

Chapter 35

The Evolution of the Scientific Virtues Toolbox Approach to Responsible Conduct of Research Training

Chet McLeskey, Eric Berling, Michael O'Rourke and Robert T. Pennock

Abstract The Scientific Virtues Toolbox is a novel scientific virtue-based workshop model for responsible conduct of research (RCR) training. This paper gives a brief overview of how Pennock's vocational virtue theory, which had previously been delivered in courses, was transformed into discussion-based RCR workshops using the Toolbox structured dialogue method. The interdisciplinary BEACON Center, which combined biologists, computer scientists, and engineers, and which aimed to model a culture of excellence, ethics, and inclusion, proved to be an ideal environment to develop and test this approach to the cultivation of scientific character. The paper describes the guided-dialogue structure of the workshops, the nature of the discussion prompts, the pilot assessments carried out, and how the workshops are now evolving beyond their scientific origin.

Key words: Scientific integrity, scientific virtues, science ethics, responsible conduct of research, RCR training, research integrity, toolbox dialogue initiative.

Chet McLeskey
Center for Interdisciplinarity, Michigan State University, East Lansing, MI, USA

Eric Berling
Center for Interdisciplinarity, Michigan State University, East Lansing, MI, USA

Michael O'Rourke
Center for Interdisciplinarity, Department of Philosophy, AgBioResearch, Michigan State University, East Lansing, MI, USA

Robert T. Pennock
Lyman Briggs College and Departments of Philosophy and Computer Science & Engineering,
Michigan State University, East Lansing, MI, USA e-mail: pennock5@msu.edu

35.1 The History of the Scientific Virtues Toolbox RCR Project

From the beginning, the BEACON Center aimed to excel not only in scientific research, but in all aspects of its activities as a science and technology center. Included in this aim were its ethics commitments. The National Science Foundation responsible conduct of research (RCR) requirement for Science & Technology Center (STC) grants stated:

The Director shall require that each institution that applies for financial assistance from the Foundation for science and engineering research or education describe in its grant proposal a plan to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduate students, graduate students, and postdoctoral researchers participating in the proposed research project. [7]

In its strategic plan, BEACON promised to not just meet the letter of the requirement, but to set a model for excellence, including its implementation of this RCR requirement. It stated that goal in the following way:

Ethics Optimal Outcome. Center participants will understand shared and discipline-specific practices of Responsible Conduct of Research (RCR) and will embody general scientific norms/virtues, including curiosity, honesty, objectivity, integrity, community, and transparency. (BEACON 2016)

Phrasing this goal in virtue-theoretic terms was unusual, but very intentional. The vision was based on a philosophical approach that Pennock had been developing since the late-1990's that looked at science as a methodological practice that had an inherent moral structure characterized by what he called "scientific virtues." This scientific virtue (SV) approach is based in an analysis of excellence inspired by Aristotle, who wrote that virtues are those character traits that lead to flourishing [2]. Aristotle had considered this in terms of general human virtue and human flourishing seen in relation to the human nature and purpose (telos), but if one thinks of it in the context of particular vocational practices rather than human life as a whole, one is able to identify traits that should lead to the flourishing—i.e., the excellence—of that practice. For the scientist, therefore, cultivating scientific virtues should lead to scientific flourishing. BEACON provided an opportunity to move the SV project out of the philosophical armchair and test it in practice.

There was a special challenge in that BEACON's goal also reflected a commitment to developing an ethical culture in a complex interdisciplinary and institutional setting. As an STC, BEACON is an "integrative partnership" that builds "intellectual and physical infrastructure" at the "interfaces" of several disciplines, including biology, electrical engineering, computer science, and philosophy [7]. Its success depended on its ability to integrate knowledge from these different disciplines, and it has worked hard to create a culture of interdisciplinarity that provides the resources and support necessary to achieve this integration. BEACON conducts interdisciplinary scientific, engineering, and educational research; holds a weekly interdisciplinary seminar series and an annual research Congress; and facilitates interdisciplinary courses. These programs are designed to bring representatives from different disciplines together to expand their research networks, catalyze integrative

conversations, and create the conditions for successful interdisciplinary collaboration.

Further, BEACON is a consortium of several universities: Michigan State University, the University of Washington, the University of Texas, the University of Idaho, and North Carolina A&T. These very different universities include two land grants, three Research 1 universities, one small research university, and a Historically Black Colleges and Universities (HBCU) institution. The multiple institutions that constitute BEACON form another dimension of difference across which knowledge integration must take place.

