Student Toolkit

Values and Responsibility in Interdisciplinary Environmental Science
A Dialogue-Based Framework for Ethics Education

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Letter to Students

Dear Students,

Welcome! We are excited to participate in your graduate learning experience and hope the following curriculum will help you develop your skills as professional scientists and environmental decision-makers. Often work in these areas will situate you in the challenging position of an expert who must navigate conversations about risk, responsibility, uncertainty, and science in the public sphere. This curriculum is designed to help you engage in these conversations with confidence, wisdom, and grace.

Imagine you are participating in a site meeting on public land somewhere in the western United States. You are responsible for making a decision about access to an area that has been used for recreation (e.g., rafting, hunting) but also has value for local Indigenous people and developers. Researchers brought in to inform your decision have disagreed on the impact of the range of possible uses, and stakeholder groups are deeply divided. The information you have is couched in different disciplinary languages, making comparative evaluation difficult. What can you do to assess the conflicting beliefs and values, as well as the competing risks and tradeoffs?

Scenarios like this arise anywhere diverse stakeholders approach issues with conflicting values and perceptions of risk, like conversations about sustainable animal production, industrial effluent and river health, or natural resources restoration. These contexts are fundamentally *ethical*, where decisions are judged *right* and *wrong* (often at the same time), and have the potential to create both benefits and harms. The curriculum contained here has been designed to prepare you for the kinds of ethical challenges you will face during your careers, emphasizing the skills necessary to communicate with a wide range of disciplinary experts and the importance of accountability to non-research partners and communities affected by your work.

Based on contemporary educational theory, we have grounded this curriculum in the idea that conceptually challenging ethical content is best learned through structured dialogue and guided self-reflection. We welcome your feedback about these activities and your overall experience with the curriculum.

Sincerely,

Michael O'Rourke
Michigan State University

Troy E. Hall
Oregon State University

Principal Investigators

With curriculum co-developers:

Jan Boll, Washington State University
Barbara Cosens, University of Idaho
Thomas Dietz, Michigan State University
Jesse Engebretson, Oregon State University
Lissy Goralnik, Michigan State University
Zachary Piso, Michigan State University
Sean Valles, Michigan State University
Kyle Whyte, Michigan State University

Four Ethical Themes Central to Interdisciplinary Environmental Science

This document supplies brief characterizations of the four ethical themes featured in the curriculum: **risk**, **expertise**, **non-human impacts**, and **policy constraints**. These "themes" are domains in which potential value differences may exist among scientists who work together in interdisciplinary contexts and whose research and advice have the potential to impact stakeholders and decision-makers. Of course, there are other themes that are also relevant to environmental science research and expertise; we have selected these specific themes because they are fairly common in interdisciplinary environmental science contexts and will provide a strong foundation for consideration of values and responsibility in interdisciplinary environmental science.

1. Risk

Interdisciplinary environmental science projects often have to assess and characterize risks that bear on stakeholders and decision-makers. Scientists in these projects may also be responsible for communicating these risks either to the public directly or to decision-makers, journalists, or other professional communicators who will take the science into the field. Reciprocally, scientists need to consider how public concerns shape the risks they choose to study. For example, should they investigate hazards that certain members of the public feel are more dangerous than scientists believe them to be (e.g., genetically modified crops), or focus their energy and resources elsewhere?

Scientists working in interdisciplinary environmental science may have the opportunity to communicate risks to decision-makers in ways that shape socially influential policies, yet they may disagree about how to do so. Consider the regulation of nanotechnology, which has emerged as an ongoing source of disputes about how to assess and respond to risks. Biochemists, pathologists, and related experts may emphasize the chemical and biological plausibility of health impacts.[1] Academics interested in Ethical-Legal-Social Implications, such as sociologists and geographers, may focus on the culturally or socially informed perceptions of risk[2] or on thought experiments, including implausible or speculative ones. Attention to these perceptions and thought experiments supports the development of scenarios that help illuminate important ethical features.[3] An important study of a range of scientists concluded that "most upstream scientists," which include engineers, chemists, physicists, and materials scientists, "do not think nanotechnologies pose new or substantial risks, while most downstream scientists," which include toxicologists, epidemiologists, and other public health

[1] Cattaneo, A. G., Gornati, R., Sabbioni, E., Chiriva-Internati, M., Cobos, E., Jenkins, M. R., Bernardini, G. (2010). Nanotechnology and human health: Risks and benefits. *Journal of Applied Toxicology* 30(8): 730–744.
[2] See (a) Douglas, H. (2000). Risk and values in science. *Philosophy of Science* 67: 559–579 and (b) Keith, D. W., Parson, E. Morgan, M. G. (2010). Research on global sun block needed now. *Nature* 463: 426–427.
[3] Rasmussen, A. J., Ebbesen, M., Andersen, S. (2012). Nanoethics—A collaboration across disciplines. *Nanoethics* 6(3): 185–193.

scientists, "are worried that they may pose new, unforeseen, and possibly substantial risks."[4] Scientists routinely have to make hard choices about which aspects of risk to emphasize to decision-makers and stakeholders, who will then in turn make regulatory decisions based on their interpretation of that information.

