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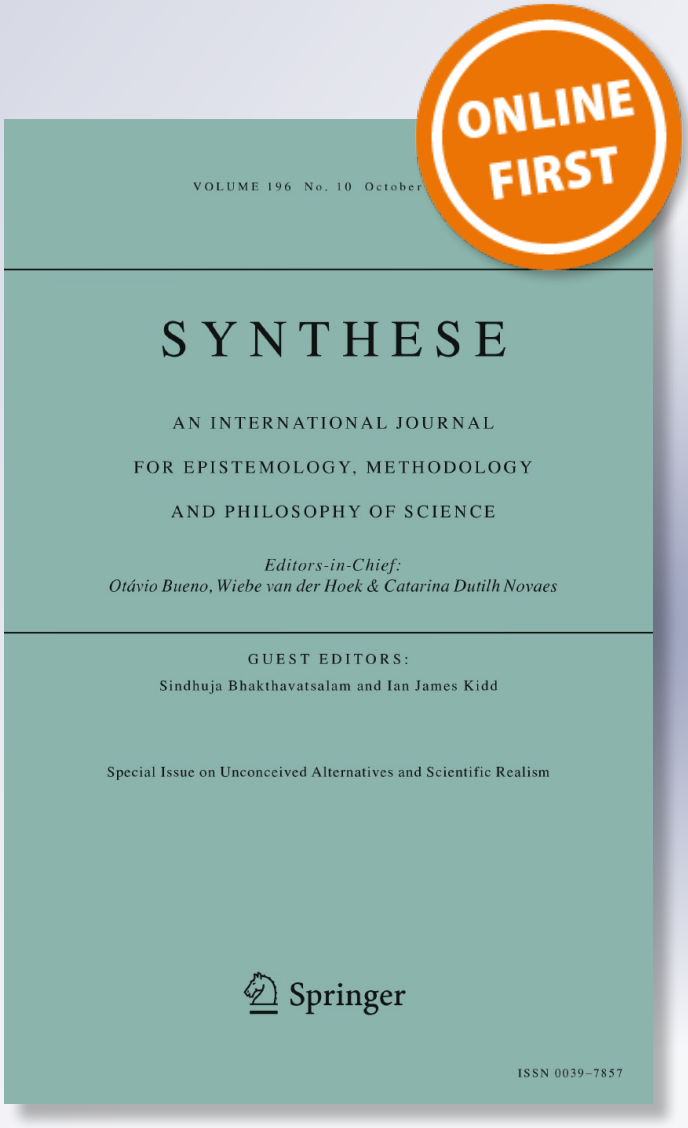

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Show me the numbers: a quantitative portrait of the attitudes, experiences, and values of philosophers of science regarding broadly engaged work

Kathryn S. Plaisance[1] · **Alexander V. Graham**[2] · **John McLevey**[3] · **Jay Michaud**[4]

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Abstract
Philosophers of science are increasingly arguing for the importance of doing scientifically- and socially-engaged work, suggesting that we need to reduce barriers to extra-disciplinary engagement and broaden our impact. Yet, we currently lack empirical data to inform these discussions, leaving a number of important questions unanswered. How common is it for philosophers of science to engage other communities, and in what ways are they engaging? What barriers are most prevalent when it comes to broadly disseminating one's work or collaborating with others? To what extent do philosophers of science actually value an engaged approach? Our project addresses this gap in our collective knowledge by providing empirical data regarding the state of philosophy of science today. We report the results of a survey of 299 philosophers of science about their attitudes towards and experiences with engaging those outside the discipline. Our data suggest that a significant majority of philosophers of science think it is important for non-philosophers to read and make use of their work; most are engaging with communities outside the discipline; and many think philosophy of science, as a discipline, has an *obligation* to ensure it has a broader impact. Interestingly, however, many of these same philosophers believe engaged work is generally undervalued in the discipline. We think these findings call for cautious optimism on the part of those who value engaged work—while there seems to be more interest in engaging other communities than many assume, significant barriers still remain.

Keywords Engaged philosophy of science · Dissemination · Collaboration · Interdisciplinarity · Barriers · Survey

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✉ Kathryn S. Plaisance
kplaisan@uwaterloo.ca

Extended author information available on the last page of the article

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1 Introduction

Philosophers of science are increasingly advocating for and undertaking work that is not only relevant to scientific and other communities but actually engages with those outside the discipline. This growing attention to engaged work is evidenced by a number of factors, including special journal issues devoted to the topic (Plaisance and Fehr 2010; Cartieri and Potochnik 2014), books that address the need for more engaged approaches (e.g., Kourany 2010; Frodeman and Briggle 2016) and the emergence of groups like the International Consortium of Socially Engaged Philosophy of/in Science and Engineering (SRPoiSE), the Joint Caucus for Socially Engaged Philosophers and Historians of Science (JCSEPHS), and the Public Philosophy Network (PPN), all of which include extra-disciplinary engagement as part of their mission. As those who have been involved in this work can attest, philosophy of science has the potential to significantly improve scientific practice, science policy, and public understanding of science. Furthermore, taking an engaged approach to one's work (e.g., collaborating with scientists) can also enable philosophers to identify new avenues of inquiry and improve the quality of philosophical work itself (Douglas 2010; Fehr and Plaisance 2010). However, philosophers of science who are interested in engaging other communities often express concerns about the barriers to disseminating their work more broadly and collaborating with others. If we cannot get our scientifically- and socially-relevant work into the hands of those who can use it, then we are seriously limiting the impact of our knowledge and missing important opportunities to influence other communities and enhance scientific research and its applications.

While some of the concerns about the barriers to engagement have been discussed in print (e.g., Fehr and Plaisance 2010), most have arisen in informal venues, such as conferences and workshops, making it difficult to critically assess and advance these types of discussions. Furthermore, the publications that directly address these issues are typically based on personal experience (Thagard 2006; Dennett 2009) or anecdotal data from a select few (Plaisance and Fehr 2010). In other words, we have little empirical data about the actual attitudes, experiences, and values of philosophers of science with respect to engaged work.[1] This gap in our collective knowledge is both a practical problem and an epistemological one. Practically speaking, we need to understand the challenges philosophers face when trying to engage other communities and/or increase the broader impact of their work, especially if we wish to cultivate actionable knowledge that can be used to overcome those challenges. Epistemologically, we lack a comprehensive understanding of how knowledge in philosophy of science is and could be mobilized across disciplinary boundaries. This paper begins to address these gaps by providing empirical data on the views and experiences of philosophers of science working in the field today. (Notably, this study

[1] An important exception to this, which we discuss towards the end of the paper, is a recent study by Valerie Tiberius on the value and "well-being" of philosophy (Tiberius 2017). In addition, Turri (2016) and Frodeman (2013) conducted surveys of philosophers and philosophy departments, respectively, though neither asked philosophers about their experiences with or attitudes towards engaged work.

was conducted by a team of researchers that included philosophers of science and social scientists. This collaborative approach enabled us to ensure that the methodology was appropriate for studying philosophy of science while also meeting rigorous standards of quantitative research.)

In this paper, we report the results of a survey of 299 philosophers of science. Our aim is to develop a statistical portrait of the field in terms of its members' attitudes, experiences, and views about the appropriate goals and approaches for philosophy of science as a discipline, especially regarding engaged work. Rather than speculate as to whether those taking an engaged approach are in the minority or what sorts of barriers they commonly face (as others have done), we asked philosophers of science directly. This allowed us to provide answers to the following questions: To what extent do philosophers of science think it is important for scientists—or others outside philosophy—to read and/or make use of their work? What percentage have actually tried to disseminate their work to scientific domains, and to what extent do they think those efforts have been successful? How common is it for philosophers of science to collaborate across disciplines or even with those outside of academia? What barriers or challenges have philosophers of science encountered in trying to engage other communities? Do some experience more significant barriers than others? To what extent do philosophers of science think engaged work is—and should be—valued by the discipline?

The emerging picture from our survey suggests that a majority of philosophers of science are interested in and think the discipline ought to value work that engages communities outside the discipline. In particular, almost every respondent reported that it is at least somewhat important to them that scientists read or make use of their work; most report having tried to disseminate their work to scientific communities or science policymakers; and many have collaborated in a variety of ways (e.g., over half had co-authored a peer-reviewed paper with a scientist).[2] While we expected there to be significant interest in and experience with engaging scientific communities, we were surprised by how high these numbers actually were. We conducted a statistical analysis of the data (using multiple regression) to determine whether key demographic variables accounted for any variation in responses. We found a few differences in responses based on gender, career stage, area of philosophy of science, and amount of scientific training. One of the main areas where differences arose was with respect to the barriers participants faced in doing engaged work. Interestingly, we found that perceived barriers were significantly higher than actual reported barriers for every barrier we listed. As we discuss below, this may suggest that, in some cases at least, barriers may not be as significant as some assume they are. However, since perceived barriers can become actual barriers, having a better understanding of the barriers that do and do not exist is crucial for determining what actions to take, both individually and collectively.

[2] Our survey asked participants about their views towards engaging scientific communities, policymakers, lay communities, and others; however, given the large amount of data we collected, we primarily focus on responses related to scientifically-engaged work in this paper. Where appropriate, we also report responses related to other types of engaged work, especially to demonstrate relative interests and experiences with respect to such work.

Of course, survey data alone do not give us a complete picture—they do not allow us to unpack individuals' experiences or identify causal relationships between particular conditions (e.g., one's institutional context) and outcomes (e.g., perceived success in influencing scientific practice). Because of this inherent limitation of quantitative data, our research team also designed a qualitative study as part of our larger research project. The qualitative aspect includes in-depth interviews with a number of philosophers of science to better understand the types of challenges they face in engaging other communities, how they have overcome those challenges, and what sorts of evidence they point to when asked about the broader impacts of their work. We report the results of that research elsewhere (Plaisance et al. 2019), though we do mention some of our qualitative findings below to provide context for the survey data. Furthermore, knowing that both surveys and interviews rely on self-report, our project also includes a bibliometric study of the citation patterns of philosophy of science articles in order to better understand broader uptake of philosophical work (McLevey et al. 2018).

