Initiating Graduate Students Into the Culture of Research

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While our graduate students have met the criteria for admission to our program, which guarantees some prior experience and academic maturity, it by no means guarantees that these students have prior research experience nor the knowledge base or skills required for research in your lab. Even the brightest incoming student can represent an enormous investment of your time---something that is in short supply as a new faculty member. Therefore, from a time-management point of view, it may be advantageous to integrate some of these specifics into your coursework, preferably in the first year of PhD or MS coursework. This allows your students to quickly transition into data collection or other research activities that contribute to your productivity but also gives you credit for teaching.

Laboratory, Numerical Modeling or Field Skills

These courses are likely only worth your time if you have multiple students or would like to recruit students into your program. Training all students during class-time to perform skills essential to their research gives your time double value and allows you to train an in-coming group of students all at once. Data generated in these courses may also be used for research purposes.

- Fieldtrips
    - Stand-alone short courses
        - Fieldtrips are a great way to introduce students to your fieldsite/area of research by immersing them in it for a short period of time. Short trips work well in terms of planning and executing (i.e., time management).
            - Some concepts can be introduced in the field even if your specific field site is not nearby. Indentify locales that are more proximal to your University or if budget allows within a plane ride and try to make a ~week-long trip.
        - Introduce specialized skills or concepts.
        - Bond lab group members.
        - Introduce collaborative or project based learning (see below).
    - Components of other courses
        - A great way to break up knowledge-based courses.
        - A way to modularize a graduate “survey” course.
- Laboratory/Numerical Modeling courses
    - Stand-alone short courses
        - Essential for some facilities for both your students and other users.
        - May be combined with parallel field courses for sample retrieval, processing and analysis.
    - Components of other courses
        - Similar to field exercises, these modules may be a great companion to knowledge based courses or modules in a “survey” course.
    - Data analysis

        - This is an excellent opportunity to introduce data analysis techniques using analyzed or canned datasets that are either observationally or model based.

Critical Review of Literature

Understanding the literature associated with one's project is essential to beginning a project but students often lack the skills to find, understand, and critically evaluate published papers.

- Written reviews
    - Assigning review papers as an assignment can be helpful to students but realize that may students may not have basic tools to *find* the essential literature. Consider:
        - An introduction to databases and library resources:
            - Georef, Web of Science
        - A philosophical discussion of the finer points of publishing and how science is "measured":
            - Peer-review
                - Double-blind, bias, etc. See Wenneras and Wold (1997), *Working Double Blind,* Nature 451, 605-606, Ware and Monkman, (2008) for possible discussion material.
            - What do citation "rates" and H-index actually mean?
            - Author order, etc.
    - Write a review of a manuscript or proposal
        - Give guidance as to what components to consider such as:
            - Data quality
            - Clarity
            - Impact to science
            - Appropriateness of venue
            - Try to teach fairness, pragmatism and positive reinforcement (i.e. sometimes it's nice to hear what you did *right*).
- Discussions
    - Group discussion are a great way to review a paper but often green graduate students aren't confident enough to criticize or comment. Some instructors are gifted discussion leaders, if you aren't consider a more structured discussion.
        - Individuals responsible for picking out specific aspects such as hypotheses, implications, methodologies, or figures.
        - Use papers to illustrate only one aspect of the paper, for example a specific technique or experimental approach.

Communication Skills

- Written
    - Writing review papers, proposals or other products is an opportunity for you to guide writing style.
    - Peer-review

        - Short writing assignments put through peer-review by classmates is a good way for students to practice critical evaluation but also be introduced to the sting of (constructive!) criticism.
- Oral
    - Research talks
        - A never-ending necessity in science is to be able to articulate clearly your science. GSA/AGU/AMS, etc. style talks are a great way to introduce organization and delivery tips.
    - Question and answer
        - Answering questions orally is another essential tool especially for PhD students who will be doing an oral comprehensive exam. Practice is the best way to prepare students. Consider giving students some guerilla tactics for answering questions under pressure. Such as:
            - Anticipate questions
            - Listen to questions before responding
            - Stay to the point
            - Create visual aids
            - Use the question as a vehicle to stress your main points if possible
        - Asking good questions is also an important part of giving feedback and critically evaluating science, stressing the questioning as well as the answering is good.

Scientific Inquiry

Even experienced students are often naïve about not only which hypotheses are original, which are testable, and which techniques are available and affordable for testing.

- Proposal Writing
    - NSF/NASA/DOE proposal review or panel review
    - Integration of all info above into proposal writing, presentation and peer-review.
        - Student's project
        - Instructor formulated hypothesis/research question
            - This is a great way to see how many different ways students approach a problem/hypothesis and start a discussion about why you make the choices you make (i.e. there are lots of different right answers) and why some choices are better than others. See examples of these types of assignments from: O'Brien and Roberts, (2008) or see part II of a scaffolded assignment and grading rubric appended.
- Experimental Design
    - If you are an experimental scientist you may find that some of your students have not had formal instruction in experimental design, in addition to presentation of formal knowledge, you might consider:
        - Comparison designs (as above)

- Paper review with focus on experimental design
- Budgetary issues—which techniques are best but also which are available and affordable.

Research as a Cooperative Endeavor

Because science is rarely a solo effort, especially in interdisciplinary efforts, the introduction of interdependent assignments and projects is valuable to beginning grad students. These efforts can be the foundation to cooperative learning and research between lab mates in your research group and set up respectful habits and interactions that persist through their time in your research group and through their careers. These experiences can consist of:

- Group projects
- Group presentations
- Group data analyses and synthesis
- Interdisciplinary Courses
  - For an example of an entire course that integrates all of these approaches see: *Thinking about the process of scientific inquiry: An experiment-based course in Geomicrobiology.* This is an example of an interdisciplinary course taught using an experimental research project. The goals were to teach the basics of geomicrobiology, but also initiate first-year graduate students into the culture of scientific research. See: http://www.cte.ku.edu/gallery/visibleknowledge/roberts/print.shtml or O'Brien and Roberts (2008) or a syllabus of this course appended.

References

Publishing Research Consortium Peer Review *in Scholarly Journals (Mark Ware Consulting, Bristol, 2008); available at http://www.publishingresearch.net/PeerReview.htm*

Working double-blind, Editorial, Nature, 451: 605-606.

O'Brien, R. and Roberts, J.A. (2008) Teaching geomicrobiology and the process of experimental research to undergraduate and first-year graduate students, *Journal of College Science Teaching*, *38*, 30-38.

Wennerås, C., and A. Wold. Nepotism and sexism in peer-review. 1997. Nature 387: 341-343.