Developing a positive culture of research ethics in this context means taking seriously the many differences that exist among BEACON members and integrating them with equity and balance. An ethical approach that privileged, say, life science over computer science would not do, nor would an approach that privileged the experience of larger research universities over smaller universities. The SV approach is well designed to operate in a context of multiplicity like this. Grounded in virtue theory as its foundation, the SV approach highlights what BEACON members have in common as scientific researchers while accommodating differences in emphasis. BEACON members may work at a computer rather than in the field or conduct research along with a substantial amount of teaching rather than run a big lab, but they are in the end scientists who strive to combine curiosity with honesty, persistence, and humility to evidence. By standing on common ground supplied by a conception of excellent science, BEACON members can develop the collective beliefs, values, and habits that constitute a distinctive and authentic culture of research ethics.

A key part of using the SV approach to create such a culture involves creating conditions in which BEACON members can reflect on and compare their own ways of thinking about what it means to be a virtuous scientist. Unless there are collective opportunities for conversation among BEACON members about excellent science, any progress toward a common, positive culture of research ethics would be accidental and unlikely. It is here that the Toolbox approach comes into the picture.

The Toolbox Dialogue Initiative (TDI, formerly the “Toolbox Project”) was originally based at the University of Idaho, a BEACON consortium partner, and became involved in BEACON at the proposal stage. TDI is a research and outreach initiative that runs dialogue-based workshops designed to build collaborative and communicative capacity in interdisciplinary teams [4, 5, 8]. Within BEACON, these workshops have been opportunities for participating scientists to have conversations structured around issues of importance to the community.

TDI was originally enlisted by BEACON leadership to serve the consortium in two roles: first, it was to run workshops designed to help build functional interdisciplinary teams, and second, it was to collect data about interdisciplinary performance that could aid in center evaluation. In the words of the proposal, TDI was to “provide training workshops and contribute to assessments to provide not only evaluative information, but more importantly, formative information to improve functionality of the teams.”

TDI’s initial involvement with BEACON came during the first Congress in 2010, when it ran five Toolbox workshops to help encourage interdisciplinary understand-

ing in the newly funded center. Focusing on scientific research, these workshops were designed to bring to the surface differences in epistemological and ontological assumptions that interdisciplinary researchers might not have otherwise recognized. They were conducted with five groups: the BEACON Executive Committee, the EHRD Steering Committee, and three cross-cutting theme research groups focused on viruses, speciation, and evo/devo. These standard Toolbox workshops ran for 2.5 hours and included a framing talk introducing the participants to the approach and a roughly 90-minute dialogue sandwiched between two periods during which participants filled out the "Scientific Research Toolbox instrument".

The Scientific Research Toolbox instrument is a survey-like instrument designed to stimulate and focus conversation that includes provocative prompts organized into six thematic groups called "modules": Motivation, Methodology, Confirmation, Reality, Values, and Reductionism [8]. The prompts are Likert items associated with a 5-point Likert scale ("Disagree" through "Agree") with "Don't know" and "Not applicable" options. Examples of the prompts include "Scientific research must be hypothesis driven", "Value-neutral scientific research is possible", and "Scientific research need not represent objective reality to be useful."

After scoring these prompts, participants discuss their views of them, noting similarities and differences and developing, coordinating, and even negotiating their alternative perspectives. Participants move through the instrument along a trajectory they determine, transitioning from module to module in a way that tracks their interest. The dialogues are facilitated, but the facilitation approach is light-handed and aimed at making sure the participants visit each of the modules. Rarely do participants discuss all the prompts, and occasionally they will visit some modules only briefly. The point of these dialogues is to enhance understanding about issues that are important to the group, which may only be a smaller subset of the overall number of prompts on offer in the instrument.

As BEACON progressed, the relationship of TDI with BEACON evolved. In 2012, Pennock and O'Rourke applied for and received BEACON seed funding to support the combination of the SV Project with the Toolbox approach in a way that could contribute to the RCR training required of graduate students and post-doctoral scholars in the center. Prior to initial work on the project, O'Rourke moved to MSU, where he joined Pennock, Berling, and McLeskey in adapting the Toolbox approach to the RCR context. Its role was still to provide contexts for structured conversation, but in this case the structure was supplied by the SV approach.

35.2 Adapting the Approaches to the BEACON Context

BEACON provided a unique situation that allowed the SV Project and TDI to combine and evolve in ways that neither might have done on their own. Pennock had previously developed a curriculum to teach science ethics with an SV-based approach for regular undergraduate courses and had taught different versions, with one organized around philosophical theory and a second where the material was

presented by way of readings (biographical and autobiographical) of the lives of scientists. The collaboration with TDI yielded a new workshop model designed to deliver RCR training for BEACON participants. The structured dialogue format of the Toolbox provided a framework for adapting the SV-based approach in a new and fruitful way that could be tailored for the needs of graduate students, postdocs, and other researchers. It also accommodated research faculty in face-to-face discussion of scientific values within an ethical framework. The Toolbox approach provided a way to give ethical structure to a conversation in workshop format that was appropriate for researchers who would never have the chance to take a full, formal course on research ethics. Bringing the two approaches together resulted in what we called the Scientific Virtues Toolbox (SVT) workshops.

