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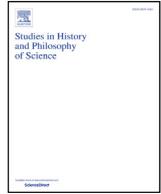
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Improving philosophical dialogue interventions to better resolve problematic value pluralism in collaborative environmental science



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ABSTRACT

Environmental problems often outstrip the abilities of any single scientist to understand, much less address them. As a result, collaborations within, across, and beyond the environmental sciences are an increasingly important part of the environmental science landscape. Here, we explore an insufficiently recognized and particularly challenging barrier to collaborative environmental science: value pluralism, the presence of non-trivial differences in the values that collaborators bring to bear on project decisions. We argue that resolving the obstacles posed by value pluralism to collaborative environmental science requires detecting and coordinating the underlying problematic value differences. We identify five ways that a team might coordinate their problematic value differences and argue that, whichever mode is adopted, it ought to be governed by participatory virtues, pragmatic resolve, and moral concern. Relying on our experiences with the Toolbox Dialogue Initiative, as well as with other dialogical approaches that support team inquiry, we defend the claim that philosophical dialogue among collaborators can go a long way towards helping teams of environmental scientists and fellow travelers detect their problematic value differences. Where dialogical approaches fare less well is in helping teams coordinate these differences. We close by describing several principles for augmenting philosophical dialogue with other methods, and we list several of these methods in an appendix with brief descriptions and links for further learning. Overall, the article makes three main contributions to the research collaboration and values in science literatures: (1) It deepens our understanding of problematic value pluralism in team science; (2) It provides actionable guidance and methods for improving values-oriented philosophical dialogue interventions; and (3) It demonstrates one way of doing engaged philosophy.

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1. Introduction

Good collaborative environmental science (CES) requires ongoing conversations among collaborators about their values and how those values might ‘play well together.’ Our goal in this article is to work out in some detail why such conversations are necessary and how they might be facilitated by philosophers. To do so we draw on two literatures that have not interacted as much as they might. The first is work on the nature and facilitation of research collaborations (e.g., interdisciplinarity, the science of team science, etc.). The second is ongoing discussions of the roles of values in science (e.g., Matthew Brown, Kevin Elliot, etc.).

We begin, in section 2, by drawing on the research collaboration literature to summarize the stated benefits and challenges of CES and to suggest that this literature gives less consideration to the *values* of collaborators than it should. This leads us, in section 3, to use the values in science literature to discuss the ways in which plural values can undermine the ethical, epistemic, and instrumental goals of research collaborations—a situation we call “problematically plural values” (PPV). In section 4, we offer a simple model of two stages required to resolve PPV: collaborators must (1) detect and (2) coordinate their problematically plural values. Section 5 describes one family of approaches for supporting CES teams through these two stages: philosophical dialogue interventions. Then, sections 6 and 7 evaluate how well extant versions of these interventions fare in providing this assistance. Finally, in section 8, we identify resources that could augment philosophically-informed dialogue in both stages.

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As the reader may have appreciated from our roadmap, our emphasis shifts gears at section 5. It quickly moves from a general solution to a particular approach for implementing the solution. This move may surprise readers who expect more thought experiments, logical proofs, theoretical triangulation, or historical case studies to validate our analysis. Our move to a practical solution is intentional because it models one form of philosophy that we value: engaged philosophy. In the current mode, philosophers *qua* philosophers can apply our philosophical analyses clearly and immediately to the real-world topics of interest. This mode of engaged philosophy contributes not only to socio-ecological issues but also to philosophical knowledge, because application of an analysis in its target setting is one of the most rigorous tests of its quality. Thus, our article serves as an example of engaged philosophy of environmental science (see section 5.1; [Plaisance & Elliott, in press](#)).

2. The need for and challenges of doing collaborative environmental science

2.1. The need for collaborative environmental science

Collaborative environmental science (CES) covers an array of scientific practices undertaken by a team of two or more people to create knowledge about the environment, broadly understood. Such knowledge is pursued for many reasons ranging from pure curiosity (basic research) to immediate action (action research). Collaboration is the norm for conducting environmental science ([Goring et al., 2014](#)), and these collaborators could include academics from different disciplines as well as NGO and agency representatives and community members. The increased prevalence of CES partially results from the demonstrated epistemic, ethical, and instrumental advantages of collaboration when addressing complex environmental problems. Epistemically, science teams have been able to understand more facets of these complex problems than individuals ([Love, 2008](#)). Ethically, participatory (e.g., trans-disciplinary) science teams have expanded justice by allowing direct users of the knowledge to shape the research ([Cargo & Mercer, 2008](#); [Lynn, 2000](#); [Sullivan & Lloyd, 2006](#)). Instrumentally, science teams generally have more equipment, money, locations, and infrastructure than individuals can access alone ([Hagstrom, 1964](#); [Lewis, Ross, & Holden, 2012](#)).

2.2. The challenges with collaborative environmental science

But these advantages come with costs arising from inherent features of collaborative science. One of those inherent features is *value pluralism*, a collection of diverse values relevant to the CES project. In collaborative work, these diverse values are imported and continue evolving with the collaborators who, even if they are similar in many ways, will likely hold at least some relevant values differently.

Value pluralism is both a resource and a hindrance to CES. It is the diversity of values among collaborators that drives many of the epistemic, ethical, and instrumental advantages of team research listed above. This is because in determining what is worth pursuing, values also establish what is worth paying attention to and developing along the way. The expansion of the team's attention and development efforts enables collaborators to seize and build upon epistemic, ethical, and instrumental opportunities. Despite advantages of value pluralism for CES, it becomes a problem when it interferes with project requirements. Examples include when value pluralism interferes with project progress and when it motivates ethical transgressions. That is, problematic value pluralism can result in pragmatic and moral failings, among other issues.

[Mayer et al. \(2017\)](#) describe an example of plural values interfering with project requirements. They interviewed climate scientists who use computational modeling to assess climate risk management scenarios. For instance, climate scientists may attempt an integrated assessment model, which combines information from the environmental and economic sciences to forecast the consequences of the proposals at hand. But while the model is an algorithm, the scientific process is not. There is no established and detailed recipe for building these models or tools; rather, at various points of their development, judgment is needed. Mayer and colleagues show that decisions must be made, and these decisions are, at least often, based on values.

Let's get specific. Suppose that one team member is deeply concerned about the wellbeing of current generations, whereas another prioritizes the interests of future generations. This difference may manifest itself at various stages of the collaboration. One is in decisions about how to compare present costs and benefits to future costs and benefits. How do, say, the costs of cuts in greenhouse gas emissions now compare to the costs of cuts 20 years down the road? If one collaborator is deeply concerned about current generations, she may be more inclined to treat future costs as less significant compared to present costs. The second collaborator, on the other hand, may be more apt to treat the two costs as being on par. The two may therefore disagree about what "discount rate" to deploy.¹ Should the team deploy a 5% discount rate, as is often used by economists when thinking about climate change? This would align more closely with the concerns of the first collaborator. Or should the team use perhaps a 1% discount rate, as found in the widely discussed Stern report?² This would fit more closely with the priorities of the second collaborator. This disagreement could bring the modeling process to a halt, interfering with project progress.³

The example just outlined illustrates possible problems in doing CES that arise from differences in values held by collaborators. They are thus examples of the sort that ought to figure prominently in the burgeoning literatures of interdisciplinarity and team science. Indeed, the lists of challenges and barriers to doing collaborative science in the research collaboration literature is long. They include institutional obstacles, disciplinary barriers, difficulties stemming from domain-specificity, and metacognitive hindrances ([Briester, 2016](#); [Donovan, 2020](#); [MacLeod, 2018](#); [National Research Council, 2004](#), [National Research Council et al., 2015](#); [P. Robinson, Genskow, Shaw, & Shepard, 2012](#); [Tuana, 2013](#)). [Morse, Nielsen-](#)

¹ For philosophical discussion, see [Broome \(1994\)](#).

² For more discount rates and the Stern report, see [Elliott \(2017\)](#), pp. 75–77.

³ A helpful reviewer noted that this example—disagreement over two discount rates due to differential concern for future generations—may not exemplify the difficult value pluralism we seek to describe in this article, because this case is actually quite easy to resolve by simply running the model with different discount rates. While the proposed solution is possible, we disagree that it will always, and easily, resolve the impasse. This is for at least two reasons. First, external project sponsors may require a clear answer from the study, and two model runs presented as equally valid would essentially prevent the team from completing the project. Second, one or both collaborators may have proposed their discount rate on **moral** grounds that they are not willing to concede by allowing the other model to move forward. For example, one collaborator may champion a utilitarian form of impartiality concerning present and future generations (as in Stern's 2007 report) and may thus feel quite strongly that operating with a non-zero discount rate is wrong—**morally** wrong. She may refuse to adopt a "run the model twice" approach. In any event, as the reviewer helpfully notes, even in cases where a collaborator's moral values and beliefs might avail her of the option of running the model twice, the issue of which discount rate to use is often bound up with a swarm of beliefs and values. This can make an adequate solution to the disagreement quite difficult to achieve. When conditions like the ones described in this footnote occur, we are certainly in the realm of disagreements that call for strategies like those discussed in this paper.

Table 1
Descriptions and examples of several types of topical and functional values.

