World Conference on Research Ethics
Focus Track - Education in the Responsible Conduct of Research

Integrating Ethics into Science and Engineering Education: An Editor's and Educator's View

by
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Science and Engineering Ethics

Science and Engineering Ethics (SEE) is an international, multidisciplinary, cross-disciplinary, and interdisciplinary journal now in its twentieth year. The focus of SEE is on promoting discussion of the ethical issues that arise during the practice of science and engineering, as well as the ethical, legal, and societal impacts of science, engineering and technology. Both the contributors and readers of the journal include not only scientists and engineers, but also philosophers, lawyers, educators, social scientists, policy makers, and healthcare workers. Thus, it is essential that scientists and engineers be able to surmount the communication barriers that may impede their capacity to convey clearly the benefits, risks, costs, and limitations of their work, not only to other members of the research community, but to the public and policy makers, as well. They must also be able to understand and be open to societal concerns if they are to engage in, and contribute to, a meaningful dialogue about appropriate uses of science and technology in society.

This kind of discussion depends upon students and trainees, scientists and engineers being aware of the values inherent in scientific research and its applications, both the intended values such as honesty and integrity, and the unintended values that can be embedded in the assumptions that underlie research questions, methodologies, data analysis, interpretation and presentation. They must understand that science can be used for good and for ill, misused and abused. They also need to understand that the science and engineering communities are *part of* the larger society, not apart from it. With rare exception, research is funded by the public directly through tax dollars, or indirectly through foundations and companies in the private sector. More importantly, research is justified and carried out in the name of, and for the good of, society. For this reason, members of the public have a right and a responsibility to understand what and how research is done, and for what purpose.

Students and trainees must also be able to recognize and discuss the professional standards and ethical values operating within the research community. The increasing focus on a technical rather than a liberal arts education has led to an emphasis on scientific concepts and research techniques in science and engineering education. Yet if one only knows the science, one will not succeed as a professional. It is also necessary to know how to write and review manuscripts, give an oral presentation, obtain funding for research, manage a research team, etc, These "survival skills" also include knowledge of, and conformity to, the professional standards and values that are reflected in accepted research practice. For example, honesty and integrity in data management techniques and practice are essential. Research results must be reproducible if future work is to build on those findings. Moreover, collaborators need to be able to rely on colleagues to maintain data notebooks that will make it possible to continue or repeat the work if

illness or some other mishap results in a turnover in personnel. Students and trainees must also be aware of the societal values embodied in research practice requiring, for example, the humane treatment of research subjects, whether human or not. Further, just as "[e]ngineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties"(National Society of Professional Engineers 2007), so too, scientists must be cognizant of the parameters of socially responsible science.

For students and trainees, the values that are embedded in scientific practice, various elements of the responsible conduct of research (RCR), and the range of accepted practice must be discussed explicitly rather than left to interpretation. -- Good role models are necessary but not sufficient because the rationale that underlies even exemplary behavior can be unclear. The goals of the open discussion of RCR are at least five fold: (1) to increase awareness and knowledge of professional standards, including identification of the range of acceptable practices, assumptions underlying those practices, and their immediate and long-term implications; (2) to increase awareness of the ethical dimensions of science and engineering; (3) to provide experience in thinking through and defending decisions about ethical problems; (4) to promote a sense of professional responsibility to be proactive in recognizing and addressing ethical issues; and (5) to develop approaches and identify resources for making decisions about ethical problems.

The recruitment and involvement of faculty in RCR education is crucial both for the expertise that they bring, and for the credibility that their participation conveys regarding the importance of RCR education in science and engineering education. Faculty and senior scientists are the experts on the responsible conduct of research, in part, because *they* know what they think is acceptable research practice and what they expect of their colleagues and trainees. Senior researchers set the standards of the community directly to the extent that they develop codes of ethics and ethical guidelines in their discipline, and indirectly when they write and review papers for scientific journals, write letters of reference for trainees, decide who will be their collaborators and their departmental colleagues, etc. Faculty serve as role models and, more importantly, they may act as mentors when they share their experience and expertise with their mentees and make explicit what is implicit. Postdoctoral associates are also a valuable resource in RCR education. They, too, bring a valuable perspective, different from that of the faculty with a different power dynamic and, often, experience that is more recent and more relevant to students and more junior trainees.

Integrating the various components of RCR into all elements of the science and engineering curriculum, whether formal or informal, is also key. RCR education can include a stand alone course involving a team of faculty from a single department or a few related departments. However, RCR education should also be highlighted in modules, study questions and problem sets integrated into core courses; laboratory and research team meetings; departmental seminars; journal clubs; informal discussions with advisors and mentors; as a component of a project or thesis; and/or research and engineering practice workshops organized by departments and/or the institution. In whatever setting, key to the effectiveness of the effort is (1) interactive discussion that incorporates didactic presentation of relevant information regarding the standards of the community and the range of accepted practices, and (2) in-depth

consideration of the immediate and long-term consequences of various practices or courses of action.

Universities and departments, too, play a critical role in RCR education since they determine the workplace climate for students, trainees and faculty. Universities and departments share responsibility for assuring that students and trainees are adequately prepared to become socially responsible professionals and citizens; and for creating a workplace environment that fosters the ethical behavior of faculty, staff and students. Toward that end, universities and departments can cultivate an ethical environment by, for example, making it comfortable to ask questions, providing clear and fair personnel policies, and designing and supporting responsive systems for resolving complaints (Gunsalus 1998). Further, institutions can train faculty and promote, facilitate and reward departments and faculty for integrating ethics and social responsibility into courses and curricula. Institutions and departments can also develop mentoring programs that train mentors, and encourage, facilitate and reward good mentoring.

Working together, faculty, senior scientists and engineers and their departments and institutions can create an environment where ethics is an integral part of science and engineering education.

References and Additional Readings

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