We believe this research can be useful in a number of ways. First of all, having rigorously-collected empirical data provides us with a much more informed picture of the discipline. In some cases, this picture is different from the one portrayed in discussions about the value of engaged work. While some philosophers have stipulated that extra-disciplinary engagement is in the minority, our data suggest that it is not as uncommon as many seem to believe. Second, even for particular findings that may be unsurprising, having data allows us to be more confident about our perceptions. Our hope is that the picture we describe here will give junior scholars a better sense of what most philosophers of science think and do with respect to scientifically- and socially-engaged work, as well as what barriers they might face if they try to disseminate their work more broadly or collaborate with others outside the discipline. (Our interview data offer more details about nature of those barriers, including their context-dependent nature and ways they can be overcome.) It should also be of interest to more established philosophers of science, either for thinking through their own approach or for enhancing their understanding of the field in a way that may help them when mentoring or supervising junior scholars. Finally, this project is also relevant to philosophers more generally, including those who do not wish to engage extra-disciplinary communities themselves. While we certainly do not think an engaged approach should be the only one, nor is it necessarily better or more valuable than more traditional work in philosophy of science, we do think it would benefit the discipline to support scholars who are trying to bring philosophical work to bear on scientific practice, science policy, or public understanding of science.

2 Data and methods

2.1 Survey development and recruitment

The results presented in this paper are based on an analysis of an online survey of philosophers of science that we conducted in 2016 and 2017. To ensure our methodology

was in line with rigorous social science methods, we developed a "sampling frame" of philosophers of science—i.e., a comprehensive list of individuals who might identify as a philosopher of science—by obtaining names and affiliations from three sources. The first consisted of membership lists for the Philosophy of Science Association (PSA), the British Society for the Philosophy of Science (BSPS), and the European Philosophy of Science Association (EPSA). Second, we used the Python package metaknowledge (McLevey and McIlroy-Young 2017) to identify author names from Ph.D. dissertations in philosophy of science located in the Proquest Dissertations and Theses database. Third, we collected names and affiliations for everyone who had published two or more articles in any of the following seven journals: *Philosophy of Science*, *The British Journal for Philosophy of Science*, *Studies in History and Philosophy of Science (Parts A, B, & C), Synthese, European Journal for Philosophy of Science, Journal for General Philosophy of Science,* and *International Studies in the Philosophy of Science*. We selected these journals based on consultations with philosophers of science who are well-established in the field. In addition, this list of journals aligns well with those reported in Wray (2010), "Philosophy of Science: What are the Key Journals in the Field?" Wray also included *Erkentnnis* and *The Journal of Philosophy*; however, we chose not to include these journals as they are more geared towards a general philosophy audience, and we wanted to restrict the sample to philosophers of science as much as possible.[3] Knowing that at least some of the individuals we included would not identify as philosophers of science (given that historians of science, sociologists of science, and even scientists themselves occasionally publish work in these journals), we included a question on the survey, "do you identify as a philosopher of science?" Respondents were given three options: 'yes', 'to some extent', and 'no'. Only the results of those who answered 'yes' or 'to some extent' are included in the results reported below.

Recruiting participants using a sampling frame has a number of advantages. Unlike other approaches (e.g., circulating a link to the survey on mailing lists or posting a link on a website or blog), constructing this frame enables us to calculate a response rate and identify potential systematic biases in our responses. In this case, our response rate for the membership-based sampling frame was 9.7%, which is comparable to response rates for other digital surveys (and possibly a bit higher given the length of the survey).[4] Participation was voluntary and respondents were not compensated. In terms of systematic bias, we suspect that non-tenured professors are underrepresented in our sample (see Sect. 2.3 for further discussion of

[3] One of the reasons for using a more restrictive set of journals is that the views and experiences of those who identify as philosophers of science may be substantially different from those who identify as other types of philosophers, and our main aim was to understand how philosophers of science view engaged work and what sorts of barriers they face in disseminating their work to audiences outside philosophy.

[4] The response rate was considerably lower for the larger sampling frame, which included anyone who authored or co-authored a paper in one of the seven journals any time since their inception. Those authors include many researchers who are not philosophers, philosophers of science who are deceased, and many who published as graduate students but did not stay in academia (and thus were more difficult to track down). Thus, we think the response rate for the membership-based sampling frame is a better rate to use.

possible sampling biases). However, we are unable to compute the extent to which that is actually the case, as our sampling frame does not include sufficient information about academic appointments or career status.

The survey instrument was developed by the two philosophers of science on the research team, in consultation with the two sociologists who have expertise in survey methodology. After pilot testing the survey with several faculty and graduate students who identify as philosophers of science, we linked it to the names and emails in our sampling frame and launched the survey (using LimeSurvey). The survey had five main sections: (1) career-relevant information about each participant, (2) interest in and experience with disseminating work outside philosophy, (3) interest in and experience with collaborating with others (especially with non-philosophers), (4) views about the goals and obligations of philosophy of science as a discipline, and (5) demographic information. Most of the survey questions in sections (2), (3), and (4) were Likert-type scale questions, with some opportunities for open-ended responses.

In the first section, we asked participants about their professional background. This included questions about the type of philosophy of science they do (e.g., general philosophy of science, feminist philosophy of science, philosophy of biology), the institution from which they earned or are earning their Ph.D., the year they earned or expect to earn their Ph.D., their current position (e.g., graduate student, adjunct, tenure-track faculty member), and the amount of education or training they have received in a scientific field. In section two, we asked participants to rate how important it was to them that other communities read or make use of their work, whether they had tried to disseminate their work to scientific communities, to what extent they thought their dissemination efforts were successful, and what sorts of barriers they faced. We also asked how much they thought philosophy of science, as a discipline, values extra-disciplinary dissemination as well as how much they thought it should be valued. The third section focused on collaboration. We asked participants to rate how interested they were in collaborating with a variety of individuals or communities (e.g., other philosophers, scientific researchers, policymakers), the various ways they had collaborated with others, and how often they had engaged in such collaborations. As with the section on dissemination, we also asked about barriers they had experienced and their perceptions of the extent to which the discipline values and rewards collaborations (with scientists in particular). Section four included questions about the goals and obligations that participants thought philosophy of science, as a discipline, ought to have. Finally, we had participants provide key demographic information, such as gender and ethnicity, so we could determine whether particular factors might be associated with variation in responses and to assess representativeness of our sample.

2.2 Participant demographics

As noted above, we received complete responses from 299 philosophers of science. The statistical details of professional backgrounds and demographic variables are reported in Table 1.

Table 1 Participant demographics

	n	%
Identifies as a philosopher of science		
Yes	188	62.9
To some extent	111	37.1
Type of philosophy of science		
General philosophy of science	203	30.7
Feminist philosophy of science	23	3.5
Philosophy of biology	79	12.0
Philosophy of chemistry	18	2.8
Philosophy of medicine	32	4.8
Philosophy of physics	91	13.8
Philosophy of psychology	56	8.5
Philosophy of social science	57	8.6
Other	102	15.4
Current position		
Tenured faculty member	181	60.7
Tenure-track faculty member	24	8.1
Postdoctoral fellow	17	5.7
Contract/adjunct faculty	9	3.0
Independent scholar	8	2.7
Has a Ph.D. and is seeking a TT position	2	0.7
Graduate student	9	3.0
Non-academic job	11	3.7
Retired faculty member	28	9.4
Other	9	3.0
Science training		
Ph.D. in a scientific field	50	16.9
Master's degree in a scientific field	61	20.6
Undergraduate degree in a scientific field	63	21.3
Undergraduate minor in a scientific field	18	6.1
Some science courses	73	24.7
Informal training	15	5.1
No training	8	2.7
Gender		
Female	57	19.5
Male	231	79.1
Another gender identity	4	1.4
Ethnicity		
Asian	5	1.7
Black	1	0.3
Indigenous	1	0.3
Latina/Latino or Hispanic	12	4.0
Middle Eastern	7	2.3
White/Caucasian	268	89.6
Other	13	4.4
LGBTQ+		
Identify as LGBTQ+	17	6.1
Do not identify as LGBTQ+	255	91.7
Prefer not to say	6	2.2

We received responses from philosophers of science who work in a variety of areas, including general philosophy of science, feminist philosophy of science, and several areas in philosophy of the "special sciences". It was interesting to see that over one-third of respondents have a master's or doctoral degree in a scientific field and over half have at least an undergraduate degree in a scientific field. In terms of demographics, the sample was overwhelmingly white and male, in line with what we see in the discipline more generally.

2.3 Limitations of our sample

One of the limitations of our study is that it is difficult to precisely determine the representativeness of our sample, especially given the lack of other surveys with which to compare it.[5] The best way of assessing representativeness was by comparing the demographics of our sample with the most recent data from a survey of Philosophy of Science Association (PSA) members (*Gender distributions among Philosophy of Science Association members* 2014). However, the only factor both surveys examined was gender (the PSA survey asked about gender and salary). In the PSA report, 17% of respondents identified as female and 82.7% as male, while in our survey, 19.5% of respondents identified as female and 79.1% as male (1.4% reported another gender identity and 2.3% did not provide an answer).[6] Thus, the gender demographics of our survey seem to be representative of other data about members of the discipline and in fact may slightly overrepresent female philosophers of science (alternatively, the PSA data may underrepresent them).

With respect to career stage, the representativeness of our survey sample seems mixed. In our sample, 60.7% of respondents were tenured faculty members and only 8.1% were tenure-track (others were graduate students, postdoctoral fellows, adjuncts, retired faculty, or were employed outside academia). Since the PSA report did not include data about career stage, we compared our sample with data from the American Philosophical Association (APA). According to a recent APA report, 61.5% of the membership were tenured faculty and 18.8% were tenure-track faculty members in 2017 (*Demographic statistics on the APA membership, FY2016 to FY2018* 2019). On the one hand, this suggests that our survey is representative when it comes to tenured faculty, but not tenure-track faculty. However, there are two other possibilities. First, both the APA data and our survey data may overrepresent tenured faculty as those who are tenured may be more likely both to become official APA members and respond to our survey. Second, there could be more tenure-track faculty in philosophy than in philosophy of science such that both surveys are actually representative of both communities. In any case, we believe our survey may

[5] Frodeman (2013) surveyed departments rather than individuals and thus doesn't provide demographic data. Turri (2016) asked about gender but not rank. Tiberius (2017) doesn't include demographic information in her paper (she provides it an a separate report, but we decided not to use that data as it was unpublished at the time of this writing).