Type of Value	Label	Description	Example from CES
Topical	Epistemic	About knowledge and how to get it	During the Flint Water Crisis, state scientists did not value the evidence collected by citizens (Michigan Civil Rights Commission, 2017; Valles et al., 2019).
Topical	Non-epistemic	About something other than knowledge and how to get it	Sustainability researchers undertook the Coweeta Listening Project to democratize local science (Burke & Heynen, 2014).
Functional	Immediate Enjoyment	Near-term pleasure from an activity or its goal	Many environmental scientists in Colorado communicate their work to the public because they enjoy it (Andrews, Weaver, Hanley, Shamatha, & Melton, 2018).
Functional	Attitudes	Dispositions to consider some things good or bad	Sustainability scientists must respect the attitudes of Indigenous scientists toward the work, e.g., stewardship and caretaking (Whyte et al., 2015).
Functional	Desires & Goals	A (considered or instinctual) attraction to a future state	Sharing data should be a goal of environmental science projects (Soranno et al., 2014).
Functional	Guiding Ideals	Deeply held visions of a perfect future	Environmental scientists often use metaphors that imply an ideal state of nature, e.g., “alien” species and ecosystem “health” (Carolan, 2006).
Functional	Attributes	Meritorious or worthy qualities of something or someone	Conservation biologists value the diversity attribute of life (Odenbaugh, 2003).
Functional	Institutional Structures	Preferred norms, policies, and strategies for societal arrangements	Equitable and inclusive civic engagement processes can improve food systems research and its relationship with policy (Forcone & Sweeney, 2018).
Functional	Ideologies-Value Systems-Worldviews	Interconnected, valenced beliefs about many topics	Environmental scientists in Japan have extended the open science research worldview to include principles for community-based participatory research (Kondo et al., 2019).
Functional	Facts	Descriptions of values (not a guide for action but an observation of the state of affairs)	Community scholars are learning what Flint, MI, residents desire in their food system (Belisle-Toler, Hodbod, & Wentworth, 2020).

Pincus, Force, & Wulfhorst, 2007 list 34 barriers to collaborative interdisciplinary research. Almost completely missing from these lists, however, is the sort of values problem at play in our example.⁴ With that said, there are exceptions. Eigenbrode et al. (2007), for example, explicitly mention value differences in their discussion of the barriers and challenges to doing collaborative, interdisciplinary research. But they emphasize problems that emerge when collaborators have different views **about** the nature and role of values in science, viz., the metaphysics and epistemology of values. What is underemphasized in the research collaboration literature, and what we think the values in science literature can contribute, is a nuanced and practical discussion of the problems that emerge when collaborators’ **values themselves** directly conflict or otherwise violate project requirements like choosing a discount rate.

3. When does value pluralism pose problems for CES?

3.1. Defining value pluralism

Above, we characterized “value pluralism” as a collection of diverse values relevant to a CES project, but this shorthand is too vague and self-referential to help us identify when and why value pluralism causes problems for the project. First, we need to clarify what “values” are. Given our focus in trying to understand the **impacts** of value pluralism on CES practices, we follow Brown (2020) in defining “values” functionally, that is, by the **roles** they play in our scientific activities. Brown proposes, “Values can be understood to an extent behaviorally, as the aims, objects, or ends

that activity is directed towards” (p.101–102). This is largely consistent with but sharper than Kevin Elliott’s (2017) definition, wherein “Broadly speaking, a value is something that is desirable or worthy of pursuit” (p.11).

While these two definitions emphasize what values do, they also imply what values can be about. That is, according to both, values have important roles to play in guiding our actions, **and** they have contents in domains of human activity. Thus, there are at least two ways of describing the types of values relevant to CES projects: by their topical contents and by their functions.⁵ Each schema helps to reveal different roots of problems with value pluralism.

In terms of topical content, philosophers of science often start with a divide between epistemic and non-epistemic values, where the former refer to values pertaining to knowledge and the latter to other things. Non-epistemic values therefore cover many, many topical domains such as the ethical/moral, social, political, and pragmatic, to name just a few. Such labels pick out *topical* types of values. Table 1 gives descriptions and examples of topical-type values as they may occur in CES projects.

In terms of their *functional* roles as guides for action, Brown (2020, pp. 116–123) offers a list of eight types of values. Values provide:

1. Immediate Enjoyment
2. Attitudes
3. Desires & Goals

⁴ The authors do list “Preference for ‘traditional’ disciplinary work” as a barrier but it is not named or discussed as a value.

⁵ Tadaki et al. (2017) survey the values literature and distill it into four ways of defining values: values as (1) magnitude of preference, (2) contribution to a goal, (3) individual priorities, and (4) relations. We contend these four categories actually mark different functions of values and therefore are subsumed by Brown’s (2020) typology.

4. Guiding Ideals
5. Attributes
6. Institutional Structures
7. Ideologies-Value Systems-Worldviews, and
8. Facts.

Table 1 also describes and exemplifies each of these in relation to CES. As Brown's list illustrates, "values" in this functional sense is an umbrella term that encompasses a wide variety of states and structures that guide decisions, including preferences, desires, goals, ideals, and ideologies. What matters in a functional view of values is not so much what the value is **about** but how it impacts one's **actions**. For instance, values for immediate enjoyment could change quickly with circumstances, but entire value systems have immense inertia and will likely remain influential throughout the project. Here, we adopt this 'big tent' conception of values as guides for action not because we think that there are no important differences between, say, preferences and long-term goals, or epistemic and ethical values. We emphasize function to highlight their similarities regarding the challenges they pose for CES and the mechanisms for answering those challenges.

Having defined "values," as used in this article, we must now define "pluralism." In this article, we focus on the type of pluralism that arises from involving multiple people in a joint activity. Certainly, individuals hold many values that guide their decisions and actions, and these values can change with time and local context; value pluralism within individuals is real and relevant in CES.⁶ While we will touch on these dynamics and how they play in team interactions, we focus on value differences arising from two or more individuals. More formally:

Value pluralism is true within a team if and only if participants P_1, P_2, \dots and/or P_n hold different sets of values in Situation S_n that are relevant to their joint activity.⁷

There are at least two ways that sets of values can differ. First, *strong* value pluralism arises when one member of the team values something that another member of the team doesn't value at all, or even may disvalue; for example, perhaps P_1 values deer welfare while P_2 doesn't (maybe valuing legislative compliance instead) (Davies & White, 2012). This form of value pluralism can be hard to detect when two people refer to different things by the same value-label, e.g., sustainability as resource sufficiency vs. functional integrity (P. B. Thompson, 2013). Second, *weak* value pluralism indicates that at least one of the values in the sets is weighted or ranked differently than its counterpart in other sets, e.g., justice is more important to me than it is to you. In short, two team members may disagree about what is valuable (strong value pluralism) or how valuable it is (weak value pluralism).

It may seem obvious to the most casual observer that value pluralism is almost certain in a collaborative project given the diversity of people, activities, and situations involved. However, work in cross-cultural psychology and sociology suggests that there is considerable agreement across individuals and across countries in

"basic values." For instance, in their analysis of over 40,000 teachers and students from 53 countries (Fischer, Vaclair, Fontaine, & Schwartz, 2010), found an astonishingly high correlation ($r = 0.98$) between individual students' and individual teachers' responses to the Schwartz Value Survey, which is a psychological measure of ten basic values such as Universalism (encompassing welfare for all people and for nature), Benevolence (regarding with the welfare of those with whom one often interacts), and Security (including the safety and stability of society) (Schwartz, 1994, 2012). The upshot is that value pluralism may not be as common or as serious in CES as we might expect it to be.

In response, we accept that collaborators may often share basic, relevant values. However, we disagree that such situations necessarily avoid problematic value pluralism. People may agree about basic values like human welfare disagreeing about non-basic values and on how those values play out in specific contexts. For example, to channel some work from empirical moral psychology, political liberals and conservatives may assign similar weights to the value of caring for others while having substantially different beliefs about how to achieve, sustain, and promote care for others (J. Graham, Haidt, & Nosek, 2009). This reveals distinct instrumental values associated with care. Or consider a slightly different version of the climate modeling example above. Let's say both modelers prize the welfare of future generations. They may still disagree about how to implement that value in the model: should the discount rate be 1% or 3%? Because their values for implementing future welfare are relevant to the project, even as they share a basic value for future welfare, they still hold a plurality of values about implementing it.

Moreover, other work provides indirect evidence there are wide differences in values among CES participants. Empirical studies exploring the philosophical commitments of practicing scientists suggest that there are significant differences among scientists. Some of these differences track disciplinary boundaries, such as views related to forms of scientific realism (Beebe & Dellsén, 2020). And some track gender, including attitudes pertaining to values in science (Steel, Gonnerman, & O'Rourke, 2017; Steel, Gonnerman, McCright, & Bavli, 2018). This work suggests that there is a wide variety of positions taken by scientists on the metaphysical, epistemological, and axiological dimensions of science *qua* science (B. Robinson, Gonnerman, & O'Rourke, 2019). It would be surprising if this variety were to stop at the borders of the more abstract philosophical dimensions of science, failing to extend to the values used day to day.

3.2. Problematically plural values: causes & effects

Value pluralism can cause problems for CES projects when the differences in values lead the team to undermine norms that define project success, even the simple norm that the project should be completed. In our view, some of these norms pre-exist a project while others are created along the way. An example of a pre-existing norm is that a CES project should produce new knowledge. In contrast, the kind of new knowledge that should be created is a norm that typically the team develops as they work together.⁸

⁶ On instability in economic valuations, see Ariely, Loewenstein, and Prelec (2006).

⁷ The definition offered here is an *internal* one focusing on values held by team members. Since collaborative teams exist within broader structures (e.g., cultural, institutional, moral) it is possible for there to be an *external* notion of values pluralism in which team values differ from some prevailing institutional (e.g., university, IRB, funding agency, etc.) values. Because we are focused on team-based interventions, rather than trace internal vs external values pluralism, we discuss external value sources as part of the larger milieu of project constraints or definitions of success (see section 3.2).

