

Diversifying science: comparing the benefits of citizen science with the benefits of bringing more women into science

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Abstract

I compare two different arguments for the importance of bringing new voices into science: arguments for increasing the representation of women, and arguments for the inclusion of the public, or for “citizen science”. I suggest that in each case, diversifying science can improve the quality of scientific results in three distinct ways: epistemically, ethically, and politically. In the first two respects, the mechanisms are essentially the same. In the third respect, the mechanisms are importantly different. Though this might appear to suggest a broad similarity between the cases, I show that the analysis reveals an important respect in which efforts to include the public are more complex. With citizen science programs, unlike with efforts to bring more women into science, the three types of improvement are often in conflict with one another: improvements along one dimension may come at a cost on another dimension, suggesting difficult trade-offs may need to be made.

Keywords: values in science, citizen science, feminist philosophy of science, political philosophy of science, women in STEM, diversity in STEM

1. Introduction¹

Calls for increased diversity within science are now, fortunately, commonplace. There are both theoretical reasons (Longino, 1990; Oreskes, 2019) and empirical evidence (Phillips, 2014) to support the idea that bringing new voices into science can promote scientific progress. Although some calls for diversity focus narrowly, e.g. on gender and race, many others cast a wide net. In their much-cited article arguing for the importance of diversity in the biomedical sciences, for example, Swartz *et al.* (2019) say, “Diversity has many facets, including background, age, gender, sexual orientation, race, ethnicity, culture, religion, geography, disability, socioeconomic status, area of expertise, level of experience, thinking style,

¹ For helpful comments on earlier versions of this paper, I thank the participants at the “Doing Science in a Pluralistic Society” conference, hosted (virtually) by the University of Dayton. I received additional very helpful comments from Marion Boulicault, Greg Lusk, Zachary Piso, and the referees and editors for this journal. Work on this paper was supported by a Burkhardt Fellowship from the ACLS.

and skill set.” Similarly broad understandings can be found in the mission statements of many scientific organizations. The Royal Society’s most recent Diversity Strategy (2019) begins by noting, “A diverse and inclusive scientific community that brings together the widest range of talents, backgrounds, perspectives and experiences, maximises scientific innovation.”

Expansive understandings of diversity like this raise a number of very important questions. One is whether different dimensions of diversity function in the same way. It seems likely that they don’t. Gender, religion, and skill set are obviously very different things. Even if diversity along each of those dimensions is beneficial for science, it seems likely that the benefits in each case may be different or may come via different mechanisms. If that is correct, it suggests that efforts to promote diversity in science should pay attention to the differences among dimensions of diversity.

I will undertake such an investigation by comparing two prominent efforts aimed at bringing new voices into science. For decades, many have worked to address the underrepresentation of women in science (NSF, 1982; NAS-NAE-IOM, 2007). And, more recently, there has been a concerted effort to bring the public — those without traditional scientific training — into the research process in meaningful ways (Irwin, 2018; Cavalier and Kennedy, 2016). In this paper, I will look at the reasons that have been offered for the importance of diversifying science in each of these respects. Specifically, I want to compare the arguments offered by feminist scientists and philosophers of science for the importance of bringing more women and feminist perspectives into science,² with the arguments many have given for

² Many of the arguments I discuss focus specifically on the importance of bringing feminist or non-androcentric perspectives into science. This is, of course, not the same thing as bringing women into science: not all women see things in a feminist way, and non-women can offer feminist perspectives. I won’t worry about this distinction, however, since securing a critical mass of women in a scientific field is, realistically, a necessary step towards ensuring that feminist perspectives are influential in that field. Okruhlik, for example, says: “It is not a logical necessity but also no accident that the advent of certain [non-androcentric] scientific hypotheses coincided with...increased representation of women in the academy and scientific communities” (1994, p. 41; *cf.* Wylie, 2012, p.65; Fehr, 2011). Though it would be natural for me to appeal to standpoint theory, I won’t do so. That’s because there are different versions of standpoint theory, and (more importantly) standpoint theory is frequently misinterpreted by its critics in serious ways (Wylie, 2012; Crasnow, 2008; Intemann, 2010). All my argument requires is the modest claim that bringing more women into science will tend to make science less sexist and/or androcentric. This could be because women are uniquely able to spot androcentric practices, because women simply notice such practices more often than men, because a critical mass of women is needed for them to have the power to push back against such practices, or even because men more often notice their own androcentrism when in the presence of women. Though I myself think some version of standpoint theory is correct, any of these possibilities would be sufficient for my analysis.

bringing the public into science, or for “citizen science,” broadly construed to include everything from simple crowdsourced data collection to community-based participatory research.³

My argument will proceed as follows. In section 2, I narrow my analysis, setting aside the ancillary benefits of inclusion to focus specifically on the ways in which diversifying science can improve the quality of scientific results themselves. In section 3, I compare the distinctively epistemic benefits of inclusion in each case. Section 4 points out that there are also non-epistemic dimensions along which we can assess scientific results. Section 5 evaluates the non-epistemic values embedded in scientific results from an ethical perspective, and section 6 evaluates them from the perspective of political legitimacy. Ultimately, I conclude that bringing the public and bringing more women into science can yield similar epistemic and ethical benefits. They can also both yield political benefits, though the mechanism is different in each case. This analysis might seem to suggest that the arguments for inclusion are largely similar, but in section 7 I argue that my discussion reveals a key difference, highlighting important challenges and complexities relevant to the planning and evaluation of citizen science programs that typically won't arise for efforts to create a more gender-inclusive science. Section 8 offers a brief conclusion.

