

## **FACULTY/STUDENT/ADMINISTRATION COLLABORATIONS FOR SCIENCE, MATHEMATICS, AND ENGINEERING COURSE REFORM**

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Over the last several years, Brown University has implemented numerous initiatives aimed at improving undergraduate science, mathematics, and engineering (SME) education through the creation of a science community which is working toward inclusiveness in science education and which is sharing, learning about, and implementing relevant programmatic and pedagogical innovations and techniques. Through experience, we have determined that these goals are best met through a variety of parallel initiatives which encourage and support collaboration between and among administrators, faculty, and students. Two of these initiatives will be described in this paper: undergraduate research assistantships for SME course reform and science education seminars for administrators and SME faculty.

### **FACULTY/STUDENT COLLABORATION**

Brown has sponsored Undergraduate Teaching and Research Assistantships (UTRAs) since 1986, providing grants for collaborations between students and faculty. With support from the Sloan Foundation, UTRAs have been offered since the summer of 1995 to specifically support the reform of undergraduate SME courses. Through these UTRAs a faculty member and student(s) work together to change an SME course to make it more "inclusive" of women and/or students of color. Grants are awarded to faculty/student teams for the student to work full-time during the summer and/or part-time during the academic year.

SME faculty are often interested in making course changes but lack the time to do all the necessary research and material development. Providing a student research assistant through the UTRA program gives a faculty member the extra support needed to develop and implement changes. Students also provide valuable input from their experiences in the course and/or simply from their perspective as a student.

In addition to benefiting the faculty member, the experience is also very valuable for the student. Through this collaboration the student has the opportunity to work one-on-one

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with a faculty member and to gain insight into the work of university SME faculty and the development of SME courses. Several of the students involved in these projects have later expressed a new-found interest in science teaching and science education.

Through the UTRA the student and faculty member work together to change aspects of a specific SME course's content and/or format. Changes may include some or all of the following: expansion of course content to include contributions to science, engineering, or mathematics by women and/or people of color; exploration of the differential impact of scientific, medical, and environmental issues according to race and/or gender; inclusion of teaching techniques which attract, retain, and effectively educate a more diverse community of scientific scholars; and improvements which will positively affect the educational experience of all students in the course.

The Sloan UTRA application process is part of the general Brown UTRA application process. A student and faculty member submit a joint proposal outlining the proposed project. Proposals are selected by a committee of administrators and faculty members based on the goals and content, the strength of the collaborative aspect of the project, and the likelihood of completion within the given time frame.

During the summer projects, it was found that regular meetings of the students involved in the Sloan UTRAs were very important. These meetings decreased students' sense of isolation, provided a forum for brainstorming, and allowed for cross-fertilization of ideas and information between projects.

**Table 1: Samples Results of Sloan UTRAs**

<b>Course</b>	<b>Changes</b>
<b><u>Organic Chemistry</u></b>	<ul style="list-style-type: none"> <li>• Design of computer simulations to support visual learning</li> <li>• Creation of course WWW site and an e-mail discussion list to increase communication between and among students, TAs and the course instructor</li> </ul>
<b><u>Introduction to Engineering</u></b>	<ul style="list-style-type: none"> <li>• Development of hands-on laboratories and design projects</li> <li>• Implementation of study groups</li> <li>• Inclusion of lab tours, field trips, and career panels</li> <li>• Establishment of ombudsperson to act as liaison between instructor, TAs, and students</li> </ul>
<b><u>Environmental Science</u></b>	<ul style="list-style-type: none"> <li>• Incorporation of minority issues into three environmental science courses</li> </ul>
<b><u>Social Psychology</u></b>	<ul style="list-style-type: none"> <li>• Use of curricula and structures which emphasize student interaction, cooperation, and inquiry-based learning</li> </ul>
<b><u>The Fossil Record (Geology)</u></b>	<ul style="list-style-type: none"> <li>• Development of collaborative projects</li> <li>• Use of study groups</li> <li>• Establishment of ombudsperson to act as liaison between instructor, TAs, and students</li> </ul>
<b><u>Calculus</u></b>	<ul style="list-style-type: none"> <li>• Use of interactive computer materials</li> </ul>
<b><u>Health Care in the United States</u></b>	<ul style="list-style-type: none"> <li>• Use of techniques aimed at increasing class participation and interaction</li> <li>• Inclusion and integration of more material on gender, race, and class issues in the U.S. health care system</li> </ul>

Our experiences have shown that faculty are often more willing to listen to students than to administrators regarding issues of race and gender in science education. Even some faculty members who deny there is a problem with respect to the lack of inclusiveness of science education may participate in making concrete changes in their teaching style or course content; regardless of the motivation, these actions often benefit under-represented groups in the sciences. The Sloan UTRAs resulted in extensive course reforms in departments across campus. Examples of these reforms can be found in Table 1.