The SVT workshops are designed with the goal of providing participants with an engaging experience that allows them to meaningfully explore RCR issues through the lens of Pennock's SV theory, which emphasizes the role of character in exemplary scientific practice. These SVT workshops will ultimately serve as one element of a broader virtues-based approach to RCR training and education. This distinct approach, with its emphasis on the Scientific Virtues, augments standard and traditional approaches to RCR training in a way that we believe is likely to strengthen the impact RCR training has on future behavior.

Each SVT workshop module focuses on a particular scientific virtue, such as curiosity. Workshop modules have been created for the following themes: the purpose of science, the purpose of engineering, curiosity, honesty, courage, humility to evidence, meticulousness, perseverance, and skepticism, with plans underway for modules for attentiveness, collaborativeness, and objectivity. A participant's first workshop session involves the Purpose of Science and Curiosity modules, with subsequent sessions involving other modules.

The workshop sessions are designed for small groups and typically run for an hour to an hour and a half. Various aspects of the SVT workshops are similar to standard Toolbox workshops, such as initiation with a preamble that introduces the approach and use of a Toolbox instrument comprising modules containing Likert items (see Figure 1). The preamble for the SVT workshops includes some background on the Scientific Virtues Theory and TDI. After the preamble is delivered, participants are divided into small groups, ideally ranging from 5-10 individuals, and one facilitator is assigned to each group. The facilitator helps administer materials, collect data, and moderate the ensuing discussion as needed. Through this moderation, the facilitator may also play the role of "Socrates in the Room" (see below for more information). Workshop participants then complete the SVT instrument and participate in a 30 to 45-minute dialogue.

During this dialogue portion of the SVT workshops, the prompts structure the discussion by encouraging participants to share and compare their reactions and responses to the prompts. After the discussion, participants then complete the same instrument they completed at the beginning, scoring their reactions to the prompts on the Likert scale. Finally, one to two weeks after the workshop, participants who consented to a follow-up interview are sent a survey that invites them to reflect upon their experiences and offer feedback.

Perseverance							
1.	Observational science requires patience; theoreticians need perseverance.						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A
2.	Impatience leads to bad science.						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A
3.	One key thing in science is to make mistakes quickly						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A
4.	Perseverance in science is indistinguishable from dogmatism.						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A
5.	Scientists' competitive nature makes it hard for them to be patient.						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A
6.	It is best to publish quickly to establish priority and deal with problems later.						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A
7.	Pressure to publish and get grants undermines basic scientific values.						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A
8.	Industrial scientists must be willing to hasten research to meet business deadlines.						
	Disagree				Agree		
	1	2	3	4	5	I don't know	N/A

Fig. 35.1: Sample prompts from the Perseverance Toolbox module.

Since beginning our SVT approach in 2013, we have administered over twenty-five SVT workshop sessions, including four or more sessions at each of the annual BEACON Congresses (2013-2018) and several BEACON Friday Seminar sessions. At the request of two professors who had participated in one of our workshops, we have also administered workshop sessions as part of the required curriculum for two graduate-level science courses and an undergraduate engineering course. In total, over 180 unique participants ranging from undergraduate students through senior faculty members have completed an SVT workshop session.

Participants who have already completed their first SVT workshop and discussed the Purpose of Science and Curiosity modules can participate in further workshop sessions with new modules at the BEACON Congress or the occasional BEACON Friday Seminar. These modules for returning participants have collectively had over 80 attendees, though this does not represent 80 unique attendees since a participant may have attended multiple additional modules over the past few years.

Adaptation occurred in the other direction as well. We made several changes in the Toolbox approach to make it work better for RCR training. First, in contrast with standard Toolbox workshops designed to help teams discover things about themselves, these were didactic workshops aimed at imparting ethical lessons to participants about virtuous scientific practice and RCR. These lessons were supported by recognizing commonalities as well as differences across the participant group, and to move past subjective opinions about ethics to a more rigorous account in which shared goals and values point the way to responsible conduct. Second, we structured the dialogues so that the participants talk about all the prompts, dividing time evenly between the modules. Third, because we were interested in making sure that partic-

ipants discussed all the prompts, we reduced the total number of modules to two, each containing six to eight prompts. Fourth, we changed the nature of the prompts so that they better fulfilled the didactic purpose and helped reveal the connection of values to responsible conduct. And finally, the facilitation style changed so that the workshop leader operates not just as a facilitator, but more like a philosophical guide—a role we came to call “Socrates in the room”.