[6] Turri (2016) surveyed philosophers more generally:16.6% of his respondents identified as female and 81.3% as male.

underrepresent junior scholars. Our main concern with this possible lack of representativeness is with respect to the barriers to broader dissemination and collaboration that we asked about. Our own statistical analyses indicate that those without tenure face more significant barriers such as lack of recognition for the purposes of tenure and promotion. To address this issue, we indicate whether there are differences between groups (including between tenured and non-tenured respondents) for each of the findings we report below. This makes it easier for readers to see where the lack of representativeness with respect to a particular demographic variable, such as career stage, may be playing a role in skewing the results.

Finally, there may be a selection effect in our sample, where those who value engaged philosophy of science may have been more likely to respond to the survey and those who think it is unimportant may have been less likely to do so. If such a selection bias occurred, then some of the figures we report may be inflated (for example, the reported proportions of philosophers of science who have co-authored with scientists may be higher than the actual proportions). We tried to minimize self-selection by not using terms like "engaged" or "socially relevant" in our recruitment materials, though we did describe the survey as part of "a study on the relationship between philosophy of science and the sciences." We caution readers to keep these limitations in mind when reading the rest of the paper.

2.4 Statistical analysis

For the majority of statistical tests, we used multiple regression to examine the strength and significance of the relationships between potential predictors (e.g., gender) and the outcome variable (e.g., reported barriers).[7] Regressions are generally understood in terms of their regression coefficients. The basic interpretation for regression coefficients is as follows: for a 1-unit increase in variable X, we expect to see a change in the outcome variable Y equal to the regression coefficient for X. Take, for example, the level of science training that a philosopher of science has acquired (e.g., an undergraduate degree vs. a master's degree vs. a Ph.D. in a scientific field) and their desire to work with scientists. In that case, a value of 0.5 would indicate that an increase in science training comparable to the change between an undergraduate and master's degree in a scientific field predicts a half-point shift in desire to collaborate with scientists (halfway between "no desire" and "some desire" for example). Similarly, philosophers of science with a Ph.D. in a scientific discipline would be expected to answer a half-point higher than those with a master's degree, and 1.0 points higher than those with an undergraduate degree in a scientific discipline. In our Findings section, we report the results of our statistical analysis in terms of effect sizes (denoted by '*B*').

There are five variables we thought might account for variation in responses, and thus five independent variables in our models: gender, career stage, amount of

[7] In preparation for the statistical analysis, responses were coded on a numeric scale, with the most negative response being 1 and each gradation being one higher. This allowed us to include such responses in our regressions and will help explain the interpretation of the results.

scientific training, area of philosophy of science (general philosophy of science vs. philosophy of the "special sciences"), and whether or not one identifies as a feminist philosopher of science. By including all these variables in our models, we were able to identify correlations that are not confounded by the other variables we examined. For instance, if our data show that there are statistically significant differences between participants who identify as feminist philosophers of science and those who don't, but no differences according to gender, then the differences associated with being a feminist philosopher of science are not attributable to the fact that there are likely more women who identify as such. Notably, while some of these variables were correlated with others, none of them were highly correlated (in other words, we didn't have multicollinearity, which would make it difficult to tease apart the contributions of the different variables). Interestingly, gender and career stage were not correlated at all.

For each of our models, we did additional analyses to determine if the model was a good fit. (Roughly speaking, "good fit" means we can be reasonably confident that the model accurately captures relationships between the variables. When determining which models to report, we excluded those that either violated a key assumption or that did not explain much of the variance.) Any statistically significant differences—or lack of differences—we report in this paper are from models that have good fit; furthermore, we explicitly note when our models did not have good fit (such that we were unable to determine whether or not there were differences between groups). Readers should note that we used $p < 0.05$ as the threshold for statistical significance; however, since we report actual p values below, readers who prefer a different threshold can interpret those findings for themselves. For the effect sizes, we used unstandardized regression coefficients (denoted by 'B' in the Findings). Interested readers can find more details about our statistical analyses (e.g., how we coded each variable and what criteria we used for model selection) in the supplementary appendix (https://osf.io/8wn6b/).

3 Findings

Below we describe our findings for the three substantive sections of the survey: dissemination, collaboration, and goals and obligations. We also report the results of the statistical analyses we performed. As noted above, for any differences that we found, our models controlled for other factors we thought were likely to play a role, which include: gender, career stage, area of philosophy of science, amount of scientific training, and whether or not one identifies as a feminist philosopher of science.

3.1 Dissemination

We began by asking participants to indicate how important it is to them that other communities read or use their research. As indicated in Fig. 1, almost all respondents

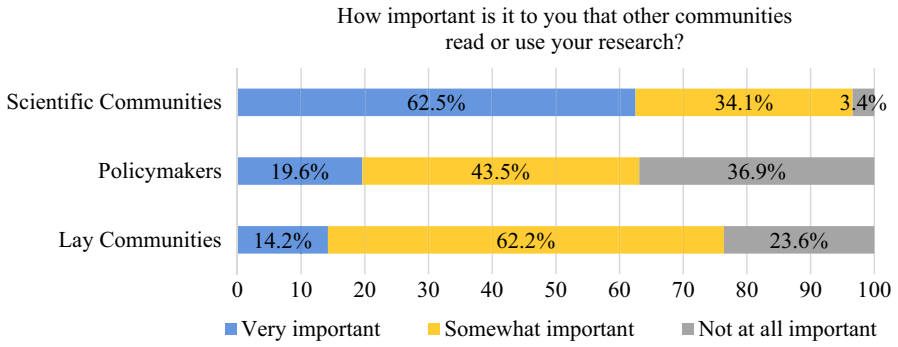

Fig. 1 How important is it to you that other communities read or use your research?

(96.6%) said that it was at least somewhat important that scientific communities read their work, with the majority (62.5%) rating it as very important.[8] Our statistical analysis showed that more science training predicted a slightly higher rating of importance on this scale (B: 0.066, $p < 0.002$). Many respondents (63.1%) also said it was at least somewhat important to them that policymakers read or make use of their work. Again, we found that those who had more science training were slightly more likely to say that it was important that policymakers read their work (B: 0.072, $p < 0.011$).

Most respondents were also interested in having lay communities read or use their work, with roughly three quarters (76.4%) rating it as at least somewhat important. We were not able to determine whether there were differences between groups for this question as our statistical model was not a good fit (i.e., we could not be confident that the model was accurately capturing underlying relationships).

Next, we asked participants whether they had tried to disseminate their work to scientists (e.g., through presentations at science conferences or publications in science journals). Most (83.8%) responded 'yes', while a few (16.2%) said 'no'. The communities to which philosophers of science disseminated their work varied widely (e.g., biologists, chemists, physicists, artificial intelligence researchers, and health professionals). Interestingly, we found statistically significant differences between men and women respondents on this question (even after controlling for other factors like career stage), where men were much more likely to say they had tried to disseminate their work to scientists (B: 2.159, $p < 0.045$). Those who were post-tenure were also much more likely to say they had tried to disseminate their work (B: 2.351, $p < 0.050$). Notably, the effect sizes for gender and career stage were quite similar (despite the fact that gender and career stage were not correlated with one another). In terms of perceived success, 52.8% thought their dissemination efforts were successful, 39.9% thought they were at least a bit successful, and only 7.3% didn't think they were successful at all (see Fig. 2). Here, there were no statistically significant differences between groups.

[8] Note that we only report responses for those who answered the question. For the dissemination section, the response rate for each question was 89–98%.

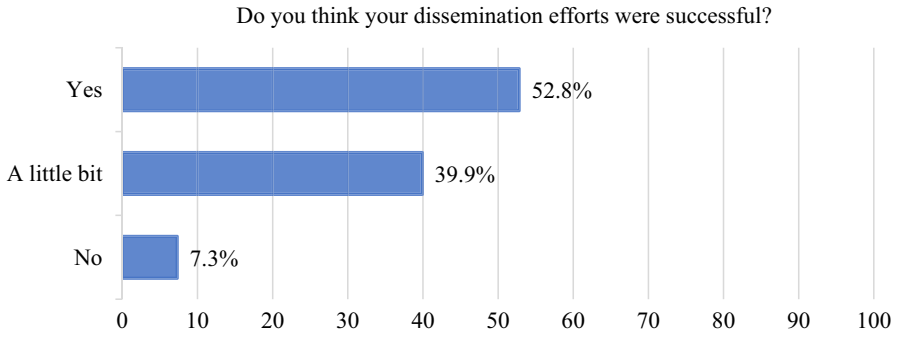

Fig. 2 Do you think your dissemination efforts were successful?

Almost half of the participants added comments in response to our question about the success of their efforts, offering insight into the types of evidence philosophers of science consider when assessing the impact of their work. Many of these examples suggested uptake of their scholarly work among scientific communities: being asked by scientists about their views on a particular topic, having their ideas incorporated by scientists in scientists' future work, noting a positive reception of one's conference talk, receiving an award for their work from a scientific association, being asked by a scientist to collaborate on a research project, being invited to write an article for scientific journals like PLOS, and having scientists cite their work. With respect to this last category, some participants specifically noted that their papers in science journals were the most downloaded or cited of all the papers they had published. One participant wrote, "my work has received almost as much attention from physicists as from philosophers." Some participants also mentioned the broader impact of their work via their teaching or service commitments. For example, one person noted science students' interest in how concepts from philosophy of science relate to the nature of those students' research questions and methods; another discussed opportunities to teach medical professionals, which affected those professionals' thinking on particular issues; yet another wrote about being able to provide input on legislation regarding insurance companies' use of genetic information.[9]

To get a sense of the types of barriers philosophers of science face when disseminating their work more broadly, we drew on other research (e.g., Fehr and Plaisance 2010) to create a list of what we thought would be the most likely barriers experienced by at least some members of the discipline. We asked those who had tried to broadly disseminate their work to rate the significance of those barriers and list any other barriers we may have missed. The barriers we included, in descending order of reported significance, were: lack of time, lack of interest on the part of scientists, lack of opportunities/

[9] For a detailed discussion of the types of impacts philosophers of science cite, what evidence they use to assess it, and what types of pathways are more likely to enhance impact, see Plaisance et al. (2019). Notably, a number of philosophers of science we interviewed for that study mentioned the impact they have had via teaching, lending support to the idea that many philosophers' broader impacts likely happen through teaching (e.g., Schliesser 2015).

