

Chapter 3

Content of PFF Programs in the Sciences and Mathematics

No two PFF programs are exactly alike. Faculty members design their offerings based on the distinctiveness of the discipline and their departments. Yet all focus on core PFF concepts, providing the next generation of faculty members with exposure to a broad range of experiences and settings that will better prepare them for their careers. This chapter examines nine common kinds of PFF activities: courses for credit, seminars and workshops, certificate programs, activities at partner institutions, mentoring programs, assessment and evaluation tools, attention to diversity, informal student activities, and activities and resources through the disciplinary societies.

Courses for Credit

Courses are the primary way education is organized, and this is true for PFF. The PFF program in biology at the University of Cincinnati offers three seminar courses for graduate credit. “Becoming a More Effective Teacher” and “The Academic Job Search Process” are offered through the graduate school and open to graduate students in all disciplines. They cover topics related to the job search process, the diversity of academic positions available, trends in higher education, and approaches to cultivating student learning. The third course, “Effective Tools for Teaching in the Biological Sciences,” is targeted to the particular challenges and opportunities of teaching in the discipline. It includes topics such as course preparation, classroom presentation

and evaluation, learning styles, technology in the classroom, and assessment. Course descriptions are available at www.uc.edu/pffls/FAQ.html. The program is open to all pre- and post-doctoral students in life sciences, including those in basic science departments and in the college of medicine.

The physics department at the University of Arkansas developed “The Internship in Higher Education Leadership” as a formal, graduate-level physics course that counts as an elective toward a physics master’s or doctoral degree. The course integrates professional experience with theory and was developed in collaboration with administrators at the institutions that provide the internship experience—Crowder College, Kansas State University, and Northwest Arkansas Community College. This is a useful illustration of a goal-driven teaching apprenticeship course, described at www.uark.edu/depts/physinfo/pfpf/547v.html.

Seminars and Workshops

Less formal than courses, seminars and workshops offer exposure to teaching and learning concepts, information about job search strategies, and discussions about faculty life. Programs on pedagogy provided by university centers on teaching and learning and graduate school programs on faculty roles and responsibilities are useful resources for departmental PFF programs.

Information about job search strategies and details of faculty life is often specific to schools or departments and is best provided at that level.

Binghamton University PFF alumnus William Hooper provides a participant’s view of the PFF program in mathematics:

Several times a semester, a faculty member from another college (frequently one which we visited with the speaker series) would come to



Binghamton to give either a seminar talk or a workshop. These presentations ranged from an explanation of the life of a new faculty member to exposure to the use of technology in improving teaching methods. These presentations were all beneficial, and reinforced the concept of teaching as a group effort, not an individual one.

A biochemistry student in the PFF program in chemistry at Queens College said of the PFF workshops:

Several of these workshops were particularly valuable to me. Those would include the daylong seminar that covered a number of topics including new teaching techniques in chemistry and how to apply for and write a grant. At another meeting, a faculty member from Manhattan College spoke to us about her career path. She included the application, interview, and tenure process. In addition she was a former Queens College graduate student, which made her experiences really hit home. I didn't quite realize how helpful the information I obtained through PFF was until I began to go on interviews myself... I left each PFF meeting feeling more focused on my career, and I also felt that my concerns as a graduate student mattered.

Queens College students also made special note of the value of a series of talks called "Pathways to the Professoriate," where graduate faculty informally discussed the paths they had followed to their present faculty positions. The students expressed amazement at the variety of routes that faculty members described and inevitably had many questions for each speaker. Personalizing the account of each faculty member's history has a way of

“demythologizing” the process of becoming a faculty member.

Another important activity sponsored by the PFF program at Queens College was an all-day summer retreat held off-campus to focus discussion on several workshop topics. The retreat allowed the participants to discuss important topics in depth and, the director noted, enabled the students and faculty involved in PFF to reach a point of greater focus and unusually meaningful communication.

Certificate programs offer the opportunity to earn a formal credential that is included in a student's permanent file.

Certificate Programs

Several PFF programs in the sciences and mathematics have developed certificate programs as a means of recognizing student achievements. Certificate programs offer the opportunity to earn a formal credential that is included in a student's permanent file.

