

The Mentoring Role in Undergraduate Research Projects

Mitchell Malachowski

Introduction—

A great deal is written in this journal and others detailing the characteristics of successful research programs at PUIs. The Council on Undergraduate Research's message is that research which actively involves undergraduates achieves a number of benefits for faculty including: keeping them intellectually vigorous, allowing them to make contributions to their field, and enhancing the quality of their teaching. In addition, students receive many benefits, including a realistic understanding of the discipline, experience in actually performing chemistry rather than just reading about it, and an opportunity to experience first-hand the thrills of success and the frustrations of failure.

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Much of the discussion of undergraduate research focuses on the outcomes of a successful program from the perspective of the student. For example, West (1994) describes the experience and preparation for life beyond the baccalaureate degree that students gain. Doyle (1996) also describes many of the attributes of a successful program, and comments on the importance of research for undergraduates. For those who have been involved extensively with undergraduates, it is clear that the relationship between the research advisor and the student encompasses much more than simply generating and analyzing experimental data, and may indeed extend well beyond the scope of the research project itself. Students often rely on their research advisors for

academic advice, information on careers and graduate or professional schools, personal assistance, and often simply for encouragement and moral support. It is as if two separate but related conversations are occurring concurrently; one pertaining to the research project itself, and one about the student's life and personal development. In this way, faculty often serve as both research directors and as mentors.

In his influential work, *College, the Undergraduate Experience in America*, Ernest Boyer (1987) calls for institutions to support faculty who are both mentors and scholars. Since there are few activities which engage faculty with students at a greater level than undergraduate research, and few that rely as much on a mentoring relationship, these projects seem to be the ideal vehicle for melding scholarship and mentoring activities. Indeed, the case can be made that the faculty advisor's most important function is to foster the growth and development of students involved in these projects. Therefore, the success of a project extends far beyond the research produced, and is often as much about relationships as it is about scientific findings.

If the goals of research projects are more than simply the challenges of generating results, then how can they be structured to include the significant mentoring component? What characterizes the mentoring aspect of undergraduate research activities and the many forms that this role can assume?

The Importance of Mentoring—

There are a variety of roles that a research director fulfills in order to run a successful research program. These include acting as a co-worker, manager, supervisor, role model and mentor. There are major differences among these roles, but a successful program will probably include all of them. The most comprehensive of a research advisor's tasks is to act as a mentor, and this is the role which will potentially have the longest-lasting impact. What exactly, then, does it mean to be a mentor? Mentoring involves a one-to-one relationship

in which the mentor encourages and guides the student's personal growth and academic development, while providing support and assistance as the student works through the challenges of undergraduate life. Mentoring is a concept that has been with us for centuries. The very term mentor is derived from *The Odyssey*, in which Homer describes Ulysses' choosing of his trusted friend, Mentor, to look after his son, Telemachus, as Ulysses begins his ten-year journey. Since Mentor gave Telemachus counsel and cared for and protected him, these attributes have become central to our modern interpretations of the term.

Alexander Astin (1993), at UCLA, has conducted extensive longitudinal studies of students and student learning, and has shown that the two most important factors in student development, satisfaction, and cognitive development are the students' peer groups and the quality and quantity of their interactions with faculty outside the classroom. It is clear from his work that the characteristics and behaviors of the faculty have widespread and important implications for student development. The extent to which the faculty at a given university are "Student-Oriented" is positively correlated with almost all measures of affective and cognitive development and outcomes (e.g., retention, enrollment in graduate or professional schools, test scores, critical thinking skills, problem solving skills, leadership, social activism, development of a philosophy of life). There is no activity that I am aware of that places students and faculty together in a more optimal situation to foster this type of development than a research project with a heavy mentoring component.

Attributes of Mentors—

I believe that, just as the content of projects should be geared to individual students, the relationship between the professor and the student should be tailored to individuals. However, even though each project has a life of its own, there are certain traits and approaches that are common to any high quality mentoring experience. What makes a faculty advisor a good mentor, and how are mentors perceived by students? Cronan-Hillix et al.'s study (1986) of the effects of mentoring on a group of psychology graduate students showed that the most important attributes of a good mentor are interest and support, positive personality characteristics (e.g., humor, honesty, dedication, empathy, compassion, patience, objectivity, flexibility), knowledge, and competence. Good mentors are sharing, giving, and non exploitative; they also have positive attitudes toward students. Negative characteristics included such

things as rigidity, egocentricity, disorganization, overextendedness, uninterested/unsupportive or exploitative attitudes towards students, and inaccessibility. Displaying all of the positive attributes, and running a research program can be challenging, but the benefits can be enormous when the nature of the mentor fulfills the expectations of mentees.

Stages of Mentoring—

Mentoring can be viewed either from the nature of the relationship between the mentor and the mentee, or from the outcomes that one hopes will result from the relationship. Just as it is possible to delineate some of the traits common to successful mentoring, it is also possible to outline the various stages that mentoring relationships typically undergo. During the first stage, the initiation stage, the relationship is driven primarily by the mentor. For instance, research advisors may seek out students for involvement in their projects, provide guidance in the early stages of project planning, and teach students how to use equipment and instrumentation. The mentor may also give presentations to the students detailing the background for the work and the goals of the project. At this stage in the relationship, the advisor may be seen as a role model more than as a mentor. Also at this stage, the mentoring tasks may include building trust, expressing commitment, and setting limits and expectations for the mentee.