⁸ We thank one of our reviewers and an editor for noting that two dynamics complicate the team's ability to understand and fulfill these project norms. First, norms can originate from external and/or internal sources. External norms are harder if not impossible to change; below we mention at least one norm—respect rather than oppression—that we believe holds regardless of project particulars. Second, pre-existing and developed norms become harder to fulfill as the team attempts to put pre-existing norms into practice. Layers of complexity are added, for instance, if the team is required to implement a specific values solution (e.g., an ethical framework) that is chosen before encountering actual values problems.

Both pre-existing and developed norms can pertain to any number of domains of activity, including the epistemic, social, pragmatic, and moral. In this section, we describe both the causes and effects of problems in these last two domains to illustrate how differences in values, in general, can become problematic for environmental science teams.⁹

3.2.1. Pragmatic problems

Pragmatic problems arise from value pluralism when the (strong or weak) differences in values create conflict or confusion about what to do to move the project forward. This includes cases where proximate values prompt actions that could ultimately undermine distal values. Let's elaborate.

Brown's recent work (2020) explains that, in many cases, problems due to value pluralism arise from "pragmatic incoherence" (p. 130)—situations marked by conflict or confusion about what to do. Brown describes a first kind of pragmatic incoherence:

The conflicts that arise in our everyday values are often not a matter of logical contradiction, a direct conflict between asserting and denying the same claim. Rather, the conflicts are a matter of pragmatic incoherence—our values pull us in different directions, suggest or demand different and incompatible courses of action. (Brown, 2020, p. 130)

Here, Brown is picking out an instrumental or process problem that can arise from value pluralism. As guides for action, differing values often call for different actions. These different actions often conflict if for no other reason than there is usually not enough time to pursue them all. But they may also conflict because what they are about—their topical content—requires conflicting actions.

For example, during the Flint Water Crisis, state-run environmental science prioritized something—perhaps simplicity, speed, state control, or the appearance of compliance—that was not citizen health. The state's motive(s) therefore rationalized using fewer water samples than required, ignoring two lead-laden samples, and disregarding citizen's sensory observations (Michigan Civil Rights Commission, 2017; Valles, Piso, & O'Rourke, 2019). Citizen scientists, however, prioritized citizen health, which led that team to test more samples than required by law, include all valid measurements, and heed citizen reports (Pieper et al., 2018). While we cannot conclude the two studies valued different things, it seems likely because they used directly competing methods. Had these teams been part of the same research project, the pragmatic incoherence of their diverging, value-based methods would have created project problems, perhaps resulting in a project split.

Continuing, Brown describes another form of pragmatic incoherence that occurs when the immediate course of action undermines our ultimate purposes: these are teleological problems of value pluralism. A special case is when values don't suggest an immediate course of action at all, which clearly undermines future goals. Brown continues from above,

There are other ways our values can be pragmatically incoherent as well, when they fail to guide action at all or if they guide it to results we find inherently unsatisfactory. If it is ambiguous what our values would have us do in a particular situation, or if we lack valuations to guide any action whatsoever in a particular case, we are in a situation of pragmatic incoherence. Our values

⁹ While pragmatic and moral problems are not the only kinds of problems that value pluralism can cause, they are two common types that are receiving increasing attention in team science and society at large and are thus worthwhile illustrations.

might be pragmatically incoherent in encountering certain genuinely novel situations. If we act on our values and nonetheless regret our actions, this may [also] generate a state of pragmatic incoherence. (Brown, 2020, p. 130)

Like any action agenda, CES projects are undertaken to accomplish some ultimate goal(s), in this case related to knowledge creation. If a team's plural values fail to prescribe any sort of action toward those goals, or if the actions ultimately undermine those goals, then value pluralism has created pragmatic incoherence—actions (or inactions) have become incompatible with each other. Brown notes that it is possible to be in a state of pragmatic incoherence and not know it, realizing it only later when regret strikes (p.131).

Data sharing in environmental science is a good example of this kind of pragmatic incoherence, which is more subtle and longitudinal than the direct conflict of actions described above. Soranno, Cheruvilil, Elliott, and Montgomery (2014) argue that environmental scientists have an ethical obligation to share their data because they should make their discipline more inclusive. However, data sharing is often delayed until the end of the project and may not be anticipated despite requirements for data management plans. Moreover, pilot data—often required to obtain funding—may inadvertently anchor the project's data in less-accessible formats. Thus, it is not uncommon for data collection, analysis, and storage to begin without the structure and metadata ultimately needed to share the data; these must be added later. Unfortunately, there is often little time and will to complete this final, onerous step even though it is a binding norm for the project. Short-term success in getting the project off the ground can therefore undermine long-term success in data sharing and, ultimately, inclusive environmental science. The short- and long-term values are incoherent.

We follow Brown (2020, pp. 1–248) in calling pragmatically incoherent situations caused by diverse values "values perplexities" (p. 134) because, as Brown observes, this term invites the counterpart to perplexity—inquiry—as a solution, which we will explore in the last section of this article. Values perplexities often arise and fade over time and in different parts of the project as local situations change. For example, a set of values that wasn't relevant can become relevant—maybe data collection requires time away from home, which now involves my family values that weren't involved before—or values can change—maybe I now enjoy virtual meetings more than in-person meetings because of an ongoing pandemic. Thus, teams must constantly navigate new value perplexities.

3.2.2. Moral problems

A second kind of problem can arise from value pluralism when the values ultimately acted upon, or the actions or decisions that they lead to, violate moral standards. To mirror the pragmatic problems, we label these cases "moral incoherences," caused not by values perplexity but what we might call "values disorder." One example of moral incoherence in CES is what we call "research oppression." This occurs when powerful team members impose their research values and consequent activities on less powerful members who do not share those values for research. This imposition violates moral principles of individual and community sovereignty and of respect for persons. Specific research oppressions include tokenism (S. M. Reich & Reich, 2006), participatory research manipulation (Aldridge, 2015; Arnstein, 1969), disciplinary capture (Brister, 2016), disciplinary chauvinism (Giri, 2002), and disciplinary policing (S. M. Reich & Reich, 2006), among others. Research oppression is a problem caused by the conjunction of value

pluralism and the wielding of power by some teammates over others.¹⁰

This situation is, unfortunately, very common with certain groups and perhaps even acceptable under views of research that regard objectivity through empirical proof as the only sign of valid knowledge. For instance, sustainability scientists increasingly appreciate the informational value that Indigenous knowledges provide but ignore the value of these knowledges for enabling the sovereignty of Indigenous peoples themselves (K.-L. Thompson, Lantz, & Ban, 2020; Whyte, 2017). This one-sided value transaction amounts to extracting and exploiting Indigenous research partners. Whyte and many other Indigenous scholars and allies have done extensive work in educating Western sustainability scientists how not to oppress Indigenous scientists when partnering with them (Chief et al., 2015; Chief, Meadow, & Whyte, 2016; Whyte, Brewer, & Johnson, 2015).

Another example of moral incoherence in CES is when researchers choose wrongly among their various values. This is not a case of research oppression because the immorality of the choice does not stem from imposing one's choice upon others. Rather, the chosen option itself is immoral. In these cases, the course of action may be clear and consistent with other values in the project, and it may have been adopted with team consensus; nevertheless, it is the wrong thing to do. Because the moral problem here stems from the implemented value itself, we call these moral incoherences “research transgressions.” Research transgressions can, of course, arise from a single, immoral value or a moral value with immoral consequences. Important for this article is the fact that value pluralism can complicate and amplify this problem. When there are multiple values at play in a project, it is harder to identify consequences of the relevant values and to identify which values may be causing the problem. Research transgression in CES is therefore a problem complicated and amplified by the conjunction of value pluralism and ignorance, vice, or *akrasia* (acting against one's better judgment).

For example, in the Flint Water Crisis, state-run regulatory science took scientific shortcuts and ignored citizen input, ultimately poisoning the community (Valles et al., 2019). This simple summary names three distinct research transgressions: (1) scientific shortcuts, (2) ignoring citizen input, and (3) poisoning the community. The state had many values for their water studies, held by many actors (e.g., lab technicians, state scientists, the emergency manager, the governor), each of whom was often aware of only their part of the study. The diverse values distributed across a fragmented team created systemic ignorance and entanglement that was driven by the vice of racism (Michigan Civil Rights Commission, 2017), and this situation led the team to violate moral norms binding the project.

To summarize, value pluralism can cause problems for CES when the diverse values in play interfere with project requirements. We gave examples of both pragmatic and moral interference, labeling their root value problems as values perplexities and values disorders, respectively. Values perplexities emerge when diverse values cause pragmatic incoherence—confusion about what to do next—due to uncertain or conflicting courses of action. Values disorders manifest when diverse values cause moral incoherence—violation of moral principles either within or beyond the team. The terms “perplexity” and “disorder” imply the violation of an ideal arrangement (e.g., “actionable” and “morally ordered”) of values constraining the project. That is, a problem occurs when

Table 2

Five main strategies for addressing problematically plural values (PPV).

Strategy	Action
1. Give Up	Dissolve the team
2. Dodge	Change context (e.g. what project the team is working on)
3. Select	Pick a subset of values (in this case those of a single individual or sub-group of the team)
4. Compromise	Pick a subset of values (in this case many or most team members 'sacrifice' some of their values).
5. Integrate	Create a new set of values—we call this integration because we envisage the new values as growing out of the combination and connection of existing team values.

the plurality of values leads to actions that fall short of project ideals.

Generalizing from these illustrations, we see three possible causes of problems with plural values in general. First, there may be strong differences in values (differences in kind) between team members or within a sequence of activities. Second, there could be weak differences (differences in degree) in these same locations. Third, there may be too many different values to coordinate appropriately with the available resources. Each of these three will likely lead to actions that fall short of project ideals, a situation we here call *problematically plural values* (PPV). Nevertheless, PPV can often be resolved or at least mitigated with strategic planning and interventions, enabling CES collaborators to take advantage of the benefits of value pluralism while minimizing its harms.

