2-1-2010

Ethical Issues in Physics: Getting Started

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Februrary 2010

Over the years, through discussions with colleagues and observations of debates in various forums, I have identified several concerns some have over the usefulness of ethics education in physics. I have classified some of these concerns as myths in that when they are accepted as fact, they lead us in the wrong direction.

I. Myths

Myth #1:It's simple: just don't falsify your data.

This statement is akin to stating that since Newton's Second Law is algebraically simple, we only need to spend a day on it in introductory physics courses. As we all know, the real challenge in this law is understanding how to apply it in a wide variety of situations. Likewise, the real challenge in most situations requiring ethical analysis is not what the principles are but how they should be applied. When we explore questions like, "What is data?" and "What does it mean to misrepresent data?" we often wind up exploring gray areas where there may not be consensus over what is ethical and what is not. Through exploration of these gray areas, the less murky areas become more sharply focused.

Myth #2 It's all subjective, just one person's opinion.

I hound students about this in my class quite often. There are standards, and I expect my students to refer to these standards when they write a paper in my course. Applying the standards may be as challenging as applying F=ma to analyze a cone rolling on a ramp, but there is at least a concrete starting point. At a minimum, students should be aware of the APS Guidelines for Professional Conduct and of university standards (which all universities receiving federal funding are required to have). Ideally, students would also explore other standards (such as engineering codes of ethics) to help them prepare for a wider range of professions.

Myth #3: You can't teach someone to be good in a single meeting or even in a single course.

In one sense, this is not really a myth. If a person comes into my course predisposed to flaunt the rules, I do not have much hope for reforming him or her in the space of one semester. However, it is my (admittedly unscientific) belief that most students and in fact most physicists are predisposed to do the right thing when they understand what the right thing is and why it is important. Consider this: it is generally understood that undergraduates cut corners from time to time in writing up lab reports and that these transgressions can be hard to police. A student who perhaps fabricates a few missing measurements for a lab report probably has a minor risk of losing some points on the assignment or, in an extreme case, failing the course. I suspect, though, that most students who fabricate missing data do not get caught. How many of these students realize what happens if they are caught fabricating data on a federally funded project? Do they know that if they are suspected of data fabrication in research, their university is *required* to launch an inquiry? Do they realize that if they are found to have fabricated data, they may be debarred from participating in federally funded projects for several years, effectively ending their chances of completing a graduate program for that period of time? This knowledge helps the student understand the seriousness of the issues surrounding research misconduct and, I believe, can turn a student who might be tempted to cut corners into a student very unlikely to do so.

Myth #4: Students get what they need through their experience in the research group.

Under ideal circumstances, students *can* get most of what they need through interactions in their research group, but it is hard to monitor whether they are in fact getting all of what they need. Among the more delicate issues is what they should do if they suspect their supervisor of research misconduct or of treating them inappropriately. These issues may be best discussed outside of the research group setting. Such issues are worth addressing not only for the situation in which a student actually does observe misconduct, but also for the situation in which a student mistakenly believes that he or she has observed misconduct. Understanding the procedures that one should follow will make it more likely that the student will be able to reach a satisfactory resolution while not unnecessarily creating ill will or unnecessarily tarnishing reputations.

II. Minimum components of Responsible Conduct of Research (RCR) education

A reasonable goal would be to have the students understand what the standards of their profession are, why these standards are there, and how the standards can be applied. Specifically, the students should become familiar with APS Guidelines for Professional Conduct and the misconduct and conflict of interest policies of their own university. Ideally, the students would first read a general introduction to ethics in science (such as Resnik's paper) to help place these standards in context. Also, if time permits, students should study codes of ethics from other professional societies, both to compare and contrast with the APS statement and to prepare them for different codes they may encounter when they enter the workforce. The Online Ethics Center provides ready access to other codes.

After laying this foundation, students will be better prepared to analyze and discuss case studies. I use the term "case studies" in a very general way. These could be brief scenarios (such as most appearing on the APS case study site) that are specifically designed for ethics education, or they could be articles or books giving detailed historical accounts of significant events. Highly publicized cases such as the Schön affair provide ways to illustrate some blatantly obvious points (don't falsify data) while raising subtler (and more interesting) issues related to authorship and collaboration. However, relying exclusively on the rare and highly publicized cases of misconduct risks leaving students with the message that since misconduct is rare, they don't really need to worry about ethics. I like to use the Millikan Oil Drop experiment as a case study, not because I want to portray Millikan as a villain, but rather because it raises very interesting questions about the line between scientific judgment and data misrepresentation. It is also a “down to earth” example for most students since they generally have either performed some variation of this experiment themselves or they know someone who has. My impression of classroom discussions is that the only students to argue that one should always report all the data taken in an experiment are those who have not actually taken data on a Millikan apparatus.