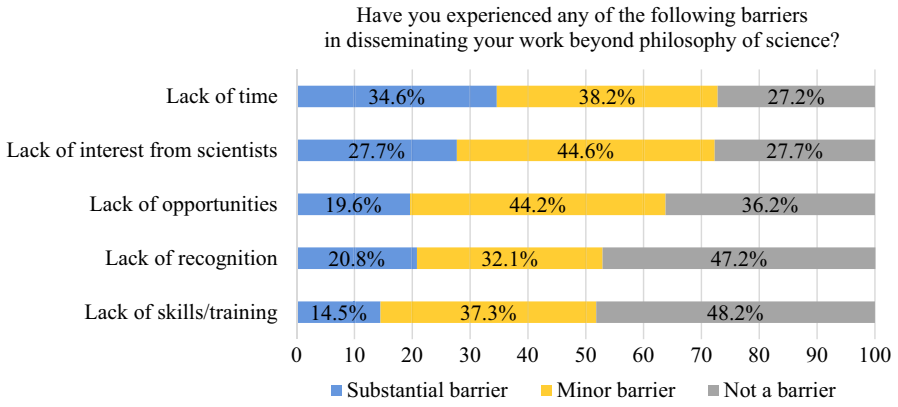

Fig. 3 Have you experienced any of the following barriers in disseminating your work beyond philosophy of science?

resources, lack of recognition (for hiring, tenure, promotion, etc.), and lack of skills/training. Figure 3 shows the responses to each of the five barriers we asked about.

For most of the barriers, we found statistically significant differences among various groups. For 'lack of time', both women and those who were post-tenure were somewhat more likely to say that time was a barrier (for women, B: 0.456, $p < 0.002$; for post-tenure, B: 0.324, $p < 0.018$). The effect size for gender was slightly larger than what we found for participants' career stage (see Table 2, below, for an overview of the various effect sizes). While individuals who did not have tenure were *less* likely to say that time was a barrier, they were much *more* likely to say that lack of recognition (e.g., for hiring, tenure, and promotion) was more of a barrier to broadly disseminating their work (B: 0.527, $p < 0.0003$). This was the largest effect size, and the highest level of certainty, for all the differences we identified amongst the barriers we asked about. In particular, non-tenure participants responded as follows: 42.9% said it was a substantial barrier, 28.6% said it was a minor barrier, and 28.6% said it was not a barrier to disseminating their work more broadly. For post-tenure participants, the responses were: 13.9% substantial barrier, 33.7% minor barrier, and 52.4% not a barrier. No other variables, such as gender or scientific training, predicted differences in reporting lack of recognition as a barrier.

Respondents who did not have tenure were also more likely to say that lack of interest on the part of scientists was a barrier to disseminating their work outside of philosophical domains (B: 0.347, $p < 0.012$). Interestingly, neither science training nor area of philosophy of science (general philosophy of science vs. philosophy of the "special sciences") made a difference. Science training did, however, predict whether a participant thought a lack of skills posed a barrier: not surprisingly, those with more science training reported this as less of a barrier (B: -0.103, $p < 0.001$). Finally, there were no significant differences when it came to lack of opportunities or resources. Table 2 provides a summary of effect sizes for the statistically significant differences we identified.

A small percentage of respondents (6%) reported additional barriers and described them in the comments. One of the main themes that arose from the comments was

Table 2 Effect Sizes for Between-Group Differences Regarding Barriers to Dissemination

	Lack of time	Lack of recognition	Lack of interest from scientists	Lack of skills	Lack of opportunities
Career stage (non-tenured)	−0.32	+0.53	+0.35		
Gender (women)	+0.46				
Level of science training				−0.11*	
General POS (vs. phil. of special sciences)					
Feminist philosophy					

*The effect size for level of science training should be interpreted differently than for the other variables, as science training was captured on a 6-point scale, ranging from no training to holding a Ph.D. in a scientific field. The effect size thus captures the result of moving up one gradation with respect to reported barriers. In this case, those who held a Ph.D. in a scientific field were much less likely to report lack of skills as a barrier compared with those who had no training; the effect size for the difference between those groups is −0.66

difficulties with cross-disciplinary communication. For instance, a few respondents cited challenges with understanding and adapting to the writing styles and publishing norms of scientific or science policy venues. Another respondent attributed communication difficulties to philosophers' lack of training, suggesting that, "Philosophers are poorly trained to talk to scientists, policymakers, and the general public. There needs to be training in how to do this effectively if we actually think we can communicate across the disciplines." Yet another noted that, among scientists, there is a "lack of understanding for what philosophy of science can contribute."

At the end of the section on dissemination, we asked participants to rate the extent to which they thought efforts to broadly disseminate one's work was actually valued and rewarded by the discipline, and the extent to which they thought it *ought* to be valued. Over half (61.8%) thought that such work was 'generally not valued' or that 'some value it but it's generally not rewarded' (see Fig. 4).

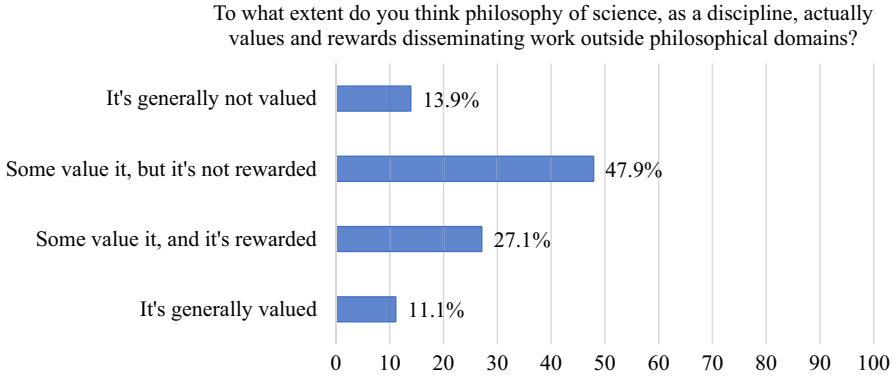

Fig. 4 To what extent do you think philosophy of science, as a discipline, actually values and rewards disseminating work outside philosophical domains?

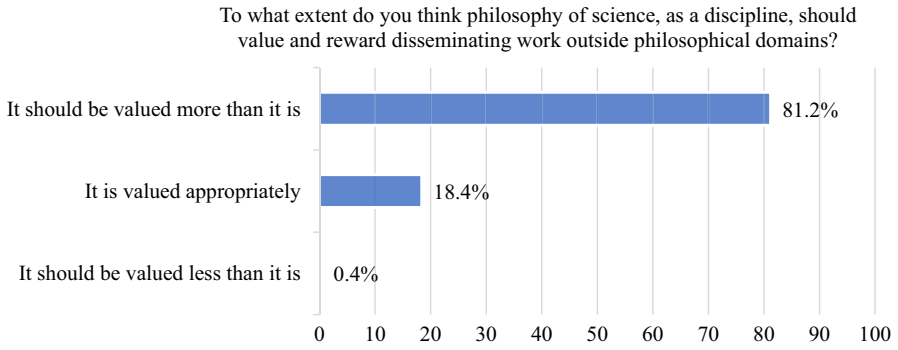

Fig. 5 To what extent do you think philosophy of science, as a discipline, should value and reward disseminating work outside philosophical domains?

Moreover, the majority (81.2%) thought that broader dissemination efforts should be valued more (notably, only one person thought it should be valued less than it is; see Fig. 5). This was surprising to us—while we expected some participants to say that broader dissemination should be valued more than it is, we certainly did not expect such a large majority.

Interestingly, we didn't find any statistically significant differences between groups on either of these questions.

3.2 Collaboration

In the section on collaboration, we asked a set of questions similar to those included in the dissemination section. In addition, we asked about the various ways participants have collaborated with others. Overall, the results indicate that many philosophers of science are both substantially interested in and have wide variety of experience with collaborating with those outside their field.

Participants were first asked about their interest in collaborating with particular individuals or groups, with the added remark: "by collaboration, we mean things like co-authoring a publication, co-presenting a conference paper, or being co-PIs on a grant proposal." As Fig. 6 shows, the majority of respondents are at least somewhat interested in collaborating with others, including other philosophers of science (95.1%), scientists or engineers (93.2%), social scientists (81.3%), and policymakers (68.8%); notably, over half were *very* interested in collaborating with scientists or engineers (64.3%). Both non-tenured respondents and those who identify as working in the philosophy of the special sciences were more likely to be interested in collaborating with scientists or engineers (for non-tenured, B: 0.211, $p < 0.023$; for philosophy of special sciences, B: 0.224, $p < 0.045$). We did not find any differences when it came to interest in collaborating with other philosophers, and our models did not have good fit for the other questions (e.g., interest in collaborating with social scientists or policymakers).