Duke University's Teaching Certificate in Biology program includes a course on teaching and learning, an opportunity to teach with supervision and feedback, and a mentored faculty experience. Students prepare a teaching portfolio containing a reflective essay, a statement of teaching philosophy, samples of course materials they have developed, syllabi of courses taught, and teaching evaluations. One alumna of the program says, “ My participation in PFF broadened my education at Duke beyond focused lab experiments and classes by providing a forum to discuss education beyond basic research. PFF enabled me to cul-

tivate skills that may not have developed within the framework of the traditional graduate school experience.”

Opportunities for teaching and mentoring experiences are available at Duke, Durham Technical Community College, Elon University, Guilford College, and Meredith College. Another student who participated in this program describes its value: “I am pursuing the teaching certificate because I have been lucky enough to receive a research fellowship, but that fellowship necessarily limits the amount of teaching that I have done. By pursuing the certificate, I can bolster my teaching credentials in spite of that limitation.”

The University of Cincinnati offers certificates from the biological sciences and the university-wide PFF programs to students who take the three seminar courses described earlier and complete a mentoring experience of at least forty hours at one of four local partner institutions. (Names of institutions associated with each cluster can be found in Appendix II. A fuller description may be found at www.uc.edu/pffls.)

The University of South Carolina has a PFF credential with set requirements that cover teaching, research, and service activities. The core requirements include attendance at teaching seminars, mentored teaching experiences with someone who is not the research adviser, mentoring undergraduate student research, and serving on the PFF steering committee. The program began with doctoral students in biology and marine science and has since expanded to include all the doctoral programs in the College of Science and Mathematics: biology, chemistry and biochemistry, geology, marine science, physics and astronomy, mathematics, and statistics.

The PFF program in physics at the University of California, San Diego, based in the university’s Center for Teaching Development (CTD), estab-

lished detailed competency-based criteria for gaining the CTD Certificate in College and University Teaching. To earn the certificate, participants must demonstrate competency in four areas: 1) course development, including curriculum and syllabus design; 2) effective implementation of a course they design as part of the first competency area; 3) professional roles and responsibilities of faculty; and 4) proficiency in utilizing instructional technology. Descriptions for all four competencies can be found at www.ctd.ucsd.edu/programs/pfpf/activities.htm

Activities at Partner Institutions

Several PFF programs have developed options other than a formal teaching internship program that offer PFF participants alternative ways to forge connections with undergraduates at partner institutions. For example, each semester the PFF mathematics program at Binghamton University sponsors visits to each of its partner institutions with graduate students frequently giving talks to undergraduates on topics in mathematics. PFF alumnus Zoran Sunik describes some of the benefits of these visits:

[T]he best part of the program is the opportunity to go to the partner institutions, take a look at different departments and feel the atmosphere from the faculty point of view. It is impossible to get a similar “insider look” in one’s own department, since the relations between graduate students and the faculty are already established on different premises. As part of such a visit to [SUNY College at] Oneonta, I prepared a talk, suitable for undergraduates, that I later gave during my job interview (and was offered the job).



At Virginia Tech, PFF participants in the mathematics department give talks on their research in undergraduate seminars during daylong visits to their partner institutions. These visits are viewed as ways to enhance graduate students' communication skills and job prospects, recruit new graduate students from the partner institutions to Virginia Tech, and provide partner institutions with interesting and informative speakers.

At King's College, three PFF alumni from Binghamton University's mathematics program are now members of the faculty. Alumna Denise Reboli talks about the values to partner faculty of participating in the program:

These [PFF participant-led] discussions are important to me as a member of the faculty at a partner school because I have been able to stay in touch with the trends in graduate education. This has given me additional background that I can use when I advise my students who are considering graduate school. Some of these conversations [with PFF participants] provide an opportunity to meet graduate students who will be colleagues, possibly in my own department, in the near future.

Understanding what being a faculty member entails in terms of not only teaching and research, but also service, helps the graduate students know what will be expected of them when they start a full-time position.

