

What Roles Can Lay Citizens Play in the Making of Public Knowledge?

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Abstract While enlisting the labor of nonscientists on a large scale for scientific knowledge making is now commonly praised as *citizen science*, citizens in those scientific undertakings usually do not contribute what Harry Collins and his colleagues in the Third Wave call *contributory expertise* and usually do not take part in the technical decision-making process of knowledge production. There are nevertheless other kinds of citizen science, in which participation of nonexperts, though not consistent with the limits imposed by the normative prong of the Third-Wave thesis, should not be judged as per se illegitimate or relegated simply to political actions. I will argue in this article, with the evidence from cases involving nonexperts in scientific truth making, that a different set of prescriptive rules is more warranted: lay citizens should not be denied participation in technical decision making simply because they do not speak the specialist language; the society that lives the form-of-life of Western science has an obligation to provide translation service to those who have stakes and wish to speak on technical questions but do not speak the language of a specialism; lay citizens who make propositional claims with the assistance of translation are only entitled to present their arguments, to question opposing claims, to defend their case, and in the end to receive an explanation of why and how the final decision is made on terms and rules mutually accepted by all parties; political decision making intrinsic to and necessary for the resolution of a technical question should theoretically be open to all, including those who do not speak specialist language, subject only to practical feasibility; disputes over values necessary for resolving a technical question should be properly settled through ideal deliberation under conditions of mutual engagement involving all parties of public life.

Keywords citizen science · Third Wave · expertise · impairment and disability · metascientific judgment · framing · probative scheme of values

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1 Introduction: The Lingering Problem of Extension

Citizen science can be broadly seen as the involvement of nonscientist citizens in knowledge production of science. While enlisting local knowledge or labor of non-scientists for scientific knowledge-making has remained an important yet very often neglected side of knowledge production even after the professionalization of modern science, “citizen science” as dubbed by both professional scientists and community actors is now gaining new momentum. Amateur bird watchers are engaged in reporting the number and species of migrant birds. Online volunteers are invited to participate in coordinated efforts to classify a large volume of satellite images of tropical cyclones. Lay people are also asked to help professional astronomers to examine and interpret space telescope images of galaxies. Those are but a few examples of what indeed should be called *crowd science*, in which large numbers of lay participants act as “sensors” or “basic interpreters” for natural scientific projects whose problem definition, study design, and data analysis are primarily made and determined by professional scientists (Haklay 2013: 105–22). Equipped merely with what the Third-Wave scholars called “beer-mat knowledge” or at best “primary source knowledge,” (Collins and Evans 2007: 18–23) citizens in crowd science simply contribute their time and labor rather than anything that can be candidly called “contributory expertise.”¹

Over fifteen years ago, Harry Collins and Robert Evans (2002), in their seminal article titled “The Third Wave of Science Studies,” urged that the scholarly attention of science studies be moved from empirically exposing the “Problem of Legitimacy” in technical decision making to normatively tackling the “Problem of Extension” of how far the involvement of citizens in technological decision making in the public domain should extend. They made a distinction between members of the general public with experience-based contributory expertise or at least interactional expertise in the relevant science from those who merely enjoy political rights without possessing enough specialist tacit knowledge for them to engage in real specialist conversation (Collins and Evans 2002: 244; Collins and Evans 2007: 23–44; Collins and Evans 2015: 115–16). They contended that the former group be considered legitimate participants in addition to the certified core scientists in respect of the making of scientific knowledge. Contributions of citizens with only stakeholder rights on the other hand should be made only to the political phase of technological decision making (Collins and Evans 2002: 249, 251, 261–62). The Third-Wave scholars believed that upholding expertise with specialist tacit knowledge as a touchstone to distinguish between legitimate and illegitimate citizen participation in technical decision making is the way to solve the problem of legitimacy without at the same time causing an unruly problem of extension and resulting in technological populism.²

It is against this theoretical backdrop that the concept of “citizen science” seems to be an oxymoron in *crowd science*. Without really taking part in the technical phase of

¹ But cf. Bonney, Ballard, Jordan, McCallie, Phillips, Shirk, and Wilderman 2009, 11, who classify citizen-science projects into three categories: contributory, collaborative, and co-created.

