Ten Time-Saving Tips for Undergraduate Research Mentors

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ABSTRACT

Undergraduate research experiences can be extremely valuable for students, but can also be very time-consuming for mentors. A series of surveys were administered to plant biologists during the last 4 years to understand the perspectives of mentors on training undergraduate and high school student researchers. The survey responses provided a wealth of ideas about how to save time and increase lab productivity while training student researchers. We have synthesized the practical advice from more than 900 survey responses to suggest the following 10 tips for undergraduate research mentors: design a simple project with clear goals, provide hands-on supervision, ensure good communication and explanations, involve students early, sign a student-mentor contract, maintain well-written protocols, establish student research communities, capitalize on inexperience, create a template file for student posters, and increase retention.

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Student research is a vital part of the infrastructure of science. Research training efforts in plant biology are especially important now because plants are central to unprecedented 21st century challenges such as world food supply, agroterrorism, environmental protection, and genetic modification. In addition, funding agencies such as the National Science Foundation (NSF) have sought to expand student research opportunities and consider "integration of research and education" when reviewing research grants (NSF, 2004).

A series of surveys were administered to the American Society of Plant Biologists during the last 4 years to understand the perspective of mentors on training undergraduate and high school student researchers. Most comments regarding disincentives for mentoring student researchers dealt with one central issue—time. Concerns about time include the overall time spent by mentors on each student, the (short) time young researchers have available to work in the lab, the frustration of watching students graduate soon after a lot of time has been spent training them, and the disadvantages of training young researchers who may produce little publishable data relative to the effort spent training them (Coker and Davies, 2002).

Time-efficient training techniques that maximize lab productivity allow mentors to overcome time-related disincentives. Because lab productivity and student research success are interrelated, many training practices that increase lab productivity will also improve teaching and learning. The following is a synthesis of ideas (from more than 900 survey responses) for saving time and increasing lab productivity while training student researchers.

The ideas are presented in order of how often they were mentioned by survey respondents. Nevertheless, the ideas themselves are more important than the rankings. Because respondents were answering open-ended questions and were not asked to rank the importance of each idea, the rankings should not be considered statistically significant. More information about the survey instruments is available at http://facstaff.elon.edu/jcoker/ASPBSurveys.htm (verified 1 May 2006).

1. Design a simple project with clear goals.

Nearly 40% of mentors' comments regarding effective mentoring mentioned project design. Mentors associated successful student project designs with (i) being well structured, (ii) being achievable in a short amount of time, (iii) using techniques common to the lab, and (iv) using a single technique. Many respondents emphasized carving out niches for students that would be valuable contributions to a lab's overall work, but are reasonable in terms of what an undergraduate can accomplish.

2. Provide hands-on supervision.

Mentors who have experienced success with student researchers usually agreed that there is no substitute for hands-on training, especially at the beginning of a student's project. Just pointing a novice student researcher into a laboratory without direct, hands-on supervision often results in failure. This can be frustrating for students and mentors, and decreases lab productivity significantly. Although it occupies a mentor's time in the short-term, working alongside students in the lab will save time in the long run due to increased performance and retention.

3. Ensure good communication and explanations.

Good communication is fundamental in the teaching–learning process. Mentors emphasized explaining the theory, background, and context for labora-

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J. Nat. Resour. Life Sci. Educ. 35:110–112 (2006).
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http://www.JNRLSE.org

tory activities. Providing clear instruction and being accessible to listen and answer questions were also mentioned frequently.

4. Involve students early.

Many mentors expressed frustrations in training students, only to watch them graduate. A common opinion was that research programs designed to train students late in their career at an institution often run inefficiently. However, a few mentors perceive that their jobs will be easier if they recruit advanced students with a greater theoretical background. It often takes just as long to teach research techniques to college juniors and seniors as it does to freshmen. An early start gives students a chance to learn basic techniques while simultaneously learning the theory behind them in their coursework. Later, these students can be very productive and help to teach younger students. In the long term, recruiting freshmen will lead to greater lab productivity than working solely with juniors and seniors who will soon leave. A number of other authors recommend getting students involved in research as soon as possible, and not waiting until they have received "more classroom training" (Boyer Commission, 1998; Fortenberry, 1998).