4. What's needed to resolve problems with value pluralism in CES

Having identified PPV as an important (and under-appreciated) barrier to successful CES, we now discuss how to overcome this barrier. How, in short, can a team move from PPV to a set of workable team values? We offer the following general account: dealing with PPV has two steps. Teams need to (1) *detect* (actual or potential) PPV, and (2) *coordinate* those values. Let's take these tasks in turn, breaking them into their elements.

4.1. Detecting problematically plural values

For a team to *detect* problematically plural values there are two challenges: the team needs to (1) identify the ‘values in play’ and then (2) determine if this set of values is (or could become) problematic.

In an ideal world, the identification part of the detecting task is pretty straightforward: construct a list of the values each team member holds that are relevant to the decision context. But in the real world, making such a list is significantly easier to say than to do. This challenge is best described in terms of specific group tools, so we will leave its discussion for sections 6 and 8.

Once a team has an inventory of relevant values, the next step is to determine if that set of values is problematic. Do they generate values perplexity, disorder, or other problems? If yes, then the team is suffering from PPV. Since project contexts and collaborator values change over time, relevant values and the actions they imply will also change over time. The problemativeness of plural values rises and falls at various points in a CES project, which can make its management quite difficult.

4.2. Coordinating problematically plural values

To move forward, a team with PPV will need to address this situation, either consciously or not. Doing so requires *coordinating* the relevant values to enable project-appropriate team actions.

¹⁰ Lisa Kretz (2018) proposes non-human life can also be oppressed. If so, CES can also inflict research oppression on nonhuman life—perhaps by poisoning it for an experiment or exploiting it for materials.

Here, we identify five strategies for coordinating PPV and thereby resolving the resulting problems (see Table 2).

First, sometimes the right response to PPV is to *give up* by dissolving the team. Some value conflicts are both deep—the values in question are (nearly) impossible to set aside—and wide—the values in question activate in vastly contrary ways in many contexts. In such cases, breaking up can be a reasonable and fruitful way to go, as exemplified by the West End Revitalization Association's decision to break ties with academic scientists (Heaney, Wilson, & Wilson, 2007). This strategy targets the team itself as the solution.

Second, sometimes the right response to PPV is to *dodge* the problems by changing contexts. Changing contexts can alter which values are relevant and/or how they are relevant. This strategy can yield a situation in which plural values are no longer problematic. For research teams a major determinant of context is the scope of the project the team is working on. So, it may well be that a team facing PPV should respond by making changes to their project such as changing their research question, setting, or approach. This strategy targets as the solution the context in which the team is operating.

Third, the team could decide to *select* an intact subset of the original values in play. In this strategy, some team members agree not to act on some of their individual values during the joint research project. Simply, those values are no longer in play. As a result, the remaining collection of relevant values does not lead to problematic situations. Which values are taken out of play and how they are chosen matters (see section 5.2).

Fourth, the team could *compromise*, defining a subset of values in play that draws some values from everyone.¹¹ In this case, no single individual or subgroup gains or loses everything they care about. Compromise is of course tricky to negotiate; we discuss more in section 5.2.

Fifth and last, the team could *integrate* individual values to create new ones. Team members can alter their existing values in ways that respond to the values of their teammates and, with hard work and a bit of luck, the team can end up with a collection of values that is no longer problematic. Once again, the issue of which values alter and the process by which that alteration takes place matter. These last three strategies—compromising, selecting, and integrating values—target changes to the values themselves in order to address PPV. All five strategies eventually coordinate the values in play in such a way that they no longer cause problems for the project.

If a team chooses not to give up or dodge and instead to select, compromise, or integrate, then they must adopt a new set of plural values that are not problematic. Our sense of how teams adopt new values is quotidian. They first gather to imagine, discuss, and negotiate. Then they keep records of their decisions and commitments and work to live up to those commitments. Finally, they check in with each other to make sure that their decisions are working as intended. We formalize this quotidian process as 4 stages: (1) Articulating, (2) Recording, (3) Enacting, and (4) Evaluating. *Articulating* is the process of discussion and negotiation that yields a statement of new team values. *Recording* involves creating a stable, explicit, low-context (i.e., unambiguous) artifact that sets out the team's value commitments (e.g., a list of norms for the

community/team). *Enacting* is the daily work of acting in ways that are consistent with and informed by the values the team has adopted. Finally, *evaluation* requires engaging in processes to test that the team is (a) following the values and (b) that those values are working—that they lead the team away from any value perplexity or disorder, while providing guidance to team activities. But again, as with “constructing a list” above, these practical steps are easier to describe than implement. We discuss their practicalities further below.

This brings us to the end of our general account of how to deal with PPV. We've said a lot about what needs to happen to deal with PPV but little about the how. We turn to that topic next. While there are many strategies and tools research teams can use to resolve PPV, we focus on a single approach—philosophical dialogue interventions. As we will see, it is an approach realized in multiple ways.

5. Philosophical dialogue interventions

In this section, we suggest that collaborators can go a long way towards identifying differences in and implications of their fundamental commitments, assumptions, and views by talking about them. More specifically, philosophical dialogue that strives to enhance self-, other-, and mutual understanding can unearth many of the value differences found in CES teams and help determine if these differences will cause value perplexities, disorders, or other problems.

We focus on dialogue methods because they are a major form of intervention discussed in the research collaboration literature (McDonald, Bammer, & Deane, 2009). It is also a method we've long examined and practiced ourselves as members of the Toolbox Dialogue Initiative (Eigenbrode et al., 2007; Hubbs, O'Rourke, & Orzack, 2020; O'Rourke & Crowley, 2013). We focus even more narrowly on *philosophical* dialogue interventions to contribute to the theory and practice of that form of engaged philosophy. Our focus therefore allows us to build on our own expertise, learn from and contribute to similar philosophical interventions, and specify how our engaged work needs to improve.

5.1. Existing philosophical dialogue interventions

The relationship that philosophers have usually taken towards the sciences is that of the passive observer. But in recent years, with the emergence of forms of philosophy like socially engaged philosophy of science (Elliott, 2018), field philosophy (Bristler & Frodeman, 2020), and applied philosophy of science (e.g., Wiegman & Mallon, 2017), there is increasing interest in philosophical reflection on the sciences that contributes to and improves the sciences.¹² One way in which philosophy of science may impact science is by publishing in science journals, rather than only in philosophy journals (Fehr & Plaisance, 2010). Another is through *philosophical dialogue interventions*, a form of engaged public philosophy (American Philosophical Association, 2017).²²

One form that a philosophical dialogue intervention may take is that of embedded philosophy. A first example comes from Nancy Tuana's work with climate scientists, policymakers, and stakeholders to develop descriptions of CRM strategies and decision-

¹¹ What we've said about modifying values grows out of a sense that collections of values can be thought of in ways parallel to sets of propositions. This is similar to much of the work on belief revision (Hansson, 2017). If a set of propositions is inconsistent (yields some form of incoherence in our framework) it can only be rendered consistent either by removing propositions or altering propositions—the two possibilities we consider above.

¹² For survey work supporting a widespread interest in philosophy of science of this sort, see Plaisance, Graham, McLevey, and Michaud (2019).

²² Indeed, in 2018, the American Philosophical Association bestowed its Prize for Excellence and Innovation upon the Toolbox Dialogue Initiative for TDI's innovations in this type of work (<https://blog.apaonline.org/2018/09/28/msus-toolbox-dialogue-initiative-wins-the-2018-prize-for-excellence-and-innovation/>).

support tools for navigating these strategies. The results of Tuana's embedded efforts include scientific fruits. An example is an integrated assessment model that predicts the economic consequences of aerosol geoengineering strategies (Goes, Tuana, & Keller, 2011). The results also include philosophical payoffs, such as detailed discussions of the ethical issues associated with aerosol geoengineering (Svoboda, Keller, Goes, & Tuana, 2011). What makes Tuana's embedded efforts qualify as a *philosophical* intervention is that she shapes the collaboration so that attention is given to philosophical dimensions of the problem. And what makes her efforts qualify as a *philosophical dialogue intervention* is that this shaping happens via dialogue.

Consider her work on coupled epistemic-ethical analyses (Tuana, 2010, 2013, 2017). When used as a philosophical intervention in the workings of climate science and decision support science, developing a coupled epistemic-ethical analysis involves raising questions about and pointing out the ways in which research decisions shaped by epistemic values (e.g., for highly reliable forecasts) may lead to consequences that negatively impact our moral and epistemic values (e.g., delayed advice that limits effective climate action), and vice versa. Dialogue of this sort, which involves placing research decisions into broader societal and epistemic contexts, has "the potential to render transparent the epistemic assumptions of the disciplines through interdisciplinary interaction and provides opportunities to rethink values and assumptions embedded in these practices" (Tuana, 2013, p. 1959). Valles et al. (2019) extend Tuana's work into a four-question protocol that can directly guide team conversations or evaluations.

Tuana's work engages the team in *ongoing* dialogue throughout their project, which has unique benefits for Tuana and the team. The Socio-Technical Integration Research (STIR) approach led by Erik Fisher is another example of ongoing philosophical dialogue embedded in a team (E. Fisher & Schuurbiens, 2013; E. Fisher et al., 2015). A different form that a philosophical dialogue intervention may take is facilitating *discrete* dialogue sessions that are not quite so embedded in the daily work of the team. These approaches also have unique benefits.

One example of a discrete philosophical intervention is values inquiry (Brown, 2020). Brown's version of values inquiry is designed to address cases of "values perplexity" described above. It employs moral imagination to develop a list of workable team values as "hypotheses." Brown's book (2020) includes a worksheet for guiding that discussion (linked in our Table A2) and guidelines for using dramatic rehearsal and tentative application as tests of the value hypotheses. We look forward to more accounts of how these discrete dialogue sessions work for science teams.