2. Narrowing the discussion

The feminist (philosophy of) science and citizen science literatures are vast and full of a diversity of perspectives and arguments. They also discuss a wide range of topics, beyond the importance of bringing women and the public, respectively, into science. (Indeed, over the past decade or two the feminist literature has increasingly moved away from an exclusive focus on gender, looking at its relationship to and connections with race, disability, and other socially-significant categories. Most of the points I make about gender can straightforwardly be extended to these other areas — a point I will briefly

³ There are a variety of phrases used to describe the many types of scientific research involving both professional scientists and the public, including community-based participatory research, participant-led research, and participatory action research. I mean to include all of them under the broad heading of “citizen science”. See Eitzel *et al.* (2017) for a discussion of the terminology used to describe such projects, and Strasser *et al.* (2019) for a discussion of its history.

return to below. In the text, though, I will focus mainly on gender, for ease of exposition.) A comprehensive comparison of those literatures would therefore be impossible. Accordingly, I will begin by dramatically narrowing my topic.

Within both literatures, there is a reasonably clear distinction between ways in which bringing new voices into science can directly improve scientific results themselves, and ways in which bringing new voices into science yields other benefits - perhaps to society at large, or specifically to those participating in research. In the former category, imagine a citizen science program that enables the collection of vastly more data than would otherwise be possible. Or imagine that a woman on a research team is able to point out certain sexist assumptions that had led the team to overlook a plausible interpretation of their data. In both cases, we would expect that the results of the study will end up being better than they otherwise would have been. Inclusion, in these cases, directly improves the quality of scientific results. The latter category contains a wide variety of potential benefits. Proponents of citizen science have argued that bringing the public into research may increase public trust in science and public support for science. It may lead to a more educated public. It may lead to research on topics that wouldn't otherwise have been studied, and it may ensure that results get used for the public good.⁴ Feminist scientists and philosophers of science have offered similar arguments (e.g. that increased representation of women will change what topics get researched and may enhance public trust in science), as well as others (e.g. that increasing the number of women in science can ultimately assist us in combatting a range of social and professional inequalities).⁵

In this paper, I will focus exclusively on the former category of benefit: the respects in which bringing new voices into science can directly improve the quality of scientific results. This is not because I think those benefits are more important or more central to the arguments put forward by proponents of diversifying science. (Indeed, I suspect in many cases it is the latter set of benefits, collectively, that are

⁴ See e.g. Cavalier and Kennedy (2016).

⁵ See e.g. Harding (1998) and Fehr (2011).

thought to be of greater importance.) I focus on the ways in which scientific results can be directly improved because those benefits constitute a more unified set and can therefore be more effectively analyzed in a systematic way. And whether or not they are *more* important than the other benefits of inclusion, they *are* important and so worthy of discussion.

3. Epistemic improvements

There are at least three distinct respects in which scientific results can be improved: they can be improved epistemically, ethically, and politically. In this section, I will focus on the first of these, which is the most obvious and straightforward type of improvement. Roughly, one set of scientific results is epistemically superior to another if it does a better job of capturing what the world is like, or gives us more accurate knowledge about the empirical world.⁶ Of course, this gloss disguises much complexity. There are a variety of epistemic virtues or values - such as consistency, precision, and generalizability - which can sometimes conflict with one another (Kuhn, 1977; Douglas, 2013). Further, as many feminist philosophers have pointed out, there is not full agreement on what the epistemic virtues are, and ethical and political values may be involved in choosing among or weighing candidate epistemic virtues (Longino, 1995). Fortunately, we can sidestep those complexities here. Empirical adequacy (or accuracy) is regarded as a critical epistemic value on all standard accounts (Longino, 1990, ch. 4; Rolin, 2017), and there are many ways in which bringing new voices into science can straightforwardly enhance empirical adequacy, thus uncontroversially yielding epistemic improvements.⁷

⁶ This formulation may seem to suggest a realist approach to science, but the underlying point is compatible with most antirealist approaches, as well. As should be clear from the examples I discuss below, greater inclusion has led to changes that nearly any non-skeptical account of science would regard as epistemic improvements (e.g. correctly identifying skeletal remains as female which had been erroneously classified as male, or producing a map of air quality with a hundred times as many reliable data points).

⁷ Could a gain in empirical adequacy or accuracy nevertheless not count as an overall epistemic improvement, if it comes at the cost of some other epistemic value (e.g. generalizability)? Possibly - though the high importance most accounts give to accuracy means that the cost to those other values would likely have to be very large. In any case, none of the examples I discuss below are plausibly such cases. They involve clear improvements in accuracy with no obvious costs along other epistemic dimensions.

Let's begin with citizen science. Citizen science projects can be categorized in a number of ways, but one of the more influential classifications divides them into three groups, based on the type and extent of public involvement (Bonney *et al.*, 2009). *Contributory projects*, which are by far the most common, are projects primarily designed by professional scientists where the public's involvement is largely restricted to data collection and simple analysis. In *collaborative projects* professional scientists still take the lead, but the public plays a larger role, by helping scientists to refine the project design, analyze and interpret data, and/or disseminate research findings. Finally, *co-created projects* are true partnerships, where the public and professional scientists work together on most aspects of the research process, from the initial framing of the problem through the final dissemination of results.

In each type of project, the involvement of the public can help scientists to arrive at more accurate results. Many contributory projects take advantage of the geographic dispersion of the public, or simply use the public as a large (usually unpaid) labor force, to collect and analyze data at a scale that would be impossible or prohibitively costly for scientists to undertake on their own. The public have been enlisted, for example, to document wildlife sightings, record local air quality, analyze images, and create 3D mappings of neurons. This has enabled scientists to conduct analyses and gain knowledge about the world that would have otherwise been inaccessible to them (Irwin, 2018; Wiggins and Wilbanks, 2019). In collaborative and co-created projects, the involvement of the public in methodological decisions can yield further epistemic benefits — for example, by harnessing the public's background knowledge concerning local environment, practices, or history. Residents of Greenpoint/Williamsburg who partnered with the EPA were able to use their knowledge of local subsistence fishing practices to challenge erroneous dietary assumptions built into an EPA model. Correcting those assumptions led the EPA to collect information on diet which they otherwise would not have sought out and which proved critical to their assessments (Corburn, 2002).