2. Expertise

In the course of their professional lives, interdisciplinary environmental scientists must make a variety of judgments about expertise. Two types are especially prominent: (a) judgments about whose expertise matters to a project—their own, other scientists', politicians', regulators', tribal representatives', hunters', etc., and (b) judgments about what their expertise puts them in a position to do, e.g., should they advocate certain actions to policy-makers or simply describe scientific results to them? Scientists should be concerned about the accountability of their judgments about expertise, since these will influence their relationships with decision-makers and the course of their research projects (e.g., will experts without academic credentials, like birdwatchers, hunters, or local knowledge-holders, be permitted to participate, and in what ways?).

Scientific disciplines are founded upon assumptions about the nature of credible knowledge and the qualifications of who counts as an expert, as well as social norms about what kinds of advice scientific experts should provide to scientists in other disciplines, stakeholders, and decision-makers. Across scientific disciplines, what makes knowledge credible is that it emerges from an empirical process sanctioned by the standards of a particular science. Experts qualify as such when they have met criteria that establish them as competent practitioners in an area of science. Experts are also positioned to offer advice to non-experts. Who counts as an expert, though, can be disputed. Climate scientists, for example, often value the knowledge of Indigenous peoples regarding climate insofar as it provides otherwise unavailable observational information, without giving it any further role in the design of their research questions, implementation of research methods, or interpretations of results.[5] By contrast, cultural geographers, anthropologists, and other social scientists often see Indigenous knowledge as far more credible, taking it to be a source of knowledge that is equal to science in many respects.[6] As for the kinds of advice experts should provide, some fields might be comfortable doing research that directly supports a particular policy option, whereas others might see their research as providing a range of options for decision-makers; still others might be uncomfortable with any connection to policy options at all.

3. Non-human Impacts

In addition to humans, interdisciplinary environmental science has an impact on non-human organisms and broader collectives such as ecosystems. Environmental scientists across the

[4] Powell, M. (2007). New risk or old risk, high risk or no risk? How scientists' standpoints shape their nanotechnology risk frames. *Health, Risk & Society* 9(2): 173–190.

[5] See (a) Williams, T., Hardison, P. (2013). Culture, law, risk and governance: Contexts of traditional knowledge in climate change adaptation. *Climatic Change* 120(3): 531–544 and (b) Arctic Climate Impact Assessment. (2004). *Impacts of a Warming Arctic-Arctic Climate Impact Assessment*. Cambridge, UK: Cambridge University Press.

[6] Pierotti, R., Wildcat, D. (2000). Traditional ecological knowledge: The third alternative. *Ecological Applications* 10(5): 1333–1340.

disciplines have different ways of conceiving how their research impacts the "interests" of non-human entities. Here "interests" refers to qualities such as the propensity to continue existing, the desire to reproduce, and the desire to ensure the safety of offspring. Should scientists take seriously the interests of non-human organisms and broader ecological collectives when designing their research? Scientists working in pollution abatement, for example, may see themselves as primarily responsible for protecting human health. Others disagree and insist that scientists should also be concerned with the impact of their research on animals and biodiversity aside from its connections to human interests, perhaps to protect things like ecosystem "integrity" or "well-being."[7] Scientists often feel responsible for making informed decisions about how to weigh the impacts of their research on these non-human entities. Some interdisciplinary environmental science programs address landscape-scale conservation issues and include in their curriculum coursework wildlife and plant biology, environmental management, and climate science.[8] Integrating these diverse sciences requires negotiating a number of value differences concerning how impacts on non-humans should figure into research and management decision-making. Consider debates among scientists about the value of nature in relation to climate change. Global warming has shifted the habitable regions for many plants and animals and could lead to potential extinctions in the future. Some scientists argue that more research should address how to conserve species, habitats, and ecosystems that are threatened by climate change. Other scientists argue that we should study new human and natural systems and simply let go of certain species, habitats, and ecosystems.[9]

For another example, consider the case of the Acoustic Thermometry of Ocean Climate experiment by oceanographers. Some biologists are opposed the research because it could interfere with the acoustic transmission of marine mammals that are already threatened by human activities. By contrast, the oceanographers are focused on the importance of their work for climate change research.[10] Research goals often conflict, and situations can arise in which opposing goals are indeed mutually exclusive in that one path negates the other. These conflicts raise interesting questions for scientists to navigate as they explore their responsibilities to non-research communities and decision-makers.

4. Policy Constraints

Policy constraints are ways in which political realities—broadly construed to include the dynamics of professional scientific organizations, funders, and research institutions—and the needs of decision-makers influence what scientists study and how they do their research. For

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[7] See (a) Sterba, J. P. (1994). Reconciling anthropocentric and nonanthropocentric environmental ethics. *Environmental Values* 3(3): 229–44 and (b) Hobson, K. (2004). Environmental justice: An anthropocentric social justice critique of how, where and why environmental goods and bads are distributed. *Environmental Politics* 12(2): 474–481.

[8] Austen, D. J. (2011). Landscape conservation cooperatives: A science-based network in support of conservation. *The Wildlife Professional* 5(3): 12.

[9] See (a) Kareiva, P., Marvier, M. (2012). What is conservation science? *BioScience* 62(11): 962–969, (b) Sandler, R. L. (2012). *The Ethics of Species: An Introduction.* Cambridge: Cambridge University Press, (c) Vaidyanathan, G. (2014). Can humans coexist with nature? *Scientific American* November 10, and (d) Cafaro, P., Primack, R. (2014). Species extinction is a great moral wrong. *Biological Conservation* 170: 1–2.

