

EXECUTIVE SUMMARY

As part of its commitment to Congress to evaluate each of its programs periodically, the National Science Foundation's Directorate for Education and Human Resources (EHR) contracted with SRI for an independent evaluation of the Undergraduate Faculty Enhancement (UFE) program. This is the final report from that evaluation.

In addition to reporting descriptive information about the program, this study provides the first systematic examination of associations between various characteristics of the workshops and their impact on faculty participants' subsequent development and implementation of courses.

The UFE Program

From its inception in 1950, NSF has supported various forms of professional development for faculty who teach undergraduates. The UFE program was created to fund a broad range of faculty development workshops, short courses, seminars, and other related activities with the goals of enabling faculty members to (1) adapt and introduce new content into courses and laboratories, (2) investigate innovative teaching methods, (3) synthesize knowledge that cuts across disciplines, (4) learn new experimental techniques and evaluate their suitability for instructional use, and (5) interact intensively with experts in their field and with colleagues who are active scientists and teachers.

The UFE program operated from 1988 through 1998, when it was incorporated into a larger program of course and curriculum development and laboratory improvement. During the period covered by this study (1991-1997), the program awarded almost 500 workshop grants to Principal Investigators (PIs) at colleges and universities, professional societies, and other qualified organizations. Specific awards ranged from less than \$10,000 to almost \$500,000 and supported more than 750 workshops.

The Evaluation of the UFE Program

SRI's summative evaluation of the UFE program was designed to collect and interpret program-wide outcome and impact data to ascertain the extent to which UFE met the goals that NSF set out for it. In addition, as the phasing in of the Government

Performance and Results Act of 1993 (GPRA) proceeded, NSF became more interested in knowing the program's broader impacts on undergraduate education.

To ascertain such impacts, SRI worked with NSF program and evaluation staff to develop a set of desired UFE outcomes, and indicators for the outcomes. The desired outcomes are:

1. SMET faculty incorporate current and relevant content into their teaching, use state-of-the-art experimental techniques and technology, and apply best practices in instruction.
2. Undergraduate students, including those from underrepresented groups, gain proficiency in SMET, improve their attitudes toward SMET, and are prepared to apply SMET concepts to their lives.
3. Institutions offer SMET courses/labs for undergraduates that are accessible to all students, use state-of-the-art experimental techniques and technology, and are relevant to the real world.
4. SMET faculty collaborate with one another and with other experts in their fields.
5. Reforms in undergraduate SMET courses are sustained.
6. Knowledge and skills from UFE workshops are disseminated widely.

The evaluation sought to illuminate which characteristics of participants, of their institutions, and especially of the workshops themselves were associated with workshop success in terms of the changes participants made to their courses and/or laboratories. Exploring these associations was deemed particularly important because a literature search revealed no systematic information on the topic.

The principal data collection methods for the evaluation were:

- A telephone survey of 1,118 faculty.
- Site visits to eight workshops and follow-up contact with workshop PIs and participants.

Characteristics of UFE Participants and Workshops

From 1991 through 1997, more than 14,000 faculty who teach undergraduates attended UFE workshops. Approximately 30% of them were female, and approximately 16% were members of minority groups. Twenty-seven percent came from 2-year institutions, 33% from baccalaureate institutions, and 40% from comprehensive or doctoral institutions. Across institutional classifications, about 5% of participants were

from Historically Black Colleges and Universities. Data were not collected on representation from other categories of minority-serving institutions.

UFE workshops were conducted in all SMET disciplines (ranging from 1% of them in astronomy to 25% of them in mathematics), and typically focused on some combination of content (subject matter), teaching methods, and/or lab techniques or technologies. Of the workshops that included a focus on content, surveyed participants said that more than half dealt with interdisciplinary content. Most workshops were held during the summer and lasted from 3 to 10 days.

While at the workshop, the vast majority of participants worked on some type of materials for their own courses, and a substantial percentage of them completed work on their materials. After the workshop, more than half of the participants reviewed or site-tested materials or products from the workshop, often receiving technical assistance from the project PI or workshop staff. Close to half also attended formal or informal follow-up activities.

Findings from Qualitative Data for Eight UFE Workshops

During the summer of 1998, SRI researchers conducted site visits to eight UFE workshops. Within scheduling constraints, sites were selected to include various disciplines, foci, geographic regions, and types of participants targeted. Workshop PIs and selected participants were contacted again in spring and summer of 2000 to obtain updated information.

The workshops visited ranged from 5 to 21 days in length. Activities included presentations by staff and/or guest lecturers, hands-on activities (including time for participants to work on materials for their own courses), and opportunities for participants to interact with one another. All workshops visited had a real-world focus, and several included field trips. In most workshops, the activities were well balanced, and presentations and activities were of high quality, according to expert site visitors and participants interviewed. Site visitors also observed that most participants were highly engaged at all times.

Face-to-face follow-up activities proved somewhat difficult to schedule. In the two years following, none of the workshop convenors had held formal follow-up activities; however, three held informal gatherings at professional meetings. A more common type

of follow-up was communication between participants and PIs or workshop staff as participants continued to work on their own materials and/or site-test those of others.

The majority of participants at the workshops visited were white males. Approximately a quarter were females, and, despite PIs' attempts to recruit individuals from underrepresented minority groups, only about 6% of participants were from such groups.

