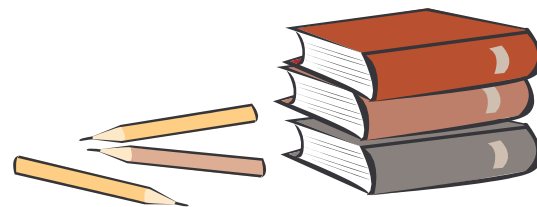


PROFESSIONAL SKILLS

The Merits of Training Mentors

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Good mentoring can be learned.

In research universities and colleges, mentoring is one of the most important skills for faculty because it affects both research productivity and the quality of training for undergraduate students, graduate students, and postdoctoral researchers. Moreover, the diversity of science is dependent on the quality of mentored research, because this experience is a key to

attracting underrepresented groups to science (1–5). In the past, many faculty learned skills such as mentoring on

the job. In recent years, various organizations have developed training programs to help prospective and new faculty learn skills such as grant writing, laboratory management, and classroom teaching, but mentoring has been largely absent. In response to this need, we developed and evaluated a mentor-training seminar. The seminar is intended to improve mentors' skills and to enhance the research experiences of undergraduate students.

In research universities, graduate students and postdoctoral researchers often serve as the primary mentors for undergraduate researchers (see photograph, this page). This arrangement provides undergraduates with guidance from a person who is accessible and whose primary focus is laboratory work. It also provides graduate students and postdoctoral researchers with experience as mentors. Therefore, our seminar focused on training graduate students and postdoctoral researchers as mentors, but it is also suitable for developing mentoring skills of faculty.

The Wisconsin Mentoring Seminar

The Wisconsin Mentoring Seminar was developed using an iterative approach of design, testing, evaluation, and revision. The seminar (table S1) reflects participation of eight cohorts of mentors led by four facilitators at the University of Wisconsin–Madison (6). This version of the seminar has since been implemented and evaluated at 11 research universities including UW-

Madison. The objectives of the Wisconsin Mentoring Seminar are to train mentors to communicate effectively, to consider issues of human diversity, to discuss mentoring approaches, and to apply a “scientific teaching” approach to mentoring (7). The seminar consists of eight sessions of discussion facilitated by faculty or staff using a collaborative, problem-solving format. The participants read articles and case studies, write biographies of their undergraduate students, compare their goals with those of their undergraduate researchers, explore time-management strategies, and write mentoring philosophies.

Communication skills are addressed with the use of exercises that include interviews with their undergraduate researchers. The aim is to help the mentors to recognize and reconcile differing expectations about time commitment, independence, and skill proficiency. Mentors learn the value of discussing mentoring issues with peers and faculty through discussion in the seminar itself and discussions they are required to initiate with their research advisers.

The mentors discuss the value of and accommodations for diversity in the laboratory. Consideration of how their own work habits, cognitive styles, attitudes, gender, ethnicity, physical ability, educational background, and nationality differ from that of their mentees complements readings of research on stereotypes and unconscious prejudices. The group brainstorms about approaches to overcoming cultural biases.

The mentors are encouraged to approach teaching with the same rigor and spirit of experimentation that they bring to research (7). They develop their own systematic approaches by identifying objectives and approaches to overcome associated impediments. They evaluate their approaches through feedback from their undergraduate researchers, peers in the laboratory, and research advisers.

Mentors design strategies to help undergraduates become outstanding experimental-

ists and to develop confidence, creativity, and independence. In addition to discussing their own scientific and ethical standards and effective ways to transmit those standards to their students, the mentors grapple with the challenge of reconciling high standards with flexibility and personal style.

Implementation and Evaluation

Over the past 2½ years, the mentoring seminar has been run 22 times at 11 institutions. To evaluate the impact of the seminar, we gathered data about mentors who either did or did not participate in the seminar and the undergraduate researchers under their supervision at UW-Madison. Although we were unable to conduct a randomized experiment, we reduced the impact of self-selection by using as the untrained comparison group entire cohorts of mentors who were not offered the opportunity to participate in the mentoring seminar and compared

them with cohorts in which all members were required to participate. Five of the seminars were conducted concurrently with summer undergraduate research programs. Three of the mentoring seminars at UW-Madison were offered in conjunction with a semester-long program in which research laboratory experience partially replaced an introductory biology laboratory course requirement. From these cohorts, we surveyed 85 mentors and 84 undergraduate researchers. In addition, we interviewed 10 undergraduate researchers and 11 graduate students and postdoctoral mentors about their experiences. We have since surveyed trained mentors and the facilitators of the mentoring seminar from 11 institutions. The surveys used in this study are available (6).