## **FACULTY/ADMINISTRATION COLLABORATION**

The Office of the Dean of the College, with support from the Sloan Foundation, has also sponsored a series of seminars and luncheon discussions for administrators and SME faculty as a means of creating and supporting a science community which is working toward inclusiveness in science education and which is sharing, learning about, and implementing relevant programmatic and pedagogical innovations and techniques.

A series of seminars related to race and gender issues in science and science education was held for faculty and administrators beginning in the winter of 1994. These seminars were usually in the form of dinner meetings which included a talk by a visiting "expert" and a discussion on the speaker's topic. Topics included women in science, model approaches to conceptual development in science, results of the American Physical Society site visits, concept-centered teaching, peer instruction, and collaborative learning methods. The goal of these seminars was threefold: to educate faculty and administrators about issues of gender and race in science and science education; to bring together faculty and administrators to discuss issues of diversity within the Brown science community; and to act as a catalyst for initiatives to improve retention of underrepresented populations at all levels of the sciences at Brown.

At the request of seminar participants, a series of monthly informal luncheon discussions on science education was started in the fall of 1995. The objective of these luncheons was to provide support for faculty implementing or interested in implementing changes in their SME courses by providing faculty and administrators from a variety of departments with an opportunity to share their ideas about and strategies for science teaching and to discuss and debate these various pedagogical and curricular approaches. The Office of the Dean of the College decided to focus its efforts on providing this more intensive training in teaching for diversity to a smaller subset of faculty, while continuing to offer periodic seminars with outside experts, sponsored either by the Office of the Dean of the College or through departmental colloquia.

At most discussions two faculty members or administrators would present a brief description of their experiences with or use of specific pedagogical or curricular reforms which have a positive effect on the retention of underrepresented populations and improve the learning experience of all students in an SME course. The remainder of the luncheon would consist of a roundtable discussion about the topic. Topics included using and assessing group work in SME courses, the use of study groups in college science classes, mentoring and diversity in SME, institution-wide reform in undergraduate SME education at Brown, and the future direction of SME undergraduate education.

Initially, the majority of SME faculty seemed skeptical about the importance of or the need for large-scale SME education reform. Now, however, SME faculty are generally interested in learning more about specific ways to improve teaching for all students and/or

for underrepresented populations in particular. This dramatic change in attitude was perhaps most apparent at a recent SME education discussion, when all faculty members in attendance (including several department chairs) outlined curricular and pedagogical changes taking place in their departments. Numerous specific changes in course structure or content have been attributed directly to these seminars and discussions; examples of these changes can be found in Table 2. Continued faculty interest has been so great and resultant course reforms so extensive that the undergraduate SME education discussion series is being continued indefinitely, even though grant funding has expired.

**Table 2: Examples of Changes in SME Education at Brown**

<b>Course/Department</b>	<b>Changes</b>
<b>Introductory Physics</b>	• Use of peer teaching
<b>Upper-level Geology</b>	• Use of collaborative learning techniques • Increased emphasis on the importance of writing
<b>Geology Department (Planetary Section)</b>	• Supported formation of new chapter of Women in Aerospace
<b>Computer Science Department</b>	• Approached Office of the Dean of the College to share cost of video lecture series on women in computer science
<b>Large Organic Chemistry Lecture</b>	• Implementation of peer instruction • Interruption of lecture to pose conceptual questions • Videotaping of course for use by individuals or study groups • Use of a wider variety of teaching techniques • Use of study groups • Videotaping of lectures as a form of feedback about teaching style

## **INSTITUTION-WIDE IMPACT**

By instituting a variety of initiatives which emphasize collaboration between and among students, administrators, and SME faculty, we have been able to foster a science community which is actively working on issues of inclusiveness and improved science education at all levels. While these collaborations have directly resulted in the numerous reforms mentioned above, they have also indirectly resulted in extensive institution-wide changes:

- Currently there are more than ninety SME faculty (>35%) aware of, interested in and actively involved in an ongoing campus discussion about issues of race and gender in science and science education.
- Providing faculty with these resources and supports has resulted in dozens of reforms in virtually all science, mathematics, and engineering departments, ranging from large-scale course revisions to implementation of small, discrete changes. (See Tables 1 & 2)
- There has been a dramatic improvement in SME faculty attitudes and student experiences, both of which can be attributed, in part, to the collaborations described in this paper.
- The Division of Engineering has instituted an annual faculty retreat to discuss and learn about engineering education techniques and approaches, including issues specific to underrepresented populations in engineering education.
- The Physics Department has established a semiannual lecture on women in science.

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- In conjunction with related co-curricular initiatives, these course reform initiatives have contributed to a dramatic increase in retention of undergraduate women in science at Brown from 59.9% in 1994 (the first year data was available) to 67.4% in 1996. A parallel increase in retention rates for men was not seen.
- The overall percentage of Brown SME graduates who are women has increased by 12.1 percentage points in six years (from 36.2% in 1990 to 48.3% in 1996), while women as a percentage of the overall undergraduate population only increased by 5.7% in the same time period.

