

EVALUATING AND IMPROVING UNDERGRADUATE TEACHING

IN SCIENCE, TECHNOLOGY,
ENGINEERING, AND MATHEMATICS

Committee on Recognizing, Evaluating, Rewarding, and Developing
Excellence in Teaching of Undergraduate Science, Mathematics,
Engineering, and Technology

Marye Anne Fox and Norman Hackerman, Editors

Center for Education
Division of Behavioral and Social Sciences and Education

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Preface

Americans have long appreciated the need for high-quality education and have invested accordingly, at levels from preschool through graduate education. Because of the impact of science and technology on the nation's economic growth, these fields have received substantial government and private research funding at colleges and universities. Indeed, since World War II, federal funding through peer-reviewed grants and contracts has placed in the hands of university faculty the primary responsibility for more than half of the nation's basic research in these fields. This investment has contributed significantly to making the United States a world leader in the discovery and application of new knowledge and has produced a well-respected system for graduate training in science and engineering. In recent years, additional financial support from industry and nonprofit organizations has provided

new opportunities for graduate and undergraduate students at many universities to participate in original research projects. Recognition of the importance of original peer-reviewed research in institutions of higher learning is clearly laudable. As Robert Gavin noted in the 2000 publication *Academic Excellence: The Role of Research in the Physical Sciences at Undergraduate Institutions*, "research activity plays a central role in keeping the faculty up to date in the field and improves their teaching."

Because of the key role of science, technology, engineering, and mathematics (STEM), mechanisms for careful scrutiny and evaluation of the quality of research in these fields are highly developed, and academic scientists and engineers often derive reward and recognition from their research achievements. As is the case with most scholarship, the criteria used in these evaluations differ from one discipline to

another, and faculty evaluations at research-intensive universities generally solicit the candid judgments of national or international peers from outside the home institution when a faculty member or program is to be evaluated. Reliance on one's disciplinary colleagues for a critique of the merits of one's research accomplishments and proposals is widely accepted as a necessary investment of faculty time and effort.

In contrast, the evaluation of teaching accomplishments has been more haphazard and less rigorous, particularly at research universities. Some faculty are not convinced of the objectivity of techniques used for describing the effectiveness of teaching and learning, especially at institutions at which competing demands on faculty time make it challenging to balance all of the normal faculty responsibilities and to focus on classroom and laboratory instruction.

Even though the dominant values, beliefs, culture, and missions of many U.S. higher education institutions often emphasize high-quality instruction, particularly in lower division undergraduate teaching, a common perception is that teaching is less closely scrutinized and less clearly rewarded than is research. Given the variety of goals among the many different sizes and types of American colleges and universities, it is not surprising that substantial differences exist in capability

and achievements in the balance between teaching and research. However, if the broad teaching missions of colleges and universities are to be attained, rigorous evaluation to improve teaching and learning must become integral to STEM departmental culture. If so, faculty and administration must be convinced that objective and comprehensive methods exist for performing such evaluations and that these techniques can be used without imposing undue burden or impossible time commitments on already busy faculty. Our study points out ways in which the fair evaluation of teaching and learning in STEM disciplines can be institutionalized as the basis for allocating rewards and promotions, at a level of effort consistent with a department's or college's educational mission.

Over the past several years, the National Research Council (NRC) has assumed an aggressive role in strengthening STEM education. The NRC's Committee on Undergraduate Science Education has coordinated this effort in colleges and universities. This study, undertaken by the Committee on Evaluating Undergraduate Teaching, examines the crucial issue of how best to evaluate the effectiveness of undergraduate instruction to improve student learning and to enhance faculty teaching skills. The committee members included faculty and administrators in

science, mathematics, and engineering; experts in assessment and evaluation; and representatives of several higher education organizations dedicated to the improvement of education. (See Appendix D for biographical sketches of the committee members.)

This is a timely undertaking. Pressures are mounting from within and beyond academe (e.g., state boards of regents and legislatures, business and industry) to improve learning, particularly in introductory and lower-division courses. These calls also request accountability of academic departments, including a new emphasis on improved teaching and enhanced student learning through curriculum revision and collegial peer mentoring.

It is the committee's view that a well-structured evaluation of teaching can be meaningful to those being evaluated and to those who must render personnel decisions based on these evaluations. Conducted appropriately, such evaluations would be crucial components of the institution's efforts to improve education. Indeed, progress in educational research has clarified the effectiveness of new methods, linking them with demonstrable outcomes: improved student learning and academic achievement. It is the committee's hope that the recent research findings presented in this report will be incorporated into existing evaluative practice.

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