At Howard University, PFF Fellows serve as interns at partner institutions. Chanda Macias, a doctoral student in biology, comments on the experience (Bogle 2001):

I had reservations about my internship because of the differences in mission between Catholic University and Howard University, an Historically

Black College and University. Prior to my internship I was assigned a mentor, Dr. Greene [in the department of biology at Catholic University] who was to guide me. The experience was priceless. I was inspired to open my horizons to teaching and learning environments, as well as to embrace academia with such vibrancy.

PFF physics students at the University of California, San Diego, and education staff at the Reuben H. Fleet Science Center at San Diego City College, jointly offer a unique electronics and magnetism workshop-based course that teaches the physics underpinning various exhibits at the Center. Undergraduate students in the course engage in individual projects to develop deeper understanding of the physics of one or more exhibits and give oral and written reports on their project results.

Mentoring Programs

Mentoring experiences provided within PFF programs have pleasantly surprised both faculty mentors and student participants. Neither group anticipated the level of personal and professional enrichment that students would experience or the range of personal interactions that developed. One graduate student commented, “The bonding between PFF students and between PFF students with faculty members has developed. The emotional aspect is very important for one’s self image.”

Binghamton University PFF alumnus William Hooper commented:

Through the mentoring program, each graduate student in the PFF program is paired with one of Binghamton University’s faculty. This pairing gives the student an adviser who is as important to developing



as a teacher as the student's thesis advisor is to developing as a researcher. The peer-review program then allows the students to observe each other teach and share what they have learned from their mentors. After experiencing this program, several of us found it so helpful that we began a seminar for first-year students in an attempt to pass on what we had learned.

As an integral part of its PFF program in mathematics, Virginia Tech has assigned two senior graduate teaching assistants to act as peer mentors to other graduate student teaching assistants. As a result of this program, graduate students are strongly supported and supervised in their role as teachers, resulting in increased confidence, decreased anxiety, and fewer undergraduate complaints.

Assessment and Evaluation Tools

Assessment is a powerful learning tool when it is viewed as a way to identify areas for improvement. The University of California, San Diego's Preparing Future Physics Faculty (PFPP) program uses three self-assessment modules for its fellows, one module each for pre-training, pre-internship and post-internship. These modules are included on the PFPP Web page: www-ctd.ucsd.edu/PFPP/index.html.

Binghamton University conducted a survey of PFF participants to assess how they felt PFF had influenced their preparation to deal with seven aspects of faculty life: faculty roles beyond teaching and research, differences between institutions, teaching diverse students, undergraduate research, advising students, balancing teaching and research, and using technology in the classroom. Initial results showed that thirteen of fourteen graduate stu-


dents indicated they felt ill-prepared to conduct research projects with undergraduates, and the majority said they did not have adequate knowledge or experience using technology in the classroom. Subsequent activities emphasized these areas. Results of the surveys and reports are online at www.math.binghamton.edu/pff/.

Attention to Diversity

Attention to diversity—a critical element in any PFF program—takes several forms in PFF programs in the sciences and mathematics, including broadening access to underrepresented groups, supportive activities that have an impact on retention and graduation, and teaching for inclusiveness.

Several departments and universities connect their PFF programs to initiatives that attract students from underrepresented groups to graduate education. Howard University links its NSF-funded Alliances for Graduate Education and the Professoriate (AGEP) programs to the PFF program by requiring AGEP students to participate in PFF. The AGEP program is intended to increase significantly the number of students receiving doctoral degrees in the sciences, technology, engineering, and mathematics, with special emphasis on those population groups underrepresented in these fields. The Howard arrangement provides opportunities for undergraduates from minority-serving institutions to enhance their understanding of science and mathematics environments in the academy.

The physics PFF program at the University of Colorado at Boulder connects with its Graduate Assistance in Areas of National Need (GAANN) program funded by the U.S. Department of Education. Applicants for GAANN grants must set forth policies and procedures to ensure that they will seek talented students from traditionally underrepre-



sented groups. The Colorado physics program also connects with the NSF-funded Integrative Graduate Education and Research Training (IGERT) program. IGERT was created to meet the challenges of educating Ph.D. scientists and engineers with the multidisciplinary backgrounds and the technical, professional, and personal skills needed for the career development demands of the future. It aims to facilitate greater diversity in student participation and preparation and to contribute to the development of a diverse and globally aware science and engineering workforce. Students supported by these grants are encouraged to participate in PFF.