The final point about our change in facilitation style deserves special emphasis. As we noted above, the traditional TDI approach utilizes a more hands-off approach to facilitation, which works well when the goal of the workshop is primarily focused on communication and resolving issues within a research team. With the RCR workshops, however, there is a pedagogical requirement—the participants need to learn something about responsible scientific conduct that will impact their behavior in the future. There are two primary factors at work here one involves what is learned, and the other involves how it is learned. Taking cues from Plato’s Socrates, we developed a Socratic role for the facilitator. This represents a move toward more guided discussion than is typical of TDI workshops, in an effort to make sure that participants leave the workshops with a deeper understanding of the nuances of RCR and the dispositions needed to act well when faced with difficult situations.

There are several key characteristics of what is commonly known as the “Socratic Method” or, in ancient Greek scholarship, the *elenchus*, that explain its relevance to our effort. The method itself is largely one of identifying contradictions within an interlocutor’s belief set by way of interrogation. In a typical case, the structure involves Socrates asking the interlocutor for something—typically this is the definition of a virtue term (like piety, as we see in Plato’s *Euthyphro*), but could also be the reasons for doing or not doing something. The interlocutor will then offer an answer, A, which will serve as the basis for further questioning. Socrates then proposes that A logically implies consequence X. The interlocutor is supposed to follow the reasoning that Socrates provides and agree that X is a logical consequence of holding A. Socrates then offers another proposition, which could be an alternative definition of the virtue term, an example of something we take to be an instance of the virtue (say, an example of something that is courageous), or something that seems tangential to the conversation but later is shown to be relevant. This second proposition, B, is understood to be a reasonable alternative to A and is then subjected to the same sort of reasoning as A. The result of this second line of questioning is the logical consequence Q.

Thus, we have two definitions, A and B, both of which the interlocutor finds reasonable (if not absolutely true), and two logical consequences, X and Q respectively. Given that the interlocutor agrees with the line of reasoning, Socrates then shows how the consequences X and Q cannot be held simultaneously—i.e. they are contradictory. The goal of this line of inquiry is to bring the person to the point of recognizing their own ignorance of the topic at hand. In the case of virtue, the idea is that people often assume they know what is good and bad, and trust their instincts and intuitions more than they should. The Socratic method is meant to show them that things are more complicated than they thought. Properly executed, the Socratic method can help people who are quite willing to admit that they do

not know what morality requires of them in a given situation as well as those who are confident in their moral or practical knowledge. It is a process of bringing the interlocutor to the point of *aporia*—i.e., a kind of confusion that is supposed to be uncomfortable—leading the interlocutor to pursue the truth more fully. Because this is a moral exercise, it is critical that the interlocutor follow the line of reasoning and also say what they truly believe. If people are not sincere in this, they will not get the benefit of the inquiry.

In relation to RCR, we have modified the Socratic method outlined here to press people on issues that are related but not obviously so. How does a proper understanding of courage lead one to being more open to criticism? How does an understanding of curiosity in scientific practice lead one to be less likely to fabricate data? These sorts of connections fall into line with Socratic inquiry. Socrates assumed that no one does what they know to be bad, i.e., no one errs willingly. Given this, the key is to know what sorts of things will hurt you and what will benefit you. This is a teleological value structure, with “the good” or “virtue” being the *telos*. In the more familiar Aristotelian sense, *eudaimonia* (often defined as happiness or flourishing) is the *telos* and virtuous activity is what enables one to be *eudaimon*.

The form that Socratic facilitation takes in SVT workshops varies from workshop to workshop. In some cases, participants make good points that do not get the uptake they should by the rest of the group. Here, our Socrates can step in to challenge others to take a more serious look at what their fellow interlocutors are saying. In other cases, Socrates may need to moderate the views of participants whose voices dominate the discussion. In any case, the role of Socrates is not to lecture, but to guide, with varying amounts of influence and pressure. Importantly, Plato's Socrates claimed that he was not a teacher, but rather a mid-wife whose job was to bring out the knowledge and understanding that was already there in the minds of his interlocutors as well as determine the bounds of that knowledge in order to understand ourselves better. It is only after we are challenged and forced to accept the limitations of our understanding that we can meaningfully discuss with others the nature of what is good and how to improve ourselves. This is just as true in the context of RCR as it is in everyday life.

