


Geoethics across the Geoscience Curriculum

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plate tectonics:
Volcano visits are an essential income for small tour operators in Indonesia. Would you demand tour operators to stop those visits because an eruption may happen soon?




Gas and steam plume over Mt. Bromo [volcano.si.edu]

climate change:
Can a Western country require an equatorial country to stop clearing their rainforest?




palm oil plantation in Sekernan, Indonesia [wwf.org]

geophysics case study (based on real documents):
developer asks geophysicist to investigate for graves ground-penetrating radar does not image any anomalies but archaeologist had uncovered graves previously...



collecting GPR data at a forensic site (winter 2023)

space/oceans:
Shall we allow mining in space/in the deep ocean? And if yes: who shall be allowed to do it?



hydrothermal vents in the Bismarck Sea [whoi.edu]

Geoethics = professional ethics + attitude of society interacting with Earth

How can/do we teach ethics in the geosciences?

- required ethics course**
students may not connect it to geoscience but rather "tick off" a requirement
- dedicated geoethics course**
departments often do not have the capacity (faculty member available/comfortable teaching it, longer list of required credits)
- ethics embedded into curriculum**
discussions at critical junctions (eg, reporting of data in a lab)

case studies that augment a topic or serve as "hook"

"wicked problems" that link geoscience knowledge to society questions

most practical option for most departments (combined with option 1)

Why should we teach ethics in the geosciences?

- model ethical thinking to our students
- clarify relevance of ethics in our work
- show exciting applications of geoscience
- science is based on values (what gets funded? who gets funded?)
- ethical thinking will be necessary for our students' careers

Five-step process to solve a wicked problem:

- recognize issue
- gather facts
- evaluate alternative options
- decide
- reflect on outcome

example, with grading rubric

lesson number and topic: **simple answer** wicked problem: **Should we exclusively promote electric vehicles?**
your name and student number: **Charly**

step 1: why this is a wicked problem?
transportation is one of the large contributors to greenhouse gases. driving an electric vehicle does not produce greenhouse gases, but the manufacturing of electric vehicles requires a lot of resources and energy.

step 2: three stakeholders their arguments for their arguments against

stakeholder	their arguments for	their arguments against
1. government	1. they are already engaged on the climate (ie, working towards net zero emissions) - will create new well-paying jobs	need of investing necessary infrastructure and possibly incentives
2. mining companies in Canada	1. mining for critical minerals and attract investment and is more appreciated by the public (than oil for example) - demand is high potential for growth	only what if new technology comes up they will open resources that do not require the same resources
3. consumer	wants to be environmentally conscious having an electric vehicle in the driveway shows this commitment - saving costs on gas	cost to purchase is high range is low (and infrastructure not fully developed)
side: economists	- new market is good for economy	the production of an electric vehicle and the mining of their resources produces around 60% more CO2 than the vehicle made to be driven about 100,000 km before it is recycled. environmentally friendly than a gas-powered car

step 3: alternative options advantages of this option challenges of this option

option	advantages of this option	challenges of this option
a. no alternative	no change	greenhouse gas emission
b. hydrogen as fuel	can use similar infrastructure - hydrogen only have smaller range as gas-powered cars and can be fuelled up quickly	need a lot of electricity to produce hydrogen - infrastructure of refueling stations want to avoid producing hydrogen from methane - hydrogen is very dangerous (though there are attempts to deal with it liquid which makes it less suitable)
c. change habits	lower car overall ecological footprint - we might live healthier if we could rely less on cars to move around	change in attitude will be difficult (eg. single family homes in suburbs and preferred by apartments in cities) - expensive public transit takes time

step 4: your decision
I don't think we should exclusively promote electric vehicles, but see them as one option and continue to promote hydrogen as an alternative fuel and further advocate people to change their habits and expectations.
note: there is no right or wrong answer, one could decide that despite the shortcomings electric vehicles are our best option and that would be valid. However, your solution should be neither based nor contradict your arguments above.

step 5: reflection
- contributions by geoscientists: explanation for this necessary resources and other steps of the mining cycle
- modeling of climate scenarios based on geoscience data
- any assumptions (implicit or explicit) you have made:
we need to actively work to curb greenhouse gas emissions and individual choice has consequences
the consumer perspective of more several than ethical alone
most people are willing to get informed about their ideas and also willing to change their way of life.
note: (1) all the wicked questions you face in this case are linked to geoscience. (2) becoming aware of, and explicitly stating your assumptions may be the most difficult aspect of these assignments.

basic grading rubric:
/2 pts: 3 meaningful stakeholders and strong arguments
/1 pts: 3 reasonable options, with clear advantages and disadvantages
/2 pts: suggested solutions, contributions by geoscientists, well-presented assumptions
total: /6
note that the quality of your work is important not just the quantity (for example, it is not sufficient to list any stakeholders and some arguments, they have to be good ones).

deciding on ethical problem mirrors scientific process


note: grades for critical thinking, not a "correct" solution

energy:
Shall the government decide on long-term storage of nuclear waste before they build a new nuclear reactor?



Onkalo deep geologic repository [bbc.com]

flooding:
Should Canada assist/pay for flood mitigation along the Nooksack River in Washington state?




flooding in BC near border, Dec 2025 [nsnews.com]

mineral resources:
Would you allow mining of "critical minerals" in an ecologically sensitive area?




boreal forest in Northern Ontario [wscanada.org]

soil:
Can we legislate rotating crops to preserve our soil as a resource?



soil loss in a potato field [umweltbundesamt.de]

paleontology:
Shall we stop the sale of unique fossils?



Ceratosaurus fossil sold for \$30.5M [artnet.com]


natural disasters:
Should taxpayers pay for tornado/hurricane/earthquake damage to private property?



storm-damaged house in Oklahoma, April 2025 [nbcnews.com]

geochemistry case study:
"Geology in the City: Ethical Issues" (by the late Anne-Marie Ryan)
[https://serc.carleton.edu/geoethics/activities/83905.html]

- based on an actual class research project
- students collect and analyse soil samples for Pb in city
- result: levels exceed guidelines
- how to share results with homeowners?



soil profile in New York City [https://urbansoils.org/blog-pedosphere/soils-and-the-city]

space for your comments/thoughts:

Resources:
Mogk and Bruckner, 2013. Teaching GeoEthics Across the Geoscience Curriculum: <https://sec.carleton.edu/74990>
Vasconcelos, Schneider-Voß, and Peppoloni, 2020: Teaching Geoethics – Resources for Higher Education, U. Porto Edições, <https://doi.org/10.24840/978-989-746-254-2>
Bank and Ryan, 2020. Engaging students in ethical decision-making: a case study from an undergraduate geoscience course, J. Ethics Ed., 5: 51-65, <https://doi.org/10.1007/s40889-020-00085-0>
International Association for Promoting Geoethics: geoethics.org
International Association for Geoethics: icog.es/iageth