[10] Sarewitz, D. (2004). How science makes environmental policies worse. *Environmental Science & Policy* 7: 385–403.

example, interdisciplinary environmental scientists may engage in research aimed to help particular communities adapt to climate change; however, it is often the case that scientists choose not to suggest certain solutions for adaptation because they would—for political or economic reasons—likely not be acceptable to decision-makers or other political groups involved in the decision-making process. In these situations, scientists are accountable for how they respond. Should they simply do whatever research is feasible within the aforementioned policy constraints, or should they openly oppose unacceptable policy constraints, e.g., constraints that they feel yield bad tradeoffs for the affected communities?

Individual environmental scientists must make decisions, whether explicit or implicit, about how they will interact with the policy constraints surrounding their work. Policy constraints include everything from the informal conventions of one's discipline, such as statistical significance standards,[11] to local and national regulations, such as The Endangered Species Act. Some environmental scientists argue for "more active participation by scientists in matters of policy,"[12] while others claim that greater participation by scientists can only make matters more complicated.[13]

Consider the case of interdisciplinary research on geoengineering approaches such as solar radiation management (SRM), i.e., releasing airborne particles to shade the earth's surface.[14] Robock (2008) points out that SRM research undermines current efforts to create greenhouse gas mitigation policies by giving the impression that climate change can be solved simply; furthermore, scientists might lack the "moral authority" necessary to pursue research that would intentionally reshape the global climate.[15] Keith et al. (2010) argue that scientists must influence the processes that will lead to funding SRM research because the failure of international climate change mitigation negotiations means that we should be prepared in the future to deploy geoengineering.[16] At the same time, some social scientists argue that scientists should not influence the specific research policy-makers fund.[17]

[11] Brosi, B. J., Biber, E. G. (2008). Statistical inference, type II error, and decision making under the US Endangered Species Act. *Frontiers in Ecology and the Environment* 7(9): 487–494.
[12] Nelson, M. P., Vucetich, J. A. (2009). On advocacy by environmental scientists: What, whether, why, and how. *Conservation Biology* 23(5): 1090–1101, p. 1099.
[13] Sarewitz, D. (2004); Vaidyanathan, G. (2014). Can humans coexist with nature? *Scientific American* November 10.
[14] Keith, D. W., Parson, E. Morgan, M. G. (2010). Research on global sun block needed now. *Nature* 463: 426–427.
[15] Robock, A. (2008). 20 reasons why geoengineering may be a bad idea. *Bulletin of the Atomic Scientists* 64.2. Available online: http://thebulletin.org/2008/may/20-reasons-why-geoengineering-may-be-bad-idea.
[16] Preston, C. J. (2012). *Engineering the Climate: The Ethics of Solar Radiation Management*. Lanham, MD: Lexington Books.
[17] See (a) Pielke Jr, R. A. (2007) *The honest broker: Making sense of science in policy and politics*. Cambridge: Cambridge University Press and (b) Shove, E. (2010). Beyond the ABC: climate change policy and theories of social change. *Environment and planning A* 42(6): 1273–1285.

Conceptual Foundations: Eigenbrode et al. (2007)

This curriculum is rooted in the idea that structured dialogue about disciplinary perspectives on values and responsibility can prepare environmental scientists to communicate in an ethically sensitive way with a wide range of partners from academic disciplines and non-academic communities. This approach is an extension of the Toolbox dialogue approach, first presented in Eigenbrode et al. (2007). We recommend reading this article as an early step in understanding the conceptual foundations of the Values and Responsibility in Interdisciplinary Environmental Science curriculum.

Eigenbrode, S., O'Rourke, M., Wulfhorst, J. D., Althoff, D. M., Goldberg, C. S., Merrill, K., Morse, W., Nielsen-Pincus, M., Stephens, J., Winowiecki, L., Bosque-Pérez, N. A. (2007). Employing philosophical dialogue in collaborative science. *BioScience* 57: 55–64.

Link: https://academic.oup.com/bioscience/article/57/1/55/224519

Learning Objectives

By the end of the module, students will be able to:

Learning Objective 1
Describe the ethical challenges of risk, expertise, non-human impacts, and policy constraints in relation to their interdisciplinary environmental science field

Learning Objective 2
Recognize risk, expertise, non-human impacts, and policy constraints in case studies related to their interdisciplinary environmental science area

Learning Objective 3
Assess how risk, expertise, non-human impacts, and policy constraints should affect their own conduct as practitioners in the interdisciplinary environmental sciences

Learning Objective 4
Identify and analyze differences and similarities among the perspectives of multiple environmental science disciplines on risk, expertise, non-human impacts, and policy constraints

Learning Objective 5
Formulate dialogue prompts that apply the broad concepts related to values and policy in interdisciplinary environmental science, including risk, expertise, non-human impacts, and policy constraints, to each student's particular research and practice specialty

Learning Objective 6
Articulate and discuss their perspectives on risk, expertise, non-human impacts, and policy constraints in interdisciplinary environmental science with other members of the course

Learning Objective 7
Produce a project that applies knowledge of the values and policy dimensions of interdisciplinary environmental science to a problem in one's own research or practice domain*

