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Geoethics: Good Teaching, Good Science

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Geoethics is an essential component of the pre-professional training of geoscientists. Geoethics encompasses the values and professional standards required of geoscientists to responsibly work in the profession and in service to society. Geoethics encompasses personal and professional behaviors in the conduct of science as well as responsibilities to society and to stewardship of Earth.. A formal course of instruction is needed to prepare students to enter the community of practice in the geosciences. Students should have the opportunity in our classes to **recognize ethical dilemmas** in the first instance, to **develop the strategies and skills** needed to responsibly participate in the profession, and **gain experience in ethical decision-making**. Instructors, at all levels, should be aware of the need for ethical training in their coursework and mentoring of students, and look for opportunities to introduce those "teachable moments" to explicitly identify and address ethical issues. Training in ethical practices in our science is too important to leave to random experiences that require ethical decision-making, and training in ethics at the graduate or post-graduate level is too late in the pre-professional training of students. We propose that a systematic curriculum that helps students identify and address ethical issues in the geosciences is now needed.

Formal instruction in Geoethics should employ the "best practices" in STEM education: articulation of clear learning goals, engagement of students using active learning methods, and assessments that are well-aligned with the learning goals. Teaching Geoethics requires three stages: 1) awareness of the ethical dilemma or problem, 2) ethical decision-making, and 3) monitoring or modifying behaviors, including taking appropriate actions. Geoethics provides a great mechanism for students to develop critical thinking, problem-solving and communication skills. They must apply the underlying scientific principles related to an ethical issue, understand the full context of impacts on and by stakeholders, and formulate a solution to the problem. Topical issues related to ethical dilemmas related to the conduct of science and impacts on personal or societal lives is an effective vehicle for engaging students with science in the first place, and can provide motivation for deeper inquiry and exploration using case studies and guided or open-ended discovery methods.

Geoethics is also essential as a self-regulating mechanism for the conduct and progress of science. The scientific community, as well as our civic communities, must have trust that the conduct of scientists and the integrity of their scientific product, is above reproach. We propose a comprehensive application of Geoethics that includes these dimensions: 1) **Geoethics and Self**: what are the internal attributes of a geoscientist that establish the ethical values required to successfully prepare for and contribute to a career in the geosciences 2) **Geoethics and the geoscience profession**: what are the ethical standards expected of geoscientists if they are to contribute responsibly to the community of practice expected of the profession? 3) **Geoethics and society**; what are the responsibilities of geoscientists to effectively and responsibly communicate the results of geoscience research to inform society about

issues ranging from geohazards to natural resource utilization in order to protect the health, safety, and economic security of humanity? 4) **Geoethics and Earth**; what are the responsibilities of geoscientists to provide good stewardship of Earth based on their knowledge of Earth's composition, architecture, history, dynamic processes, and complex systems?

To support instruction in Geoethics across the geoscience curriculum, we have developed a comprehensive website that contains a rich collection of resources, case studies and references: <http://serc.carleton.edu/geoethics/index.html>. We invite the geoscience community to use and contribute to these collections for the health and future growth of the geoscience profession.

