Introducing Ethical Issues in the Physics Classroom

Marshall Thomsen
Department of Physics and Astronomy
Eastern Michigan University

Ethical issues in physics have been a formal part of the physics curriculum at Eastern Michigan University since 1988. Students are given the opportunity to consider and discuss ethical issues which they may encounter in their careers as physicists. Coincidentally, the National Council for Accreditation of Teacher Education (NCATE) has moved to require "study of science, technology and society issues and ethics related to physics" (NCATE 1990). Furthermore, there has been increased coverage in the popular press on issues relating to scientific fraud which, by focusing on biological and medical sciences, may create the erroneous impression that physicists are immune from these issues. Finally, the technological consequences of physics research this century have generated lively debates about the responsibility of physicists for the negative impact of their research. These are some of the factors the Physics and Astronomy Department considered in making their decision to include ethical issues in the curriculum.

Ethical issues in physics span a broad range. These issues can be conveniently divided into two categories, those involving interactions within the scientific community and those involving interactions between physicists and the rest of society. The former category includes research fraud, carelessness, criteria for judging scientific merit, etc. Issues in the latter category include responsibility for the consequences of one's research, the distinction between political and technical advice, and the effective use of society's resources. There are several types of questions one can ask about a particular issue. For instance, what ethical principles are involved? Do these principles seem to be violated on a consistent basis in the physics community? Is there something about the way the physics community is structured which may tend to encourage violations?

As a specific example, several class sessions have focused on the responsibilities of physicists who give technical advice. One set of readings comes from the autobiographical work of Richard Feynman, in which he discusses his well publicized role on the Challenger accident investigation commission (Feynman 1988) and his less well publicized role on the California textbook selection commission (Feynman 1985). In both cases, it appears that he was selected for his reputation as a scientist but without the expectation of his providing genuine scientific input to the commissions. While scientific curiosity rather than ethical considerations may have been his primary motivation, in both cases he felt compelled to give scientific input. The net effect was that he did not merely lend his name and reputation to a commission in order to rubber stamp the work of someone else, but rather he worked to ensure that the outcome of the commission's deliberations reflected, to some extent, his own scientific perspective. This issue may be characterized as one of truth in advertising to the extent that if a reputable scientist's name appears on a report, one might rightfully expect the report to reflect scientific deliberations on the part of that scientist. A closely related issue of when scientific advice crosses the line to political advice has also been the focus of classroom discussion. This issue is explored in more detail by Howes in a subsequent article in these Proceedings.

The primary goals of introducing ethical issues into the curriculum are preparing students for situations they may face later in their careers and opening up the debate of these issues in the physics community. Achieving these goals is facilitated by three strategies. First, classes are discussion, not lecture, oriented. Insisting that students do most of the talking forces them

to develop their own ability to analyze ethical issues. Second, discussion focuses on real case studies where possible as opposed to hypothetical situations. This focus can not only provide some of the most useful preparation for situations students encounter later in their career, but it also keeps the students' heart in the discussion by convincing them that the questions raised during the course of the discussion are relevant. Finally, the role of the instructor is to facilitate and guide the discussion, ensuring diverse opinions are respected. The instructor's role in maintaining the focus of the discussion is particularly important in making efficient use of the limited class time. While respect for diverse opinions is not only common courtesy, it is also important in keeping all students involved in the discussion. Furthermore, with several students providing their own perspective, it becomes more apparent to the rest of the class that many situations involve conflicts between moral principles and the best resolution of these conflicts is often not obvious.

Two mechanisms for introducing ethical issues into the physics curriculum have been tried. The first approach has been to add material to several existing courses. In particular, a short unit on data analysis has been incorporated into an introductory physics course on a trial basis. Among the advantages to adding a little material to several courses are that it stresses the relevancy of the issues by relating it to material discussed in class; it can allow material to be introduced over the course of several years, encouraging students to get into the habit of thinking about these issues; and all of the students in a given class are likely to be at the same technical level. The drawbacks to this approach are that it is often difficult to find time in an existing course to add new material and piecemeal presentation of the issues makes it more difficult to develop structure in analyzing the issues.