Graduate students, postdoctoral researchers, and research scientists served as the primary mentors, and each seminar was facilitated by a faculty or staff member. The facilitator was provided with a manual, “*Entering Mentoring*,”



Mentoring in microbiology. Graduate student Courtney Robinson (left) participated in the Wisconsin Mentoring Seminar while she mentored undergraduate researcher Yolied Ramos at the University of Wisconsin–Madison.

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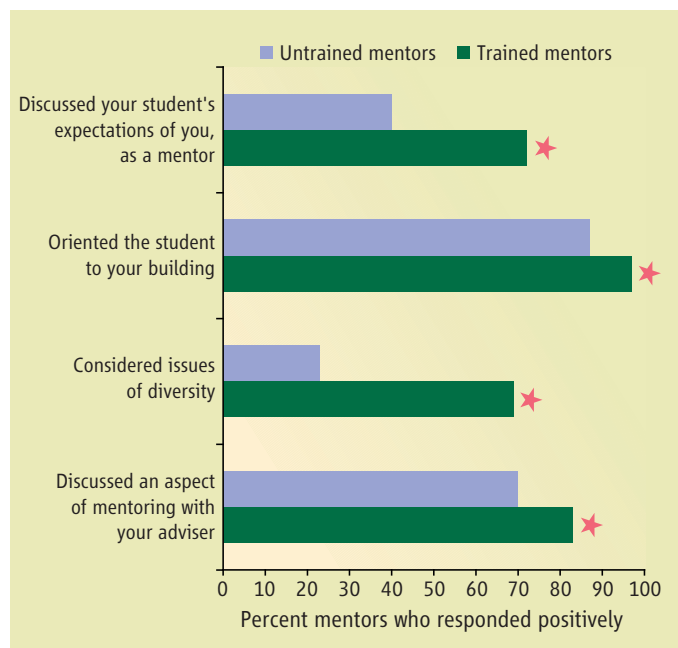
that contains reading material and detailed instructions for facilitating the seminar (6). All of the respondent facilitators found “*Entering Mentoring*” useful and interesting (table S2).

Surveys of 12 facilitators of the mentoring seminar from nine institutions indicated that all considered facilitating the seminar to be a positive experience that they would recommend to a colleague (table S3). Most (64%) indicated that their own philosophy of mentoring changed as a result of facilitating the seminar. Several facilitators said they were more aware of their students’ needs and had more ideas about how to address these needs. One professor commented, “The mentors empowered me to be more bold in my own mentoring.”

Our results indicate that the mentoring seminar was successful in achieving the set objectives: Mentors who participated in the seminar (“trained mentors”) were significantly more likely to discuss expectations with their undergraduate researchers, to consider issues of diversity, and to discuss mentoring with peers and faculty than were those who did not participate in the seminar (“untrained mentors”) (see graph, this page). The mentors trained at UW-Madison and eight other research universities self-reported gains in a number of areas (table S4, A and B), and 87% said they would recommend the seminar to their peers. Mentors reported satisfaction with each of the discussion topics in the mentoring seminar, as shown in table S5. In addition, when mentors reflected on their mentoring after the training, they noted their intentions to work harder in future mentoring in many of the areas covered in the training, including setting clear expectations, regularly assessing their student’s understanding, fostering independence, and asking colleagues for advice when confronted with a challenge in mentoring. Such insights about their mentoring were also reflected in their mentoring philosophies (table S6).

The mentoring seminar favorably influenced the undergraduate research experience. Students who had been previously mentored were asked to compare their experiences, and they consistently reported that mentors who participated in the seminar were more available to them, were more interested in them as individuals, and gave them more independence.

