a scientifically and technologically literate citizenry.

The primary product of our CCLI portfolio is the construction of a well-warranted case for improving the quality of undergraduate education in STEM. The process of building a scholarly case for action (i.e., a warrant) is a complex one. It starts with a *claim* (that a particular condition exists, that something has value, that a particular action should be taken), builds on evidence that tests and supports the claim, establishes a *warrant* (a statement justifying the evidence that serves as a basis for a particular claim), and carefully spells out any *qualifications* for the claim (the specific circumstances under which a claim may be true and the likelihood that it is true.) A *warrant* involves a complex interweaving of evidence, explanation, and clearly articulated values (House, E.R., and K.R. Howe. 1999. *Values in Evaluation and Social Research.* Thousand Oaks, CA: Sage). No single investigator can bring all of this together, but the

Preface

community of investigators within the CCLI network can work together to do so. Underlying this continuous examination of what we have learned and what we can do with what we have learned is a cycle of innovation that is guiding the work of the entire directorate as well as the planning and evaluation of the portfolio of awards we maintain. In its current form, the cycle looks like this. As we work with the ideas, our conception of the cycle itself is changing. In the long run, we hope to fill in some of the gaps and weak spots in this cycle so that a well-researched case for improving STEM education can lead to tangible improvements in student learning and success (Figure 1).

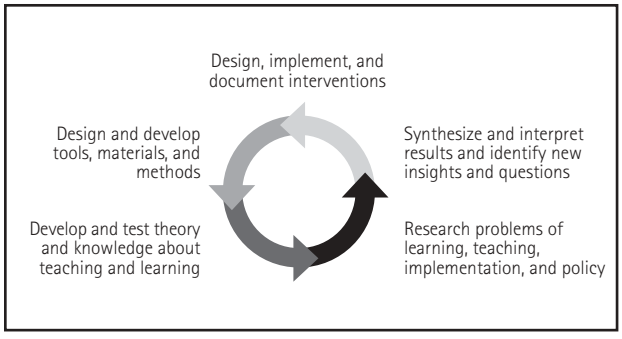

*Figure 1: Cycle of discovery, innovation, and application. Adapted from the RAND Mathematics Study Panel (*Mathematical Proficiency for All Students: Toward a Strategic Research and Development Program in Mathematics Education. *Office of Educational Research and Improvement, U.S. Department of Education, 2003, p. 6)*.

In reflecting on the work being done by our CCLI investigators, I am struck by the importance of connecting up the phases in development of a case for change and then the process of diffusion of those ideas and their introduction into practice in a variety of different environments. We simply do not know very much about how ideas catch hold and lead to responsible and collaborative action. Gatherings like this one help advance our understanding of the connection between research and practice and the role of innovation and development as a mediator between basic research and the daily challenges of the classroom and teaching laboratory. We always learn from our meetings with scholars and educators, and we are grateful for their commitment to their students, to their colleagues, and to the broader community that we all serve.

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