III. Minimum coverage of an ethics in physics course

In my view, ethical issues in physics encompass not only (RCR) issues but also issues related to how physicists interact with each other and how physicists interact with society at large. For this reason, my course on ethical issues in physics includes, in addition to what is covered above, a discussion of peer review in the context of career advancement, why some groups seem to be underrepresented in physics, what role physicists play in providing advice to the public at large on issues of technological importance, and what some of the pressing societal issues are for which input by physicists is needed.

IV. Format

Whether leading a short course on RCR or teaching a full course on ethics, I would argue that discussion is an essential component. Minimally, if a seminar approach is being used, more than the usual five to ten minute question and answer period should be set aside for discussion. Even if not all students are able to participate in the discussion, it is important for them to observe the give and take involved when several people bring their own perspectives to a given issue.

Ideally, the discussion will take place in a group small enough so that all are able to participate. The leader can ensure that essential issues are covered in the discussion and can also correct factual errors. It has been my experience that one common outcome of a discussion is the identification of additional information that would be useful in order to make a more informed analysis of the ethical issues associated with a given situation. This is a productive result in that it reminds students that often it is important to seek more information before making a decision.

A useful approach that can be employed towards the end of a course is the student-led panel discussion. Each of three to five students reads a different source related to a common topic. After each student summarizes the material for the class, an open question and answer or discussion time follows. This approach allows the instructor to more closely observe the panelists’ ability to analyze ethical issues while giving the rest of the class the opportunity to hear several perspectives on the same issue.

V. Sample Two Hour RCR Seminar/Discussion

First, bear in mind that you cannot cover all of RCR or ethics education in a two-hour session. You can, however, provide a reasonable educational experience on one or two topics. What follows is one example of how you might format a two-hour block of time.

Hour 1: Seminar leader introduces APS Guidelines for Professional Conduct and relevant institutional standards that define misconduct and describe how misconduct cases are handled. Time permitting, the leader introduces one of the simpler cases from the APS Ethics Case Study web site to illustrate how the standards are applied. For instance, “Data Handling and Record Keeping” under “Data Acquisition” illustrates the importance of good record keeping, of knowing what your options are when you are suspicious about a situation, and of not jumping to conclusions.

Hour 2: Seminar leader either introduces a more complex case or distributes copies of an article on that case for participants to read. For instance, if attendees will have the opportunity to read in advance of the seminar, the following, related resources can be used:

> Physics Today -- January 2005
> Volume 58, Issue 1, pp. 35-41
> Computational Science Demands a New Paradigm
> Douglass E. Post and Lawrence G. Votta
>
> Physics Today -- August 2005
> Volume 58, Issue 8, pp. 12-15
> Validating the Need to Validate Code
> Thomas P. Sheahen, Craig Bolon, Rudolf Eigenmann, Josip Loncaric, Bob Eisenberg, R. Casanova Alig, Denes Marton, Douglass E. Post, and Lawrence G. Votta

For groups of a dozen or less, open discussion can follow. For larger groups, it may be necessary to break up into subgroups to increase the likelihood that everyone can and will participate. The seminar leader should have a list of questions or issues to be addressed. If the above readings are used, these questions might include:

- What can a referee of a computational physics paper reasonably look for in evaluating a submission?
- What is the difference between validation and verification?
- On what basis can researchers decide if they have sufficiently verified and validated a code?
- In what ways is the assessment of computational results for believability similar to or different than assessments of experimental or traditional theoretical results?
- What standards of openness apply to computational physics? That is, how much information related to a computational program and result should be freely available to others in the field?

Alternatively, if reading in advance is not an option, consider using “Long Distance Collaboration” under “Publication Practices” on the APS Ethics Case Study website. This multipart case is described one step at a time, making it easy to guide the discussion of a realistically complex situation.

Integrating RCR seminars into an existing seminar series at the rate of three or four a year can help maintain ongoing discussion of key issues while allowing for a wide range of issues to be addressed over the two to four years that students and post docs may be actively involved in research in a given department.