When designing the prompts that make up a module, we have several goals. First, prompts are constructed not as survey items with precise wording to elicit consistent, uniform responses, but, rather, as stimuli to guide thought. They are designed to help participants articulate issues about which there may be multiple reasonable responses, thereby stimulating productive reflection and discussion. In some cases, this means that prompts are intentionally ambiguous, so that participants can work through the nuances of context or multiple possible interpretations.

Second, prompts aim at content that is meaningfully relevant and that will ideally help participants come to an appreciation of the focal virtue and the ways in which it may play a role in the practice of science.

Module topics are not created ad hoc but reflect both Pennock's theoretical approach and empirical findings from his national survey of exemplary scientists (Pennock and Miller, in preparation). As noted above, the characteristic scientific virtues arise in relation to science's central, guiding purpose—its *telos*. For that reason, the

first module that we have every participant do involves a discussion of the purpose of science. We typically combine this with a module on curiosity, which, together with honesty, stands at the core of science's characteristic values that arise in relation to its telos [11]. For subsequent workshops, participants are given modules that focus on other virtues important to science as identified theoretically and substantiated by Pennock's survey.

We organize the prompts of each module to cover three areas and loosely ordered them so that dialogue participants are more likely to see how virtues relate to conduct. The first couple of prompts in each module explore the concept of some particular virtue in a general sense (e.g., "Being meticulous means paying attention to every detail"). The prompts that follow examine the virtue's role in scientific practice (e.g., "Perseverance in science is indistinguishable from dogmatism"). The final few prompts explicitly connect the virtue to RCR issues (e.g., "A responsible scientist is more skeptical of bold and exciting findings").

This ordered structure changes the nature of the dialogue about RCR, especially in relation to traditional RCR training. The traditional approach often begins with some explicit definition or statement of a particular form of research misconduct, accompanied by examples of misconduct, real or hypothetical, with some history of why the rule came to be made and how it is enforced [13]. Our approach reverses this, beginning with internal values and then showing why responsible conduct flows out of them; the prompts are worded and ordered so that participants come to the discussion of particular RCR issues only after having talked about the values that underlie them. The SV-based approach also allows us to raise broader issues about responsible conduct and ethical culture that go beyond the standard RCR issues of falsification, fabrication, plagiarism and such [10].

Our usual procedure is to devise a set of prompts for a module and then test them in practice at a BEACON seminar or the BEACON Congress. The final version of a module will usually have six prompts, but we typically include eight or nine prompts in a test module so we can determine which work best in live dialogue. We record the dialogues, take notes, get participant feedback, and later discuss how these worked in different sessions. This formative process allows us to pick a subset of prompts that worked best and revise the wording as needed to make them more effective.

35.3 Outcomes

We have already published a few articles about this novel RCR approach [3, 9, 10, 12], and we have another manuscript now in progress that will survey and discuss the RCR literature in light of our virtue-based perspective. Berling et al. [3] reports pilot results from the first few BEACON workshops (e.g. 2013-2015 Congresses), showing that overall respondents (n=44, response rate 67%) believed that a virtues-based approach could contribute to RCR training and preferred our SV approach over traditional RCR training methods.

Since those pilot workshops, we have added to and refined the post-workshop survey questions sent to participants and collected these additional data from eleven workshops groups (Figure 2). These groups have included nine voluntary workshops offered at the 2017 BEACON Congress, 2018 BEACON Congress, and a 2017 BEACON Friday Seminar. These workshops have had a total attendance of 88, with 43 responses to the post-workshop survey (response rate = 48.9%). Also included are a graduate science course and an undergraduate engineering course in which SVT modules were used by the professor as part of the required curriculum, though consent to have deidentified data collected was still voluntary. These courses had a total of 40 students, with 36 responding to the post workshop survey (response rate = 90.0%).

	Workshop	Participants	Responses to Survey	Response Rate
Voluntary BEACON Workshops	2017 BEACON Friday Seminar: Objectivity	11	8	72.7%
	2017 BEACON Congress: Purpose of Science & Curiosity Groups (2)	24	8	33.3%
	2017 BEACON Congress: Meticulousness Groups (2)	18	7	38.9%
	2018 BEACON Congress: Purpose of Science and Curiosity Groups (2)	18	9	50.0%
	2018 BEACON Congress: Skepticism Groups (2)	17	11	64.7%
	TOTAL	88	43	48.9%
Courses	2016 Science Graduate Course	8	6	75.0%
	2017 Engineering Undergraduate Course	32	30	93.8%
	TOTAL	40	36	90.0%

Fig. 35.2: Attendance and post-workshop survey response rates to the workshops conducted since refining the survey sent 1-2 weeks after participation.