Another example of a discrete philosophical dialogue intervention comes from the Toolbox Dialogue Initiative (TDI) (Hubbs et al., 2020). Since TDI is a widely deployed form of philosophical intervention,¹³ and because it is an intervention with which we are intimately familiar, we emphasize it in what follows. TDI, formerly "The Toolbox Project," emerged as a response to problem with communicating across disciplines (Hubbs, 2020). Its central insight is that many problems associated with communicating across the disciplines are partly rooted in philosophical differences (Eigenbrode et al., 2007; Hubbs et al., 2020; O'Rourke & Crowley, 2013). Scientists, whether in the environmental sciences or not, each enter into research collaborations with many commitments, assumptions, and views. Some of these are metaphysical (e.g., What is nature?). Others are epistemic (e.g., Can we come to an adequate understanding of an ecosystem through reductionism?). And yet

others are moral, ethical, and social (e.g., Are biological entities morally valuable independent of human interests?). A scientist's prior and fairly long-standing epistemic and non-epistemic values, functioning in various ways, play key roles in these domains. However, scientists often leave their philosophical views implicit during their work, which can hinder the resolution of any problematic value pluralism.

The Toolbox approach to surfacing these commitments consists of the Toolbox instrument used in the Toolbox workshop (O'Rourke & Crowley, 2020). The instrument contains a series of dialogue-provoking statements, or *prompts*, organized into clusters of six or seven statements, or *modules*. Each module centers a core question such as the ones listed just above. Although the precise details of the instrument will vary depending on the group for which it was designed, all Toolbox instruments aim to highlight several families of philosophical issues that are important to the team's project. To illustrate, consider the Values module in the most frequently used instrument—the scientific research instrument (Looney et al., 2014; Hubbs et al., 2020, Appendix A).¹⁴ It opens with the core question, "Do values negatively influence scientific research?" The five prompts invite participants to explore their commitments regarding aspects of this theme by registering their level of agreement or disagreement on a five-point Likert-style scale with additional "I don't know" and "N/A" options. For example, Values prompt 3 reads, "Value-neutral scientific research is possible."

There are many considerations that go into the design of a Toolbox prompt. Primary among these is its ability to spark rich, helpful dialogue—discussion that unearths philosophical differences among collaborators (Rinkus, Donovan, Hall, & O'Rourke, 2020). To this end, Toolbox prompts sometimes propose strong positions (e.g., that value-neutral science is possible) and often house contested, ambiguous, or vague terms (e.g., "advocacy", "human construction", and "uncertainty"). Each module in the scientific research instrument ends with a "similar views" prompt, "The members of this team have similar views concerning [this] core question." It is designed to encourage both individual and team metacognition.

After completing the Toolbox instrument on their own, workshop participants are encouraged to discuss their responses to the prompts and core questions. A member of TDI lightly facilitates discussion through the instrument, but the group decides which prompts they would like to discuss and for how long. Indeed, the discussion can—and often does—deviate from the particularities found on the instrument. One advantage of a light facilitation approach is that it helps to ensure that the discussion is about the team, and not the facilitator (O'Rourke & Crowley, 2013). It gives the team autonomy to pursue issues that seem most important to them. The overall goal of the dialogue is for participants to identify and articulate their views about philosophical issues relevant to their joint project, including issues related to values and science.¹⁵

5.2. Ideals for philosophical dialogue interventions

Since philosophical dialogue interventions are supposed to be helpful for resolving PPV, we should be explicit about what counts

¹³ Since 2005, TDI has carried out over 360 workshop interventions across the world.

¹⁴ The full scientific research Toolbox instrument is available under a creative commons license as Appendix A in Hubbs et al. (2020).

¹⁵ Under our IRB approval and with participant consent, TDI records the audio from most workshops. For excerpts of workshop transcripts, as examples of the types of dialogue TDI promotes, see Looney et al. (2014), O'Rourke & Crowley, (2013), Laursen (2018), (2019b), Rinkus et al. (2020), and Hubbs O'Rourke, & Orzack, (2020) among others. TDI welcomes collaborators interested in analyzing our data.

as “helpful help.” Of course, we would like to see a particular outcome: movement towards workable team values. But we also have expectations for the process of getting there. This is one limit on our own pluralism about legitimate values in CES, closely tied with our prohibition of research transgressions, above. We propose that the process of resolving PPV, like the process of CES itself, should be governed by the ideals of democratic experience and communication as expressed by John Dewey, Iris Marion Young, and pragmatist-feminists who emphasize the necessity of mutual respect and empathy in group life. Space prohibits a full exposition of this family of thought, so here we present [Ferkany and Whyte \(2011\)](#) discussion of participatory virtues as a guiding vignette of that literature.

Ferkany and Whyte propose that public deliberation of environmental problems must not only be structured well, participants must also behave well in those structures according to habits (of mind, heart, and deed) that promote respectful, effective deliberation in such contested spaces. These habits they call *participatory virtues*, of which they name 11, including Friendliness, Dependability, and Attentiveness. These virtues, they argue, will help secure an inclusive, engaged, epistemically productive discourse—that is, one marked by the pragmatic resolve and moral concern we introduced above.

CES is one arena in which such environmental deliberation takes place (albeit, one more centered on knowledge than policy decisions) and therefore CES should be governed by these participatory virtues. The model we proposed above for stages needed to resolve PPV in environmental science teams marks the **structure** of the deliberation while participatory virtues and similar ideals for engagement¹⁶ mark the **process** of deliberation, viz., how participants should engage in it. Thus, any attempt to resolve PPV is governed by at least three sets of goals: the outcome (resolution), the structure (our two-stage model), and the process (virtuous participation).

6. The roles of philosophical dialogue interventions in detecting PPV

6.1. Philosophical dialogue can help teams detect PPV

Detecting PPV is the first stage of resolving it. Recall from section 4 that in order to detect problems arising from plural values, the team must first identify relevant values and then determine if they are problematic. Philosophical dialogue interventions can help with both stages and do so in a democratically virtuous way. First, when it comes to identifying personal or team values, the dialogue can help make those values more introspectively available by focusing discussion on values questions.

When an environmental scientist is prompted to articulate her value commitments perhaps by an embedded philosopher like Tuana or by the prompts on a Toolbox instrument, it is generally expected that she will try to express her commitments so that her audience can understand them ([Gonnerman, O'Rourke, Crowley, & Hall, 2015](#)), especially since they are her collaborators and she thus has some obligation towards them ([Brister & Frodeman, 2020](#)). Meeting this expectation requires that the speaker clarify her commitments to herself well enough that she can express them adequately. She may use inner speech to work towards this clarity ([Morin, 2011](#)). The clarification may also happen through external

dialogue. When a speaker is unclear about her value commitments, dialogue can prompt further reflection on the matter through questions or challenges from her fellow collaborators. Challenges, in particular, encourage the speaker to specify the reasons behind her values or how they apply in the decision context at hand. So long as the challenge gives rise to a disagreement that is collaborative and not adversarial ([Laursen, 2018](#); [O'Rourke, Hall, & Laursen, 2020](#)) and as long as the disagreement doesn't end prematurely ([Crowley, Gonnerman, & O'Rourke, 2016](#)), improved self-understanding emerges from a better understanding of what grounds the value and the ways in which it may be challenged. Clarity during a philosophical dialogue intervention might also emerge from the elaborations that others offer of the speaker's contributions ([O'Rourke et al., 2020](#)).

Collaborative exchanges pertaining to individual value commitments also foster group-level understanding of the individuals' values in play. Such exchanges can promote collaborators' understanding of the speaker's values, especially when they are accompanied by Patience, Persistence, Charity, and Generosity ([Ferkany & Whyte, 2011](#)). What emerges, then, out of such collaborative exchanges are two key ingredients for mutual understanding ([Crowley & O'Rourke, 2020](#)) or common ground ([Beers, Boshuizen, Kirschner, & Gijssels, 2006](#); H. H.; [Clark, 1996](#); [Stalnaker, 2002](#)): (1) Self-understanding and others-understanding, and (2) Appreciation of this work undertaken by the others. That is, (1) I now understand my position and so do you, and (2) I'm aware that you understand my position and you're aware that I understand my position. These two levels of bi-directional understanding together increase individual and group Reasonableness ([Ferkany & Whyte, 2011](#)). This is a complex, interwoven foundation of group knowledge and virtues upon which the team can build in later stages of resolving PPV.

6.2. Philosophical dialogue does help teams detect PPV

Thus far we have provided only theoretical arguments that philosophical dialogue interventions **can** help environmental science collaborators identify their value commitments. To close section 6, we present empirical evidence that such interventions **do** help achieve this goal in many respects, though not all. We emphasize TDI data mostly because it is the only mode of philosophical intervention that we know of that has systematically collected data for assessing its effectiveness over multiple years and in multiple contexts. It has also commissioned an external evaluation in 2017 that augments these internal data.

Toolbox (TDI) workshops typically collect three streams of data: (1) pre- and post-workshop quantitative responses to prompts on the Toolbox instrument, (2) transcripts of the workshop dialogue, and (3) quantitative responses to workshop evaluation surveys completed two weeks after the workshop experience. Each data stream provides some reason to think that TDI interventions help to support the advancement of mutual understanding among teams of diverse collaborators.

