

PREFACE

The call for a more scientifically literate society is a constant drumbeat coming from the mainstream media and from reports of concerned organizations like the National Academy of Sciences. Typically enhanced STEM (science, technology, engineering, and mathematics) education, from elementary grades through life-long learning, is at the core of proposed solutions to this major national problem. This volume focuses on the role of higher education in confronting this national mission and cause.

Over recent decades, the United States has made a huge investment in understanding how to enhance student learning in STEM fields. Nonetheless, there can be little doubt that there is still a major disconnect between our knowledge of how to optimize student learning and the actual learning experiences that STEM faculty provide for most STEM undergraduates. Enhancing undergraduate learning is a duty of the national STEM faculty, but the responsibility is much more broadly distributed. Many stakeholders, including academic leaders, disciplinary organizations, and funding agencies, have important roles to play in the process of improving STEM teaching and learning in higher education.

This volume was conceived during conversations within the Center for the Integration of Research, Teaching and Learning (CIRTL) on how best to prepare future STEM faculty. (Note that CIRTL defines STEM as the natural and social sciences, technology, engineering, and mathematics.) CIRTL is one of two National Science Foundation Centers for Learning and Teaching focusing on higher education. The mission of CIRTL is to develop a national STEM faculty committed to implementing and advancing effective teaching practices for diverse student audiences as part of their professional careers. CIRTL seeks to prepare STEM graduate students and postdoctoral researchers to be both excellent researchers and excellent teachers.

The graduate schools of research universities are a critical leverage point for the improvement of national STEM education. Graduate students, 80 percent of whom are trained at only 125 research universities, flow into the STEM faculties of more than four thousand research universities, comprehensive universities, liberal arts colleges, and community colleges. Ironically, the research universities housing these graduate schools are the institutions of higher education whose missions most tend to draw faculty attention away from teaching. The most successful future faculty preparation programs tackle this challenge head-on by

demonstrating that achieving excellent research and excellent teaching is far more aligned than traditionally recognized. In CIRTl this concept is called teaching-as-research; Handelsman et al. (2004) call a similar idea scientific teaching.

However improved the preparation of future faculty in advance of their first faculty positions becomes, this national investment will be for naught if the institutional environments and disciplinary cultures in which STEM faculty find themselves do not continue to foster the advancement of their teaching. This volume acknowledges these climate issues and considers how to improve the climate for undergraduate teaching and learning in STEM fields across all institutions of higher education. Ideally, stakeholders at all levels (individual, departmental, disciplinary, institutional, state, and national) must work to improve conditions for teaching and learning in STEM and coordinate their efforts in support of the national STEM faculty.

The role of federal funding agencies has been and will continue to be central. Particularly important to elevating the attention to quality STEM education has been the National Science Foundation's (NSF) broader impact criterion. While broad impact was part of the original NSF charter, this recent emphasis in policy began with the *Shaping the Future* report, which suggested research directorates should expand resources for educational activities that integrate education and research. Critically, this call to action was targeted directly to the NSF STEM research directorates, in contrast to this mission being assigned only to the Education and Human Resources Directorate from which STEM educational funding traditionally derived. In association with this evolution in policy came an array of programs providing funding incentives to STEM researchers who aligned themselves with this policy. Most notable among these was the NSF CAREER Award for junior STEM faculty that requires proposers to develop innovative plans of work in both research and education. Recently the National Institutes of Health has been moving in a similar direction in its training grant programs and requirements for enhanced professional development of the many post-doctoral researchers that it funds.

STEM disciplinary societies also can play important roles in the effort to improve STEM undergraduate education. Academic departments, institutions, and funding agencies are remarkably insular, which is a major inefficiency and impediment for broad national change. Disciplinary societies have the potential to be powerful connection points fostering change across higher education. They can also play a key role in supporting the higher education initiatives of federal funding agencies as the societies interact with Congress and executive offices.

You will find the chapters in this volume to be insightful and inspiring. I am confident that *Improving the Climate for Undergraduate Teaching and Learning in STEM* will make an important contribution to the national dia-

logue on strategies for promoting high-quality undergraduate education in STEM fields.

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References

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