

The Senior Scientist as a Resource for Mentoring Undergraduate Research

Ben Plummer
Professor Emeritus of Chemistry
Trinity University

The Camille and Henry Dreyfus Foundation created a new grant program in the chemical sciences in 1999 called the Senior Scientist Mentors. The philosophy of the program focuses on using the experience and dedication of emeritus professors who have developed a long history of directing undergraduate research in chemistry. The Foundation believes that these people are a valuable resource who can encourage undergraduates to become excited about chemistry. Early involvement of students in undergraduate research allows students to see how the chemical enterprise really works. Students are then better prepared to make the important decision about making the study of chemistry their career goals. Some student participants will find that their interests are incompatible with the subject; others will find that they can pursue a rewarding career in medical research; and many will find a new enthusiasm for studying chemistry.

A faculty member with emeritus status on or before July 1, 2001 who maintains an active research program in the chemical sciences may apply for the award. Successful applicants will be granted \$20,000 for a two-year period to mentor undergraduates at the scientist's home institution. The deadline for receipt of all materials at the Foundation is August 31, 2001. The money is to be used to pay stipends to students and to buy supplies that are needed by the students during their research collaboration. No remuneration for the mentor is allowed. An award of \$10,000 annually is made with the requirement that a satisfactory progress report be submitted after the first year that justifies continuation of the award for a second year. The program is not limited to summer collaborations. One of my students who participated last summer continued her research effort throughout the following academic year without a stipend. Whether or not a student is paid a stipend during the academic year would depend upon local departmental and university policies. However, the funds are available to purchase supplies throughout the entire period of the grant. In the first year of the program, 18 faculty at research universities, and a few undergraduate institutions were chosen by the Foundation to be mentors. It currently solicits applications for the third year of the program. Awards typically are made before the spring semester after evaluation of applicants during the fall. Details about proposal requirements and conditions can be found on the website www.dreyfus.org.

It was my good fortune to have taken an early retirement from Trinity University in 1999 and to find that I was eligible to apply during the first year of the new program. My department chair supported my application for the award. She was instrumental in getting the University to maintain my access to necessary office equipment and undertake another summer of research with students. I was excited by the prospect of continuing my research collaborations with undergraduates. With the aid of our laboratory manager we began the summer program with a minimum of logistical strife.

Each spring semester the department encourages students formally to make a written application to perform summer research. Notices are posted in the department and students are given notices in their chemistry courses. Our department has a standard form that all students fill out. On the bottom of this form is a place for signatures of faculty members whom the student has contacted. All faculty participants make a brief presentation about their research interests at a meeting that student applicants are expected to attend. After this meeting students are then encouraged to visit with individual faculty members to discuss in more detail potential collaborations. After the student-faculty interviews, students and their interests are matched with faculty mentors in the department. Last year two first year students participated in summer research with me. This summer (2001) five students pursued research projects. My approach is to train novice students with reactions of a model compound that is commercially available. First year students in the research group are taught specific techniques that they have seen only briefly or not at all. Once they have mastered these techniques we then focus on specific objectives that we need to accomplish to achieve potentially publishable data.

From past experience, I know that students beginning a career in chemical research have a very limited knowledge base from which to draw inferences about physical properties of organic substances. For example, a particular reagent that we needed had undergone some decomposition to become a dark brown-black liquid. Inexperienced students observing a bottle of this material do not necessarily question its appearance. After all, tires

Dr. Ben Plummer, Ann Hilton and Erik Bullock in front of the 400 MHz nuclear magnetic resonance instrument at Trinity University.



are organic and they are black! So students have to be taught that substances that are this color are generally impure and must be purified before use. They are then amazed that from this tarry substance a pale yellow or colorless substance can be obtained by the appropriate technique. Thus these simple laboratory experiences enlarge the knowledge base and techniques for these participants beyond those encountered in a standard laboratory course. Critical thinking is continually emphasized as the students pursue various goals. I constantly challenge students to explain to me why they made a mistake and we mutually arrive at solutions for avoiding similar mistakes in the future.

Most students progress rapidly in developing appropriate techniques such that they perform sophisticated experiments by early summer. Students can achieve positive results as is illustrated by a recent publication.¹ Faculty colleagues benefit from the work of the senior mentor because the mentor develops in the students skills that can be of benefit to colleagues in future research collaborations. Similarly, the mentor is available for consultation with other students and faculty colleagues while the mentor is in residence.

Each student is given a brief handbook of requirements for laboratory work and record keeping that I have written. Among the issues that I address is the one concerning publication of original research. I impress in the narrative in strong terms the necessity for keeping excellent notebook records and for working hard to achieve good results because the ability to fund the effort of subsequent generations of students depends on publishing the research that each student accomplishes. I also emphasize that in pursuing original research, we attempt to move our science incrementally forward with new discoveries.

As an additional learning experience, we have a group meeting once a week during the summer. Each student is assigned a journal paper to present followed by a question and answer period. This gives the students experience in oral presentation and in answering questions while addressing an audience. This seminar format prepares them for an oral presentation with appropriate media to all faculty and students, who number about 40 at the end of the summer projects. At the end of the summer, each student must write a report in appropriate journal style that describes the project. The mentor can then write a professional manuscript based upon these reports.

I hope that this article will encourage other undergraduate universities in similar circumstances to use the experience of emeritus professors offered by the Camille and Henry Dreyfus Foundation. I believe that a majority of emeritus professors continue to be vitally interested in their professions and would welcome the chance to participate in the development of a new generation of young scholars. Perhaps colleagues in other disciplines can approach other funding agencies and ask them to consider a program similar to the one described here.

My collaborations with undergraduates have led to published articles that were funded by the Welch Foundation, The Petroleum Research Fund, The Camille and Henry Dreyfus Foundation, and the National Science Foundation. We are eternally grateful to these organizations for their foresight in supporting our research efforts. As I observe the successful academic, professional, and medical careers of former students, I know that the game was worth the candle. And the excitement that continues to stimulate me about my discipline is carried in the collective memories of the hundreds of students who traveled through my research laboratory.

— Ben Plummer, emeritus professor of chemistry, received his B. S. in chemistry from Iowa State University in Ames and his Ph. D. from The Ohio State University in Columbus. He was department chair from 1976-1980 at Trinity University, a program officer in Chemical Dynamics at NSF from 1993-1994 and he received a Camille and Henry Dreyfus Teacher/Scholar Award in 1991-1993. He was one of the early CUR councilors. He is currently a Senior Scientist Mentor.

Reference

1. Plummer, B. F., Moore, M.J.B., and Wright, J. (2000) The Photochemical Dimerization of Acephenanthrylene and the Heavy Atom Effect, *J. Org. Chem.* 65, 450-452.

research responsibility: a theme for mentoring undergraduates