² While the original Third-Wave theory along with its SEE (studies of expertise and experience) scholarship were introduced by Harry Collins and Robert Evans in 2002, they were later joined on some occasions by Marin Weinel to refine and elaborate its contents (Collins, Weinel, and Evans 2010; Collins, Evan, and Weinel 2016). I will call them by the term *Third-Wave scholars* in this article.

knowledge production, the nonexpert participants of *crowd science* do not trigger the problem of extension and do little to address the problem of legitimacy. They are more often the voluntary recipients of a new mode of knowledge transmission that actually helps to reinforce the legitimacy of the existing scientific empire (Dickel and Franzen 2016). They may usurp the name of “scientists,” but their participation does not in any way violate the prescriptive rules of the Third-Wave thesis.

There are, however, other kinds of citizen science, in which participation of nonexperts does not exactly abide by the expertise limits imposed by the normative prong of the Third-Wave thesis, although neither does it entirely go against them. And yet, the contribution of their participation, though sometimes in competition with core scientists in knowledge production, should not be judged as per se illegitimate or relegated simply to political actions. Air quality investigations initiated by local residents around a petrochemical plant who have acquired experience-based tacit knowledge of air pollution data collection but are not considered able to speak fluently the specialist language of environmental engineering and health risk assessment may still pose a legitimate challenge to current scientific presumptions and question the adequacy of regulatory standards. The knowledge produced therefrom actually enhances the opportunity for those nonexpert citizens to contest and find solutions to problems in the local communities (Ottinger 2009, 2010). Citizen science of this sort is not only more likely to turn once inconceivable *nescience* into *non-knowledge* (Gross 2007: 749–50); it also has the potential to expose and re-negotiate the value judgments masked as technical necessities in current scientific practices and public policies. It is therefore imperative to develop an alternative normative theory, with which nonexpert participation in technical decision making, especially in the domain of regulatory or policy science, once condemned as illegal, would be recognized under terms and conditions that are compatible with both the demands of participatory legitimacy and the form-of-life of Western science to the greatest extent possible.

In this article, I present three cases involving nonexperts in scientific truth making to illustrate that a specialist language speaking skill is a sufficient and useful, but not always necessary, condition for making a direct technical contribution. Also, the case studies help to elucidate why the ability to speak specialist language is neither a sufficient nor a necessary condition for ensuring that political decisions are properly made to resolve only technical questions whose resolution inevitably requires value judgments.

In the end, I will propose five prescriptive rules to revise the prescriptive prong of the Third-Wave thesis. First, lay citizens should not be denied participation in technical decision making simply because they do not speak the specialist language. Second, the society that lives the form-of-life of Western science has an obligation to provide translation service to those who have stakes and wish to speak on technical questions but do not speak the language of a specialism. Third, lay citizens who make propositional claims with the assistance of translation are only entitled to present their arguments, to question the opposing claims, to defend their case, and in the end to receive an explanation of why and how the final decision is made on terms and rules mutually accepted by all parties. Fourth, intrinsic political decision making that is necessary for the resolution of a technical question should theoretically be open to all, including those who do not speak the specialist language, subject only to practical feasibility. Fifth, disputes over values necessary for resolving a technical question should be

properly settled through ideal deliberation under conditions of mutual engagement involving all parties of public life.

2 The Demarcation Project Reexamined

Vocal critics, such as Sheila Jasanoff (2003) and Brian Wynne (2003), have long criticized Collins and Evans for relying on uncontextualized concepts of expertise to demarcate technical from political matters. They contend that expertise is always constituted within particular historical, political, and cultural contexts. It is not an objective Archimedean point from which one can separate science from politics and settle the problem of extension without dispute. For them, more pertinent questions to be asked are how particular kinds of expertise in relation to certain institutions come about, what tacit commitments to particular meanings are harbored in existing propositional knowledge-claims, and what functions and purposes various boundaries between experts and nonexperts serve in a society.