**The project assignment is an optional extension of the main curriculum*

Frequently Asked Questions

What do you mean by values, ethics, and responsibility?
By *values*, we mean assumptions and beliefs, held by scientists, about (1) what goals are important for scientists to achieve when designing research or providing recommendations to decision-makers, and (2) what boundaries are not worth crossing in order to protect empirical and professional integrity. The values we hold are at the heart of our judgments about which actions are right or wrong, that is, the *ethics* of our actions. Scientists in different fields may disagree about what interventions are ethically acceptable. In particular, they may disagree about the ways in which they are responsible to decision-makers and non-research communities. By *responsibility*, then, we mean the degree to which environmental scientists should be concerned about how their work impacts decision-makers and stakeholders.

How are values related to the four curriculum themes?
The four ethical themes that provide the foundation for our curriculum—risk, non-human impacts, expertise, and policy constraints—are domains in interdisciplinary contexts where values and perception differences commonly arise. Values, as well as disciplinary training, lie at the heart of potential disagreements that emerge around these issues. The four themes are also domains in which *not* taking a position is still a position—e.g., ignoring the relevance of policy constraints to one's work is an ethical stance about the independence of science and politics, or communicating risk information in ways that only specialists would understand assumes that non-expert stakeholders do not need to be fully informed of certain risks. Exposure to and dialogue about these themes can help unearth one's own particular value stances, stimulate reflection on the role of values in interdisciplinary environmental science contexts, and facilitate awareness of the value stances of others regarding scientific responsibility in the public sphere. While additional themes exist that are relevant to particular interdisciplinary environmental science areas, we selected these four because they are widely applicable to many interdisciplinary science areas.

What is the purpose of the dialogue exercise?
The structured dialogue exercise is a chance to participate in an informed and informative discussion of the ethical dimensions of their specific interdisciplinary environmental science context, synthesizing what you learned about yourself and your classmates during the initial part of the curriculum. The exercise is structured by prompts designed by you to reflect your own professional priorities and concerns. To support this opportunity and enhance your self- and mutual understanding, it helps to ensure you are participating in an interdisciplinary dialogue group and, if possible, that you are using a set of dialogue prompts designed by another group in the class.

By providing scaffolding to support a sophisticated ethical discussion, the dialogue exercise enables the achievement of the 5th learning objective: "Articulate and discuss their perspectives

on risk, expertise, non-human impacts, and policy constraints in interdisciplinary environmental science with other members of the course." The exercise also provides an opportunity to discuss the relationship between the ethical themes and their practice, thereby satisfying the 3rd learning objective: "Assess how risk, expertise, non-human impacts, and policy constraints should affect their own conduct as practitioners in interdisciplinary environmental sciences."

Why should I think about my role as an expert in relation to decision-makers?

People with credentials, especially graduate degrees in science fields, are often asked for their opinions on key issues by journalists and activists. Experts are also asked to serve on local, state, and federal government advisory committees that directly advise policy-makers. When people with credentials feel strongly about an issue, they may decide to advocate with respect to that issue and use their scientific credentials to validate their point of view. Others may decide to categorically avoid interactions with journalists, activists, and policy makers. But this avoidance is itself a stance with great ethical significance. For these reasons, acquiring a credential in environmental science could put you in a position to advise policy-makers and other members of the non-science public. It is advisable to consider the implications such activity will have for your career, as well as consider your own values, commitments, and intentions, so that you are prepared for these situations before they arise.

How are non-human impacts an ethical issue related to interdisciplinary environmental science?

Non-human impacts influence decisions about what kind of research should be supported and pursued, marking some research as appropriate and other research as inappropriate for reasons that are grounded in the values of scientists. For example, some scientists believe it is important to conduct research about how best to shelter biodiversity from climate change; this kind of research relies on a belief that we should avoid contributing to certain extinctions or changes in habitat. By contrast, research on resilient landscapes that can adapt to climate change is driven by a belief that some plant and animal extinctions are acceptable. That is, some scientists see it as inherently bad when humans contribute to species extinctions, while others instead worry about the rippling impacts extinctions might have on systems. Different values about the non-human impacts of research can affect what research questions are regarded as significant and what scientific work is seen as fundable.

How are policy constraints related to my future role as a scientist?

Policy constraints describe the ways in which political realities and the needs of policy-makers influence what scientists study and how they conduct research. That is, as a scientist, your research is not entirely under your control. Funding decisions are in part determined by ideas about what kind of research is worthwhile. Many of these decisions are made by decision-makers and reflect the interests of voters, corporations, non-profit organizations, and charitable donors. Sometimes scientists will have to adapt their research to respond to policy or funding changes outside of their control. These are examples of policy constraints, or external constraints on scientific research. As a scientist, should you simply go with the flow? Or should you attempt to make your voice heard to the people and groups that affect how and what science is funded? These are important ethical questions about how scientists ought to behave professionally.

I thought 'risk' was a measurable technical concept. How is risk also an ethical issue?
Because risk involves the assessment of states of the world that have been judged desirable or undesirable, it is inseparable from ethics. Deciding how to weigh or balance risks, and ultimately how to proceed in light of risks, will necessarily involve ethical judgments. Risk is sometimes operationalized or mathematized in environmental science practice, but these risk calculations are just one way of pre-committing to particular ethical positions (e.g., that a potential harm to human health and a potential harm to the habitat of an endangered species can be directly compared). The impacts of these positions still merit careful attention.