Feminist philosophers of science have shown how the background knowledge and evaluative perspective of women has in many cases led to similar epistemic improvements (Richardson, 2010).

Women anthropologists, for example, have pointed out respects in which the methods used to sex hominid remains were biased, e.g. by simply assuming that more robust skeletons belong to males (Donlan, 1993). And feminist scientists have shown how models of fertilization have been influenced by stereotypical courtship norms, which led biologists to overlook or misdescribe important phenomena (Martin, 1991; The Biology and Gender Study Group, 1988). Feminist philosophers of science have spent less time discussing cases where the inclusion of women has facilitated data collection, though examples aren't hard to find. It seems unlikely, for example, that Nancy Scheper-Hughes would have been able to cultivate the relationships among local women and children that proved critical to her ethnographic research in Brazil had she been a man (Scheper-Hughes 1993, pp. 18 and 25; discussed in Crasnow, 2008). And Milicent Shinn's work on child development was based on the detailed observations mothers took of their own children (von Oertzen, 2013).

I conclude that the epistemic benefits that come from the increased representation of women in science and from the involvement of the public in science are similar. In both cases, inclusion can directly promote data collection and analysis, allowing scientists to reach conclusions that would otherwise have been inaccessible to them. And the background knowledge and perspective brought to scientific research by those who hadn't previously been a part of it can similarly improve the epistemic quality of research outcomes in straightforward respects. To the extent there is a difference, it is a difference in frequency, with citizen science programs more often focusing on data collection and analysis, and feminist philosophers of science highlighting cases where women bring different, epistemically beneficial background knowledge and perspectives.

4. Non-epistemic values and scientific results

Many feminist scholars and proponents of citizen science have discussed ethical and political reasons to bring previously excluded voices into science. Most of those discussions, however, focus on the kinds of benefits I set aside above — such as ensuring that the products of research are used in an

ethical manner, increasing public support for science, or fulfilling ethical and political obligations of inclusion. In the succeeding sections, I want to talk about a different kind of benefit: how diversifying participation in science can improve scientific results *themselves*, in both ethical and political respects.

To see how scientific results can themselves be better or worse in ethical and political senses, a short detour is necessary. As discussed above, scientific results can be assessed in light of a variety of epistemic values. Recent work from philosophers and other scholars of science has shown, though, that science is also structured by non-epistemic values — ethical, political, or personal values. Scientists must appeal to such values when managing inductive risk (e.g. balancing the risk of false positives against false negatives), choosing classification systems, structuring quantitative measures, determining study endpoints, choosing statistical representations of their results, defining terms, and so forth.⁸ These choices and the values that contribute to them will be reflected in the results of a scientific study. A study's conclusions will look different if it uses a different classification system, or if it employs a different standard of proof. This suggests that when assessing scientific results we shouldn't simply look at their epistemic aspects; we should also look at and evaluate the non-epistemic values that are reflected in those results.

Indeed, this is a natural and common thing to do. Consider research on sexual assault. One obvious question to ask about any study on sexual assault is how it defines or operationalizes key concepts like “consent” or “sexual assault”, since definitions of those terms can vary considerably (Graham *et al.*, 2017). To take an extreme example, a study that presumes consent unless a victim physically resists her assailant is clearly flawed for that reason. This flaw, though, isn't in any straightforward sense epistemic, at least if we think in traditional epistemic terms. The study may do an exceptionally good job of identifying instances of sexual assault *given that definition*. The problem here

⁸ See, e.g. Elliott (2017), Elliott and Richards (2017). As noted above, ethical and political values may also be involved in choosing among epistemic values (Longino, 1995). To the extent this is true, the relationship between epistemic assessment, ethical assessment, and political assessment may be a complex one. Nevertheless, we saw above that there are clear cases in which we can document epistemic improvement without inquiring into ethical or political matters. And the examples below will show clear cases in which we can document ethical and political improvements without inquiring into epistemic matters. In this paper, I will focus on cases where the three dimensions are assessable independently of each other.

is that the definition of consent employed is grounded in values that we have good reason to find unacceptable. As a result, the conclusions of the study won't be as meaningful or significant as they could have been — they will fail to capture what we ought to care about, or what truly matters (*cf.* Anderson, 1995).

So we can and often do evaluate the non-epistemic value judgments made in the course of scientific research. There are, though, at least two distinct and potentially conflicting standards we can use when doing so. We can evaluate scientists' value judgments from a *substantive ethical perspective*, or we can evaluate them from a *political perspective* (Schroeder, *forthcoming*). That is, we can ask whether the values are substantively correct or best or justifiable, in the sense that they align with true ethical principles or capture what we ought to care about.⁹ Or we can ask whether the values are politically legitimate, in that they are appropriate bases for public decision-making. These standards — unfortunately! — can come apart. A decision can be right from a substantive ethical perspective, while at the same time being politically illegitimate. (Imagine a government official who makes decisions you think are substantively correct, but who bends rules and cuts corners in doing so.) A decision can also be politically legitimate while being wrong from a substantive ethical perspective. (Public officials, for example, might be politically bound to carry out the will of voters even when voters have made bad decisions; and judges might be bound to follow the law, even when lawmakers have passed unwise laws.)

Return, then, to the definition of consent used in a study of sexual assault. We can, on the one hand, ask whether that definition is a good one in a substantive ethical sense. That might involve consulting scholarly work on the nature and moral significance of consent, listening to the experiences of survivors or activists working on the issue, or simply engaging in first-order ethical reasoning. On the other hand, we can also ask whether that definition is politically legitimate. That might involve asking

⁹ The correct formulation here will depend on the particular meta-ethical view one endorses. But the basic idea that some ethical judgments or values are superior to others should be acceptable to any non-skeptical account. Even non-cognitivists, for example, can accept that some ethical principles are true or that there are certain things that everyone ought to value (though, of course, they may mean something different by 'true' than a meta-ethical cognitivist). See e.g. Blackburn (1998).

whether the definition has been endorsed by some governmental body, or whether it embodies the values held by the public.

