Chapter 1: How Ethics and Values Intersect in Science

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Description

Chapter 1 of Michael Pritchard and Theodore Goldfarb's instructor guide, "Ethics in the Science Classroom."

Body

The roles of ethics in science

A book devoted to advocating the infusion of ethics/values into the teaching of science rests on the assumption that ethics and values play a significant role in science and that ignoring this fact will diminish a student's comprehension of the true nature of the scientific enterprise. But this is not an assumption that is accepted and appreciated by most secondary school students, nor by all of their teachers. When asked about the connection between ethics and science, many science teachers will make reference to such issues as scientific fraud and plagiarism that have occasionally made dramatic headlines. They will generally view such behavior as the exception rather than the rule and profess a belief that science is for the most part an objective and value-free activity practiced by honest, moral individuals. Our point is not to deny that fraudulent behavior among scientists is unusual, but rather to emphasize the fact that science *is* the product of human activity, and as such it inevitably involves a wide variety of value-laden choices and judgements, many of which have ethical dimensions.

What is science? Professor John Ziman of the Imperial College of Science and Technology, London, one of the most influential writers on the practice of science, points out that definitions given by professional scientists, historians of science, philosophers of science, and representatives of other related disciplines tend to emphasize "different aspects of the subject, often with quite different policy implications."John Ziman, An Introduction to Science Studies: The Philosophical and Social Aspects of Science and Technology (Cambridge, England: Cambridge Univ. Press, 1984), p. 1. Philosophers might emphasize the methodological aspects of science focusing on experimentation, observation and theorizing as elements of the means by which reliable information about the natural world is gleaned through the practice of science. Historians are prone to view science as the accumulation of knowledge, stressing its archival aspect as a significant historical process worthy of special study. Ziman concludes that: "...science is all these things and more. It is indeed the product of research; it does employ characteristic methods; it is an organized body of knowledge; it is a means of solving problems."Ziman, p. 2.

The fact that the practice of science is a human social activity is a central theme of a booklet entitled "On Being a Scientist," initially published in 1989. This booklet was written by the Committee on the Conduct of Science under the auspices of the National Academy of Sciences as a description of the scientific enterprise for students who are about to begin to do scientific research. The reader is instructed that:

Scientists have a large body of knowledge that they can use in making decisions. Yet much of this knowledge is not the product of scientific investigation, but instead involves value-laden judgements, personal desires, and even a researcher's personality and style.Committee on the Conduct of Science of the National Academy of Sciences, On Being a Scientist (Washington: National Academy Press, 1989), p. 1.

Debunked is the notion of a rigid Baconian scientific method by which scientists derive truth about the universe by making observations with no preconceptions about what they may discover. Instead the authors claim that:

> ...research is as varied as the approaches of individual researchers. Some scientists postulate many hypotheses and systematically set about trying to weed out the weaker ones. Others describe their work as asking questions of nature: "What would happen if ...? Why is it that...?" Some researchers gather a great deal of data with only a vague idea about the problem they might be trying to solve. Others develop a specific hypothesis or conjecture that they then try to verify or refute with carefully structured observations. Rather than following a single scientific method, scientists use a body of methods particular to their work.Ibid, p. 2.

The booklet includes several real-life stories that illustrate the fallibility of scientists, and the ways in which they can be influenced by personal or social values.

Mentioned as examples of the values that can distort science are attitudes regarding religion, race and gender. Assurance is given that science has social structures and mechanisms that tend to limit and correct the influences of such biases. The peer review process, the requirement that experiments be replicable and the openness of communication are claimed to serve this purpose. The booklet ends with a strong appeal for scientists to exercise social responsibility. A second edition of this booklet, revised by a joint committee of the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine, was published in 1995 and retains much of the discussion of the role of values in science.

The claim that the peer review process and openness of communication significantly reduce the influences of bias in science assumes a set of historic norms for the behavior of scientists that are less descriptive of scientific behavior today than when they were codified by the eminent sociologist R. K. Merton in 1942. Merton's norms, as expressed by ZimanZiman, p. 84. include the principles of **communalism** (that science is public knowledge available to all), **universalism** (there are no privileged sources of scientific knowledge), and **disinterestedness** (science is done for its own sake). In today's world, where the vast majority of scientific research is funded by corporate or other private interests which often place rigid restrictions on the publication of scientific results and the exchange of scientific information, and where academic scientists find themselves in a highly competitive environment, these norms can no longer be viewed as generally applicable to the practice of science.

The tendency of many scientists and teachers of science to portray science and scientists in an idealistic and unrealistic manner is often motivated by belief that this will result in a greater willingness on the part of students and the public to accept scientific, rational thought as a powerful tool for learning about, and understanding, the world and the universe. There is no evidence to support this view. On the contrary, when students are taught that scientists are mere mortals who are subject to the same social pressures and temptations, in their work as well as in their private lives, that influence all human endeavor, they are more likely to identify with scientists. The powerful methods that science offers for seeking knowledge about the universe then become personally accessible rather then a set of exotic tools available only to the members of an elite priesthood.