The responses to the closed-ended questions from the post workshop survey can be seen in Figure 3. For ease of visualization, the responses to the voluntary BEACON workshops are grouped together as are the responses to the two course curriculum workshops. The agreement column combines “Strongly Agree” and “Agree” responses together, and the disagreement column combines “Strongly Disagree” and “Disagree” responses.

Participants from both the voluntary BEACON workshops and the student courses largely view the workshop’s discussion as an open exchange of thoughts and ideas (88.4% (38) and 86.1% (31)). Participants also overwhelmingly reported that the SVT prompts were effective conversation starters (95.3% (41) and 94.4% (34)). Given this, we believe that the prompts and discussion-environment of the SVT workshops can produce efficient, targeted discussion that increases the chances that the ensuing dialogue resonates with participants.

Overall, the respondents from both the voluntary BEACON sessions and the student courses reported enjoying their SVT experience (93.0% (40) and 83.3% (30), respectively). While enjoyment is not a direct measure of effective pedagogy, we

	Voluntary BEACON Workshops			Course Curriculum Workshops		
Participants	88			40		
Respondents	43			36		
Response Rate	48.9%			90.0%		
QUESTION	Agree	Neutral	Disagree	Agree	Neutral	Disagree
Overall I enjoyed the SV Toolbox Workshop	93.0% (40)	4.7% (2)	2.3% (1)	83.3% (30)	16.7% (6)	0% (0)
The SV Toolbox prompts were effective conversation starters.	95.3% (41)	2.3% (1)	2.3% (1)	94.4% (34)	5.6% (2)	0% (0)
Our conversation was an open exchange of thoughts and ideas.	88.4% (38)	9.3% (4)	2.3% (1)	86.1% (31)	8.3% (3)	0% (0)
Participating in the SV Toolbox workshop is likely to help my professional development.	65.1% (28)	30.2% (13)	4.7% (2)	44.4%** (16**)	38.9%** (14**)	13.9%** (5**)
Since the SV Toolbox workshop, I have thought about the topics raised in the workshop.	60.5% (26)	25.6% (11)	14.0% (6)	63.3%* (19*)	13.3%* (4*)	23.3%* (7*)
Since the SV Toolbox workshop, I have discussed the topics raised in the workshop with others.	48.8% (21)	27.9% (12)	23.3% (10)	50.0% (18)	22.2% (8)	27.8% (10)
My participation in the SV Toolbox workshop contributed to a change in my views of scientific [focal virtue].	30.2% (13)	27.9% (12)	41.9% (18)	26.7%* (8*)	33.3%* (10*)	40.0%* (12*)

Fig. 35.3: Responses to the post-workshop survey sent to participants 1-2 weeks after completing the workshop. Responses with (*) are only responses from the undergraduate engineering course (30 respondents, 93.8% response rate), as these two questions were not asked of the graduate science course students. For the results marked (**), one of the respondents left the field blank, so the responses here only total 35.

believe that enjoyable and engaging RCR training approaches are more likely to be effective than approaches that are not. A comparative test would be required to establish this, of course, but such a test poses a challenge given that assessing the effectiveness of RCR training remains a problem for the field (see Antes et. al [1] and May and Luth [6] for useful discussions on this). We do take it to be encouraging that a majority of our respondents (60.5% (26) and 63.3% (19*)) reported thinking about topics from the workshop after completing it. Nearly half (48.8% (21) and 50.0% (18)) of respondents discussed the topics of the workshop with someone else. These results demonstrate that some participants are mentally engaging with the content of our workshops even after leaving the session. Furthermore, nearly

a third of BEACON participants (30.2% (13)) and 26.7% (8*) of students report a change in their views on the focal virtue in light of the workshop discussion.

Adding responses from these workshops to responses from past workshops [3], we see a continuation of the trends first observed. When looking at the first impression from the BEACON workshops, participants overwhelmingly believe that a virtues-based approach can add to the development of RCR, and this trend is also seen in responses from students who received SVT modules as part of their course work (Figure 4). Additionally, BEACON workshop participants prefer a virtues-based approach to RCR training over more traditional approaches (Figure 5). While students from the two courses were also asked this question, their responses are not included since many of them reported not having sufficient experience with traditional methods to make a judgment (e.g. "I have no experience with traditional RCR training, but I expect it would be less interesting and engaging than the toolbox exercise" and "The virtue approach was exceptional for my first RCR experience. As it was my first, I'm not sure what a more traditional approach is, therefore I can't answer.").