5. Ethical improvements

In the last section we saw that we can evaluate the non-epistemic value judgments that help to shape the results of a scientific study, and that there are (at least) two different standpoints from which we can do so. In this section, I'll consider the extent to which bringing new voices into science can improve scientific results in an ethical sense.

It seems fairly clear why bringing more women into science is likely to improve scientists' non-epistemic value judgments in an ethical sense. Science has long been shaped by androcentric, sexist values, and such values are ethically unacceptable. Women are collectively more likely to spot those sexist values and more motivated to push back against them. Thus, bringing more women into science — and, of course, taking steps to ensure their voices are heard — is likely to lead to classification systems, concept definitions, and inductive risk thresholds that are ethically superior to what would have been produced absent their involvement.

The feminist philosophy of science literature offers plenty of concrete examples. Elizabeth Anderson, for example, discusses the research on divorce conducted by Abigail Stewart's research group (Anderson, 2004, discussing Stewart *et al.*, 1997).¹⁰ As she explains, Stewart's team felt that existing research was built on certain assumptions that tended to disadvantage women, or to reflect men's interests — for example, that a “traditional” family unit (where husband and wife live together and raise their biological children) was ideal, that divorce should be conceived of as an event, and that financial status should be assessed purely in objective terms. Stewart's team made different methodological choices: they didn't presuppose that a “traditional” family unit had intrinsic value; they conceived of divorce as

¹⁰ In referencing Anderson's discussion, I don't mean to be endorsing the entirety of her argument, e.g. her view of the relationship between values and evidence. Though I don't think anything she says is necessarily in conflict with the view I've presented here, it also isn't critical to my use of her case study.

one component of a temporally extended process, contextualizing it with the events preceding it; and they assessed financial status in both objective and subjective terms, asking people not just how much money they had, but also how they felt about their financial situation and how much control they felt they had over their money. These changes are ones that many different ethical approaches should recognize as improvements. There are good consequentialist, deontological, and virtue ethical reasons, for example, to think that when assessing a divorce, we should take note of the factors that led to it, and that we should care about how a person feels about their financial situation. Assuming, then, that the (explicitly feminist) values endorsed by Stewart's group are ethically superior to the values embedded in prior research on divorce, the results of Stewart's study will be ethically superior in the sense that they will better capture what matters from an ethical perspective, or what we ought to care about.¹¹

It is less obvious that including the public in science will yield similar ethical benefits, though I think that in contributory and co-created citizen science projects, it has the potential to. First, note that members of the public often hold different values from professional scientists concerning the value-laden aspects of research. Brown (1992), for example, shows that members of the public investigating epidemiological questions tend to hold different views than professional epidemiologists concerning inductive risk; and Ottinger (2016) documents citizen-led air pollution studies that rejected standard scientific practices in ways that reflected different values and interests. Thus, in a contributory or co-created citizen science project, if the public is given a voice in making the value judgments that go into defining terms, managing inductive risk, and so forth, they will often make those decisions differently than professional scientists working alone would have.¹²

¹¹ Of course, some might question whether all of Stewart's assumptions constituted ethical improvements. According to some religious traditions, for example, the traditional family unit does have intrinsic value. But for those not convinced by any particular example here, the feminist philosophy of science literature contains plenty of additional examples of uncontroversial ethical improvements. See, e.g., Kourany (2010).

¹² As Mahr and Dickel (2019) explain, in most citizen science projects the public's involvement is restricted to limited, pre-defined, well-structured tasks. To realize the ethical benefits I discuss here (and also the political benefits discussed in the next section), the public must be given more autonomy and greater input into the design and structure of research.

The important question is whether this difference will tend to be an improvement in a substantive ethical sense. I cautiously think it will be. In contributory and co-created citizen science projects, the public involved in research tend to be those who have a special interest in or connection to the issue being studied. (This will be true whether “stakeholders” are specifically sought out, or whether the public at large are invited to participate.) In such cases, their personal experiences may give them ethical insight that professional scientists, as outsiders, might lack. We would expect, for example, the residents of a community affected by industrial pollution or underperforming schools to have special insights into the meaning, importance, and consequences of those problems.¹³ If the public brings such knowledge, then it seems likely that a truly collaborative process — one where scientists and the public work together to make ethically-laden methodological decisions — will yield decisions that are ethically superior to what professional scientists would have come up with on their own. We can therefore expect the results of such a study to do a better job of capturing what matters or what we should care about.

6. Political improvements

The prior section looked at the non-epistemic values embedded in research results, arguing that both sorts of inclusion can be expected to lead to improvements in a substantive ethical sense. As noted in section 4, we can also evaluate those values from a different and potentially conflicting perspective, asking whether they are politically legitimate. In this section, I will argue that bringing the public into science and bringing more women into science can each yield scientific results that are more politically

¹³ Even theorists who believe that moral principles are knowable *a priori* typically can (and should) recognize that experience is critical to gaining moral knowledge. See McGrath (2011).

legitimate, in the sense that they provide more appropriate bases for public decision-making. But I will argue that the path to legitimacy is different in each case.¹⁴

To understand why, consider one very natural observation about political legitimacy. Often, legitimacy flows from a process, such as a referendum, or a legislative or judicial proceeding. For a political candidate to legitimately assume office, she must win an election. For a law to be legitimate, it must be passed by the appropriate legislative body. For a punishment to be legitimate, it must be preceded by a fair trial. In such cases, it is typically important that the process actually be carried out. (A defendant who is clearly guilty is still entitled to a trial; a political candidate far behind in the polls is still entitled to an election.) There are some cases, though, where processes are unnecessary: certain decisions or values can be ruled out as politically illegitimate based solely on their substance. There are no political processes, for example, that could legitimate enslaving a portion of the population. And according to standard versions of liberalism there are no political processes that could justify coercively establishing a state religion. Such actions are, by their nature, politically illegitimate. I claim that when citizen science increases the legitimacy of scientific results, it is typically through the first method: the inclusion of the public in the process of making certain non-epistemic value judgments can count as the sort of process that makes those judgments legitimate bases for policy. But when increasing the number of women in science increases the legitimacy of scientific results, it is typically via the second track: women may help purge science of values that are, by their nature, politically illegitimate.