[Robinson & Gonnerman \(2020\)](#) analyzed the pre- and post-workshop quantitative responses for evidence of mutual understanding. They used participant responses to the similar-view prompts described above. Not only did Robinson and Gonnerman witness a substantial decrease in “I don't know” responses to these prompts from before to after the workshop, they also report evidence that the dialogue improved the accuracy of these responses post-workshop. In other words, the data that they analyzed suggests that Toolbox dialogue interventions tend to advance self- and other-understandings of the philosophical commitments found on the team—the basic ingredients of mutual understanding. This conclusion is reinforced by an external evaluation of TDI. It found

¹⁶ These include “mutual respect” and “equal communicative freedom” ([Bächtiger et al., 2018 Table 1.1](#)). [Beierle \(2002\)](#) adds that intensively involving all stakeholders in environmental decision making fosters these ideals and therefore should be an ideal itself ([Elliott, 2011](#)).

that after the workshop, 83% of the evaluation respondents felt they were better able to identify their own research worldviews, and 75% of respondents believe they are better able to identify research worldviews expressed by others (Watts, Means, & Perk, 2017).

Rinkus & O'Rourke (2020) add to the evidential story by examining the second stream of TDI data: transcripts. They examined six dialogues and revealed rich conversational patterns that exhibit both self-examination of one's own philosophical commitments (what they dub "reflexivity") and perspective taking of others'.

Finally, as regards the post-workshop evaluation surveys, thematic analyses revealed that over 80% of the respondents had indicated that the philosophical dialogue during the TDI intervention improved their awareness of the knowledge, opinions, or scientific approach of their teammates (Schnapp, Rotschy, Hall, Crowley, & O'Rourke, 2012).

Moreover, there is some reason to think that TDI nurtures these gains in self and team understanding in ways that tend to uphold participatory virtues like Sincerity (Ferkany & Whyte, 2011) and democratic structures like freedom of communication (Bächtiger, Dryzek, Mannsbridge, & Warren, 2018). The external evaluation found that 93% of their respondents agreed they "felt free to present a view that was different from others in [their] group," and 89% agreed the "conversation was an open exchange of thoughts and ideas" (Watts et al., 2017). This openness translates to workshop engagement: 89% of evaluation respondents remember most people participating in the conversation.¹⁷

Thus, we see strong evidence that TDI helps collaborators identify their value commitments. But what about determining if those commitments are problematic? How capable are philosophical interventions when it comes to determining whether the values found on the team could lead collaborators towards incoherent or disorderly research decisions? We have less evidence of TDI's effectiveness in this respect.

Because TDI has focused on helping collaborators articulate their views using the abstractions of philosophy (Crowley, Eigenbrode, O'Rourke, & Wulfhorst, 2010), TDI supports the identification of values more than the analysis, comparison, and implication of those values in context, which is the work needed to determine if team values are, or could become, problematic. However, even without strong facilitation toward this end, teamwork in identifying values naturally increases the likelihood team members will do that determining work anyway.

Participants usually open their dialogues on any topic by comparing each others' quantitative responses to the Likert style prompts (e.g., "Oh, I put a 3 for the first prompt; what'd you put?"). This leads to mutual understanding by comparison (Rinkus et al., 2020). We frequently observe elaborations on previous points and co-constructions of meaning (Rinkus & O'Rourke, 2020), as well as challenges and argumentative exchanges (Laursen, 2018). Earlier versions of the Toolbox approach used open-ended questions (Eigenbrode et al., 2007). Experience with this format revealed that Toolbox participants were reluctant to engage with open-ended questions. The result was a workshop exercise in which commitments were not explored to the extent they could be. The Likert-like responses seem to encourage discussion through (mostly friendly) disagreement (Rinkus et al., 2020). Such comparison is a promising first step to detecting problematic values that could be extended with stronger facilitation, more prompts about concrete

actions (which TDI has started to use; Hubbs, O'Rourke, Eigenbrode, Rinkus, & Malavisi, 2020), and/or the use of additional tools, which we will discuss later.

And we must admit that, despite its strengths, TDI is not the panacea for identifying relevant values, either. A 90-minute discussion is unlikely to fully reveal one's values, especially when those values are implicit and dynamic. Moreover, while Toolbox instruments often do include prompts designed to get at participant values (e.g., "Bridging science and policy should be a top priority of research on large water basins"), any one instrument is only going to explore part of the entire values landscape that may impact the project. Moreover, instruments are often designed in collaboration with team leaders, but topics salient to team leaders may not be the ones important to other team members. And projects often shift. Discrete dialogue sessions like Toolbox workshops necessarily face these limitations. And in this respect, dialogue that fails to surface a relevant value difference is a dialogue that fails to determine whether the difference is problematically plural.

7. The roles of philosophical dialogue interventions in coordinating PPV

To resolve PPV, it is not enough to detect the problematic values; a team must go on to coordinate them into workable team values. What role can philosophical dialogue interventions play in that task?

7.1. Philosophical dialogue can help coordinate PPV

In section 4, above, we mentioned five basic strategies for coordinating PPV: (1) give up, (2) dodge, (3) select, (4) compromise, and (5) integrate. Here we focus on the power of philosophical dialogue interventions to help with this last strategy of *integration*. Of all five strategies, we emphasize integration because it is the hardest case and one necessary for inter- and transdisciplinary CES.. We argue if philosophical dialogue can help teams integrate their values, it can also help with the other four strategies as appropriate for the context.

In section 4 we also labeled four necessary steps for coordinating PPV if a team chooses not to give up or dodge: (1) articulating the new set of values, (2) recording the decision, (3) enacting the new values, and (4) evaluating that enactment. There are several reasons for believing philosophical dialogue interventions like the Toolbox could aid integration in each of these steps, although we will see the potential is strongest for articulating and evaluating.

At the start of the articulation phase a team has a set of clearly stated problematic values. At the end of this phase they will have an equally clear but no longer problematic set of values. How does this happen? In the case we're considering the new team values are the result of *integrating* the original values. We understand this using our preferred model of integration, the IPO model (O'Rourke, Crowley, & Gonnerman, 2016). According to the IPO model the general phenomenon of integration can be understood by focusing on inputs (I), process (P), and outputs (O). Applying the IPO model to team values integration, it is clear what both the inputs and the outputs will be (problematic and resolved value differences, respectively).¹⁸ The mystery then is the process.

¹⁷ Unfortunately, none of these agreement rates were 100%, showing we still have work to do in ensuring a welcoming environment for all participants at all times. Evaluation respondent comments indicate Toolbox facilitators need to facilitate more strongly in this respect to, as one respondent wrote, "restrain the more obnoxious [participants] from dominating discussions."

¹⁸ Work on the nature of integration is ongoing and hardly a settled matter. We draw your attention to Holbrook (2013) for an important early summary of work in this area and to Laursen (2019b), O'Rourke et al. (2019), and O'Rourke & Robinson (2020) for some recent developments in the area.

According to the IPO model, the main action in the integrative process is the use of an *integrative relation*.¹⁹ Examples of integrative relations include sequencing, emergence, nesting, and subordination. In terms of logic, these are relations that combine two or more inputs into fewer outputs without deleting any of them (O'Rourke et al., 2016). In terms of cognition, they are ways of understanding that reveal meaningful, coherent connections between entities (e.g., theories, models, data structures, values, etc) that had seemed unrelated or incompatible. Earlier, we named two examples of such mismatches: values perplexities and values disorders.

If one is trying to resolve a mismatch, a valuable first step is to frame it—to find or create a model or framework in which the mismatched entities can both be expressed. To a large extent, the challenge of engaging with a complex system, especially an environmental system that spans multiple disciplines like climate change, coastal fog, or human-induced species extinction, is forging the tools for relating things that have yet to be recognized as related and for marking out possibilities for navigating and modifying the system. This may be, in part, why some interdisciplinary scholars say that integration requires the construction of a shared language (Klein, 2014). A shared language, through an expanded vocabulary, is a tool for relating the unrelated. And it may also be why pragmatist insights on language get such a grip in interdisciplinary studies. These insights emphasize “languages’ attunement to different possibilities of action to suit different needs and interests,” especially in complex, real-world systems (Piso, 2016, p. 52). Here, the complex system we are considering is a set of PPV in a CES team project. Language can thus be a powerful tool for relating these values by representing the mismatched values as differing choices within a shared action context.

Philosophical work suggests at least two approaches to framing mismatched values: hierarchical taxonomies and reflective equilibrium. The first of these grows out of the tendency of philosophers to organize values into hierarchical taxonomies (Mason, 2018). We proposed two of these early in this paper: topical and functional types of values. There are others (Dietz, Fitzgerald, & Shwom, 2005; Schwartz, 2012; Tadaki, Sinner, & Chan, 2017). What matters for our purposes is that a taxonomy provides a framing structure. Tuana’s coupled epistemic-ethical analysis and Brown’s moral imagination framework are two such framing taxonomies used to start the dialogue of how new values could interact if the team adopted them. The frame is not only a conversation starter, it is also a negotiation aid. If the values causing challenges for a team all fall within a single category, then they can be seen as different realizations of the underlying (or overarching) category. Shared frames thus support the classic negotiation technique of emphasizing shared interests (ultimate values) rather than different positions (instrumental values) (R. Fisher, Ury, & Patton, 2011).

Hierarchical taxonomies aren’t the only framing tool philosophy provides for teams negotiating mismatched values. For Catherine Elgin (2005), drawing on the work of Rawls, values are parts of practices which themselves are networks of mutually supporting factors. In Wittgensteinian language, they are elements of “forms of life,” which are “the ways that social practices are organized and social goals are prioritized” (Piso, 2015, p. 32). Practices themselves can stand in need of justification and that justification comes from a process of reflective equilibrium in which the practice is evaluated as a part of a system of commitments. In this frame, how to think about a value depends on whether it is doing its part to support a practice which is itself justified by being part of a system in reflective equilibrium. Toolbox instruments can support this sort of

systems thinking by including several prompts under a single core question, but Tuana’s and Brown’s approaches specifically target value interactions. It is likely Fisher’s STIR philosophers also ask these systems-level questions during their midstream modulation of scientific projects (E. Fisher & Schuurbiens, 2013). In using philosophical taxonomies, however, it is key that dialogue facilitators weave closely between these categories, which are usually foreign to a scientific team, and the team’s daily practices; the meta-level, philosophical deliberation must gain meaning from application in the team’s practice, not from academic philosophy (Piso, 2015).