An alternate approach is to create a stand alone course. As structured at Eastern Michigan University, this course meets one hour a week for one semester, targeting primarily advanced undergraduates but open also to graduate students. Students are given weekly reading assignments coming from a wide range of resources. These include selections from autobiographical material of prominent physicists, historical articles from *Physics Today* and the *Bulletin of the Atomic Scientists*, news articles from various scientific magazines and newspapers, and opinion pieces appearing as letters to the editor or as editorials. The course grade is based on classroom participation and a term-long research project in which students examine an issue of their choosing in more detail. Credit is also earned by identifying relevant resource material that is not included on the course reading list. This helps the instructor in producing a more comprehensive bibliography for the course and it encourages students to actively explore a wide range of resources for insight into ethical issues. Resources turned in for credit have ranged from newspaper and magazine articles to videotapes of television broadcasts.

A course dedicated to the field allows the full scope of issues to be treated in a more organized fashion. At the same time, the students are likely to focus more of their attention on ethical issues in a stand alone course rather than looking upon it as a distraction from traditional physics. A major drawback is that some physics faculty may be reluctant to grant physics credit for what is primarily (although not exclusively) a nontechnical course. By making the course offered at Eastern Michigan University worth one credit hour, the likelihood of another significant physics course being displaced by this one is minimized. However, there is clearly enough material to teach a two or three credit hour course. The alternative of offering the course but not counting it for credit in a physics program would, in all likelihood, substantially reduce the enrollment.

The presentation and discussion of ethical issues in physics has been well received by those who choose to participate. This group, however, is somewhat self-selective. The stand alone course that has been taught (five times so far) is an elective so that generally only those students who are interested take the course. Enrollments are typically about five per year, compared to 10 - 15 for other courses at the same level in this department. Perhaps a truer

test of student interest will come when the NCATE-generated requirement of this course on the secondary education program takes effect at EMU. Similarly, the group of participants in the discussion held in the introductory class was somewhat self-selective in that the students knew ahead of time which day the discussion was going to be and class attendance is not mandatory for that course. Hence many of those not predisposed to interest in this field skipped class that day.

The discussions in both situations have been lively and almost without exception could have gone on longer than the scheduled class hour. One of the biggest difficulties encountered has been keeping the discussion from drifting too much into policy issues as opposed to ethical issues. For instance, in a discussion of nuclear weapons research, it is hard to resist the tendency to focus on United States nuclear policy. While some such discussion is necessary, of more relevance is the question of what the responsibilities of a physicist are given a particular opinion he or she may have about U. S. nuclear policy. Specifically, should someone who finds U.S. nuclear policy fundamentally flawed still accept research money from the military? Does a physicist who supports further nuclear weapons development have an obligation to be actively involved in that work, since he or she is one of a select group capable of performing such research?

Finally, in a number of areas the students found the background discussion particularly illuminating. Nowhere has this been more obvious than in the discussion of scientific communication in general and publication issues in particular. It is quite apparent that few undergraduate students have any real understanding about this process and its significance. Providing them with this background lends greater insight into how the academic scientific community is structured and how research gets formally validated.

While much has been learned in these first few years of introducing this material into the curriculum, the course is built around a collection of articles and book chapters from a wide range of sources, with the selection varying from year to year. Thus it is not easily transferable to other departments. Ultimately, to increase the likelihood that this material will be used in other departments, and to avoid having other people redo some of the same background research, the material needs to become better structured. One way of structuring the material would be around course modules. The modules would be self contained so that individual ones could be incorporated into an existing course, or several could be put together for a stand alone course. With a sufficient number of modules, the course could be tailored to the interests of a particular class or instructor.

