Supplement on the Teaching of Professional Ethics

The ACS Committee on Professional Training recommends that instruction in professional ethics be part of the undergraduate chemistry curriculum. This instruction may help students achieve the following results. (1) Ethical sensitivity: students should understand that science is filled with ethical judgments and they should be able to recognize the ethical component of complex situations. (2) Knowledge of relevant standards: students should learn the professional standards of chemists as articulated in the ACS "The Chemical Professional's Code of Conduct (2007)" and in relevant works on scientific ethics. (3) Skill in ethical decision making: students should learn to analyze complex ethical problems and design appropriate solutions. (4) Ethical actions: often the most ethical course of action is difficult. By education and example, chemistry faculty can help students act ethically in difficult situations encountered later in their professional lives.

Beyond the intrinsic value of exposing students to professional ethics, education in responsible conduct of research is mandated for **all** researchers (including undergraduates) supported by grants from the National Science Foundation or the Department of Health & Human Services (*e.g.,* NIH).

There are many important and interesting questions in professional ethics. The following could profitably be part of any program of instruction:

- Responsible treatment of data: Since no scientist uses or reports all the data, students need to learn when data can be discarded. They also need to learn how to use and report data.
- Reporting scientific information: Science is based on a principle of open communication. Students should learn the standards related to publication of scientific results, including proper citation of others' work, the standards related to plagiarism, and questions of intellectual property.
- Responsibilities of the peer review system.
- Conflicts of interest: All scientists have competing interests. Some involve financial interests; others do not. Students should learn to recognize a conflict-of-interest situation and how to deal with it.
- When and how questions of possible ethical misconduct should be raised.
- Use of animals and humans in scientific research: While the use of animals and humans is relatively rare in chemical research, at least a brief discussion of these questions is important.
- Relationship of chemistry to society: What are the responsibilities of a chemist to society, both as a chemist and as a citizen, including areas such as sustainability and green chemistry?

Strategies for Instruction in Professional Ethics

Strategies for offering ethics instruction in chemistry include a guest-lecture program, a separate course, or integration of ethics broadly into the curriculum. Which is most effective depends on the goals and resources of the particular institution. A guest-lecture program may be the simplest. Experts in professional ethics can be invited to give lectures in appropriate courses or as part of a regular departmental seminar program. The advantage of this approach is its simplicity; it does not require significant changes in curriculum, nor does it ask often overburdened chemistry faculty to learn a new field. The disadvantages are that it is difficult to assure that all the relevant issues are covered and that a guest-lecture program can send the subtle message that ethics is just for a few experts and not important to the working scientist. Finally, it may be difficult to find and schedule speakers on a regular basis.

An attractive alternative is to create a separate course or to incorporate ethics as a significant part of an appropriate existing course such as a capstone course or a seminar for chemistry majors. Such a course might also be offered in conjunction with other science departments. Descriptions of such courses have appeared in

The Journal of Chemical Education, among other places. The advantage of a separate course is that coverage of relevant topics can be assured. The disadvantage is that it is often difficult to add a separate course to an already crowded chemistry curriculum. Finally, it can be difficult to find someone willing and able to teach such a course.

The third possibility is integration of ethics into the curriculum, raising and discussing ethical questions in all courses. The advantages are that the questions can be discussed in context, so that ethics will be seen by students as integral to the practice of science. The disadvantages are that it is difficult to coordinate instruction that is spread among a variety of courses and that all, or at least most, of the chemistry faculty need to be trained in the teaching of professional ethics. There are, however, some simple strategies for introducing professional ethics into any chemistry course. One is what is sometimes called the "ethics moment," which is merely raising a question of professional ethics, such as proper use of evidence, when it arises in context. A second is the "ethics homework problem." Here students are asked to write a brief essay concerning a question of professional ethics that arises in the course.

No matter which of these approaches is used, an important tool for teaching ethics is the incorporation of appropriate case studies, either hypothetical or real. Students can analyze cases, construct arguments related to all sides of an issue, and discuss these in class. Good ethics case materials are available in print and on the Internet.

Sources of Materials

The booklet *On Being a Scientist: A Guide to Responsible Conduct in Research* (3rd Edition, National Academies Press, 2009) contains information on a wide variety of ethics issues, many pertinent case studies, and an extensive bibliography.

Another valuable resource is Francis L. Macrina's *Scientific Integrity: Text and Cases in Responsible Conduct of Research* (4th Edition, ASM Press, 2014).

Examples specific to chemistry can be found in *The Ethical Chemist: Professionalism and Ethics in Science*. J. Kovac (Prentice Hall, Upper Saddle River, 2004).

A guideline for a course in ethics is presented in the article "Implementing and Evaluating a Chemistry Course in Chemical Ethics and Civic Responsibility," C.P. McClure and A.L. Lucius, *J. Chem. Ed.*, **87**(11), 1171 (2010).

An approach to integrating ethics into the chemistry curriculum to contained in the article "A Directed Framework for Integrating Ethics into Chemistry Curricula and Programs Using Real and Fictional Case Studies," E.R. Fisher and N.E. Levinger, *J. Chem. Ed.,* **85**(6), 796 (2008).

The brochure *ORI Introduction to the Responsible Conduct of Research* by N.H. Steneck (Revised Edition 2007) is a valuable resource for government-mandated education in ethics. This brochure can be accessed at http://ori.hhs.gov/documents/rcrintro.pdf or ordered from the Superintendent of Documents, U.S. Government Printing Office, ISBN 978-0-16-072285-1. Resources from the NSF on responsible conduct of research can be found at http://www.nsf.gov/bfa/dias/policy/rcr.jsp.

The Collaborative Institutional Training Initiative (CITI) in the University of Miami Medical School has developed online ethics modules for which institutional subscriptions are available. The modules include text and quizzes, and can be tailored for the physical sciences. Modules can be sampled at no cost at https://www.citiprogram.org/Default.asp.

Other electronic resources can be found at http://research-ethics.net/topics/overview/ and http://www.onlineethics.org/. In addition, the ACS Committee on Ethics has links to electronic resources, including case studies, on its Web site: www.acs.org/content/acs/en/about/governance/committees/ethics.html.

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