Once the relationship is established, the second stage, or cultivation stage, involves greater and more equal interaction between the mentor and the mentee, with information exchanged more freely. There is also more explicit setting of goals at this point. Since the mentor and mentee share a number of experiences, more interpersonal communication and empathy are exhibited during this stage. Advice is offered, and the mentee is encouraged to think of the project as his or her own. The student may also present work orally to others in the group, or to the mentor, and write periodic progress reports on the research project.

In the next stage, the transformation stage, the mentee begins to develop greater autonomy and requires less guidance. By this time, decision-making and goal-setting skills have developed to the point where the mentor may be acting primarily as a supervisor for the project by giving feedback to the student. The student may suggest changes in existing protocols, propose additional experiments to be done, or interpret results and data for him or herself. In these respects, the student has now become a collaborator on the project. Additionally, the student may be writing

student research grant applications or planning presentations for conferences at this stage.

Finally, in the separation stage, the mentee works even more autonomously, and the mentor embraces more of the student's decisions and relies on the mentee for taking over the project. It is even possible for students to go off onto new projects and ideas of their own undertaking. The mentee may now be serving as a mentor to other students and the cycle may begin again. It should be noted that throughout this scenario, there is not usually a linear progression from one stage to another, but rather progress is made in fits and leaps.

Role Models vs. Mentors—

A distinction needs to be made between a role model and a mentor. A role model is one who offers a concrete image of who an observer could become if the role model were emulated. Studies show that students involved in their education typically choose one or more role models whose lifestyles and values they admire. Students learn how to set priorities, interact with people more effectively, communicate better with others, and learn more self-confidence through observing a role model. Students generally have little difficulty identifying a role model who has demonstrated the kinds of commitments, skills, and qualities they see as important for themselves. A research advisor often serves this role. However, one can be a role model without having direct contact with the student, and in this regard it is a less active type of relationship than that described for mentors. Certainly, many students use classroom instructors as role models even though the extent of a student's engagement with the professor may not extend beyond the classroom.

As a research advisor, it is possible to be both a role model and a mentor. One direct way is to work alongside a student in the laboratory and allow him or her to observe good laboratory technique and approaches to problem solving. It is also obvious that students observe their advisors' work habits, job approaches and interaction with faculty colleagues, as well as other students and staff. Certainly they are learning a great deal about shaping their own outlooks from these observations; however, mentoring relationships typically lead to greater personal growth and development than the simple emulation of a role model.

Outcomes of Mentoring—

Along with analyzing the nature of the relationship between mentor and mentee, one can focus on the

outcomes that might result from such a relationship. Reilly (1992) has compiled the results of numerous research studies, and has listed ways that mentoring relationships have affected and benefitted students. Benefits include honed thinking skills, enhanced creativity, increased self-esteem, improved skills

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within the discipline, more clearly defined career options, connections between school and a profession, increased motivation to learn, a matured sense of responsibility and direction, and inspiration. Although these studies were not specific to undergraduate research experiences, presumably many of these outcomes would also be the result of mentoring in research projects.

In addition, Noller (1982) has described twelve attributes that a mentor should try to impart to mentees: a positive attitude, value searching, open-mindedness, interrelations, creative problem-solving, effective communication, discovery, strengths and uniqueness, confidence, awareness, risk-taking, and flexibility.

Mentoring research students has much in common with another expectation of faculty at PUI's, that of academic advising. Since both of these are developmentally oriented activities, the similarities between the two are striking. As described in Gordon (1988), the most important developmental tasks of college-age students can be described by Chickering's seven vectors. The three vectors key to a discussion of mentoring consist of the following:

- Developing competence so that increased intellectual, physical and social skills lead to a sense of confidence that one is capable of handling and mastering a range of tasks.
- Developing autonomy so that a series of issues which ultimately lead to the recognition of one's independence is confronted.
- Developing purpose so that a student assesses and clarifies interests, educational and career options, and lifestyle preferences, and integrates these factors in setting a coherent life direction.

Certainly these developmental outcomes are fostered in the lab when students engage in research


projects. Astin's studies on students involved in undergraduate research projects have shown just such changes, and constitute compelling evidence for the importance of mentoring activities.

Benefits to the Mentor—

Another important feature of mentoring is the impact it has on the mentor. In fact, according to Zey (1984), the career benefits to the mentor from the relationship may be as striking as the benefits that accrue to the protege. There is a vicarious pleasure associated with facilitating another's accomplishments; since mentoring another person provides an opportunity to pass along knowledge, skills, attitudes, and values, it can satisfy a mentor's internal need to contribute (Erikson, 1980). Along with the satisfaction of this psychological need, mentors often experience renewed enthusiasm and reevaluate the meaning of their work as a result of the ideas of a mentee. In addition, a student can help a mentor do his/her job since (s)he is often essential to the progress occurring in research.

Many friendships also are started and maintained as a result of research experiences. Some of the students with whom I remain in closest contact are those who worked in my lab. In addition, many of the collaborations I have undertaken have been with these students.

Conclusions—

Mentoring relationships that are a part of undergraduate research experiences can have powerful impacts on both mentees and mentors. Recently, Barr and Tagg (1995) have discussed an emerging new paradigm in education, the learning paradigm, that is supplanting the outdated instruction paradigm. While the goal of the instructional paradigm is the transferal of knowledge, the goals of the learning paradigm include creating environments and experiences that help students to discover and construct knowledge for themselves, and making students members of communities of learners. Most importantly, colleges should aim to create a series of ever more powerful learning environments. In doing so, the goal becomes to improve the quality of learning for students. Undergraduate research experiences where faculty members engage students in important projects, and which include committed mentoring components, may be the best models of this learning paradigm that currently exists. 

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