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"A Point-of-View"

ENHANCING PERSONAL SATISFACTION, PROFESSIONAL SUCCESS, AND THE QUALITY OF SCIENCE--PROVIDING FRANK ADVICE

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Have you taken a careful look at your diploma recently? Mine was awarded with unspecified "privileges and obligations." What are these "obligations"? I believe that we must provide frank advice to new and prospective graduate students about becoming scientists and doing science.

Our professional associations, graduate schools, and departments provide helpful advice. For example, The National Academy of Sciences publishes *On Being a Scientist* (1989); and The Council of Graduate Schools distributes: *The Doctor of Philosophy Degree* (1990), *Research Student and Supervisor: An Approach to Good Supervisory Practice* (1990), and *The Role and Nature of the Doctoral Dissertation* (1991). Such advice, however, is unlikely to be frank because it represents the interests of scientists and research organizations rather than the interests of new or prospective graduate students. Successful scientists will on occasion offer candid advice, but their advice is often only for "insiders" working in their laboratories. Every new generation of students should have this opportunity because inside information can enhance the success and happiness of future scientists and the quality of science.

Beginning graduate students should understand that they will be making a transition from consuming knowledge to generating and disseminating knowledge. They should understand that although they were selected for excellent performance in undergraduate courses, what counts most in graduate school is research.

For some students the transition will be very difficult. In comparison to the classroom, research is often less structured and often provides less immediate feedback. In addition to effective time-management skills, students need strong communication skills to effectively write manuscripts, speak at conferences, and teach.

The success of the transition depends most critically

on whom they choose as their adviser. Students need to understand that this choice is almost as important as whom they select as their spouse. It is not merely that an adviser provides equipment and supplies, access to assistantships, and vital letters of recommendation. Advisers provide immediate and constructive feedback regarding a student's attempts to understand nature. Without such feedback students are likely to waste precious time or simply fail. We must, therefore, frankly discuss criteria for evaluating potential advisers and motivate students to acquire the relevant evaluative information.

The ideal adviser should be with the student at the laboratory bench. Ivan Pavlov was described as watching experiments for hours, regularly examining protocols, and often remembering data better than did his students (Babkin, 1949). For non-laboratory or non-experimental sciences, the ideal adviser should be with the student as data is collected.

The ideal adviser should have an ongoing research program. A new student in Pavlov's laboratory was required to replicate the last dissertation conducted there. This requirement both enhanced the care with which Pavlov's senior students conducted their work and provided a test of a new student's ability to follow directions. Subsequently, the new student extended the replication. Obviously, new students did not have to conduct an exhaustive literature survey. They worked in the laboratory where the most systematic and current research was being conducted!

Of course, not every student can have a "Pavlov" for an adviser. Nevertheless, if a student's adviser is enthusiastic about research and is at the bench with the student, an alternative strategy is to replicate and extend important work conducted in some other researcher's laboratory. Should the research be successful, this strategy has the advantage that this other researcher will likely be chosen as a reviewer and positively evaluate the extension. Another advantage of having an adviser who is not eminent is that when their students earn their doctorates they will not have to contend with the "shadow effect" e.g., "Yes we know that you studied with famous Professor Pavlov but we don't know whether the work is yours or his!" It is possible for students to even have the best of both worlds by choosing a less prestigious scientist for an adviser, and having most prestigious scientists on their dissertation committees. The eminent scientists can provide sage advice and later vital letters of recommendation.

Students must understand that replication and extension is a cautious but productive strategy. Doing anything else is traveling off the beaten path. Certainly "riches" may be found where others have not ventured, but there is

also danger. A series of interlocking, replications and extensions can minimize risk and provide a "rich" context of justification and discovery. Confirmations extend the generality of the original conceptualizations. Disconfirmations can force assumptions to be reconsidered by the investigator and, perhaps, an entire discipline.

Students should understand the psychological and social effects of the replication and extension approach. First, the approach enhances students' confidence in the quality of their work. Second, their record of building on their research increases the chances that others will notice the work and extend it too. Replication and extension, consequently, can enhance immediate personal satisfaction and eventual professional recognition.

There are, of course, no magic rules for scientific discovery, professional success, or personal happiness. Consequently, it is important that vital issues such as searching for and selecting an adviser; choosing a research topic; and being a responsible scientist be thoughtfully discussed with other students and scientists. For undergraduates a multi-disciplinary science seminar concerned with preparing for graduate school is most appropriate; for graduate students there are, of course, proseminars and departmental colloquia.

There are several texts that offer advice which is often more candid than "official" advice. I enjoyed Dukelow's *Graduate Student Survival* (1980), and Stock's *A Practical Guide to Graduate research* (1985). More texts can be located by using the following Library of Congress subject headings: (1) dissertations, academic --handbooks, manuals, etc.; (2) research--handbooks, manuals, etc.; (3) research--methodology, (4) universities and college graduate work; (5) sciences--vocational guidance, and (6) e.g., "physicists--biography" for physicists, "psychologists--biography" for psychologists, etc.

Frank advice is occasionally published in journals and is often exchanged on the USENET news group "soc.college.grad" or, of course, when scientists speak candidly. I believe that most scientists would feel privileged to provide frank advice in a seminar or colloquium. Should some appear reluctant, have them look for the "privileges and obligations" clause on their diplomas!

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