Let me briefly sketch my reasoning. First, take citizen science. One of the main benefits touted for citizen science programs is that they “democratize” science. This can mean many different things, but many authors specifically claim that research conducted with the public’s involvement can for that reason

¹⁴ To be clear, I mean here to be talking about actual legitimacy, as opposed to perceived legitimacy. These are not the same thing. A majority might think that a government that regularly consults (only) them is legitimate, and they might regard as illegitimate a decision-making process that made a special effort to give voice to the viewpoints of unjustly marginalized minority groups. But the majority’s perceptions here would be wrong: the latter process would actually be more legitimate. Proponents of diversifying science have, I think, spent more time discussing perceived legitimacy. (See e.g. Sarewitz, 2010.) I think it is important to begin with a discussion of actual legitimacy, for reasons similar to those I offer elsewhere for focusing on what makes science trustworthy, before focusing on what makes science trusted (Schroeder, 2021).

be politically legitimate (Bäckstrand, 2003; Evans and Plows, 2007; Brown, 2009; Douglas, 2009; Kitcher, 2011; Eigi, 2017; Schroeder, 2021; Lusk, 2021). The basic idea is this. In a democracy, the values that influence policy should ultimately come from the public at large. In situations where it is not feasible to get the whole public or its elected representatives to weigh in on some issue, a reasonable substitute is to get a representative subset of the public to speak on its behalf. (This is the idea behind mini-publics, deliberative polling, consensus conferences, and citizen juries.¹⁵) This suggests that if a citizen science program included a group that could reasonably claim to represent the relevant public, their participation in determining standards for inductive risk, creating classification systems, and so forth could potentially legitimate those decisions. Of course, many details remain to be worked out - most critically, how such deliberations would need to be carried out in order to achieve political legitimacy, which population counts as the “relevant” public for any particular research program, and what it takes for some citizens to legitimately represent others. But I think a strong case can be made that citizen science programs which recruit a group representative of the relevant population and which give that group meaningful input into value-laden methodological decisions can potentially generate legitimacy via the procedural route.

Now, it is important to remember that these conditions are rarely met in existing citizen science efforts. As noted above, most citizen scientists contribute mainly via data collection and analysis, and have no input into methodological decisions. And most existing citizen science programs do not involve a group that could plausibly claim to represent the public (Fiske *et al.*, 2019), skewing whiter, younger, and more male than the population as a whole (Strasser *et al.*, 2019). For these reasons, most existing citizen science efforts do not achieve political legitimacy in the way I’ve described. There are examples, though, of cases where public involvement has arguably led to politically legitimate science. In Valdez, Alaska, for example, stakeholders with opposing interests jointly advised a risk assessment study looking at the potential for oil spills in Prince William Sound, ultimately arriving at a report that was recognized

¹⁵ For arguments, see Landemore (2020) and Guerrero (2014).

as legitimate by all sides (Busenberg, 1999, discussed in Douglas, 2009, ch. 8). And consensus conferences and citizen juries, where a randomly selected group of the public is brought together, educated about some issue, and then asked for their views, have frequently been used to solicit public input on scientific issues (Braun and Schulz, 2010; Evans and Plows, 2007; Tomblin *et al.*, 2017) and could be more widely incorporated into scientific research (Douglas, 2009).¹⁶ All of this suggests that bringing the public into science has the potential to secure politically legitimate research results.

Turning, then, to efforts to bring more women into science, can we offer a similar argument? I don't think we can. Bringing greater numbers of women into science will increase its representativeness along one dimension, but the women coming to science will likely not be representative of the general public in other crucial respects. (In what follows, I will focus on the U.S. context, since I know it best. But I suspect that the claims generalize.) For obvious reasons, women who enter science as a profession will be better-educated than the population as a whole. Given the higher income associated with many STEM jobs, they will likely earn more than average. Scientists tend to be much less religious than the public as a whole, and women scientists in the U.S. are just as (non)religious as their male colleagues — despite the fact that women overall tend to be more religious than men (Ecklund, 2010, p. 32). And there is reason to think that increasing the number of women in science will make science even more politically liberal than it is now, since women in the U.S. tend to skew more liberal than men at higher education

¹⁶ There may appear to be a problem with achieving political legitimacy in this way. In order to meaningfully weigh in on technical issues, citizens need to be well-informed. But, on most issues, well-informed citizens are not representative of the public as a whole. There is thus a tension between representativeness and being sufficiently informed. The examples cited here show two different ways of addressing this tension. In Valdez, Alaska, participants were selected from stakeholder groups who were already well-informed about the issues. They were therefore not likely to be demographically representative of the public. But they arguably could still claim to represent the public. One of the main stakeholder groups participating, for example, was the Regional Citizens Advisory Council, an organization whose explicit mission was to represent the interests of citizens impacted by oil transport in the region. As several political theorists have noted, cases of such “informal” political representation by unelected bodies are common, and can play an important and necessary role in democratic deliberation (Salkin, 2021).

Consensus conferences and citizen juries provide a different type of solution. Since they start with a randomly-selected sample of the public, they at least initially meet the representativeness condition. They then seek to meet the information requirement by educating the recruited group on the relevant issues. The output of a consensus conference, then, may not be representative of the public's *actual* views, but it does represent what the public would think, if it were well informed. According to deliberative democratic theorists, this latter sort of representativeness is in many contexts a legitimate foundation for political decision-making.

levels (Pew Research Center, 2015).¹⁷ Recruiting more women into science therefore isn't a promising way to get a truly representative sample of the population, and therefore doesn't seem likely to provide the foundation for a legitimacy-bestowing process.