The most important characteristic about participants is that the vast majority of them were extremely eager to learn and to apply what they had learned. In a few cases, their eagerness was robust in the face of poor presentations or a less-than-optimum schedule of activities.

Findings from Survey Data

UFE's Impact on Faculty and Their Institutions

New and/or Revised Courses. Almost all UFE participants learned new content, teaching methods, laboratory techniques, and/or new technologies at UFE workshops, and approximately four-fifths applied what they learned by developing at least one new course and/or revising at least one existing course. We estimate that, as a result of UFE workshops, approximately 5,000 new courses were developed, 7,300 courses underwent major revisions, and 8,600 courses underwent moderate revisions. More than three-quarters of these new or revised courses received departmental approval.

Programs of Study for Majors. Approximately 17% of participants developed or redesigned a program of studies as a result of the UFE workshop they had attended. Even under very conservative assumptions, this translates to the development or redesign of approximately 1,200 programs of study.

Dissemination. Through a variety of formal and informal dissemination activities, participants extended the impact of the workshops beyond themselves. More than half of participant survey respondents reported that they had shared what they had learned with colleagues and that, as a consequence, at least one of their colleagues had developed a course or lab and/or modified the content of a course or lab. From these survey responses, we estimate that at least 2,700 of UFE participants' colleagues developed a new course or lab and that at least 7,200 modified the content of an existing course.

UFE's Impact on Students

Participants' professional enhancement and consequent development of new or revised courses would mean little if students did not take the courses or if the changes did not result in improved student learning. We estimate that, by 1999, more than 1,850,000 students, 1 in 22 students nationally, had completed courses that were developed or had undergone *major* revisions as a result of the UFE workshops held in 1991-1997.

Approximately 965,000 additional students, 1 in 43 students nationally, had completed courses which had undergone *moderate* revisions as a result of the workshops. Slightly fewer than half of these students were female, and approximately one-quarter were from underrepresented minority groups. Twenty-eight percent of the students were in 2-year institutions, the same percentage in baccalaureate institutions, 24% in comprehensive institutions, and 20% in doctoral institutions.

Faculty reported that students in their revised or modified courses performed better along a number of dimensions than comparable students in traditional courses. In addition to improvements in content knowledge, faculty cited improvements in students' abilities to solve problems, think critically, communicate, collaborate, use technology, and understand the scientific method.

The greater the changes faculty made to their courses, the more likely they were to report substantial improvement in their students' performance. Because student performance was neither observed nor measured by third parties, the extent to which faculty may have over-reported improvements in their students' performance cannot be known; however, our data collection techniques attempted to minimize this possibility.

Factors Associated with Workshop Success

More than half of UFE participants who developed and/or revised courses encountered some type of barrier. According to survey respondents, the most common barriers concerned lack of time to work on courses because of a heavy teaching and/or administrative load, not having the necessary equipment or technology, and lack of funds. Resistance to change by other faculty was not a commonly reported problem.

We performed a multivariate analysis to examine the associations of characteristics of participants, their institutions, and the workshops with participants' probability of developing or revising a course after the workshop. Neither characteristics of

participants nor those of their institutions showed any statistically significant associations. Characteristics of the workshop that were found to be positively associated with developing or revising courses were: the number of days of the workshop, the inclusion of teaching methods and/or new technology in the workshop, and activities that included work on lecture notes, handouts, problem sets, project descriptions, and/or lab exercises. Neither completing their materials at the workshop nor taking part in face-to-face follow-up activities showed significant associations with developing or revising courses. In contrast, testing materials at their home institutions and receiving technical assistance from workshop PIs or staff did show significant positive associations.

Conclusion

To judge whether the UFE program was successful, two questions must be addressed: *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 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 those faculty went on to make at least moderate changes to their own courses or to develop new courses. Thus, the answer to the first question is a definite “yes.”

Answering the question of 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 (total corrected for number of repeat attendees) who attended UFE workshops represent approximately 1 in 22 SMET faculty in the United States. Of these participants, we estimate that 11,666, or 1 in 27 U.S. SMET faculty, developed and/or made moderate or major changes to at least one course and attributed these actions to the UFE workshop they had attended.

The proportion of U.S. students affected by classroom changes made as a result of UFE workshops is still greater. We estimate that, between 1991 and 1999, approximately 1,850,000 students—1 in 22 undergraduate 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 2,815,000 students represents 1 in every 15 undergraduate students in the United States over the 8-year period covered, and the total will increase as the new and revised courses are taught again over the next few years.

Moreover, dissemination efforts of UFE participants 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 per participant 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.

In addition, although the impact on students of revisions to major programs of study was not (and perhaps cannot be) measured, that impact also appears to be considerable; at a minimum, more than 1,200 major programs of study were created or redesigned.

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, UFE grants totaled \$46,024,461. This number translates to approximately \$3,900 for each participant who made at least moderate changes to his or her courses. Taking into account participants' colleagues who also made changes, the cost per faculty member who made changes due to someone's participation in UFE drops to approximately \$2,400.

In terms of cost per course and per student, we can take into account only participants' courses and students (not those of participants' colleagues). Nevertheless, for courses developed by participants, the cost per course was approximately \$2,200 (including new courses as well as courses that underwent major or moderate revisions). The cost per student in such courses through 1998-99 was approximately \$16, and this cost will decrease as more students attend the courses.