Case Study Guide

For each article below, we highlight the text in the article that supplies the case study, indicate which of the ethical themes are emphasized in the case study, and offer sample questions that can be augmented as necessary to emphasize connections with your course.

Case 1				
Citation:	Arquette, M., M. Cole, K. Cook, B. LaFrance, M. Peters, J. Ransom, E. Sargent, V. Smoke, and A. Stairs. (2002). Holistic risk-based environmental decision-making: A native perspective. *Environmental Health Perspectives* 110(S2): 259-264.			
See:	*pp. 259–261, from "Risk assessment…" to "into any assessment or risk-management scenario"*			
Ethical emphases:	*Risk*	*Expertise*		*Policy Constraints*
Relevant Questions:	1. How do different scientific disciplines view the importance of involving non- scientists in scientific research?			
	2. How do different scientific disciplines understand how to express risk?			
	3. What are some of the different views on how policy constraints should shape research?			

Case 2				
Citation:	Oreskes, N. (2004). Science and public policy: what's proof got to do with it? *Environmental Science & Policy* 7: 369–383.			
See:	*pp. 372–375, from "Rachel Carson and Silent Spring"* *pp. 376–379, from "From DDT to global warming: the unfulfilled promise of ATOC"*			
Ethical emphases:	*Risk*		*Non-human Impacts*	*Policy Constraints*
Relevant Questions:	1. What does the Rachel Carson case study reveal about value-based trade-offs between *good science* and *good policy*?			
	2. What can we learn from the President's Science Advisory Committee about evaluating scientific evidence in the context of conflicting values?			
	3. How do the non-human impacts of ATOC influence the debate between the different environmental scientists involved—specifically, the oceanographers who defend ATOC and the biologists who criticize it?			

Case 3				
Citation:	Elliott, K. C. (2009). The ethical significance of language in the environmental sciences: case studies from pollution research. *Ethics, Place & Environment* 12(2): 157–173.			
See:	*pp. 159–160, from "The occurrence of endocrine disruption"*			
Ethical emphases:			*Non-human Impacts*	*Policy Constraints*
Relevant Questions:	1. How do different agency definitions of 'endocrine disruption' reflect different views on the way that policies should manage chemicals with unknown biological effects?			
	2. In what way and to what extent should endocrine disruption in non-human organisms influence regulatory policy?			

Case 4				
Citation:	Sarewitz, D. (2004). How science makes environmental controversies worse. *Environmental Science & Policy* 7: 385–403.			
See:	*p. 390, from "For example, consider the controversy" to "biologists' values were not," and especially from "Oceanographers working on the experiment" to "the potential benefits of ATOC (Oreskes, 2004)"*			
Ethical emphases:	*Risk*		*Non-human Impacts*	*Policy Constraints*
Relevant Questions:	1. How do different agency definitions of 'endocrine disruption' reflect different views on the way that policies should manage chemicals with unknown biological effects?			
	2. In what way and to what extent should endocrine disruption in non-human organisms influence regulatory policy?			

Case 5				
Citation:	Elliott, K. C, and D. J. McKaughan. (2014). Nonepistemic Values and the Multiple Goals of Science. *Philosophy of Science* 81(1): 1–21.			
See:	*pp. 7–9, from "3. Expedited Risk Assessments" to "generate accurate results"*			
Ethical emphases:	*Risk*	*Expertise*		
Relevant Questions:	1. How do the different approaches to chemical development, testing, and regulation in this case reflect differences in how risk is understood and managed?			
	2. How do the different approaches reflect different views on how scientists should advise policy-makers?			

Case 6				
Citation:	Vaidyanathan, G. (2014). Can humans and nature coexist? *Scientific American*. November 10. Accessed online: < http://www.scientificamerican.com/article/can-humans-and-nature-coexist1/>.			
See:	*full article, but especially the section "Bumping heads over the bumphead parrotfish"*			
Ethical emphases:	*Risk*		*Non-human Impacts*	
Relevant Questions:	*1.* How does the intrinsic value of non-human organisms (i.e., the value of these organisms in and of themselves without regard for humans) figure into the debate between traditional conservationists and the New Conservationists?			
	2. According to the New Conservationists, what are the risks to non-human organisms if we do not decouple nature from the economy?			

Instructions for Developing Dialogue Prompts

Overview[18]

The primary goal of this curriculum is to help you learn about values and responsibility issues that are important in interdisciplinary environmental science. One key component is a class discussion about these issues, which will be structured by "prompts" (i.e., statements serving as discussion starters) the class will design. These prompts will express important standpoints that vary across scientists and stakeholders working on environmental problems in your specific interdisciplinary context. Dialogue about how much and why one agrees with these prompts will give participants an opportunity to articulate their own standpoints and discuss them. A successful dialogue is one in which the participants share their own disciplinary or professional worldview, learn about the worldviews of their collaborators, and come to see the research problem(s) they are addressing through each other's eyes.