But consider the second way to increase legitimacy: to purge science of values that are, due to their substance, politically illegitimate. There is unfortunately no consensus among political philosophers about exactly which values qualify as substantively illegitimate. Many philosophers, however, have singled out anti-egalitarian values as paradigm examples of the sort of values that can never be politically legitimate.¹⁸ The reason anti-egalitarian values have that special status is that, according to one standard account, equality is the foundation of democracy — democratic government is legitimate because it is a form of government that respects the fundamental equality of persons. A government action grounded in public values which deny the fundamental equality of persons therefore undercuts the source of its own legitimacy. Thus, anti-egalitarian values undermine political legitimacy in a way other values — even values which are, from an ethical perspective, equally problematic — do not (Christiano, 2008).¹⁹ As we saw in our earlier discussions of epistemic and ethical improvements, the primary reason feminist philosophers of science have cited for the importance of bringing more women into science is to root out the sexist and androcentric assumptions that have long structured scientific inquiry. The sort of feminist perspective likely to be brought to science through the greater inclusion of women can therefore make science more legitimate by purging it of anti-egalitarian values which by their nature are unacceptable foundations for government policy.²⁰

¹⁷ I have been unable to find reliable data about scientists' political affiliation by gender. But Atkeson and Taylor (2019) looked at one field, political science, and found that although political scientists as a whole leaned strongly liberal (endorsing the Democratic party), women in political science leaned even more strongly in that direction than men.

¹⁸ See Nussbaum (2011, pp. 29 and 38), Rawls (2005, p. 243n32), Christiano (2008, p. 269), and Gutmann and Thompson (1996, pp. 2-3 and 73-79).

¹⁹ We wouldn't want to say that *all* values that are normatively mistaken or suboptimal are politically illegitimate. If we are to leave any meaningful room for procedures to operate, we have to respect their decisions in at least some cases where those decisions are suboptimal. You can't, for example, declare a law politically illegitimate simply because it has flaws. It is only specific types of failures that render a decision politically illegitimate.

²⁰ I offer a fuller argument for this and related claims in Schroeder (*forthcoming-b*).

If something like this analysis is correct, we can draw a number of conclusions. First, as many feminist philosophers of science have noted, the argument for the greater inclusion of women generalizes. We should expect that increasing the number of scientists of color and disabled scientists, for example, will also increase the political legitimacy of science for the same reasons.²¹ But note that it is not clear that the argument generalizes in other ways that some have proposed. Science, in addition to being disproportionately white and male, has (at least in the U.S.) also been disproportionately politically liberal and non-religious (Pew Research Center, 2009). Shouldn't we also, therefore, seek to increase the number of politically conservative and religious scientists? Not necessarily. Recruiting more religious or politically conservative individuals into science isn't by itself likely to secure legitimacy via the procedural route, for the same reason recruiting more women into science won't. So if it is going to increase legitimacy, it would have to do so via the substantive route. Are, then, politically conservative or religious scientists likely to identify non-epistemic values operating in science that are, by their nature, politically illegitimate?²² Notice that the question is *not* whether they will be able to identify any mistaken or unethical values. That might be relevant to whether or not their inclusion would bring about improvements in the *ethical* sense discussed in the previous section. The question here is whether they will be able to identify any values that specifically qualify as *politically* illegitimate.

I don't see any reason to think that politically conservative scientists will be especially likely to identify such values. Many of the disputes between the political right and the political left — e.g. about the proper extent of the social safety net, or about how to balance liberty and equality — are grounded in values that plausibly lie within a range of “reasonable disagreement”.²³ They will likely be matters where (even if one side or the other has a more defensible position in substantive terms) we ought to abide by

²¹ Indeed, the argument generalizes along all three dimensions we've discussed: we should expect that the greater inclusion of scientists of color and disabled scientists will yield epistemic and ethical benefits for the same reason the greater inclusion of women does. This, of course, fits with the analyses offered by many feminist philosophers, who see their insights as not specifically tied to sex and gender, but to power structures and social hierarchies more generally (Crasnow and Intemann, 2020).

²² I thank Heather Douglas for pushing me to think more carefully about this possibility.

²³ See e.g. Rawls (2005).

the outcomes of political processes, not matters where we can preemptively declare one position or the other out of bounds.

When it comes to religious scientists, there might appear to be a more promising argument. According to mainstream versions of liberalism, the state has an obligation to ensure a robust sort of religious freedom. Even if, for example, a supermajority wanted to ban the practice of some minority religion, doing so would not be legitimate. Perhaps, then, religious scientists might be especially well-positioned to identify value judgments that marginalize religious practice in politically illegitimate ways. In principle, this sort of argument could be a good one. But in practice, I doubt it will justify efforts to recruit more religious individuals into science. The reason that the case for increasing the representation of women, racial minorities, and disabled individuals in science is so persuasive is that the case is not merely hypothetical: science has a documented history of working from sexist, racist, and ableist value judgments. I am not aware of the same documented history when it comes to value judgments that infringe on individuals' rights to religious practice. (This isn't surprising, since scientists have historically been religious themselves, and since the broader society in the U.S. is not anti-religion.) And, to the extent that science has been grounded in values that conflict with religious individuals' rights, it seems more likely that it will be the adherents of non-dominant religions who will have their perspectives marginalized. Thus, *if* there were to be a good, politically-based argument for the recruitment of religious scientists in the U.S., it would probably focus on recruiting (for example) Jain or Sikh scientists, as opposed to Christians.

7. Similarities - and a key difference

Let me summarize the discussion so far. I considered three different dimensions along which we can evaluate the results of a scientific study. First, we can evaluate them epistemically: do they do a good job of capturing what the world is like, or giving us knowledge of the empirical world? Second, we can evaluate them ethically: are the non-epistemic values reflected in the results appropriate ones from a

substantive ethical perspective, capturing what we ought to care about? Third, we can evaluate them politically: are the non-epistemic values reflected in the results politically legitimate ones, values that are appropriate bases for public decision-making?