Similarly, the University of South Carolina has linked its PFF program in the College of Science and Mathematics to activities sponsored by its GAANN grant. Its PFF participants have given presentations to students participating in South Carolina's Louis Stokes Alliances for Minority Participation (LSAMP) program. LSAMP is a NSF-funded program designed to strengthen the preparation and increase the number of minority students who complete baccalaureates in science, technology, engineering, and mathematics fields. This objective facilitates the long-term goal of increasing the production of Ph.D.s in these fields, with an emphasis on entry into faculty positions. The South Carolina LSAMP has increased the number of minority undergraduate degrees in these fields by 75 percent since 1992.

The mathematics department at Arizona State University has introduced PFF participants to the pedagogical issues facing minorities through

*Attention
to diversity ...
takes several forms
in PFF programs
in the sciences and
mathematics.*


the Strengthening Understanding of Mathematics and Science (SUMS) Institute. One of the participants, Tamil Maldonado, a Puerto Rican student, enriched her PFF experience by attending the annual Society for Advancement of Chicanos and Native Americans in Science national conferences. She said:

It is a wonderful activity to meet people from all sciences, math, and education areas, start making new contacts and get any kind of professional and educational information you may need. The highlight for many students was the opportunity to present their research and receive feedback from top scientists.

Later in her report, she adds:

It is my third time coming to these meetings, and every time it has been a motivation for my educational and professional career. It is wonderful to meet excellent researchers, meet new people, and actually see their work.

The Arizona State University campus-wide PFF program—which includes students in the sciences and mathematics—incorporates activities that focus on teaching for inclusiveness. Diversity is the overarching structure that ties the program modules together, and instructional and curricular content reflects that concern. Each panelist who presents in a seminar is asked to address issues of diversity. One of its seminars is called “Teaching and Learning in the Inclusive Classroom.” Among the topics included are connecting with students with disabilities, being a member of an underrep-



resented group in the discipline, speaking from a position of privilege in the classroom, dealing with sensitive topics, and the burden of trying to represent all members of an ethnic group.

Several institutions with large enrollments of students from underrepresented groups are members of PFF clusters. Visits to these institutions help PFF students to understand a variety of institutional missions, curricular issues, and approaches to teaching and learning. Partnering with these institutions can also serve as a source of recruits to graduate study in science and mathematics. For example, Virginia State University, an historically Black university, partners with the PFF mathematics program at Virginia Tech. Adams State College and the Community College of Denver, both of which serve large numbers of Hispanic students, partner with the University of Colorado at Boulder physics program. Howard University, a historically Black university, is a lead university in physics that partners with Bowie State University, another historically Black institution.

Informal Student Activities

At Queens College, PFF students in chemistry organized a student-only regular weekly meeting, informally known as “Happy Hour.” These Happy Hour meetings became informal forums to discuss research, teaching experiences, job hunting, thesis problems, social aspects of graduate school, and a number of other relevant topics. The students developed closer collegial relationships with each other as they shared their experiences and ideas.


Unexpectedly, they benefited from these conversations so much that experienced doctoral students came to serve as mentors to the more junior doctoral students.

The University of Michigan's chemistry department created a number of educational projects that were pursued by small groups of graduate students and faculty members interested in the scholarship of teaching and learning. In addition to producing significant educational products, individuals learned from each other through their informal interaction. Brett Duersch, a graduate student, observed that PFF offered a "richer" experience with increased communication and support among graduate students.

Activities and Resources through the Disciplinary Societies

The disciplinary societies, via their regional and national meetings, provide a forum for bringing educational issues in the discipline to the attention of faculty from all types of institutions. They provide a means for networking and professionalization that can and should start with graduate students and continue throughout all stages of the academic career.