In the quantitative analysis, we found no significant difference between responses from undergraduates whose mentors did or did not participate in the mentoring seminar, in part because the undergraduate researchers had positive experiences regardless of the status of their mentor. Our results confirm published



Behaviors of trained and untrained mentors. Percentage of mentors who indicated that they engaged in the noted activity while mentoring an undergraduate researcher. Stars indicate that the difference between the trained and untrained mentors was significant ($P < 0.05$).

studies to this effect (1, 2), showing self-reported gains in 19 categories, with the greatest gains in “developing a research project” and “working independently on research” (table S7A).

Comparison of how undergraduates themselves and their trained or untrained mentors assessed the progress of the undergraduates (table S7, A and B) shows that trained mentors’ assessments more closely matched the undergraduates’ self-assessments (table S7C). Undergraduates working with trained mentors were more likely to agree with the statement that their mentor “regularly assessed the skills and knowledge that they had gained in the lab” ($P < 0.05$). We conclude that the seminar enhanced the ability of the mentors to assess the skills of their students and likely enhanced the accuracy of the undergraduate students’ assessment of their own skills. Because alignment of mentee and mentor skill ratings is an important measure of the validity of self-reported data (3), mentor training may have the unexpected benefit of increasing the reliability of assessments based on self-reporting, which are often used to evaluate undergraduate research programs.

At the conclusion of the summer programs at UW-Madison, 80% of the mentors who participated and none of those who had not participated in the mentoring seminar said that their view of their own adviser was altered by the summer mentoring experience (table S8), enhancing the mentors’ understanding of their advisers’ mentoring strategies and their empathy for the challenges faced by advisers.

Conclusion

We developed a seminar on mentoring that fills a critical gap in graduate education and training of future faculty. Evaluation of the seminar suggests that it is an effective means of improving communication and evaluation skills that are essential to good mentoring.

Mentoring relationships between faculty and students are often cited as critical in the decisions of undergraduates to pursue graduate education, but the effective elements of those relationships are not clear (4, 8–10). In our study, undergraduate researchers who compared experiences with trained and untrained mentors stressed communication as a key feature of good mentoring.

The mentored research experience represents an intersection of many aspects of research and education in our research universities, offering an opportunity for generating multiple effects with a single intervention. The most direct effect is an improvement in the quality of the undergraduate research experience,

which has been shown to be pivotal in attracting students in general, but especially racial minorities, to science (1–5). But we anticipate other effects, including an improved quality of undergraduate research, resulting in greater faculty satisfaction and perhaps a greater willingness to host undergraduate researchers. Training graduate students and postdoctoral researchers in mentoring might also produce a new generation of scientists who enter the professoriate as skilled mentors. The minimal resources required to teach this seminar seem worth investing to achieve these diverse outcomes.

References and Notes

1. Reviewed in E. Seymour et al., *Sci. Educ.* **88**, 493 (2004).
2. D. Lopatto, *Cell Biol. Educ.* **3**, 270 (2004).
3. C. M. Kardash, *J. Educ. Psychol.* **92**, 191 (2000).
4. R. S. Hathaway, B. A. Nagda, S. R. Gregerman, *J. Coll. Stud. Dev.* **43**, 614 (2002).
5. B. A. Nagda et al., *Rev. Higher Educ.* **22**, 55 (1998).
6. J. Handelsman, C. Pfund, S. M. Lauffer, C. Pribbenow, *Entering Mentoring: A Seminar to Train a New Generation of Scientists* (Univ. of Wisconsin Press, Madison, 2005).
7. J. Handelsman et al., *Science* **304**, 521 (2004).
8. A. W. Astin, *What Matters in College? Four Critical Years Revisited* (Jossey-Bass, San Francisco, 1993).
9. E. T. Pascarella, P. T. Terezini, *How College Affects Students* (Jossey-Bass, San Francisco, 1991).
10. J. C. Hearn, *Res. Higher Educ.* **27**, 119 (1987).
11. We thank J. Heitz and the Biology 152 staff and the undergraduate researchers, mentors, and faculty who participated in this program. Supported by the University of Wisconsin–Madison and the Howard Hughes Medical Institute through a grant to J.H. from the Howard Hughes Medical Institute Professors Program. J.B. was supported by NSF grant no. 0402549.

Supporting Online Material

www.sciencemag.org/cgi/content/full/311/5760/473/DC1
10.1126/science.1123806