Epistemically, the benefits from the greater inclusion of women and the public in science look similar. As feminist philosophers of science have clearly demonstrated, bringing more women to science can yield epistemic benefits in a number of ways, most prominently by uncovering and challenging certain androcentric assumptions that have epistemically led science astray. Citizen scientists, similarly, can bring epistemically beneficial knowledge and perspectives that differ from those of professional scientists. More often, though, members of the public contribute to science simply through their labor — providing a large and geographically dispersed team of researchers who are able to collect and analyze data in ways that wouldn't be feasible for professional scientists working on their own.

Ethically, the benefits again look similar. Women are more likely than men to identify and push back against the sexist non-epistemic values involved in scientific inquiry — those embedded in classification systems, the management of uncertainty, and so forth. Replacing those values with non-sexist alternatives will be an improvement in ethical terms. When it comes to citizen science, I argued that members of the public plausibly have special ethical insight on matters of importance to their local community. That suggests that a decision-making process that includes them has the potential to make better decisions — that is, to arrive at concept definitions and inductive risk thresholds that are grounded in ethically superior values.

Turning to the political benefits, I argued that including more women in the research process can increase the political legitimacy of scientific results by rooting out certain anti-egalitarian values — specifically, values that don't properly attribute equal status to all individuals — that are, by their nature, illegitimate bases for public decision-making. Including the public in research could, if done properly, increase legitimacy in a different way: by serving as a body that can in certain cases claim to speak on

behalf of the public as a whole. There is thus a difference of method in the political case. But, ultimately, we again see a similarity, as both types of inclusion have the potential to increase political legitimacy.

The foregoing summary may suggest that the two cases are largely similar. However, a closer look reveals a critical difference. Note that the epistemic, ethical, and political improvements that come from the inclusion of women all have the same source: bringing more women into the research process can facilitate identifying and challenging the sexist and androcentric assumptions that have been and continue to be a part of scientific research. As we've seen, this androcentrism has been harmful to science epistemically, ethically, and politically.²⁴ In the case of the public, however, the improvements along each dimension come from different sources. The epistemic benefits from public inclusion can come from background knowledge possessed by the public, or simply from the size of their labor force or their geographical distribution. The ethical benefits come from specific pieces of ethical knowledge possessed by certain members of the public — perhaps those with personal experiences connected to the research topic. The political benefits come when a group representative of the relevant public is involved in the research process in an appropriate way. (See Figure 1.)

This means that efforts to recruit women into science don't need to pay too much attention to the difference between epistemic, ethical, and political improvements. Since they all flow from the same source, they won't generally be in conflict with one another and can typically be realized at the same time. (The same will be true of diversity efforts linked to disability and race.) That, however, is not the case when it comes to citizen science. Many scholars have pointed out that the various aims of citizen science programs can conflict, and therefore that trade-offs may be necessary when recruiting participants and determining how they will be involved in research (Braun and Schultz, 2010; Eigi, 2017; Bedessem and Rupy, 2020). Those discussions, though, tend to focus either on trade-offs within the epistemic (e.g. trading one type of accuracy for another; or one epistemic virtue for another), or else trade-offs between

²⁴ Many feminist scholars have pushed back against a sharp distinction between epistemic and non-epistemic (ethical/political) goals of science. See e.g. Anderson (1995) or Longino (1994). This result vindicates such an approach in the cases feminist philosophers of science have discussed. If the problems have the same source, it makes sense that it might not be possible to clearly distinguish them.