Next, we asked participants how often they had actually collaborated with various individuals or groups. As Fig. 7 illustrates, the majority of participants (84.9%)

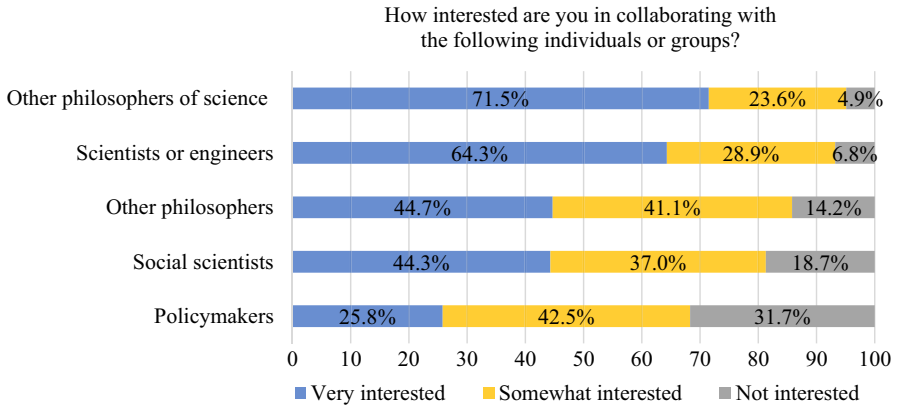

Fig. 6 How interested are you in collaborating with the following individuals or groups?

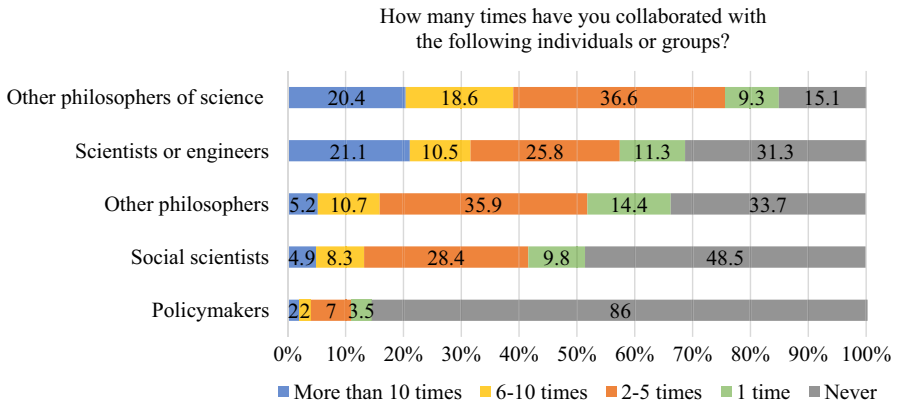

Fig. 7 How many times have you collaborated with the following individuals or groups?

have collaborated with other philosophers of science at least once; over half have collaborated with scientists or engineers (68.7%) or social scientists (51.5%); and a few participants (22.1%) have collaborated with policymakers. It is interesting to note that about one-third of participants have collaborated with scientists or engineers six or more times, suggesting that a significant number of philosophers of science are involved in frequent collaborations.

Not surprisingly, we found statistically significant differences between tenured and non-tenured respondents, where being tenured was associated with more collaborations (*B*s ranged from 0.28 to 0.60 and p-values from 0.001 to 0.022, depending on which group of collaborators we were looking at). Since we didn't control for age, this could be explained by the fact that tenured respondents have had longer careers than those without tenure and thus more opportunities to collaborate. However, it is also possible that this difference is due in part to concerns about the negative consequences of collaboration when it comes to receiving tenure; in fact, as we demonstrate below, 'lack of recognition' is a more significant barrier for non-tenured

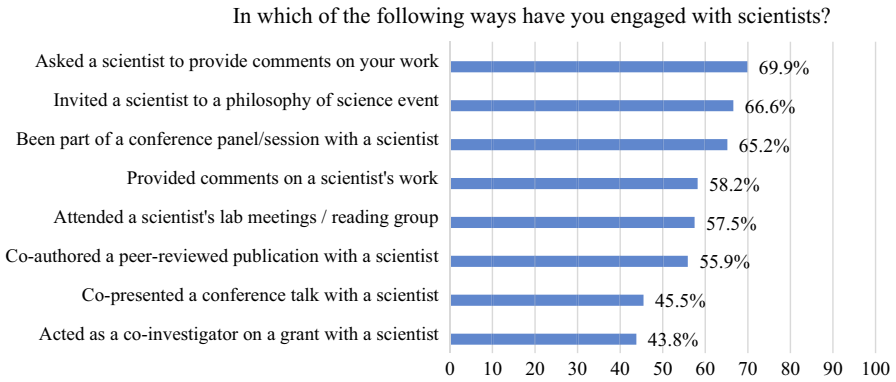

Fig. 8 In which of the following ways have you engaged with scientists?

respondents than it is for those who have the security of tenure. We also found differences associated with gender and science training when it came to frequency of collaboration. Women collaborated with other philosophers more often than did men (B: 0.471, $p < 0.019$), while those with more science training collaborated more often with social scientists (B: 0.104, $p < 0.041$) and scientists or engineers (B: 0.245, $p < 0.00001$) than did those with less science training.

To better understand how philosophers of science engage with scientists or scientific communities, we listed various modes of engagement and asked participants to check off any they had done (see Fig. 8). Some of the more common ways of engaging were relatively informal (e.g., asking a scientist to provide comments on their work), while others involved more formal collaborations (e.g., co-authoring a peer-reviewed paper).

Notably, over half (55.9%) of respondents had co-authored a peer-reviewed publication with a scientist or engineer and just under half (43.8%) had been co-investigators on a grant.[10] We found these numbers to be surprising, especially given the typical narrative of philosophy as a solo-authored discipline. While philosophy of science may be thought of as a more collaborative enterprise than other areas of philosophy, we did not expect to see that the majority of respondents had actually co-authored with scientists.[11] (Others didn't expect this either: during our interviews, and when presenting this work, we often asked philosophers of science what they expected these numbers to be. With one exception, everyone we asked predicted significantly lower estimates.)

When it came to more formal types of collaborations (e.g., co-authoring a peer-reviewed paper or acting as co-PI on a grant), we found that non-tenured respondents were less likely to have collaborated with scientists (for co-authoring, B:

[10] We could not calculate a non-response rate for this question; thus, these numbers may actually be slightly higher. On the other hand, if selection bias occurred, then the numbers may be slightly lower than what we report here.

[11] While post-tenure respondents were more likely to have co-authored with scientists or engineers than their non-tenured counterparts (62% vs. 41%, respectively), even the proportion of non-tenured respondents was still higher than we expected.

−0.209, $p < 0.005$; for co-PI, B: −0.204, $p < 0.006$). It is important to remember that our sample likely overrepresents post-tenure philosophers of science, so these percentages may not be representative of philosophy of science more generally (that is, taking into account non-tenured scholars, who are less likely to have formally collaborated with scientists). Regardless, this still suggests that philosophers are more collaborative than many may assume.

As we saw with participants' dissemination efforts, well over half of respondents (71.6%) considered their collaborations with scientists to be successful, and almost all (96.8%) said they were at least a little bit successful (Fig. 9). Notably, non-tenured respondents were less likely to report their collaborations as successful (B: −0.201, $p < 0.040$). We did not find differences in ratings of success for any other groups.

To assess what sorts of challenges philosophers of science face when doing collaborative work, we listed several barriers we thought might be prevalent and asked participants whether each was an *actual* barrier they experienced (and if so, whether it was a minor or significant barrier). We also asked them to share additional barriers they faced that the survey did not already capture. Figure 10 shows the list of

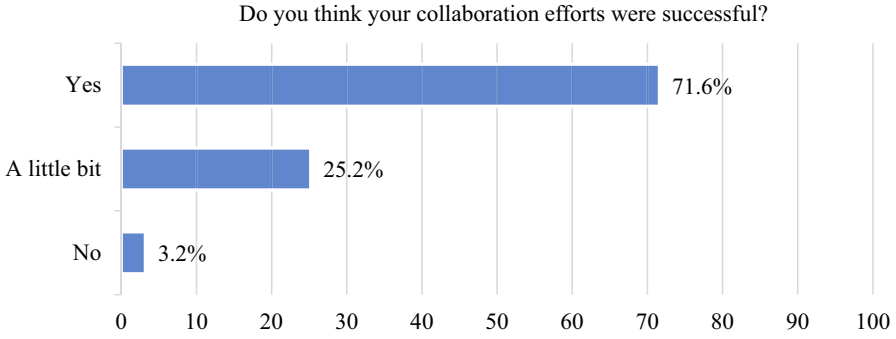

Fig. 9 Do you think your collaboration efforts were successful?

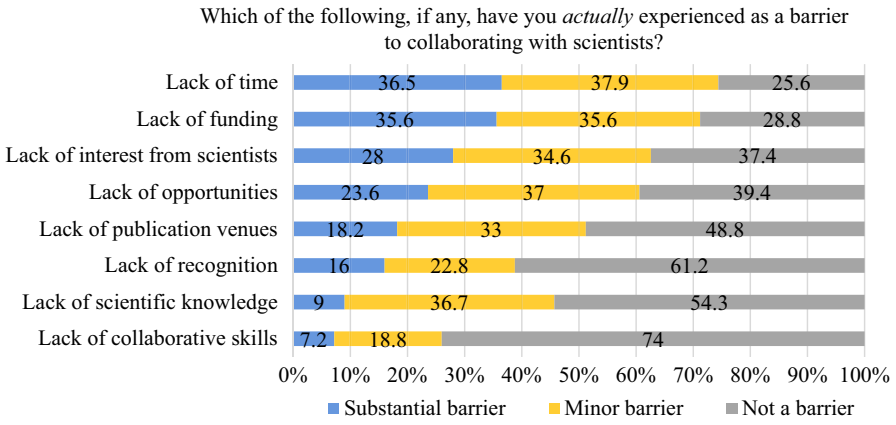

Fig. 10 Which of the following, if any, have you *actually* experienced as a barrier to collaborating with scientists?

Table 3 Effect Sizes for Between-Group Differences Regarding Barriers to Collaboration

	Lack of time	Lack of recognition	Lack of pub. venues	Lack of sci. knowledge
Tenure (pre-tenure)	−0.30	+0.36	+0.30	
Gender (women)				
Level of science training				−0.06
General POS (vs. phil. of special sciences)				
Feminist philosophy				−0.41

barriers, in descending order of significance.[12] Interestingly, lack of time was again the most significant barrier overall. Lack of recognition was much less of a barrier than we expected, though it was a much more significant barrier for those without tenure, as discussed below. Note that we added additional barriers we suspected might be at work (e.g., lack of funding) but which we did not include in the section on dissemination.