So, philosophical dialogue interventions can support integration by providing language and value frames to aid discussion. However, these interventions, especially the Toolbox approach, have little potential to help with recording group value decisions or enacting these. After all, dialogue is about talking, not recording or putting into action. We note, of course, that talking is an action and team values will have implications for how the team holds future conversations. Philosophical dialogue is distinguished by using some level of abstraction that tends away from the specifics of enacting values in context. Thus, while there is some potential for philosophical dialogue to return as a form of enacting values, this is not its main strength. When it comes to recording the team’s decision about which values to adopt, philosophical dialogue interventions will fall short because spoken words are ephemeral.

However, philosophical dialogue can play a larger role in evaluating how well the team is enacting their values. This is because the act of evaluating a team’s value-driven actions is, in fact, to reiterate the early stage of detecting PPV. And above we saw that philosophical dialogue interventions provide excellent support for that work.

7.2. Philosophical dialogue does help coordinate PPV

Little empirical work documents if and how well philosophical dialogue interventions actually promote values integration. In TDI, that initial work is positive. Bethany Laursen and Michael O'Rourke have reported several instances of integration in Toolbox transcripts and they continue to hunt (Laursen, 2018; Laursen & O'Rourke, 2018a; 2018b; 2019a; 2019b). Their work builds on unpublished analyses of conversational threads in six Toolbox transcripts that, while being coded for participant engagement (see report in Rinkus & O'Rourke, 2020) also informally noted many “integrative moments” that have yet to be fully analyzed. And no work has yet identified if these moments integrate values specifically. So, while we have leading evidence that Toolbox workshops do help teams integrate, it remains to be seen if the dialogues specifically aid the articulation of new, workable sets of team values. But as with detecting problematically plural values above, the Toolbox has strong potential to aid this sort of articulation given more targeted facilitation, integrative prompts, and the use of complementary tools. Indeed, we are developing taxonomies of integrative communication (O'Rourke & Robinson, 2020) and integrative relations (Laursen & O'Rourke, 2018a; 2019a) that could eventually shape Toolbox instruments and facilitation so they frame workshop dialogues not only as values identification but also as integration.

We can speak with more confidence about the Toolbox’s performance in recording new team values: the answer is, “Very little.” Audio recordings may capture such teamwork, but given our own difficulties in parsing our transcripts, it seems unlikely the audio recordings (or transcripts) would be of much use to a team in this regard. Toolbox facilitators have more recently added “co-creation” activities to the end of dialogue sessions to start teams on the road to integration and enacting (O'Rourke & Crowley, 2020), but these activities are usually quite brief (10 minutes) and are limited to flip

¹⁹ This is intended as an illustrative rather than an exhaustive account of integrative relations.

charts or surveys that record a brainstorm rather than a full decision. Clearly, there is potential here for other recording tools.

Translating the Aha! moments of self- and other-understanding and even integrated team articulations into scientific collaboration practices has proven difficult for TDI, because this is just not a strength for dialogical modes. As just mentioned, the co-creation activities aim to jumpstart the enactment of any new consensus, but we have not evaluated the extent to which this works. We have seen some generally positive signs with 64% of our external evaluation respondents agreeing “The activity improved collaboration in my group” and 74% agreeing it improved the group’s communication (Watts et al., 2017). Toolbox has also begun using more concrete, action-specific prompts in recent workshops to facilitate team movement to action, but again, effects are unknown. In interviews, our external evaluation respondents noted the dialogue session is not enough; they asked for other tools that would help them “deal with their own [research] traits and beliefs” and those of others after those had been identified and articulated in the workshop (Watts et al., 2017).

Toolbox has had only a few opportunities to help a team revisit topics raised in earlier workshops.²⁰ However, most of these have not prompted evaluation of past value-driven actions; rather they have explored new topics or recurring topics more deeply. With a little rewording and facilitation, however, the Toolbox instrument could easily support the kind of evaluation needed to detect any problematic values that have come up since a previous decision about team values.

While Toolbox potential and actual performance in helping teams coordinate their problematic values is still mostly unknown, we do know that Toolbox and other discrete dialogue interventions will never be able to ensure complete enactment of values, even the participatory virtues we expect to see in our workshops. This is because enacting a values change (as with altering a habit) takes thought, repetition, and forgiveness of failure over long periods. However, regular, thoughtful dialogue can play a significant role in building the sort of relationships between team members that allow for the learning process involved in changing values (O’Rourke et al., 2020). For example, the task of enacting shared values is supported by the affective bonds between team members that are enriched by meaningful conversation.

To sum up, philosophical dialogue can be at the core of dealing with PPV but it needs to be ongoing rather than one off, and it needs to be supplemented with activities that support recording, enacting, and evaluating values solutions.

8. How to improve philosophical dialogue interventions to better resolve PPV

So far, we have shown that the Toolbox Dialogue Initiative excels at identifying many of the values relevant to a CES project, offers some help in determining if values are problematic, and only lightly touches the task of coordinating the problematic values. Embedded approaches such as Tuana’s and STIR likely have a different profile; with their extended engagement, we would not be surprised if these approaches focused just as much on identifying relevant values as determining any incoherencies for the project. But their effectiveness for facilitating workable team values appears unknown, at least in print.

Regardless of the specific intervention, our discussion has made clear that philosophical dialogue can facilitate some values work well, some not so well, and still other work rather poorly. This is

simply the nature of such dialogue. Philosophical dialogue, in our experience, emphasizes clarity of thought and expression, which plays well to the identifying task. It also emphasizes tracking implications, which **can** (depending on the kinds of implications being tracked) help identify values that will eventually lead to problematic actions; Brown’s values inquiry is an example of a philosophical dialogue intervention that does ask such questions. What philosophical dialogue does not do well is implement values solutions.

To be more specific, when it comes to the final stage (coordinating PPV), these interventions could aid the team in the first step of articulating a set of values for moving forward. However, if they lean heavily on the disagreement framework often present in Western philosophy, they will mostly support those strategies that end up with winners and losers, namely selecting or compromising. Brown’s approach to values inquiry avoids this win-lose mentality by promoting imaginative dialogue that can support the articulation of new, workable sets of team values. Interventions that don’t emphasize disagreement but don’t aim for integration either will often allow the team to give up or dodge their values problems—at least, for the duration of the dialogue. This has been the mood and mode of TDI with its emphasis on mutual understanding and not mutual action. TDI and perhaps other such interventions have shied away from facilitating values integration, leaving that work up to other forms of team communication and collaboration at other times and places. There can be good reasons for this choice. But, even if philosophical dialogue interventions pushed integration as a strategy, on its own, philosophical dialogue does little to assist the remaining stages of coordinating PPV, viz., the need to record, enact, and evaluate the team’s chosen set of values.

Fortunately, one of the good reasons that dialogue might eschew any attempt to help teams address problematic values unearthed in the dialogue is that there are other team process tools that excel with this task. They can be undertaken separately or woven into the dialogue. Doing so will take facilitative—and not clearly philosophical—skills. Intervention teams that lack this skill will need to partner with those that do, so that the team becomes a blending of experts just as the intervention becomes a blending of approaches.

We describe over a dozen of these complementary tools in the article’s appendix. Here, we note three features these tools tend to have that makes them good complements to philosophical dialogue. First, they **creatively structure participation** (Lipmanowicz & McCandless, 2014). That is, these tools go beyond designating someone a facilitator and leaving the rest as generic ‘participants’: they also require particular steps, group arrangements, and distributions of participation. These design choices not only encourage integrative thinking but also equitable participation, a deliberative ideal of which philosophical dialogues can fall short if they use too little or too much facilitator power.

Second, many tools center on some kind of **external representation or recording** of the group process and decisions. Visual, audio, tactile, or other representations are not only more lasting than spoken words, they also add to expression by using more channels of communication. While dialogue must always add some form of recording, many other tools have it baked in.

Third, these tools **emphasize experimentation**. As Brown (2020) reminds us, problems of value are often not solved immediately or once and for all. Rather, they require testing, adjustment, and re-testing. It is partly their dependence on external representations that leads these tools to support experimentation.²¹ After all: how many times do we ever get our writing, drawing, acting,

²⁰ We are working to expand our longitudinal work with teams (Eigenbrode, Vasko, Rinkus, Laursen, & O’Rourke, 2020).

²¹ On the role of external representations and artistic creativity, see Clark (2001).

etc. the way we want it the first time? The push to externalize creates a *de facto* push to iterate.

Lastly, we want to note that these other tools are not the only resource we have for improving our philosophical dialogue interventions. Additionally, different dialogue approaches can complement each other, and examples of this strategy are also included in the appendix. We believe much synergy could result from smart combinations of TDI, values inquiry, STIR, and coupled ethical-epistemic analysis. We challenge ourselves and our colleagues to explore these options more intentionally.

9. Conclusion

The first half of our article contributes to the philosophy of values in science by offering the following model of how problematically plural values (PPV) are resolved in teams, specifically of environmental scientists:

1. Detection—Does your team suffer from PPV?
 - a. Identification—What values do members of the team bring to the table?
 - b. Determination—Do those values yield incoherence?
2. Coordination—What can your team do about PPV? A team can give up or dodge at this stage. If it chooses to continue by addressing its values (select, compromise, or integrate), then the steps become
 - a. Articulating—Coordinating a set of shared values
 - b. Recording—Making a record of those values
 - c. Enacting—Carrying out those values
 - d. Evaluating—Making sure the values are in operation and are effective

The model is grounded in both academic literature and our own experiences. Thus, we turned to those experiences to test our model in the second half of our article.