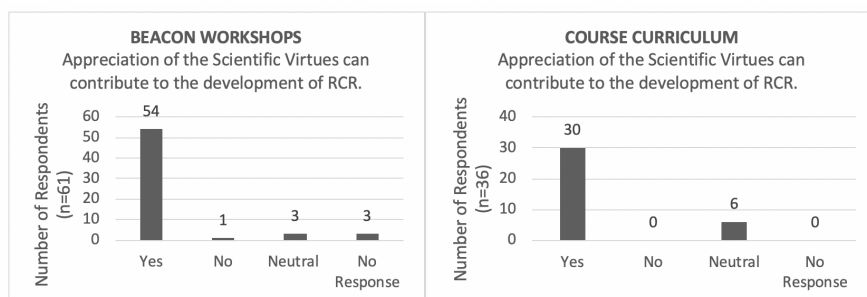


Fig. 35.4: Responses on the left are from BEACON Workshop participants ranging from 2013-present, with each response being a unique individual. In the case of workshop participants who have responded to this survey question multiple times by virtue of having completed multiple workshops, only their first response is included here (so it represents 61 unique respondents). Early workshop participants were asked the open-ended question "Explain whether you think appreciation of the Scientific Virtues can contribute to the development of RCR training," and these responses were coded into "Yes," "No," "Neutral," and "No Response." Later workshops asked participants to rate their response to the statement "Appreciation of the Scientific Virtues can contribute to the development of RCR" on a 5-point Likert scale from "Strongly Disagree" through "Strongly Agree," and in order to combine this data with earlier years "Strongly Disagree" and "Disagree" are treated as "No" responses while "Strongly Agree" and "Agree" responses are treated as "Yes". Responses on the right are from the students of the two courses where SVT modules were a part of their curriculum. Responses were scored on the Likert scale as a reaction to the prompt, and converted here to "Yes" and "No" for comparison purposes.

We find these results promising. While we do not know how effective the SVT approach is in affecting future behavior when faced with RCR issues or whether

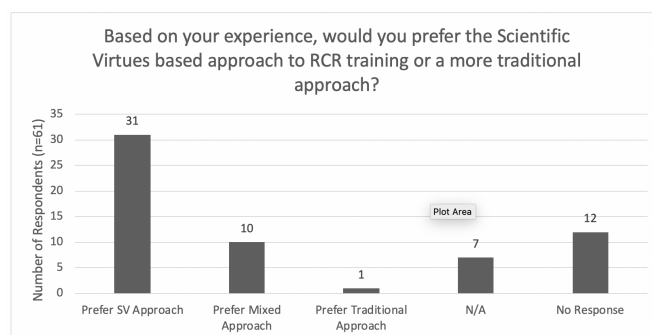


Fig. 35.5: Respondents from BEACON workshop participants ranging from 2013-present, with each response representing a unique individual. In the case of workshop participants who have responded to this survey question multiple times by virtue of having completed multiple workshops, only their first response is included here (so it represents 61 unique respondents). Respondents were asked the open-ended question, and responses were coded to “Prefer SV Approach,” “Prefer Mixed Approach,” “Prefer Traditional Approach,” “Not Applicable,” and “No Response.”

it is more effective than the traditional approaches, we are optimistic that our approach can meaningfully augment traditional approaches. Given that participants enjoy their workshop experience, believe that the virtue-based approach can contribute to RCR training, and think about and discuss the issues after the workshop is over, we believe that their engagement is likely to have a positive influence in their future behavior. Future work will include the development of additional modules and continued offering of workshops to expand our sample size.

We have also begun to disseminate aspects of the SV Project and the SV Toolbox at national and international professional meetings. For instance, Berling, McLeskey, and Pennock each gave presentations related to this work at the Character and Virtue in the Professions conference held at Univ. of Birmingham in the UK in June 2016 and also at the 5th World Conference on Research Integrity held in Amsterdam, The Netherlands in May 2017. Pennock gave a talk on “Rethinking Science Ethics Training in light of the Scientific Character Virtues” at the National Science Foundation Science & Technology Centers Directors Meeting in Washington DC in August 2016, and gave the invited keynote talk on “Curiosity and the Moral Character of Science” for the Undergraduate Research Summer Institute (URSI) Conference at Vassar College in September of the same year, and led a week-long workshop “A Virtuous Instinct for Truth” at Friends General Conference Gathering in Toledo, Ohio in July 2018. We have presented posters and presentations at various other professional meetings and reported on our efforts at NSF meetings and BEACON site visits.