Modules could be built around particular issues (e.g., ethical concerns in the publication process), ethical ramifications of events (e.g., the Manhattan Project), or the perspective of an influential physicist (e.g., Edward Teller). The module would contain an introductory essay which would give students relevant background information and identify key issues. An annotated bibliography would assist both the student and the instructor in identifying appropriate reading material to complement the essay. Finally, several mechanisms for encouraging active student participation would be included, such as discussion questions, exercises, and role playing scenarios.

A second tool useful in making it easier for other physicists to launch a similar course is a well developed bibliography. In conjunction with the course, such a bibliography has been put on a computerized database, using the ProCite software. All entries are keyword accessible and include a synopsis of the ethical issues addressed by the source. For longer sources, such as books, chapter or page references to the relevant material are given. There is a wealth of information available detailing physicistsí perspectives on ethical issues in their own field. Most of this is not readily accessible by keyword searches on standard, broader based indexing services. This specialized bibliography should fill in this information gap, making it easier for others to develop their own courses.

In conclusion, it is clear that ethical issues can be introduced in a physics curriculum in a

way which is of benefit to the students. There currently exists some strong interest in these issues in a portion of the physics community, but it is not clear if this interest is growing. NCATE standards will lead to some growth of interest, but it will likely be up to those of us with concerns in this area to generate interest in the rest of the academic community.

REFERENCES

Feynman, Richard P. *"Surely You're Joking Mr. Feynman!"* Norton, 1985.

Feynman, Richard P. An Outsider's View of the Challenger Inquiry. *Physics Today* 41:2 p. 26 (1988).

NCATE. National Council for Accreditation of Teacher Education Standards for Secondary Physics, 1990.

DISCUSSION

How many physics departments are willing to accept the idea of giving physics credit to study ethical issues? It is clear that there would be at least some resistance to giving physics credit for a course of this nature. The approach of limiting the course to one credit hour has the advantage of increasing the likelihood of acceptance by physics faculty, but it may have the disadvantage of sacrificing too much content. Clearly there is enough material for a full three credit hour course. Attracting students to such a course is sometimes problematic--especially for students working their way through school, paying for each credit hour and having to stretch out the undergraduate degree program over five to six years: each credit carries with it a measurable cost. Unless a course such as this were required, students may be more likely to opt for an additional more technical physics course (such as optics or solid state physics) which may appear to have more direct application to their chosen career. A one credit hour course has the advantage of limiting the cost to the student yet still introducing the topic. There does appear to be a sincere interest among some students in these issues, as evidenced not only by the author's experience, but also by those who incorporate ethics material into Research Experience for Undergraduate (REU) programs sponsored by the National Science Foundation.

An alternative solution would be the establishment of an interdisciplinary course with a philosophy department, thus opening up the possibility of satisfying a general education requirement as opposed to a requirement on the physics major. Such an offering is harder to coordinate but does avoid the problem of displacing other physics courses. Does the approach of inserting ethics material into existing courses have promise, or would it not allow for treatment of issues in sufficient depth? It may be that in some departments this is the only feasible approach as it requires no significant curricular changes.

Is there likely to be much demand for course modules? Certainly, this workshop has sparked interest in teaching about ethical issues in physics, but realistically, there is not presently a big demand for course materials. On the other hand, physicists have in recent years been active in issues involving society and emerging technologies, and this forms a component of the study of ethical issues in physics. Organizations such as the Forum on Physics and Society provide further evidence for interest in the issues within the community of physicists. Furthermore, focused courses dealing directly or indirectly with specific issues, such as the physics of nuclear weapons, have been taught. Thus it can reasonably be expected that an interest in the more general area of ethical issues in physics will develop as more workshops such as this one press the issue.

Finally, more focused discussion has arisen concerning the inclusion of "carelessness" as an ethical concern. Some argue that carelessness is a factor to be considered only in judging scientific competence. Others argue that errors in science have a real cost to the scientific community and to society at large. To the extent errors can be avoided by carefulness, the scientist is obligated to exercise due care and avoid this cost.

RETURN TO PROCEEDINGS TABLE OF CONTENTS

RETURN TO MARSHALL THOMSEN'S HOME PAGE