

VII. CONCLUSION

The ultimate purpose of a summative evaluation is to judge whether a program was a success or a failure. However, before a judgment can be made, clear criteria for success must be set. Earlier in this report, we enumerated two sets of criteria by which UFE could be judged: (1) the goals that the UFE program set for itself, as described in program announcements; and (2) the broader NSF goals, the criteria for which were established by using the indicators for the outcomes developed by SRI (see Introduction and Appendix A). The former focused principally on whether workshops were held in all fields, how many participants were served, and what participants learned at the workshops. Those outcomes, although necessary, are intermediate ones. The latter criteria focus on more final outcomes, such as whether participants developed new courses or changed their existing courses after the workshops, the extent to which the new or revised courses had received formal approval, and the impact of participants' course changes on their students' performance.

All the criteria for success discussed in the preceding paragraph can be subsumed by two questions of equal importance: *Did the UFE program achieve its goals? Was the UFE program an effective strategy for achieving NSF's broader goal of transforming undergraduate education generally?*

The first question can be answered easily with a firm "yes." The UFE program held more than 750 workshops over a 7-year period, reaching more than 14,400 undergraduate faculty from all types of institutions. Eighty-one percent of them went on to make at least moderate changes to their own courses or to develop new courses. Two-thirds of participants introduced new content to their courses and/or changed the content to focus on "big ideas," (i.e., unifying concepts). Two-thirds introduced new laboratory techniques or new technologies, and two-fifths changed their teaching methods in some other way. Most changed their teaching in some combination of the three ways. Most also felt that the changes they had made resulted in improvement in their students' academic performance, as well as in general skills needed for the modern world, such as problem solving, critical thinking, communication, collaboration, and ability to use technology.

Judging whether the UFE program was an effective strategy to meet NSF’s goals of transforming undergraduate education is somewhat more difficult because benchmarks are less clear, but again, we believe the answer is “yes.” The 14,402 participants who attended UFE workshops represent approximately 1 in 22 SMET faculty in the United States.¹ Of these faculty, 11,666 participants made moderate or major changes to at least one course and/or developed at least one course, *and attributed the revisions or changes to the UFE workshop*. Such participants represent 1 in 27 SMET faculty in the United States. More specific changes were as follows:

Area of change	Number of faculty	Ratio to faculty in the United States
Content	9,600	1 in 33
Technology or lab techniques	9,600	1 in 33
Other changes in teaching methods	5,600	1 in 56

The proportion of U.S. students affected by classroom changes made because of UFE is still greater. Between 1991-92 and 1998-99, approximately 1,850,000 students—1 in 22 students nationally—completed courses that 1991-1997 UFE participants had developed or had revised in *major* ways, and another 965,000 students—1 in 43 nationally—completed courses to which UFE participants had made *moderate* revisions. This total of approximately 2,815,000 students represents 1 in every 15 students in the United States over the 8-year period covered.² According to faculty reports, approximately 46% of these students were female, and 25% were from underrepresented minority groups.

The UFE program also provides some evidence that workshops can affect undergraduate education beyond the participants’ own courses. First, it is noteworthy that 17% of participant survey respondents indicated that, because of the workshop, they had gone on to develop or redesign a new program of study for a major. As stated in Chapter IV, if we estimate very conservatively that many of those faculty were working together and calculate that only one program was developed or revised for each two participants working on a program of study, it would still mean that 1,200 programs of

¹ According to National Science Board (2000), Appendix Table 4-46, there were 315,500 SME&T faculty in the United States in 1997.

² From National Science Board (2000), we estimate that there were approximately 41,442,000 undergraduate students enrolled in the United States from 1991-92 through 1998-99. See calculation in Appendix E.

study were developed or revised. Additional evidence that the change brought about by the UFE was broader than simply modifications of individual courses is the fact that 38% of survey respondents—approximately 5,500 faculty between 1991 and 1997—worked on *interdisciplinary* courses. More than three-quarters of all courses developed by participants became institutionalized, having received formal approval (if needed) from the department, school, or college by the time of the survey. Thus, the UFE program, which did not target systemic reform as such, resulted in considerable systemic change.

Second, UFE participants' dissemination efforts appear to have been very fertile; slightly more than half of survey respondents reported that such sharing resulted in their colleagues' developing or revising their own courses. Even if only one colleague of each of these participants made such changes, this would add more than 7,300 faculty, so that altogether more than 19,000 faculty revised or developed courses because of UFE. This represents 1 in 17 SMET faculty in the United States. We doubt that many, if any, other programs targeted at undergraduate education can make a similar claim.

Not only did the UFE program bring about considerable changes in undergraduate education, it did so in a cost-effective way. Between 1991 and 1997, awards totaled \$60,963, 917. This number translates to approximately \$5,200 for each of the 11,666 participants who made at least moderate changes to his or her courses. Taking into account the estimated 7,300 colleagues who also made changes, the cost per faculty member drops to approximately \$3,200.

In terms of cost per student, we can take into account only those who attended *participants'* courses (not those of participants' colleagues). Nevertheless, for courses developed or revised by participants, the cost per student through 1998-99 was \$22, and this cost will decrease as more students attend the courses.

In our judgment, the UFE program was successful in accomplishing its own goals, as well as helping to accomplish NSF's undergraduate education goals, at a relatively low cost. What we have learned about UFE does not stop with this conclusion, however. This evaluation also was able to document some barriers to change as well as factors associated with workshop success.

Heavy teaching and/or administrative loads, lack of funding, and lack of equipment and technology were the most often cited barriers to developing or revising courses or labs. These factors have been mentioned as barriers to change elsewhere. For example, the former two were mentioned by more than half of Institution-wide Reform (IR) PIs surveyed as part of an evaluation of that program.³ In contrast to a finding of the IR evaluation, few UFE participants indicated that faculty or institutional resistance was a barrier to change for them. This result points to an advantage of the UFE strategy: participants were able to work on their own courses, over which they had control, and win their colleagues over by discussing or demonstrating their own successes.

Every principal investigator wants to design his or her workshop to maximize its success, but to date there has been no hard evidence of what factors are associated with success. This evaluation found that participants' likelihood of designing or revising courses after a workshop increases when a workshop includes a focus on teaching methods and when participants work on materials for their own courses or labs at the workshop. The probability of designing or revising courses is not increased by completing materials at the workshop; however, it is increased when participants continue to work on the materials after the workshop, as well as when they receive continuing technical assistance from workshop staff. Thus, NSF might want to suggest that Principal Investigators include these features in their future development activities.

We acknowledge that our findings are based on analyses of data that include almost exclusively faculty who were willing and eager to reform their courses. They may not apply to faculty who are content with their existing courses or are resistant to change. Nevertheless, the vast majority of undergraduate faculty who attend professional development activities of any kind—not just UFE activities—do so of their own volition. Therefore, we believe the findings apply broadly to faculty development activities.

³ In SRI's evaluation of NSF's Institution-wide Reform Initiative (in final preparation for NSF publication).