Recent surveys have shown that despite a renewed interest in mysticism, and growing concern about the contribution of technological development to environmental degradation, public regard for science and technology remains very high. This is particularly true in the United States and other industrialized nations, but also in the developing world. While a high regard for science is certainly a desirable public attitude, it can be associated with an uncritical acceptance of any conclusion or opinion that is presented in the name of science. This is contrary to the essence of the scientific approach to knowledge, which seeks to engender a critical/skeptical attitude and recognizes that all of the results of science are to be viewed as subject to further verification and revision.

By presenting science to students as the product of the work of fallible human agents, rather than as a body of unassailable factual knowledge about the universe, gleaned by means of value-free observation and deduction, we can teach students proper respect for science, while nurturing an appropriate attitude of skepticism. Bringing scientists down from a pedestal is necessary if students are to recognize their own humble efforts in school science laboratories as requiring the same honesty in the reporting of observations and treatment of data that they assume was employed in the deduction of the scientific knowledge contained in their textbooks.

Examples of ethics and values issues in science

In an essay entitled "The Ethical Dimensions of Scientific Research"Nicholas Rescher, in Philosophy and Science: the wide range of interaction, Frederick E. Mosedale, editor (Englewood Cliffs, New Jersey: Prentice Hall, 1979). the widely published logician and philosopher of science Nicholas Rescher attacks the view that science is value free, and shows how ethical considerations enter into many aspects of the practice of scientific research. Rescher describes ethical problems and issues in science under several headings. We will use Rescher's headings, describing the major ethical issues that he discusses, and adding a few that he doesn't mention:

- **Choosing research goals.**

Rescher states, "Perhaps the most basic and pervasive way in which ethical problems arise in connection with the prosecution of scientific research is in regard to the choice of research problems, the setting of research goals, and the allocation of resources (both human and material) to the prosecution of research efforts."Ibid, p. 317. At the national level, he asks whether we are morally justified in committing such a large fraction of the federal research budget to space exploration at the expense of larger appropriations for the advancement of knowledge in medicine, agriculture and other fields of technology bearing directly on human welfare. Other major value- laden choices that he doesn't mention are the balance between the funding of military versus non-military research and between the funding of fossil fuel and nuclear energy investigations as opposed to those involving renewable energy sources. A recent issue that has divided the public, politicians and the scientific community is the extent to which "BIG SCIENCE" projects like the supercollider subatomic particle accelerator or the Human Genome Project should be funded as compared to funding a broader variety of more modest "small" science endeavors.

At the institutional level of the department, laboratory or research institute, Rescher mentions the issue of support for pure, or basic, versus applied, or practical, research. Today, with an increasing fraction of research being done by, or funded by, industry the constraints imposed by corporate interests on the choice of research projects, or on the direction of the research is becoming an increasingly significant ethical issue.

At the individual level Rescher cites difficult, and even painful, ethical decisions that often must be made. These include the choice between pure and, frequently more lucrative, applied research, and for those who choose applied science, such questions as whether to work on military projects. Recently the media have publicized the moral dilemma of whether former researchers for the tobacco industry should violate secrecy agreements by revealing that the industry knew more about the addictive nature of nicotine than was claimed in sworn testimony by company spokespeople.

- **Staffing of research activities.**

Rescher includes under this heading the ethical concerns that arise when scientists become administrators of large sums of public money that are needed to fund most forms of contemporary scientific research. As he points out, the increasing administrative responsibilities imposed on scientists is an ethical issue, in and of itself, because it impairs a scientist's ability to devote his or her energies to the practice of science. In research at universities, the employment of graduate students to do research raises issues about whether the assigned research is the optimal work in terms of the education and the training of the student. An additional ethical concern related to staffing a research group is the fact that women and minority members have historically been under-represented in scientific research. Making good on commitments to equal opportunity is a serious moral obligation of the scientist as research administrator.

- **Research methods.**

The ethical concerns related to the use of human subjects and animals in research are the focus of Rescher's remarks about issues related to the methods of research. We will discuss the topic of human subjects in some detail, both in the next chapter and in connection with the case study about the Tuskegee syphilis experiment in Chapter 4. The heightened public concern about animals as research subjects resulting from the animal rights movement is an issue familiar to most science teachers, particularly biology teachers. The deletion of experiments using animals in school science laboratories, due to moral objections by teachers, students, parents or the community, is becoming an increasingly common occurrence.