This latter portion contributed mainly to the practice of engaged philosophy by discussing a single mode of engaged philosophy practice—that of a philosophical dialogue intervention—that both tests the model through application and assists science teams through the intervention itself. By applying our model to these interventions (specifically, the Toolbox Dialogue Initiative), we were able to pinpoint some of the strengths and shortcomings of philosophical dialogue as an intervention that could help resolve PPV for environmental science teams. The fact that our model was useful in this regard gives us more reason to believe it is an accurate sketch of how to resolve PPV in CES. In the end, however, we prioritized the benefits of the analysis for scientific practice and not philosophical knowledge by highlighting a dozen tools that could make philosophical dialogue interventions more effective for resolving values-driven team problems. We look forward to additional theorizing and practicing.

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Appendix.

Table A1
Detecting PPV in single dialogue interventions

Activity	Description	Values Related Contribution	Citation	URL
Blend with another philosophical dialogue technique	E.g., Tuana et al.'s coupled ethical-epistemic analysis	Determines if problems will arise from epistemic, ethical, and coupled epistemic-ethical values.	Tuana (2013); Valles et al. (2019)	NA
Reflect!	Argument mapping customized for synthesizing perspectives on wicked problems	Explicitly structures the relations between concepts - improving identification and detection. Also a great tool for Representing when you are working on coordinating PPV	Hoffmann (2020)	https://reflect.gatech.edu/
MentalModeler	Free, online, intuitive software for mapping systems, including systems of values and resulting actions.	See Reflect!	Gray, Gray, Cox, & Henly-Shepard (2012)	http://www.mentalmodeler.org/
CoNavigator	Process that uses special tactile objects to identify collaborators' interests and contributions	See Reflect!	Lindvig, Hillersdal, and Earle (2018)	https://conavigator.org/
Dialogue mapping	Facilitates a dialogue to identify the questions, ideas, and arguments that structure a problem, and visually maps it	See Reflect!	Conklin (2006)	http://www.cognexus.org/id41.htm
NarraTopia	A game with physical pieces that prompt storytelling	See Reflect!	Kurtz (2014)	https://www.narratopia.com/
Emancipatory boundary critique	Questions based on Critical Systems Heuristics that help	Supports deliberative, democratic	Pohl (2020); Williams & Hummelbrunner (2009)	https://zenodo.org/record/3717029

Table A1 (continued)

Activity	Description	Values Related Contribution	Citation	URL
Ethical matrix	less powerful collaborators investigate the impacts and driving values of decisions made by more powerful collaborators Mode 1: Collaborators record their specific values for each of several categories of values. Mode 2: Collaborators record value impacts of a chosen course of action for each stakeholder.	participation. Identifies values in play and Determines if their resulting actions are problematic. Deciding which values form the column headers supports values Identification. Stakeholders can include all collaborators, which supports democratic dialogue. Mode 1 supports values Identification. Mode 2 helps Determine if any values-based actions are problematic. Can also support perspective taking.	Forsberg (2014); Mephram, Kaiser, Thorstensen, Tomkins, & Millar (2006)	NA
Futures/implications wheel	A brainstormed mind map that starts with a single (set of) values and records possible action-implications of it, up to however many layers of implications is helpful.	Detects problematic actions likely to result when adopting that value. Two or more maps can be compared to detect incoherences between values.	NA	https://www.mindtools.com/pages/article/futures-wheel.htm
Triz	The group brainstorms “What would be the worst ____ ever”	Identifies values in play by Identifying their opposites	Lipmanowicz and McCandless (2014)	http://www.liberatingstructures.com/6-making-space-with-triz/
Heard, Seen, Respected	Pairs break out from the plenary to take turns sharing a time they felt heard, seen, & respected.	Identifies specific values in play for deliberative team process	Lipmanowicz and McCandless (2014)	http://www.liberatingstructures.com/19-heard-seen-respected-hsr/
Mindfulness exercises	Any technique aimed to still the frenzied (individual or group) mind to allow masked thoughts and desires to surface	Supports Identification of one’s own values and supports perspective taking (see Perspective Taking)	NA	https://positivepsychology.com/mindfulness-exercises-techniques-activities/
Arts-based exercises	Any technique aimed to support authentic expression of oneself	Alternative to dialogue for noticing what’s important to you and others thus improving Identification. Can also be helpful in developing ideas as part of the articulation phase of Addressing.	Klammer (2017)	https://coursecraft.net/c/expressiveartsfacilitation/splash
Perspective-taking exercises	Any technique aimed to understand another’s view or experience	Supports better Identification and Determination of problematic actions.. Also a valuable resource for Articulation and Evaluation phases of Addressing	NA	NA
Reflexivity exercises	Any metacognitive technique: carefully considering patterns and processes in one’s own actions	Can excavate deeper values, identify ties between values and actions, and support deliberative, democratic team engagement. Also supports perspective taking (see perspective taking) by clarifying one’s own perspective.	NA	NA

Table A2
Detecting PPV in ongoing dialogue interventions

Activity	Description	Values Related Contribution	Citation	URL
Blend with another philosophical dialogue technique	E.g., conduct a Toolbox workshop as part of a STIR project	Blends unique benefits of each technique, e.g., focused Identification of values within ongoing Determination of problematic values	Fisher and Schuurbiens (2013)	NA
Create & revisit team ground rules	Team ground rules are values-based expectations for behavior.	Forces Identification of values and resulting actions. Can Determine any conflict in expectations, even as they change over time.	NA	NA
Team & personal coaching	Coaches use incisive questions to help teams and individuals discover their values	Facilitates Identification of values in play.	Whitworth, Kimsey-House, Kimsey-House, and Sandahl (2018)	NA
Executive scientist/I2S specialist/ community manager on the team	A team science process expert will monitor and help the team evaluate underlying values and alignment with actions	Facilitates Identification and Determination of values conflicts	Bammer (2013); Hendren & Ku (2019)	NA
Issue mapping	Dialogue mapping without dialogue facilitation, only mapping	Over time, can track the values in play and implied or resulting actions to Detect PPV.	Conklin (2006)	http://www.cognexus.org/issue_mapping_faqs.htm
NarraFirma	Online tool for conducting Participatory Narrative Inquiry on teams	Identify values and their impacts over time as part of a research project.	Kurtz (2014)	https://narrafirma.com/

Table A3
Coordinating PPV during discrete dialogue interventions

Activity	Description	Values Related Contribution	Citation	URL
Values inquiry	A dialogue investigating which values should be adopted in a situation using moral imagination, dramatic rehearsal, and tentative application, among other tools	Brainstorms and tests implications of possible sets of values that could Address PPV	Brown (2020)	https://www.matthewjbrown.net/professional/book/worksheet.pdf
Theory of change or Logic Model	A visual or tangible representation of how a project works	Values can be included in the diagram to Articulate & Represent how they drive actions.	Rogers (2017)	NA
Manifesto	A strong, clear, usually public statement of values	Creating a manifesto will help the team identify coherent values. The manifesto itself is a Representation that will aid the Enacting & Evaluating parts of coordinating PPV.	Bell (2015)	NA
What I need from you	Participants ask for what they need from others to enact a specific goal. The other responds unambiguously to the request.	Supports Enactment and Evaluation of the new values.	Lipmanowicz and McCandless (2014)	http://www.liberatingstructures.com/24-what-i-need-from-you-winfy/
Agreement/Certainty matrix	Maps values or actions on two dimensions: level of agreement and level of certainty.	Helps all stages of coordinating PPV by identifying which items need more specificity, discussion, information, etc. and which are ready to go.	Lipmanowicz and McCandless (2014)	http://www.liberatingstructures.com/27-agreement-certainty-matrix/
Generative relationships	Collaborators identify current team performance along four dimensions and identify strengths and weaknesses	Helps Enact and Evaluate new values by looking at team interactions	Lipmanowicz and McCandless (2014)	http://www.liberatingstructures.com/26-generative-relationships-st/
Wise advisors	Aristotelian virtue theory argues only a wise person will know what to do in any given situation. Advisory boards or mentors can play this role.	The advisor will Articulate the values the team should Enact.	Mason (2018)	https://plato.stanford.edu/entries/value-pluralism/#PraWis
Super value scale	A scale that superordinates all values and prioritizes them in relation to each other	Sets up a common framework to aid Articulation of a new set of workable team values	Mason (2018)	https://plato.stanford.edu/entries/value-pluralism/#SupSca
Minimum allowable roles for values	A meta-value about the minimum roles values should play in the project	Identifying minimum roles is a starting point for Articulating new values	Douglas (2009)	NA

Table A4
Coordinating PPV during ongoing dialogue interventions

Activity	Description	Values Related Contribution	Citation	URL
Executive scientist/2S specialist/ community manager on the team	A team science process expert will monitor and assist with the entire process of coordinating PPV	Support for the entire Addressing process	Bammer (2013); Hendren & Ku (2019)	https://www.cscce.org/what-is-community-engagement-within-science/
Memorandum of understanding	An official document solidifying working relationships	Articulates & Represents ongoing Enactment of values	NA	NA
Collaboration plan	A comprehensive document defining expected team process & products	Articulates and Represents adopted values for all areas of teamwork. Aids Enactment & Evaluation.	Bennett, Gadlin, & Marchand (2018); Hall, Vogel, & Crowston (2019)	NA
Authorship guidelines	Principles, rules, or criteria for how to qualify as an author on a team manuscript	Helps enact values for contributing to the work	Oliver et al. (2018)	NA

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