Our statistical analysis revealed several between-group differences when it came to experiencing certain types of barriers (see Table 3 for a simplified chart summarizing the significant differences and their effect sizes). As we saw in our analyses of the barriers to broader dissemination, those without tenure were less likely to rate lack of time as a more significant barrier than were those who had received tenure (B: −0.300, $p < 0.041$). However, those without tenure were more likely to report lack of recognition as a significant barrier (B: 0.356, $p < 0.014$). In particular, for non-tenured respondents: 27.3% said it was a substantial barrier, 30.3% said it was a minor barrier, and 42.4% said it was not a barrier to collaborating with others. For post-tenure participants, the results were: 12.7% substantial barrier, 20.6% minor barrier, and 66.7% not a barrier.

The only other barrier for which we found differences was lack of scientific knowledge. As we would expect, those with more scientific training were less likely to report this as a barrier, though the effect size was relatively small (B: −0.062, $p < 0.031$). Interestingly, lack of scientific knowledge was much less likely to be reported as a barrier by those who identified as feminist philosophers of science (B: 0.412, $p < 0.020$), and in fact was the largest effect size for all the barriers to collaboration. We detected no differences for lack of funding, lack of interest on the part of scientists, lack of opportunities, or lack of collaborative skills. (While we did detect a difference between pre- and post-tenure respondents for lack of publication venues, the fit of our model was just below the threshold of what we considered to be acceptable.)

In addition to asking about actual barriers that participants experienced, we asked about barriers they *perceived* to exist for others in the field (see Fig. 11).[13]

[12] Note that these numbers represent the percentages of those who responded to the question. Our response rate for the questions about barriers was about 85% of those who completed the survey.

[13] The response rates for questions about perceived barriers were lower than they were for other questions (roughly 75–80%, depending on the particular barrier). Again, note that the numbers represented in the figure only include those who responded.

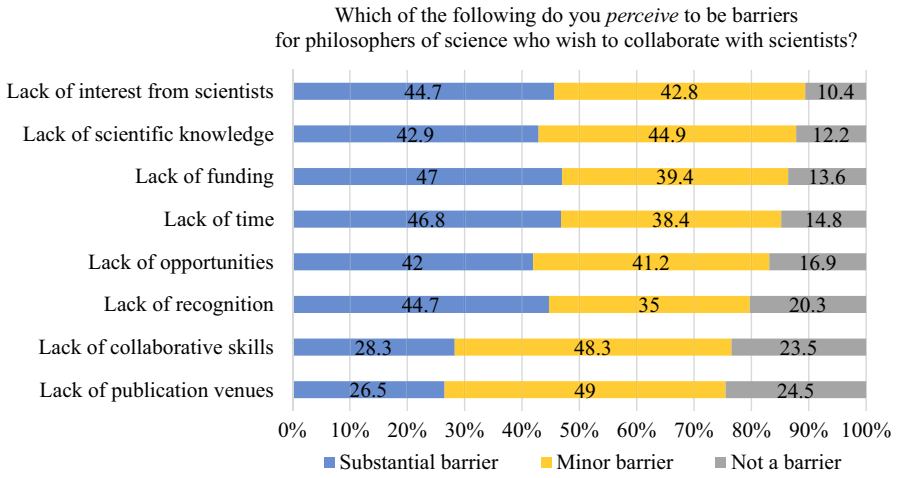

Fig. 11 Which of the following do you *perceive* to be barriers for philosophers of science who wish to collaborate with scientists?

Our results illustrated several interesting findings. First, *for every single barrier we listed*, participants rated perceived barriers as more significant than actual barriers. Second, with respect to lack of recognition in particular, about half of the participants rated it more highly as a perceived barrier than an actual one, while the other half rated it the same whether it was a perceived or actual barrier; notably, not one participant rated lack of recognition more highly as an actual barrier than as a perceived one. We also looked at the size of the gap between perceived and actual barriers when it came to lack of recognition and found that there were no statistically significant differences between tenured and non-tenured participants (though a larger sample size might reveal such a difference). We thought it was important to look at this particular barrier in more detail given the attention to disciplinary reward structure as one of the major barriers to doing broadly engaged work (e.g., Fehr and Plaisance 2010); we discuss this finding in more detail in Sect. 4.

The third finding worth highlighting is that the rank order of barriers differed for perceived barriers compared with actual barriers. For example, while lack of scientific knowledge was almost last on the list of actual barriers, it was rated as one of the most highly significant perceived barriers (9% rated it as a significant barrier for themselves, while 42.9% perceived it to be significant for others). Similarly, lack of interest from scientists was rated as a much more significant perceived barrier compared with the actual barriers reported by participants (28% rated it as an actual significant barrier, and 44.7% as a perceived one). Notably, this suggests that philosophers of science might believe that other philosophers of science are less knowledgeable about science or that scientists are less interested in philosophy than may actually be the case.

Finally, we asked participants whether they thought philosophy of science, as a discipline, actually values and rewards philosophers collaborating with scientists, as well as the extent to which they thought it *should* be valued (Fig. 12).

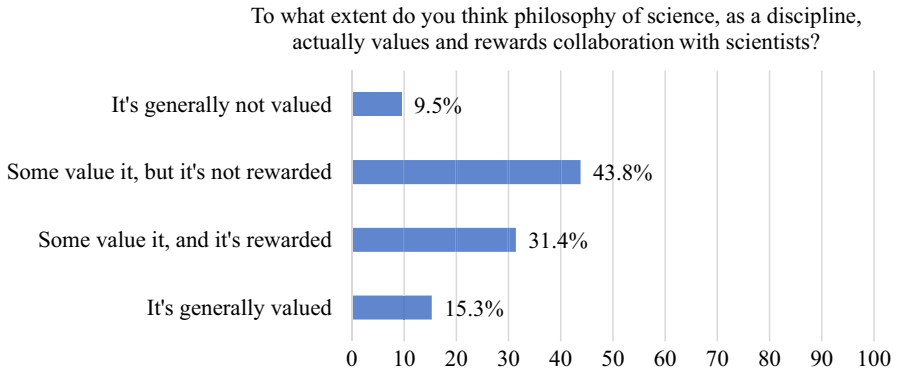

Fig. 12 To what extent do you think philosophy of science, as a discipline, actually values and rewards collaboration with scientists?

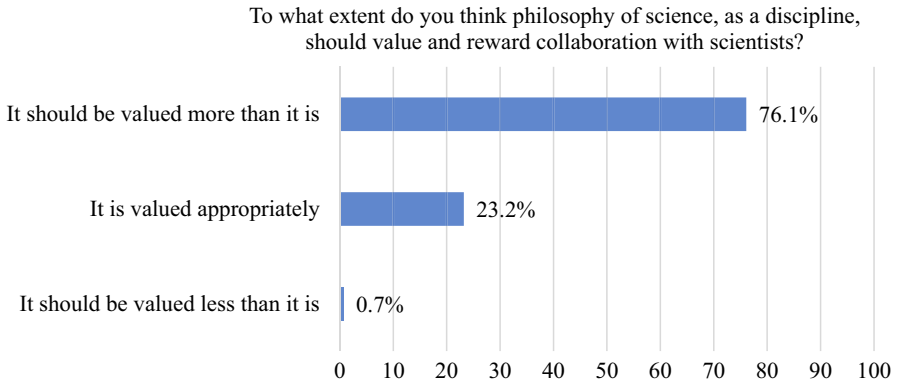

Fig. 13 To what extent do you think philosophy of science, as a discipline, should value and reward collaboration with scientists?

In general, the results were similar to what we found for dissemination: most (76.1%) thought collaboration was undervalued by the discipline, and almost no one (two people) thought it should be valued less than it is (Fig. 13). Again, these numbers were significantly higher than we expected.

The only between-group differences we found on these survey items were for science training, where those with more science training were slightly less likely to say that collaboration with scientists is actually valued (B: -0.077, $p < 0.025$). Interestingly, we did not find any differences with respect to how much participants thought it should be valued.

3.3 Goals and obligations of philosophy of science

In the last substantive section of the survey, we asked participants about what they thought the goals of philosophy of science ought to be, as well as what obligations, if any, they thought philosophy of science has as a community. We listed eight possible goals and solicited suggestions for additional goals. For each goal, we asked respondents whether they thought it was an essential goal, a good goal but not essential, an acceptable goal, or whether it should not be a goal of the discipline.[14] The list of goals can be found in Fig. 14, with those rated more 'essential' at the top and those as less 'essential' or important at the bottom. Interestingly, for all eight of the goals we listed, no more than 4.5% of respondents said it should not be a goal.

As with our other survey questions, we conducted a statistical analysis to determine if there were any differences among groups. For five of the goals, we found no statistically significant differences. These were: analyzing concepts, methods, assumptions, and/or inferences in science; exposing ethically or epistemically problematic science; having an impact on the epistemic aspects of scientific research; having an impact on the moral, social, or political aspects of scientific research; and enhancing public understanding of science. For the other three goals, the only variable that predicted a stronger endorsement of a particular goal was identifying as a feminist philosopher of science. These were: addressing socially relevant research in science, such as race and IQ (B: 0.590, $p < 0.004$; identifying social values in scientific research (B: 0.588, $p < 0.002$); and helping policymakers make use of scientific research (B: 0.540, $p < 0.007$).[15] There were no goals for which gender, career stage, or amount of scientific training was associated with the strength of the response.

Next, we asked what obligations, if any, participants thought philosophy of science has as a community. This question was motivated by a discussion in Fehr and Plaisance (2010) about whether philosophy of science has extra-disciplinary obligations, as we were curious what most members of the discipline thought about this issue (see Fig. 15). The responses to this question were quite surprising. In each case, *over half* of participants agreed that philosophy of science, as a discipline, has an *obligation* to ensure philosophical work has an impact on science, to address socially relevant issues in science, and to ensure the discipline has a positive impact on society. While we expected a few respondents to endorse extra-disciplinary obligations for the discipline, we certainly did not expect those endorsements to be so high. Unfortunately, our statistical models for this question did not have good fit and thus we do not know if there were any significant differences between groups.