Other ethics and values issues related to research methods include such questions as whether a double-blind protocol is needed in cases where subjective interpretations of research data may influence experimental results. Additionally, there are issues related to the manipulation and presentation of data, many of which are discussed in connection with the Millikan case study in Chapter 4. The use of placebos in tests of the effectiveness of a new drug can raise ethical issues associated with the withholding of a potentially effective treatment of a serious illness.

- **Standards of proof and the dissemination of research findings**

Rescher discusses the issue of the amount of evidence a scientist must accumulate before announcing his or her findings. As he states, "This problem of standards of proof is ethical, and not merely theoretical or methodological in nature, because it bridges the gap between scientific understanding and action, between thinking and doing..." Personal factors, such as the need to publish in order to advance his or her career goals may tempt a scientist to exaggerate the certainty of scientific results. The fact that positive results are often rewarded by increased funding from research sponsors increases this temptation.

In most cases, the science establishment scorns the scientist who chooses to announce his or her findings via public media before they have been published in a peer- reviewed journal. As discussed by Rescher, there is good reason to be concerned about premature publicity about findings that have not been accepted as valid by the scientific community. Well known researchers or research institutions can use the sensationalism, which is as much a characteristic of science reporting as other types of journalism, to influence public opinion and governmental funding agencies. The media emphasis on such values as the novel and the spectacular which, if translated into more funds for this type of study, can distort the development of science.

Other types of ethical conflict, not mentioned by Rescher, may result from publication standards. A scientist may be convinced that the results of a study are valid, and may have significant, perhaps even urgent, social value, although they do not quite meet the often rigid standards set by his or her peers. One such standard is the generally accepted requirement that in order to be considered valid, a result derived from statistical analysis of data must have less than a 5% chance of being a result of chance. Suppose a scientist analyzes some geological data that show that some natural disaster is likely to occur at the 93% rather than the 95% statistical confidence level. No possibility exists of doing further studies that might increase the certainty of the result. Peer reviewers at the relevant scientific journal reject the report because it fails the 95% test. The scientist must make the decision whether to accept this judgment or risk the opprobrium of colleagues and make the results known by seeking the help of news-hungry science journalists.

- **Control of scientific "misinformation".**

Rescher affirms that scientists have a duty to control and suppress scientific misinformation. This obligation extends to preventing erroneous research findings from misleading their colleagues and, perhaps more urgently, to protect against the danger that false results may endanger the health or welfare of the public.

On the other hand, Rescher warns against misusing this need to censor misinformation in a way that stifles novelty and innovation. Too often in the history of science, scientists, particularly those who are young and not yet well-established, have found it very difficult to gain acceptance for revolutionary discoveries that do not fit within the prevailing disciplinary paradigm.

Rescher also raises the issue of science versus pseudo-science. Whereas the need to control misinformation would logically extend to pseudo-science, he points out that the distinction between what is accepted as science and what some members of the scientific community would label as pseudo-science is not always clear. As examples of contemporary problems in this area are the scientific standing of various forms of extra-sensory perception, herbal and other non-Western, "traditional" medicines, acupuncture and the recent controversy over the validity of "cold fusion." Rescher urges caution to those who would settle such disputes through censorship and suppression of views that they fear might damage the public image of science. He suggests, instead that scientists have faith that truth will "...win out in the market place of freely interchanged ideas..."

- **Allocation of credit for scientific research achievements.**

For obvious reasons, scientists are no less interested than those in any other field of endeavor in receiving appropriate credit for their work. Rescher mentions the bitter disputes that have arisen over the years with regard to decisions about who should receive credit for a particular discovery or invention. The agreement by the international scientific community to give such credit to the scientist(s) whose report of the discovery is first submitted to an appropriate journal has provided a means for resolving most, but not all such disputes. The recent controversy over the discovery of the virus that causes AIDS demonstrates that this procedure is not infallible, at least in cases where it may be difficult to determine if research reports from different laboratories are describing the same phenomenon. Furthermore since different laboratories frequently make nearly simultaneous, independent discoveries of the same scientific result or phenomenon, the question arises as to the ethical justification for giving all of the credit to the one who just happens to be first to submit the results for publication.

As Rescher points out, the fact that since scientific work is usually a collaborative effort, either within a single research facility, or involving several laboratories, the issue of allocating credit can be very complicated. This has become an even more problematic issue since Rescher first wrote his essay in 1965. In some fields, like high energy nuclear physics, the list of authors can exceed ten, or even twenty. Cases where junior colleagues or graduate students believe that a senior researcher has usurped credit that they deserve are not uncommon. Even issues like the order of the names on a published research article -- should they be listed alphabetically, in decreasing order of the contribution made, or in order of seniority -- can result in controversy.