5. Sign a student–mentor contract.

Some mentors have found it beneficial to discuss and sign a formal student–mentor "contract" before research begins. A contract could include expectations of the student and the mentor, objectives, procedures, costs, schedules, additional projects (literature review, report, etc.), deadlines, and/or grading criteria (Beer, 1995). By drafting and signing it together, expectations for students and supervisors are clearly stated so that future disappointments can be more easily avoided.

6. Maintain well-written protocols for all standard lab equipment/techniques.

Very few people will remember every detail of a protocol after being led through it only once. Therefore, to save time, it is extremely helpful for students to have written protocols to help guide them. These may be standard commercial protocols from kits or notes, which the students take themselves. Nevertheless, to ensure accuracy and consistency, it is often preferable to have a set of protocols written specifically for a particular lab. These might include details such as where equipment is located and troubleshooting tips. A complete set of protocols may be kept in the lab and given to students on their first day.

7. Establish student research "communities."

Research mentors who reported time difficulties often alluded to training one student at a time. A number of other respondents find that training several students at once is more efficient in terms of time and generating tangible research products. Establishing small groups (2–4) of students to perform a research project, or parts of a larger research project, can be very effective. The team approach can build teamwork skills, improve quality, allow for peer teaching, and prevent individuals from feeling alone and isolated in a lab full of older scientists. We are all social creatures, but social interactions are especially high on the priority list of typical undergraduates and high school students; this can play a significant role in student attitude and performance. Establishing a community atmosphere among beginning researchers, grad students, post-docs, and senior researchers (and others) increases the chances for high school and undergraduate research success.

8. Capitalize on inexperience.

Despite limitations in the knowledge of conventional laboratory skills, many inexperienced students contribute immediately to the lab environment. Survey comments pointed out three immediate impacts of some students. Enthusiasm was mentioned most frequently—research mentors felt invigorated by the energy and open-mindedness of students. The second most frequent advantage was the willingness of students to think "outside the box" and offer fresh perspectives to old problems. Mentors commented that new students drill them with questions that force both a synthesis and a rethinking of ideas. The third immediate contribution was the knowledge and comfort of many students with computers. Using computers as a research tool to run lab equipment, gather data, analyze results, review online literature, and so forth caters to the strengths of many students.

9. Create a template computer file for student posters.

Even at undergraduate research symposia, most posters are now printed on a single sheet of paper using a large-format printer. This process requires that there be a computer file with customized settings, borders, fonts, and so forth. Having every lab member do this independently can be a tremendous waste of everyone's time, with no obvious educational benefit. Simply emailing students a template file or a previous poster will be enough for most to overcome the logistical issues of poster printing.

10. Increase retention.

Retention was another important issue affecting the lab productivity of respondents. In fact, the average length of time students stay in a research program may be an excellent indicator of that program's overall effectiveness. Respondents agreed that the longer students worked in their laboratories, the better the experience for everyone, both in terms of research productivity and educational value. Therefore, it seems a high priority for mentors to create situations where students are able to remain in a lab for several years, which requires coordination of curricula and funding support. Retention problems may result from shortcomings in several areas including lack of institutional support, guidance, planning, curriculum integration, communication, or motivation.

In conclusion, training student researchers in time-efficient ways is advantageous for everyone involved. Mentors can maintain or increase research productivity while enjoying the personal and professional benefits of mentoring students more effectively. Likewise, students can heighten their learning experiences while achieving higher quality (and sometimes publishable) work. In the end, there seem to be few trade-offs for being an excellent mentor—training practices that increase lab productivity will also improve teaching and learning.

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Jeffrey Coker is an assistant professor in the Biology Department at Elon University, whose scholarly activity involves both science education and plant bioinformatics. He is a member of the Education Committee of the American Society of Plant Biologists, through which the surveys leading to this paper were administered.

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