The reaction at these events, as from our workshop participants, has been very encouraging. To mention just one example, the SVT RCR efforts were called out for special praise by external evaluators in a recent BEACON site review in their official report: “[We] commend their innovative approach to the ethical conduct of

research based on the virtues of science.” Site visitors cited it as an example of an opportunity for continued “major involvement at the national level to engage in leadership related to reforming American science education,” noting that:

There is a strong emphasis on understanding and promoting the nature of science and the value of science in education through the Science Virtues project, which serves as example of how to instill responsible/ethical practices in science education. Simultaneously, the Science Virtues project could influence STEM identity development and be used to help mitigate some of the challenges in recruiting and retaining underrepresented groups in STEM. (Site Visit Report 2016)

Based upon these promising early results and feedback, the project has now begun to evolve beyond its initial development within BEACON.

35.4 Adaptive Radiation of the SVT Approach beyond the Natural Sciences

Although its initial foray concentrated on the sciences, this virtue-centric SVT approach is widely applicable. Pennock saw early on that other vocational types of disciplines, namely medicine and engineering, would be natural next steps in what we now call the Vocational Virtues Project. During the development of the RCR component of the project, we wondered what it might look like to apply our approach to other disciplines within the university. Being a group of philosophers, we naturally thought about the impact we could make in the humanities—an area of the university that has had far less exposure to RCR. Coincidentally, a new mandate took effect at Michigan State University requiring all graduate students to engage in RCR training. This meant areas such as the humanities and the arts would now need to develop and implement an RCR curriculum. The stage was set for us to adapt to a new university environment for which we were now particularly well suited.

In the fall of 2017 we initiated development of an RCR curriculum tailored for the humanities. Using our work on the Scientific Virtues as a model, we began the process of filling in the teleological structure that reflects what it is to be excellent in humanities fields with the dispositions and values that support such excellence. To explore possible overlap between humanities and science in what counts as excellence, we started with the concept of curiosity and the role it plays in fulfilling the purpose of humanistic scholarship. Defining the purpose of the humanities is a tall order, although there may be some parallels to the purpose of science. For instance, a common refrain in science is that its purpose is to discover empirical truths about the world around us, and many humanists see themselves as truth-seekers as well even if not in the same empirical sense as scientists. There are obvious methodological and epistemic differences between science and the humanities (and even among humanities disciplines themselves), however, so we might not expect that the pursuit of truth will look the same for each.

Likewise, the role of curiosity about the world around us (and, in some cases, within us) may not look the same when one examines scholarly activity in the hu-

manities compared to science. The object of this curiosity, the truth being sought, understandably varies from discipline to discipline, and the methodological concerns vary with the epistemic demands of the discipline. For example, what counts as a good explanation in a given domain will directly impact the sorts of methods that are likely to lead to such an explanation. Moreover, some humanists do not see themselves as offering explanations at all but rather as offering interpretations or even wholly new creations. This means that if virtues such as skepticism, humility to evidence, and others are relevant to the humanities, they may manifest quite differently. Other virtues, such as honesty and perseverance, may turn out to be quite similar across disciplines. However, we might also expect to see some divergence in the prominence (if not existence) of virtues, such as objectivity, that are central to science but are optional, or at least less central, for some of the humanities, such as art or creative writing.

The interdisciplinary nature of BEACON afforded us the opportunity to bring together different sorts of scientists and engineers and, when combined with TDI's approach to structured conversations, this led to an appreciation for the challenges that confront us in transitioning to the humanities. For pilot workshops involving humanities graduate students, we adapted the approach to meet the needs of scholars in the humanities broadly construed. There are challenges that require working and re-working the details, such as different manifestations of the virtues, different virtues taking prominent roles, greater differences in terminology and research practices between disciplines, as well as a larger population of potential participants. Our expansion into this new, unexplored environment is a direct outgrowth of the work we started in BEACON.

35.5 Conclusion

Research environments are demanding on a number of fronts. The pressure to produce results quickly, the highly technical language used to communicate challenging concepts, and the difficulties associated with value systems that are often entrenched and unspoken all contribute to the sometimes frantic and often stressful conditions faced by researchers of all stripes. RCR work occupies a special place in this environment, as it is called upon to critique and improve the research environment while also being subject to the same sorts of pressures and time and funding constraints that are being critiqued. BEACON's initial investment of time, money, and most importantly support and buy-in at all levels allowed us to do work that is branching out into other areas of the university and into the wider world. Having an understanding of the difficulties presented in doing RCR work and recognizing the importance of that work led directly to the flowering of an approach that impacts people who have never heard of BEACON, and perhaps never will. BEACON has provided a warm and hospitable environment for this early work in fostering the development of new kind of RCR training rooted in core scientific values. Drawing inspiration from Charles Darwin and the words that concluded the *Origin of Species*, we might

hope that “from so simple a beginning” a newly enriched culture of integrity will continue to evolve.

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