These instructions describe how the class will move from thinking broadly about values and responsibility issues, based on earlier general discussions and examination of case studies, to more focused, structured identification of specific issues that are especially important to the group. After general discussion of the nature and development of dialogue prompts, we describe a step-by-step process for groups to follow in developing their own prompts.

The Dialogue Instrument and Its Modules

The collection of prompts the class assembles is a dialogue instrument organized into a set of thematic modules, each of which concerns an important theme related to values and responsibility in interdisciplinary environmental science. The number of modules will vary, depending on the number of themes the group identifies. Many who use this curriculum concentrate on the four themes we have identified (namely, risk, expertise, non-human impacts, and policy constraints), developing one module for each of these themes; however, groups are also welcome to identify their own themes that relate to values and responsibility and build modules for them. For each of the modules developed, it is helpful to express the theme as a question—the *core question*. The module will then be filled out with specific dialogue prompts known as *probing statements*, each of which expresses a view on a particular aspect of the module theme.

For example, in our sample module "Risk", our core question is, "How should risk be conveyed to policy- makers?" This question is developed with four probing statements, each of which

[18] For related discussion of the issues in this document, see the Looney et al. (2013), which is found linked from the last page of this document. The approach described in this document is known elsewhere as the "Toolbox approach" and is related to work done by the Toolbox Dialogue Initiative, http://tdi.msu.edu/.

expresses a view about an aspect of risk, for example, “Risks identified by people directly affected by a policy should be the primary concern for policy-makers.” This is the kind of issue we use to structure the dialogue. We call issues like this *dialogue issues*.

What Exactly Is a Dialogue Issue?

Not all issues that divide collaborators are appropriate for use as dialogue issues. Dialogue issues should help identify challenges that can divide investigators along disciplinary lines. The goal is a focused and structured conversation about such challenges that will enable students representing multiple disciplines to be more thoughtful when they engage in interdisciplinary collaboration. This ability is a valuable professional skill. Four characteristics make issues appropriate for inclusion in the dialogue:

1. *They are important in many different disciplines.*

   Dialogue issues are *boundary objects*—they should be issues that members of your class all care about, even though their perspectives on them may differ. Given this, these issues should not be particular to just one discipline or be issues that are unfamiliar or perhaps unrecognizable to members of other disciplines. To locate them, the class will need to abstract away from the specific details of a particular disciplinary perspective by considering how fundamental elements of a particular discipline might intersect or share common foci with other disciplines. For example, instead of discussing how anthropologists incorporate traditional ecological knowledge in their studies, you could focus instead on how different forms of non-scientists’ knowledge can and should be used in research. And instead of talking about the specific ways in which hypotheses figure (or not) into your scientific practice, you could discuss whether or not scientific research must be hypothesis-driven.

2. *They are conceptual.*

   The issues should concern *conceptual* aspects of collaborative, interdisciplinary research. That is, they involve aspects of research that pertain to how researchers classify and organize phenomena of interest. When you examine a research problem, certain things will stand out for you that will not stand out for someone from another discipline. For example, consider the issue of removing a dam to restore lost salmon habitat: if you are an ecologist, you might examine the impacts on the fish, whereas if you are an economist, you might be concerned with the economic impacts of dam removal on the surrounding human populations. What stands out for you as a critical aspect of the problem will be a function of what you are trained to see, and what you are trained to see will include the considerations you deem relevant to your research. Differences among what are classified as relevant to understanding the problem can lead to disagreement (or worse) among collaborators, so learning about these differences in advance in a dialogue setting can help groups function more effectively by identifying potholes in the road before they hit them. This will require that you carefully reflect on the ideas underlying basic assumptions and priorities in your scientific training. Concepts such as population, harm, testability, and stability are widely used concepts that are developed into assumptions such as “the only relevant harms are

ones that can be expressed in economic terms."

3. *They concern norms, standards, and core beliefs*

   Dialogue issues typically highlight norms or standards that apply to research and practice across disciplines that contribute to environmental science. They could concern what you take to be fundamental features of good scientific practice in environmental science, such as addressing uncertainty or considering a variety of perspectives on a complex issue. They could also address important disciplinary standards, such as being objective or valuing the application of scientific results to real-world problems. In most cases, the issues won't be purely factual, since factual issues can often be settled by accurate observation and in such a case will not typically serve to promote vigorous dialogue. Values and ethics dialogues are primarily about the way the world should be, not the way it is.

4. *There is no objectively right answer.*

   Importantly, dialogue issues should not be issues for which there is a *right* answer—you are choosing questions that are difficult because judgments of the best answer will depend on one's values and priorities. These questions should be open to conversations that involve a variety of perspectives and informed opinions. Discussions about values and responsibility address the questions that remain after we set aside true-or-false questions that have been settled with data or could be settled later with data.

   Try to avoid designing prompts around narrow complaints about your own experiences. If expressed in the form of a probing statement, e.g., "My administration does not adequately recognize interdisciplinary scholarship" or "The first author on our papers should be the one who did the most work, whether they conceived of the paper idea or not," the type of dialogue prompted might devolve into specific complaints about incentives and infrastructure, or worse, into a business meeting. Because they are concrete, these prompts are unlikely to reveal anything especially interesting about one's research or professional worldview, given that they focus less on how one thinks about the research space and more on specific rules for acting in that space.