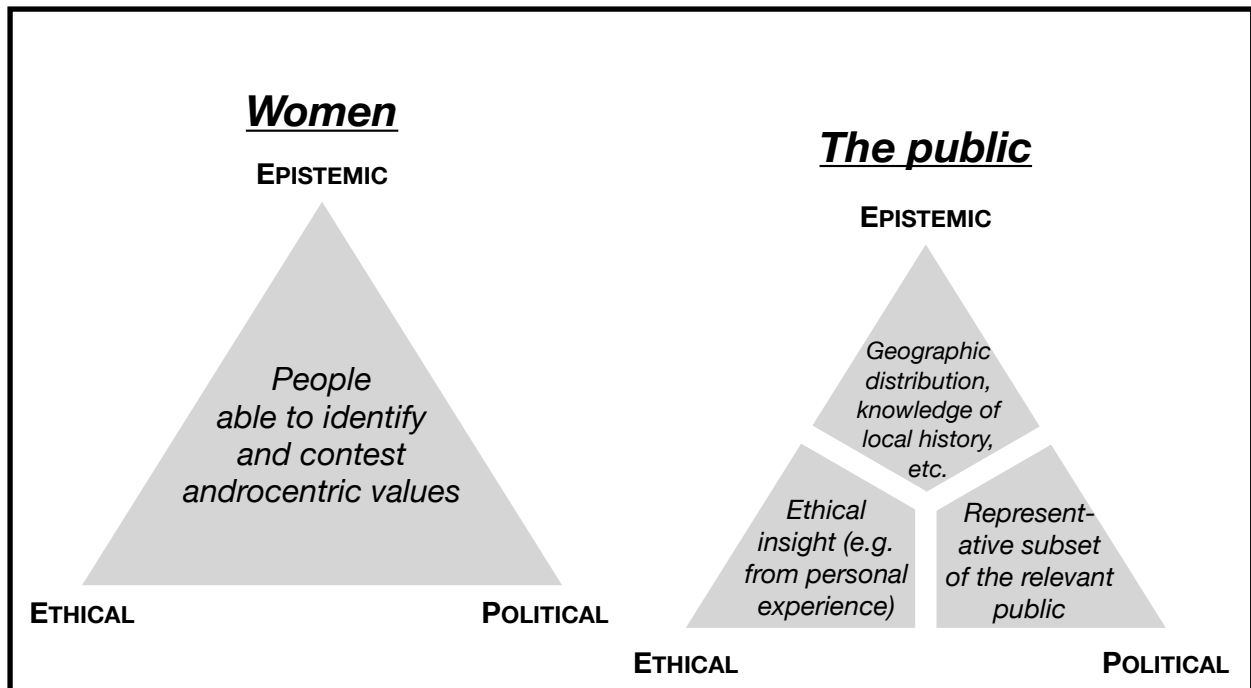


Figure 1. The source of the benefits of greater inclusion

epistemic benefits and the ancillary benefits I set aside earlier (e.g. educating the public, or increasing public support for science).²⁵ The argument here shows that things are even more complicated. In addition to those tensions, there are also tensions among the three dimensions we’ve considered. The members of the public needed to achieve epistemically superior results will often be different from the members of the public needed to secure ethical improvements, who in turn will often be different from those needed for political legitimacy. A pollution monitoring effort, for example, might realize the greatest epistemic benefits from having a large number of participants distributed across a wide geographical area. It might benefit ethically by restricting involvement to individuals who have experienced the most serious consequences of pollution. And to achieve political legitimacy it might require a representative sample of residents of the affected county or state (who of course might be

²⁵ Many authors discuss conflicts between epistemic, ethical, and/or political aspects of inclusion. But nearly all of those discussions use ‘ethical’ and ‘political’ differently than I do here, to refer to the *motives* for inclusion the public, rather than the value judgments embedded in scientific results. When it comes to scientific results themselves, their focus tends to be exclusively epistemic. (See Wylie 2015 for an example of this.) A few authors do speak of a conflict between epistemic and political goals, in a sense similar to mine. (See e.g. Solomon 2009 — though she interprets “democratized science” in a very different way than most proponents of citizen science — and Eigi 2017.) But, to my knowledge, no one has discussed a 3-way conflict between epistemic, ethical, and political assessment of scientific results.

clustered in major population centers). Since these criteria won't typically align, those planning citizen science programs will need to think carefully about their aims in recruiting members of the public, since improvements on one dimension may come at a cost on the others, and in many cases may not be simultaneously realizable.²⁶

It is worth noting that the paths to epistemic, ethical, and political gains may not line up with traditional ways scholars of citizen science have partitioned the public. In a widely cited paper, for example, Braun and Schultz (2010) identify four major "publics" that are regularly recruited for participation in science: the general public as a whole, the "pure" public (i.e. a sample of the general public, excluding those with strong opinions on the object of study), the affected public (i.e. those impacted, but excluding vocal activists or lobbyists), and the partisan public (i.e. those socially or politically active on the subject). Though we might hope to draw general conclusions about which publics are most likely to deliver each type of benefit, in fact the benefits each public brings will vary from case to case.

Those involved in planning citizen science projects are well aware that there is no simple recipe for epistemic gain. In some cases, epistemic benefits might best be achieved through recruiting the largest group possible; but in others, greater epistemic improvements might come through taking advantage of the background knowledge possessed by the affected public, or the lack of bias exhibited by the "pure" public. Different roles for the public, combined with the many different members of the public who could fill those roles, mean that any choice comes with potential epistemic advantages and disadvantages (Bedessem and Ruphy, 2020). The ethical and political dimensions will, I think, prove similarly complex. In some cases, personal experience may make the affected public the best source of ethical wisdom; in others, partisans' extensive reflection on and passion for an issue may give them deeper insight; and in

²⁶ To say that there may be trade-offs is of course not to say that there always will be. Scientists' partnerships with indigenous groups, for example, may yield improvements along all three dimensions. Note, though, that this is because the case parallels the case for the inclusion of women: science has a documented history of making unethical assumptions concerning indigenous people, failing to treat them as equals. For philosophers writing about the benefits of such collaborations, see e.g. Wylie (2015) and Whyte, Brewer, and Johnson (2016).

still others, the “pure” public may be best suited to fairly adjudicate conflicting ethical claims put forward by different groups. In some cases, democratic ideals can best be satisfied by surveying the public as a whole; in others, it may be preferable to sponsor a consensus conference made up of a “pure” group of the public; and in still others, democracy may require giving special voice to those impacted by a problem. Determining how to secure epistemic, ethical, and political benefits, and then negotiating the trade-offs among those dimensions will therefore require careful and context-sensitive reflection on the details of particular research projects.

8. Conclusion

I began this paper by suggesting that efforts to diversify science that adopt an expansive conception of diversity can benefit from paying attention to the different dimensions of diversity, and recognizing that they may not all operate in the same way. The analysis of this paper provides one illustration of this. Comparing the arguments offered for a more gender-inclusive science with the arguments advocating for the greater inclusion of the public has shown that each type of diversity has the potential to improve scientific results in all three senses we considered: epistemic, ethical, and political. But the analysis has also revealed two important differences. First, the path to political legitimacy in each case is different. Bringing more women into science can increase the legitimacy of scientific results by helping to filter out anti-egalitarian values that are by their nature politically illegitimate. Bringing the public into science can count as a legitimacy-bestowing procedure, if the public are selected appropriately and given meaningful input into methodological decisions. Second, and more importantly, in the case of a more gender-inclusive science, the three types of benefit harmonize. Because epistemic, ethical, and political benefits all flow from an ability to identify and contest androcentric values, all three types of benefit can be achieved simultaneously. When it comes to citizen science, things are much more complicated. Each type of benefit often flows from a different source, meaning that efforts to improve science along one dimension via the inclusion of the public may end up coming at a cost on another.

Efforts to structure a citizen science program to achieve maximal epistemic benefits, for example, may render it less able to yield ethical or political benefits. In many cases, there may be no feasible way for public inclusion to achieve all three types of benefit — thus suggesting that efforts to increase diversity via the inclusion of the public require navigating trade-offs not present in efforts to bring more gender diversity to science.

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