Finally, we asked participants to what extent they agreed with the statement, "philosophy of science has no obligations to communities outside the discipline." The majority of respondents (76.9%) disagreed or strongly disagreed with this statement, while only a few (13.8%) agreed or strongly agreed that philosophy of science has

[14] Our response rate was about 95–97.5% for each question we asked.

[15] It is interesting to note that identifying as a feminist philosopher of science was associated with stronger endorsements of several goals, but was not associated with a higher likelihood of having tried to disseminate one's work more broadly or how often one collaborated with others.

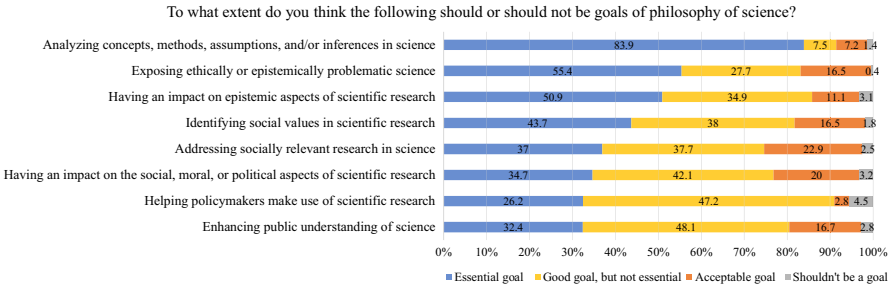

Fig. 14 To what extent do you think the following should or should not be goals of philosophy of science?

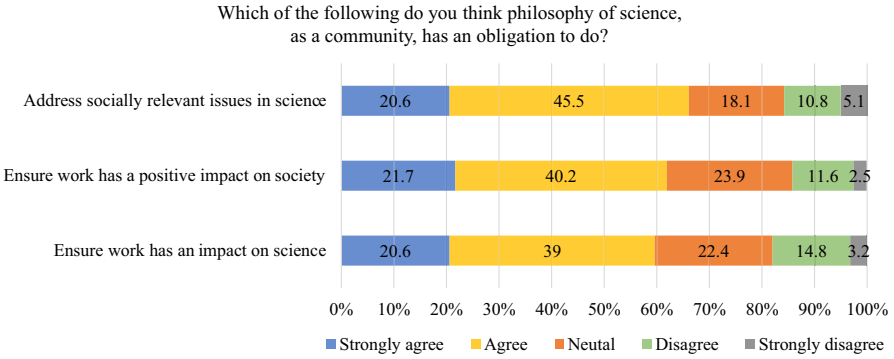

Fig. 15 Which of the following do you think philosophy of science, as a community, has an obligation to do?

no extra-disciplinary obligations. As we discuss below, since obligations come with responsibilities to fulfill them, this finding suggests that philosophy of science ought to find ways to assess its broader impact, as well as to increase that impact if necessary.

4 Discussion

4.1 An emerging picture of philosophy of science

Overall, our survey paints a picture of philosophy of science as a more engaged enterprise than some may assume it to be. Many philosophers of science express interest in taking a more engaged approach to their work; the majority think we ought to value broader dissemination and collaboration more highly; and over half believe the discipline has an obligation to ensure it has a broader impact. The data also demonstrate that philosophers of science have been successfully collaborating with scientific communities, policymakers, and others in a variety of ways. We were particularly surprised at how many participants had co-authored peer-reviewed

manuscripts with scientists: about 55% overall and just over 40% for those without tenure. It would be interesting to see how these figures compare with philosophy more generally regarding co-authorship with non-philosophers.

These findings align with what we heard in our interviews, where many philosophers of science emphasized the fruitfulness of their extra-disciplinary collaborations (some actually told us that their work with scientists and policymakers was amongst the most meaningful work they had done). Furthermore, as we demonstrate elsewhere, there is evidence to suggest that philosophers' broader impacts are much more likely to come from face-to-face engagement with other communities than by publishing in philosophy journals alone (see Plaisance et al. 2019). Our citation study revealed something similar: for the most part, when it comes to citing publications by philosophers of science, scientists tend to cite those publications that appear in science journals, while other philosophers are more likely to cite publications appearing in philosophy journals (McLevey et al. 2018). This lack of disciplinary cross-over suggests that disseminating one's work to scientific communities is essential for philosophers of science who wish to have their work taken up in scientific domains.

While many philosophers of science have been successful engaging other communities, significant barriers to broader engagement remain. For one, the survey data indicated that men were much more likely than women to have tried to disseminate their work to scientists. At the same time, we didn't find differences when it came to the value men and women placed on having scientists read or make use of their work, nor their perceptions of success. Women, however, were much more likely to cite time as a barrier. It is possible that women have other professional commitments that leave them with less time to disseminate their work more broadly (indeed, as we discuss in Sect. 4.3, many studies suggest that there are higher expectations for women when it comes to teaching and service, leaving them with less time for their scholarship). Regardless of gender, lack of time was the largest barrier for our sample overall. This barrier may be especially salient when disseminating one's work to or collaborating with others outside philosophy. Our interview data indicated that both can be quite time consuming. Publishing in non-philosophy journals, for instance, requires learning the writing and publishing norms of other disciplines, while cross-disciplinary collaboration often requires a significant time investment to understand others' disciplinary perspectives (Thagard 2006). Those without tenure can't always risk the reduced credit that often comes with interdisciplinary and/or collaborative work, especially when that work takes more time.

Barriers to doing more engaged work are definitely significant for some (we discuss strategies for addressing them in Sect. 4.3). However, the survey data also suggest that these barriers may not be as strong as many have assumed: in every case, we saw that perceived barriers were viewed as being more significant than actual ones. This held true even for non-tenured respondents. Moreover, when it came to lack of recognition, not one respondent rated it more highly as an actual barrier than a perceived one. So, what might be driving these discrepancies? In Sect. 4.2, we consider a few likely alternatives, followed by strategies for addressing them in Sect. 4.3.

4.2 Explaning the gap

Our survey data indicate that engaged work is both relatively common and significantly valued by many philosophers of science; yet, the dominant narrative seems to be that engaged philosophy of science is in the minority and is undervalued by most members of the discipline.[16] We suggest four possible explanations for this discrepancy.

First, of course, it is possible that our survey data do not accurately represent the views of most scholars in the field and that the perceptions of barriers and the minority status of engaged philosophy of science are correct. As we noted above, it is not possible for us to determine exactly how representative our survey is nor rule out any selection bias. The fact that our survey asked about 'the relationship between philosophy of science and scientific domains' may have increased the chance that those who value engaged work responded to our survey. If such a selection bias occurred, then our data may overrepresent those views and distort the overall picture of philosophers' attitudes, values, and experiences. While we acknowledge this potential bias, we don't believe these findings are a complete distortion of the discipline given the alignment between our survey results, interview data, citation data, and a related but independent study discussed below. In other words, we believe the emerging picture of a relatively engaged philosophy of science has good support. Assuming this picture is generally accurate, then, we consider three additional possibilities.

The most optimistic possibility is that many philosophers of science are overestimating the barriers to doing broadly engaged work and underestimating the extent to which others value it. This is consistent with the gap we found between perceived and actual barriers and the fact that the majority of respondents agreed that both extra-disciplinary dissemination and cross-disciplinary collaboration ought to be valued more than they currently are. Interestingly, another recent study also found that philosophers in general—not just philosophers of science—value extra-disciplinary engagement. In her (2017) study on "The Well-Being of Philosophy," Valerie Tiberius asked philosophers what they value about philosophy as a discipline and what type of work they think is important.[17] Tiberius found strong support for interdisciplinary approaches and "moderate support for the idea that philosophy should engage with the 'real world'" (2017, p. 72). Thus, it might be the case that those who think engaged work is not "real philosophy," or shouldn't be counted for tenure and promotion, are actually the ones in the minority.

While this possibility has merit, the fact remains that several philosophers of science report significant barriers to doing engaged work, ranging from a lack of

[16] Frodeman and Briggle (2016), for instance, claim that "field philosophy" is in the minority. While it seems that their claim is in tension with our findings, it is possible that field philosophy captures a stronger form of engagement than what we asked about in the survey. This suggests a need for further work to tease apart different types of engagement, which we have begun to do by asking survey respondents to list different ways of collaborating with others.

[17] Tiberius's paper is based on her Presidential Address at the Central Division of the American Philosophical Association meeting in 2017, which can be freely accessed online: https://blog.apaonline.org/2017/04/11/the-well-being-of-philosophy/.

interest on the part of scientists to a reward structure that disincentivizes crossing disciplinary boundaries. Many of our interviewees shared stories of colleagues saying that engaged work didn't count as "real philosophy." Regardless of how prevalent such disciplinary boundary policing actually is—and there is no question that it happens—even a few dismissive remarks can have lasting effects. In fact, research in psychology, sociology, and medicine shows that people's beliefs significantly shape their behaviors (e.g., Crum and Phillips 2015). As one of our colleagues aptly put it, perceived barriers can become actual barriers to doing certain kinds of work.[18]

A third and related possible explanation for this gap is that those who devalue engaged approaches are in the minority, but they comprise a *powerful* minority—one that includes members of departmental hiring committees, chairs of tenure and promotion committees, editors of top-tiered journals, and/or referees for highly-ranked journals in the field. As Fehr and Plaisance (2010) point out, such 'gatekeepers' can play a substantial role in shaping the culture and norms of philosophy of science, and philosophy more generally, where norms shape actual practices. As an example, Vaesen and Katzav (2019) demonstrate how the policies of the National Science Foundation (NSF) in the 1950s and 1960s substantially favored philosophical work that embraced the 'value-free ideal' of science.

