PROFESSIONAL DEVELOPMENT

Summer Institute to Improve University Science Teaching

The goal of the National Academies Summer Institute is to change teaching practices in introductory, undergraduate biology courses.

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Introductory science courses at large universities in the United States serve as the portals that connect undergraduates to frontiers in research and scientific ways of thinking (*1*–*3*). According to the National Research Council report, *BIO2010* (*4*), however, teaching practices have not changed in correspondence with advances in scientific research. Consequently, the gateway through which most students pass is antiquated and misrepresents the interdisciplinary, collaborative, evidence-based culture of science. To provide faculty with the knowledge and skills they need to improve undergraduate teaching, *BIO2010* recommended an annual summer institute for biology faculty devoted to teaching and learning. Here, we report the design of such an institute and its impact on participants' teaching practices, challenges faced when they returned to their institutions, and how they disseminated institute practices.

Dissemination activity	Respondents (%) who engaged in activity
Mentored a colleague in teaching	89
Presented a seminar or workshop about teaching	72
Submitted a manuscript about teaching	25

SI alumni as agents of change. Two years after the SI, most SI alumni report leading educational reform efforts at their home campuses (n = 75).

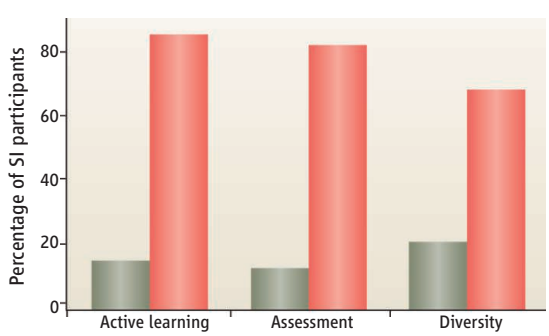
The Summer Institute

The Howard Hughes Medical Institute, the National Academies, and the University of Wisconsin–Madison partnered to create and implement the National Academies Summer Institute on Undergraduate Education in Biology (SI) (*5*, *6*) (http://academiessummerinstitute.org). Offered annually since 2004, the SI has as its goal helping biology faculty learn the skills necessary to transform high-enrollment undergraduate courses into more effective, learner-centered environments, by using practices proven to be effective. During the week-long institute (*7*), SI participants learn about "scientific teaching" (*8*–*10*); they develop teaching materials that define students' learning goals, include classroom activities that address these goals, and assess student learning. Participants also explore the challenges and benefits of diversity in teaching methods and in the students they teach. They also are expected to practice and disseminate the new activities they developed upon returning to their home campuses. Starting in 2007, SI participants were provided additional training and resources to conduct workshops about scientific teaching for other faculty at their institutions.

Admission to the SI is by competitive application. Priority is given to universities that send teams of two to three instructors, ideally including both junior and senior faculty, who teach large introductory biology courses. Applicants must demonstrate financial support from their campus for travel to the SI and for implementation of new teaching practices when they return to their campuses. Since 2004, five cohorts from 64 U.S. institutions in 36 states have participated in the SI. These include public and private institutions, of which 69% are research-extensive (offering a wide range of baccalaureate programs, and committed to graduate education through the doctorate). The 107 male and 102 female participants include 39% tenured faculty, 33% untenured faculty, and 27% instructional staff (*7*). Collectively, these SI alumni teach an estimated student population of over 90,000 undergraduates annually.

Reported Changes in Teaching Practices

On leaving the SI, participants reported by survey significant learning gains in areas of scientific teaching ($P < 0.001$) (*7*). Most SI alumni (87%, n = 135) reported increased confidence in their ability to implement these strategies after the SI and expressed their intentions to do so. To determine whether these attitudes persisted and the intentions were realized, we again surveyed SI alumni 1 and 2 years after the SI. Over the 2-year period following the SI, alumni reported sustained learning gains and confidence, and 98% indicated that they were still experimenting to improve their teaching (*7*). When asked to describe evidence that their teaching had changed over the past 2 years, 96% of the survey respondents provided examples that ranged from identifying specific activities that are now different in their



The effect of SI on reported teaching practices. SI alumni (n = 68) used scientific teaching approaches more frequently two years after the SI (red) than before the SI (blue).

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classrooms—using case studies, clickers (audience-response systems), or cooperative groups—to describing general attributes about their teaching and student learning generally. These perspectives included demonstrations of improved learning by their students, and attempts to research, measure, and document the effects of their changed practices.