   That said, if there are relatively concrete issues that strike your class as important enough to be represented in the dialogue, then feel free to include them and see how it goes! We encourage each class to customize the Values and Responsibility in Interdisciplinary Environmental Science curriculum to meet their own needs.

Constructing Dialogue Prompts

The main business of the dialogue prompts is to get people talking. *A bad dialogue prompt is one that people ignore.*

The core questions are open-ended questions that express important dialogue issues related to values and responsibility. We have included five such issues in the Generic Dialogue Instrument (below, or click **here** or in the **Table of Contents**) that correspond to our four ethical themes: risk, expertise, non-human impacts, and policy constraints. There are additional issues similar to these in interdisciplinary environmental science, and you are encouraged to identify issues that are especially important to the areas and interests represented in your class.

While the job of the core question is to get the participants thinking about the dialogue issue, the job of a probing statement is to provoke people to discuss the specific issue it expresses. Given this, it should not be wishy-washy or too easy to ignore. There are several heuristics to writing a good probing statement. These are:

1. *A probing statement should take a stand on a specific issue.*

   Remember that dialogue participants can agree with it *or* disagree with it, so whether it expresses your view or not is unimportant. What is important is that it expresses a particular position, so that respondents can position themselves with respect to this starting point. Since respondents need to read these statements and agree or disagree, statements must be written as clearly positive or negative assertions ("Interdisciplinary environmental scientists should be environmental advocates" or "Interdisciplinary environmental scientists should not be environmental advocates"), and cannot be wishy-washy or non-committal in a way that makes agreement or disagreement confusing for the respondent ("Interdisciplinary environmental scientists may or may not be environmental advocates").

2. *Probing statements can include ambiguous or vague terms (e.g., 'values' or 'risk').*

   The idea here is that a vague (or imprecise) statement, or one that can be interpreted in various ways, can provoke conversation and encourage participants to sharpen its meaning. In doing this, other participants will chime in with their interpretations, resulting in the discovery of multiple different ways of thinking about the specific issue expressed. However, it is important that the vague or ambiguous term (e.g., 'values', 'risk') be a central one, that is, one that is useful and important. (For social scientists this will run against years of training to avoid ambiguous or vague terms in survey questions. But the primary purpose of the dialogue prompts in this case is to provoke people to critically reflect on and possibly change their views, not to simply report what they already believe.)

3. *Probing statements are effectively spiced up with extreme terms like 'must', 'none', 'all', etc.*

   As with vagueness and ambiguity, strong rhetoric will encourage the participants to react to the prompt. Be careful not to make the prompt so easy to agree or disagree with that people move past it too quickly. An example of a good extreme prompt would be one

where some of the participants react negatively to it as stated and then the discussion leads the group to scale back the force of the claim to the point where they would be inclined to change their opinion in a positive direction (i.e., shift from *disagree* to *agree*).

4. *Probing statements should be stated simply to avoid logical complexity.*

   If you include terms that introduce logical complexity into the prompt (e.g., 'and', 'or', 'if ... then'), it will be less clear what a person's reaction to the prompt means. In this vein, each prompt should make only one claim, e.g., "Animal welfare is a key consideration when designing good environmental policies." A prompt that has two parts, like a so-called "double-barreled question," confuses respondents by making them give one response to a statement with multiple independent components, e.g., "Animal welfare and endangered species conservation are key considerations when designing good environmental policies." A positive response to this statement would endorse both claims: animal welfare is a key consideration *and* endangered species conservation is a key consideration. If a respondent agrees with only one component, rather than both, then they will have to disagree with the entire statement. This makes constructive dialogue confusing.

5. *Include a Likert-type response scale*.

   Each probing statement in the Generic Dialogue Instrument is associated with a Likert-like response scale that ranges from "strongly disagree" to "strongly agree," with the opt-out choices "don't know" and "not applicable." It is useful to include these in your modules for two reasons: (a) they invite your participants to *react* to the prompts, engaging with them by marking a response on the scale, and (b) they can uncover disagreement, which can spur dialogue.

The Process in General: Analysis and Synthesis

By now, you have had the chance to think in general about the values and responsibility dimensions of your interdisciplinary context. It is important to spend time at the beginning of a dialogue development process getting oriented to these dimensions. Once you have done this, it is time to start thinking about writing dialogue prompts.

In general, the process is one of *analysis* followed by *synthesis*. The analysis stage is devoted to identifying candidate dialogue issues related to values and responsibility in your particular interdisciplinary context. As a class, you should analyze articles, experiences, case studies, and your own class discussions to identify the specific values and responsibility issues that matter to you. The synthesis stage concerns taking what the analysis stage gives you—which is often quite a lot—and combining and condensing it down into a more manageable and focused form. This synthesis stage should involve identifying module-level issues that can be articulated as core questions, along with more specific issues that can be expressed as probing statements. Together, these are the dialogue prompts that constitute the modules you'll discuss in your dialogue.

In the end, you will want 2 to 4 modules, each of which should contain a core question and

between 5 and 7 prompts. Keep in mind that module discussions tend to run about 30 minutes, as long as the group is interdisciplinary and talkative.