The societies encouraged PFF students to actively participate in disciplinary conferences. Several of these students expressed surprise that by doing so, they gained valuable insight into effective methods for teaching in their discipline. The idea that groups of mathematicians, for example, could work together to develop and refine a pedagogically sound way to teach a course in calculus was a surprise to graduate students who had the impression that teaching was a solitary activity. PFF participants in mathematics at the University of Washington had a similar experience when they attended a local conference on the teaching of linear algebra. They also were enthusiastic about the opportunity to interact with several attendees, especially community college faculty members, because those faculty were innovative in teaching mathematics to a broad range of students.



The American Association of Physics Teachers (AAPT) reports that PFF programs help departments take seriously the importance and relevance of physics education research to the discipline. Further, the idea of seamless education from kindergarten through the baccalaureate degree is becoming part of the vocabulary of physics educators as well as of the education community in general. AAPT disseminates information about new approaches and developments in physics education through its two publications, *The Physics Teacher* magazine and *The American Journal of Physics*. In addition, the association hosts two annual meetings where workshops and presentations focus on issues of pedagogy and course content. Preparing Future Physics Faculty programs complement AAPT's vision of the future of physics education, as well as the society's other programs for the preparation of elementary and secondary teachers, the New Physics and Astronomy Faculty Workshops, and efforts focused on the revitalization of undergraduate physics.

The American Chemical Society (ACS) supports a strong program in chemical education and has a tradition of offering graduate students opportunities to develop their professional skills through presentations at meetings, which also serve as a forum for establishing contacts with individuals who will be professional colleagues. ACS views the PFF program as a logical extension of existing professional development efforts sponsored by the Society, including: The new Office of Graduate

The idea of seamless education from kindergarten through the baccalaureate degree is becoming part of the vocabulary of physics educators as well as of the education community in general.

Education (see www.acs.org/education/gradededucation.html), the *Journal of Chemical Education*, the world's premier chemical education journal (see jchemed.chem.wisc.edu/AboutJCE/index.html), and the department of career services (see Chemistry.org/portal/Chemistry?PID=acsdisplay.html and DOC=education\student\career.html).

The American Mathematical Society (AMS) and the Mathematical Association of America (MAA) have recognized the importance of sharing effective approaches to teaching and learning in undergraduate mathematics courses primarily through their meetings, workshops, and Web sites. Their meetings provide a fertile environment for reinforcing the importance of incorporating modern teaching and learning concepts. PFF programs strengthen these approaches by encouraging early, active involvement of doctoral students in association activities. Among the professional development activities organized and supported by MAA are a calendar of professional development opportunities for faculty and graduate student members, pilot programs such as the Teaching Future Teachers Pilot Workshop held after the 2002 annual meeting, workshops on grant writing, access to a teaching assistant handbook, and guidelines for programs and departments in undergraduate mathematics. MAA also maintains a teaching and learning section on its Web site (www/maa.org) that provides articles about teaching mathematics. It includes information about the MAA special interest group on research in undergraduate mathematics education, as well as Project NExT: New Experiences in Teaching, the MAA program for new faculty members interested in the teaching and learning of undergraduate mathematics.

The Association for Computing Machinery's (ACM) Special Interest Group on Computer Science Education (SIGCSE) holds an annual technical symposium to discuss education-related issues. The 2001 meeting included

the session “The Nuts and Bolts of Academic Careers: A Primer for Students and Beginning Faculty.” Participants addressed faculty work issues, different types of institutions and idiosyncrasies of institutions within types, and orientation for new faculty members. This session was followed by an informal Birds-of-a-Feather discussion led by current Ph.D. candidates in computer science. Also of interest at this meeting was a panel discussion on pedagogical techniques. *ACM Crossroads*, the association’s electronic magazine for students, includes links to mentoring and internship opportunities, as well as articles on career development and discipline-specific topics (see www.acm.org/crossroads/resources/career.html).

Although the content among PFF programs varies from institution to institution, the kinds of program activities described in this chapter are quite common. One of the strengths of PFF is its flexibility, which allows each program to adapt to the needs of students, faculty, and the challenges of a particular discipline.