A current ethical issue related to credit, and to authorship of research reports, is the extent to which a scientist whose name appears as an author should be held responsible for all the data and results reported in a published paper. This issue emerged from cases where data in a paper have been challenged as being wrong and perhaps fraudulently represented. If the work is a collaborative effort, involving researchers from different scientific disciplines, is it reasonable to expect all of them to vouch for the entire content of the paper? If not, should each author's contribution be clearly stated in the paper, or in a footnote?

One source of disputes concerning credit for research ideas and ownership of intellectual property is the peer review process. The National Science Foundation reports that accusations that a peer reviewer appropriated an experimental or theoretical idea or result from a research proposal or paper he or she was sent to evaluate, is the largest category of scientific misconduct complaints that it receives. Of course, the number of such serious accusations is only a very small fraction of all the proposals and papers that are reviewed.

This completes our discussion of ethical issues related to the practice of science under the headings in Rescher's essay. It is by no means an exhaustive list of issues of the types he discussed. There are also other important categories of ethical concerns not mentioned by Rescher. For example, there are ethical concerns related to the relative importance of cooperation and competition in scientific research, and the related issue of the extent to which scientists are obliged to share their data. (This issue is discussed in chapter 4 in connection with the case study on the discovery of the structure of DNA.)

Rescher explicitly states that he chose to ignore ethical issues related to societal uses of science as opposed to those associated with the practice of science. He claims that issues related to the exploitation of science "are not ethical choices that confront the scientist himself." This very assertion has been a continuing subject of dispute, both within the scientific community itself, as well as among philosophers, historians and sociologists of science. Not only is the obvious point made that scientists are members of society, and are therefore confronted by questions related to the social uses of science, a more controversial ethical claim is made by those who take issue with Rescher's disclaimer. They assert that scientists, because of their special knowledge, and because of the support they demand from society, have a social obligation to concern themselves with the uses that society makes of science, and to help the lay public make informed choices about technological issues.

Independent of this question concerning the social responsibility of the scientist, we believe that the introduction of ethical issues in the secondary school science curriculum should definitely include those related to the social uses, as well as the "doing" of science. Most students will not become scientists, but all students will need to participate, as citizens, in making informed choices about the uses of science.

We will mention two major contemporary developments in which numerous ethics and values issues related to the uses of science arise. The first is the rapidly developing field of bioengineering, including the application of the powerful techniques associated with modern genetics research. The results of the massive international Human Genome Project will further expand the need to confront a long list of extremely controversial social uses of this work. With increasing frequency, front page headlines and prime time TV news stories draw public attention to these controversies. Should society condone, or even encourage the cloning of animals, and perhaps human beings? Should prospective parents be able to buy embryos, with specific genetic pedigrees, for implantation into the woman's uterus? Should an individual's genetic code be kept on file by the government, and if so, to whom should it be available?

A second contemporary development that poses numerous ethics and values choices related to applied science is the worldwide concern about the potential conflict between industrial development and the ecological health of the planet. The growing list of serious local, regional and global environmental problems, including the pollution of air, water and land, acid precipitation, soil erosion, stratospheric ozone depletion and global warming, has spawned an increased sense of urgency among the world's people and their political leaders about the present and future health of the earth's ecosystems. Decisions concerning what to do about these problems involve an evaluation of the scientific facts in the context of many other value-laden social and political factors. Should the developing nations of the world be denied the benefits of the technologies that have resulted in serious pollution problems as a result of their widespread use by the developed nations? Is it appropriate to base environmental decisions on cost-benefit analysis when this requires measuring such human values as life, health and beauty in economic terms? Should the use of a chemical be banned when it is estimated to cause one death in a million, ten thousand or one thousand exposed people? What roles should scientists, political leaders and informed citizens play in making environmental decisions?

Further discussion of ethics and values issues related to the "doing" and "using" of science will be found in connection with the examples used in Chapters 2 and 3, and in more detail in association with the case studies presented in Chapter 4. We certainly make no claims to present, in this brief text, a comprehensive treatment of the vast terrain occupied by the intersection between science and ethic/values issues. Our purpose in this and succeeding chapters is to demonstrate the important and essential need to teach science in a manner that illuminates its ethical content. One reason for doing this is the practical result discovered by the teachers who attended our Summer Institutes: it heightens the interest of their students because of the "humanizing" effect of incorporating ethics into science teaching. But, we believe that a more important reason is our obligation as teachers to convey to our students the true nature of the human enterprise that we call science. As Rescher states in the final section of his essay, "It is a regrettable fact that too many persons, both scientists and students of the scientific method, have had their attention focused so sharply upon the abstracted 'logic' of an idealized 'scientific method' that this ethical dimension of science has completely escaped their notice. This circumstance seems to me particularly regrettable because it has fostered a harmful myth that finds strong support in both the scientific and the humanistic camps -- namely the view that science is antiseptically devoid of any involvement with human values."Rescher, in Mosedale, p. 325.

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