The Process in Particular: Step-by-Step

A key part of this curriculum is the transition between reading and talking in general about the values and responsibility dimensions of your interdisciplinary context to isolating and articulating specific standpoints on each dialogue issue in your particular context. The commitments you're after are fundamental, framing the way in which people in your context think of values and responsibility. In this section, we provide step-by-step instructions for moving through this transition, organized into the *analysis stage* and the *synthesis stage.*

1. **Analysis Stage:** *These can be done individually and compiled later, or done collectively as a group*.

    - In reviewing the reading materials assigned by your instructor on the values and responsibility dimensions of your particular interdisciplinary context and in reflecting on your class discussions, write down the concepts, ideas, and issues that were observed. For example, if you discussed the idea of *risk*, you might write down *uncertainty*, *trade-offs*, *negative consequences*, *trust, intellectual property*, etc.

    - Don't filter at this point—aim to be as comprehensive as possible on your list.

    - Once you have compiled this list, phrase each of the items in the form of a statement, or perhaps several statements if there are different aspects of the concept or idea that are relevant. These become candidates for dialogue prompts.

    - Review the list to see if there are connections or extensions that appear when looking at the prompts as a group. These connections and extensions are also candidates for additional dialogue prompts (e.g., a new prompt that connects a prompt about uncertainty to another prompt about trust).

2. **Synthesis Stage:** *This stage begins after the analysis stage has yielded a long list of statements expressing values and responsibility issues*

    - Group all of the statements together according to topic.

    - Express the topic in the form of a general question: these will be candidate core questions.

    - Review each statement group to see if it contains any repetition. If so, eliminate the repetition.

    - Review each statement group to see if there are prompts that, while not repetitive, cover more or less the same ground. If so, select one to keep and discard the others. The goal is not to address every issue, but rather to address important issues that are

different enough from one another to cover a broad range of possible commitments in each module. Think here of a constellation—you want the group to be able to relate the probing statements in different ways, revealing different and potentially surprising connections.

- If two statements can be combined into one without introducing undue complexity, combine them.

- Reduce the number of prompts for each module idea to the 5 to 7 most promising ones.

- Name each module with its theme, and include the probing statements with their Likert-type response scales under the core question for the module.

There are several ways to choose the prompts that constitute a module. For example, the instructor could select from among the prompts you identify. Alternatively, the prompts could be selected using a more democratic process, with voting aimed to reduce the number to a manageable total. (This might be required even at the end of a synthesis stage, if the number of original prompts is too great.)

Generic Dialogue Instrument

Risk Module

Risk

Core Question: How should risk be conveyed to policy-makers?

1. Risk is an objective calculation of the probability of some uncertain state of affairs.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

2. Policy-makers should always attend to the risks identified by scientific experts.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

3. Risks identified by people directly affected by a policy should be the primary concern for policy-makers.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

4. Policy-makers should focus on risks that matter to voting citizens, whether or not they are directly affected by a policy.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

Expertise #1 Module

Expertise #1

Core Question: Who should participate in the research phase of interdisciplinary environmental science?

1. To have relevant knowledge for interdisciplinary environmental science, people must have formal academic credentials.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

2. Experts who are not academics, such as indigenous elders, have knowledge that should impact interdisciplinary environmental science research.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

Expertise #2 Module

Expertise #2

Core Question: How should interdisciplinary environmental scientists contribute to policy-making?

1. Interdisciplinary environmental scientists must keep their personal values out of their role in the policy process.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

2. Interdisciplinary environmental scientists should be environmental advocates.
   Disagree *Agree*

   1 2 3 4 5 I don't know N/A

3. Interdisciplinary environmental scientists should only provide information to policy-makers based on their scientific expertise.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

Non-human Impacts Module

Non-human Impacts

Core Question: Should interdisciplinary environmental scientists be concerned with how their research impacts the interests of non-human organisms and collectives?

1. Non-human animals and plants should be protected for their own sake.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

2. Non-human collectives, such as landscapes, biomes, or ecosystems, should be protected for their own sake.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

3. It is a scientist's responsibility to protect anything non-human for its own sake.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

4. Non-human interests need only be protected when they have an impact on human interests.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

Policy Constraints Module

Policy Constraints

Core Question: How should interdisciplinary environmental scientists interact with the policies that constrain their research?

1. Interdisciplinary environmental scientists have an obligation to make their research policy-relevant.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

2. Interdisciplinary environmental scientists should advocate against policies that limit scientific research they value.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

3. Society has an obligation to fund interdisciplinary environmental research that scientists deem to have intellectual merit.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

4. Elected officials should set funding priorities in interdisciplinary environmental science.

   Disagree *Agree*
   1 2 3 4 5 I don't know N/A

DIY Toolbox Workshops: Looney et al. (2013)

The process of delivering a Toolbox workshop is discussed in detail in Looney et al. (2013), a book chapter written to enable people to run their own Toolbox workshop.

Looney, C., Donovan, S., O'Rourke, M., Crowley, S., Eigenbrode, S. D., Rotschy, L., Bosque-Pérez, N., Wulfhorst, J. D. (2013). Seeing through the eyes of collaborators: Using Toolbox workshops to enhance cross-disciplinary communication. In M. O'Rourke, S. Crowley, S. D. Eigenbrode, and J. D. Wulfhorst (Eds.), *Enhancing Communication and Collaboration in Interdisciplinary Research*. Thousand Oaks, CA: Sage Publications.

Link: *<URL>*