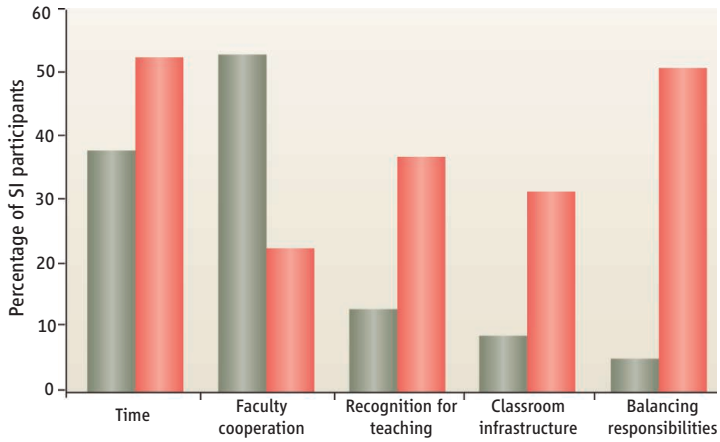
The frequency with which SI alumni reported using learner-centered classroom activities (active learning), measuring student learning and teaching effectiveness (assessment), and employing diversity-aware teaching strategies (diversity) increased substantially in the two years after their participation in the SI; more than 68% of participants reported using these methods in at least half of their class sessions (see chart, p. 470, right). SI alumni also reported using techniques to engage students such as problem–based and cooperative learning multiple times each semester (*7*).

SI alumni reported using multifaceted assessments of student learning and teaching effectiveness, and teaching methods that provide immediate feedback about learning, including listening to groups of students discuss problems, inviting student responses (often using clickers), and scoring rubrics (*7*). One alumnus summarized his changes in teaching practice as follows: "I look over the material I presented … [before the SI] and realize how much I have changed the emphasis to student learning…. My syllabus lists learning objectives for each class period, and those learning objectives are reflected in multiple forms of formative assessment and in the exams students take." SI alumni also reported gains in broadening their definition of diversity to include diversity of student learning styles and the application of diverse teaching methods (*7*).

Challenges: Anticipated and Actual

Upon leaving the SI, participants were asked what challenges they anticipated facing as they implemented new instructional materials and teaching approaches at their home campuses. Many participants predicted that gaining cooperation of colleagues in their departments would be most difficult.

One year later, the group of alumni were asked to rate what actually proved to be the major challenges. They found that time pressures, balancing responsibilities, and lack of recognition for their teaching efforts were most challenging (see chart, below). However, some alumni commented that the SI enabled them to negotiate change. For example: "The stature of attending the SI has helped me gain respect of colleagues in the department to foster their consideration of such methods…." This recognition may be aided by naming each participant as a National Academies Education Fellow in the Life Sciences.



Implementation challenges. Challenges predicted by participants at the end of SI (blue, $n = 67$); reported challenges 1 year after SI (red, $n = 101$).

Other barriers, such as funding limitations, also did not turn out to be as significant as predicted. One participant stated: "Before this workshop, I thought lack of resources (funds!) would be a problem. Now I know that lack of funds for various gadgets is just an excuse on my part. No funds are required for: forming student groups, pre-testing, post-testing, etc."

Dissemination

SI alumni are asked to become agents of change and to promote improvements in undergraduate biology education at their home institutions and nationally. They have taken this charge seriously (see table, p. 470); most have talked informally about the SI to colleagues in their departments (98%); others have led events, including formal seminars, workshops, and institutes; 25% reported writing manuscripts about their teaching efforts [e.g. (*11*–*17*)]. Many alumni (74%) reported that colleagues in their department were positively affected by their team's experience in the SI. In addition, 44% of the respondents reported mentoring a colleague in teaching within 6 months of the SI; and 2 years after the SI, this number increased to 89%.

Conclusions

The SI changes the university experience for the faculty participants and the students they teach. SI alumni disseminate the principles of scientific teaching, thereby acting as a coherent force for advancement in science education and improvement in student learning. The participants chose to attend the SI; consequently, they may be predisposed to consider change in teaching practices and, therefore, are not representative of undergraduate science educators. However, independent of their starting points on the continuum, the SI participants reported substantial change in their teaching practices and efforts to disseminate information both formally and informally. Some have also published effects on student learning. Further research is needed to triangulate these results with independent assessment of classroom teaching practices and their effects on student learning. Such studies are under way, as are those that examine the impact of SI participants on their departments and broader teaching communities.

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