The final explanation we consider is that people may be more willing to endorse abstract values than they are to advocate, support, or even be open to particular strategies that instantiate such values. Social scientists typically refer to this as the 'value-action gap' or the 'attitudinal fallacy'. Tiberius found compelling evidence of this gap in her survey. Statements endorsing engaged or interdisciplinary work received strong support, while "the item that received the lowest support was the very practical question about whether publications in non-philosophy journals should be given equal weight" (Tiberius 2017, p. 72). As Tiberius puts it, "people are (a little bit) more in favor of diversity, interdisciplinarity, and engagement in the abstract than they are in favor of particular strategies for promoting these values. I would predict that this difference will be bigger when it comes to taking real action so that if we could measure how many people actually do give credit to public engagement in promotion cases, we would see a smaller number than we do for those who report in the survey that they favor doing this" (p. 73).

Assuming Tiberius is right, many philosophers of science (and philosophers more generally) face a tension between their goals and values, on the one hand, and typical training and reward structures, on the other.[19] These structures can disincentivize engaged approaches, such that individuals feel they must "wait until tenure" to do broadly engaged or collaborative work. Our survey and interview data suggest that those who already have tenure do not view the disciplinary reward structure as much of a barrier, though that may be of little consolation to junior scholars. Even still, tenured scholars who do engaged work may be less likely to be promoted or hold positions of power in the discipline. This can reinforce the view that such work

[18] We thank Carla Fehr for this particular phrasing.

[19] There are exceptions to this for the lucky few who are trained in and hired by departments that value and reward engaged work, exemplified by institutions like Michigan State University and the University of Waterloo.

is of 'lower status'—and it can perpetuate the existence of a powerful minority that considers engaged work to be less valuable (or even less "philosophical") than do other members of the discipline. Indeed, a recent analysis of the history of the Philosophy of Science Association indicates that its own mission used to be more in line with engaged approaches (Douglas 2016; see also Howard 2009). Even today, Frodeman and Briggle found that "extra-disciplinary efforts, that is, the ability to attract funding, engage in applied research, or publish outside of philosophy journals continued to rank at the bottom of the criteria for tenure and promotion" (2016, p. 42). This may explain why a significant proportion of philosophers of science agree that the discipline has an obligation to do broadly engaged work and yet we hear that some discourage their graduate students from doing so. In these instances, supervisors may believe engaged philosophy of science is important but that junior scholars ought to focus on more traditional work before broadening their approaches. Whether or not this position is a well justified one is open to debate.

4.3 Strategies for aligning values and actions

Given the considerations discussed above, how might philosophers of science—and philosophers more generally—address these apparent gaps?

We can start by recognizing that there is already a lot of excellent work that falls under the heading of 'engaged philosophy of science'. This includes, but is not limited to, making one's philosophical work accessible to those outside the discipline, collaborating with scientists, working with policymakers to draft new legislation, and enhancing public understanding of science via popular articles and blog posts (see Fehr and Plaisance (2010) for additional examples). Also, it is important to acknowledge that there is at least some support for this work on individual, community, and institutional levels. At the individual level, our interviews evince examples of senior philosophers of science supporting colleagues who wish to take a more engaged approach to their work. At the community level, organizations like SRPoiSE and JCSEPHS provide venues for engaged scholars to discuss their work and build their professional network. At the institutional level, places like Michigan State University have developed structures that support and reward interdisciplinary and public scholarship; examples include the Center for Interdisciplinarity and the Toolbox Dialogue Initiative, the latter of which is itself designed to enhance communication across disciplines.

To further improve the alignment between the goals of ensuring broader impacts of philosophical work and the specific practices which support them, philosophers of science must first be able to recognize where these gaps exist; we hope the findings presented here will aid in that endeavor. Second, closing this gap requires continued implementation of effective strategies (such as those listed above), and the development of other ways to actively support and/or participate in efforts to broaden the impact of philosophy of science.[20]

[20] One of the goals of our interviews is to identify best practices for doing engaged philosophy of science and to provide specific case studies from which others can learn.

Tiberius herself suggests strategies philosophers can use to embody the values many endorse. These include: recognition for philosophical work that has a positive impact on other communities (e.g., through departmental awards), making public declarations about the value of such work (which Tiberius herself did as part of her Presidential Address at the 2017 meeting of the Central Division of the APA), and advocating for concrete ways to support broadly engaged work in tenure and promotion guidelines (Tiberius 2017). Moreover, it helps to view work that carefully analyzes the state of our field as serious scholarship, as Frodeman and Briggle mention in their (2016) book. Additional research is needed to determine the strategies that are most likely to be effective and how best to implement them. It would also help to identify which strategies would receive broad support from others in the discipline, and determine who is in a position to execute them. This latter part is essential—for, if the majority of philosophers support particular changes but no one in a position to do so takes action, then change is unlikely to occur.

These strategies have the potential to broaden the conception and reach of philosophy of science (and philosophy more generally), and to do so at a time when philosophy's relevance is unfortunately in question.[21] Such strategies can also help philosophy of science meet what some think are obligations of the discipline (recall that over half of respondents thought that philosophy of science, as a community, has an obligation to ensure it has an impact on science and to benefit society). However, we are *not* suggesting that more traditional work in philosophy of science (e.g., work that grapples with issues like realism vs. anti-realism and/or that is published wholly within philosophical venues) should be valued *less* than it is, nor that engaged philosophy of science, in whatever form it might take, is more valuable than traditional approaches.

We also want to stress that supporting engaged approaches to philosophy of science, and philosophy more generally, has the potential to benefit philosophy itself. As some scholars have demonstrated, engaging scientific communities, policymakers, and others can open up new avenues for philosophical research (Tuana 2010) and shed light on traditional topics in philosophy of science (Douglas 2010). Moreover, support for diverse types of scholarship can enhance support for diverse practitioners, especially underrepresented groups such as women and people of color (Dotson 2012). As our own survey demographics (and those of the American Philosophical Association and Philosophy of Science Association) attest, there is a serious lack of diversity in academic philosophy (Haslanger 2008). Sean Valles brings attention to this problem and highlights the fact that philosophers of color face particular risks when doing non-traditional forms of work. As he points out, philosophers of color (and women) are already asked to do more mentoring and service work and thus have less time for research; therefore, when it comes time to choosing what sorts of scholarship to pursue, they often must be more strategic with their approaches

[21] Philosophers are not limited to broader engagement via their research. As mentioned earlier, one of the more effective pathways to impact is via the classroom (see Plaisance et al. 2019 for a detailed discussion about the best avenues for broader impacts).

(Valles 2017).[22] This is consistent with our finding that although women were just as interested as men in doing engaged work, they were much less likely to have tried to disseminate their work to scientists and were more likely to cite lack of time as a barrier to doing so. By finding ways to more significantly and concretely support engaged work (e.g., with clear guidelines for how collaborative work is counted in tenure and promotion documents), we can reduce the risks that underrepresented philosophers face, especially when they do not have the security of tenure. In doing so, however, we must be careful not to put the burden of change on already marginalized groups, which can easily occur (Dotson 2012). We encourage further conversations about how to implement strategies for support, along with identifying which community members are in the best position to be the motivating force behind them.

4.4 A caveat regarding the culture of justification

Finally, we wish to acknowledge a potential downside of our research. Our goal with this paper was to develop a statistical portrait of the discipline in terms of the views, attitudes, and experiences of philosophers of science with respect to engaged work. In doing so, we risk inadvertently contributing to what Kristie Dotson calls the 'culture of justification', which privileges "legitimation as an assessment tool for appropriate disciplinary conduct" (2012, p. 7). While we certainly do not intend to contribute to or reinforce justification norms, we do think it is valuable to demonstrate that there appears to be more support for engaged work than many assume. Furthermore, our larger research project seeks to identify the conditions that facilitate and block the pursuit of engaged work, as well as strategies for improving those conditions. To accomplish this, we think it is important to understand the various attitudes and experiences of members of the discipline. As Dotson herself points out, "justifying norms [can be] falsely taken to be commonly held and univocally relevant" (2012, p. 26), and our survey data suggests that the norms and values that appear to be dominant may in fact be in the minority. By encouraging scholars to tease apart the various types of engaged approaches and the contributions they make, we support Dotson's call for a "culture of praxis," where "validation is determined according to contribution," and thus "need not be understood according to a legitimation narrative" (2012, p. 17). Rather than philosophers of science having to justify the engaged work they do as "real philosophy", they can instead focus on the contributions they make to their target audience (which may, of course, include philosophers themselves).

4.5 Conclusion

Overall, the results of our survey make us cautiously optimistic that there is growing support for broadly engaged work. The results suggest that a majority of philosophers of science are interested in and value disseminating their work more broadly

[22] There are several studies documenting the extra burden placed on women and racial minorities with respect to service work and various types of invisible labor. Joseph and Hirshfield (2011) discuss this in terms of the 'cultural taxation' of faculty of color, while Pyke (2015) examines the ways institutional structures make it difficult for women to 'just say no to service'.

and/or collaborating with others outside the discipline. At the same time, however, other scholarship (e.g., Frodeman and Briggle 2016; Tiberius 2017), as well as our own interview data, indicate that there is a significant gap between what philosophers say they value when asked and what they actually value when making decisions about how to train graduate students, whom to hire, and what sorts of work to count in favor of tenure and promotion. We hope this project encourages further conversation about how best to address this gap.

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Affiliations

Kathryn S. Plaisance[1] · Alexander V. Graham[2] · John McLevey[3] · Jay Michaud[4]

Alexander V. Graham
a24graha@uwaterloo.ca

John McLevey
jmclevey@uwaterloo.ca

Jay Michaud
jay.michaud@uwaterloo.ca

[1] Department of Knowledge Integration (Cross-Appointed to Philosophy), University of Waterloo, 200 University Ave W., Waterloo, ON N2L 3G1, Canada

[2] Department of Sociology, University of Waterloo, 200 University Ave W., Waterloo, ON N2L 3G1, Canada

[3] Department of Knowledge Integration (Cross-Appointed to Sociology), University of Waterloo, 200 University Ave W., Waterloo, ON N2L 3G1, Canada

[4] Department of Philosophy, University of Waterloo, 200 University Ave W., Waterloo, ON N2L 3G1, Canada