Sensible and promising though it is, the call to inquire into wider social and political contexts of the production of scientific knowledge with the understanding that knowledge and social order are mutually constituted does not diminish the legitimacy or necessity of asking the normative question about how far the involvement of citizens in technological decision making in the public domain should extend. Such a normative project certainly cannot be understood as merely about epistemology. It has to draw in political theory along with embedded epistemic assertions. Thus, while conducting a comprehensive review of the debates between advocates and skeptics of the Third Wave and its SEE scholarship is beyond the scope of this article, it is worthwhile to reexamine both the political and positive assumptions of the Third-Wave thesis. The endeavor may provide a springboard to develop a normative theory about citizens' roles in the making of public knowledge, which is more in line with the contextualized nature of how knowledge is produced.

Much ink has been spilled on the prescriptive prong of the Third-Wave thesis demanding that members of the general public who do not possess either *contributory* or *interactional* expertise with respect to a targeted domain should be prohibited from participation in the technical phase of public-domain technological decision making. Moreover, despite the fact that politics is never absent from scientific truth making, only those who possess specialist tacit knowledge alone should be granted the prerogative "to dispose of the political influences that bear upon it" in the technical phase (Collins and Evans 2002: 245). The Third-Wave scholars candidly claim that their normative judgments and prescriptive rules are based primarily on the political preference for what they call "elective modernism," in which not only is Western science a distinct form-of-life but also *intentional* actions of scientific truth making should be honored and stubbornly pursued (Collins and Evans 2002: 244–45; Collins and Evans 2007: 116–17; Collins, Weinel, and Evans 2010: 189–92). Two positive propositions indeed play an equally indispensable role in constructing the Third-Wave thesis.

The first positive proposition undergirding the Third-Wave's prescriptive thesis, which the Third-Wave scholars concluded from their several case studies, posits that those who do not possess either contributory or interactional expertise do not know how core scientists practice and would only make bogus propositional claims that are

incomprehensible even to themselves (positive proposition *a*). Although both kinds of expertise involve specialist tacit knowledge, the former, which refers to the ability to take part in the *practices* in a domain of practical accomplishment, necessarily presupposes the primary ability of the latter to *speak* fluently the practice language of the target specialist domain (Collins and Evans 2015: 118–19; Collins, Evans, and Weinel 2016). Immersion in the language alone, even in the absence of practical competence, allows one to acquire a complete understanding of a form-of-life and to engage in the interchange of thoughts by posing questions or discussing the possible answers (Collins and Evans 2015: 116). The SEE scholars believe that the case of Madeleine (Collins and Evans 2007: 81–83) and Collins’s own experience in interaction with gravitational wave physicists both show that such understanding could be “as good as practitioners’ understanding when it comes to making technical judgements” (Collins and Evans 2015: 115; Collins 2004: 750). Conversely, the SEE scholars gave two examples to illustrate that those who do not speak the specialist-practice language or those who only acquire low levels of expertise that do not allow them to engage in real specialist conversation (Collins and Evans 2007: 18–23) do not understand the practices of a certain form-of-life deeply enough to tell the nuances and the significances underneath the appearance of an ostensible technical statement.³ Any proposition-related claim that those people make therefore could not possibly be expected to contribute meaningfully to the scientific truth making.

Specialist language speaking skill thus seems to be a reasonable ground to draw a boundary between legitimate and illegitimate participation. With the concurrence of the protagonist (Collins 2011: 10), Darrin Durant (2011) provided a sympathetic account situating the Third Wave’s normative call within the concept of democracy proposed by John Rawls. Against the criticism that the Third Wave thesis is illiberal and anti-democratic, Durant argued that the Third-Wave scholars’ insistence on allowing only those who possess specialist tacit knowledge to answer propositional questions can be related to what Rawls would have advised for licensing only *public reason* when making decisions on constitutional essentials and matters of basic justice behind the veil of ignorance (Durant 2011: 697–700). Public reason in Rawls’s thinking is a necessary means to persuade the fellow citizens in a plural polity by offering reasons that they can accept (Rawls 1997: 766). To construct public justification with public reason, the argument needs to proceed “from premises we accept and think others could reasonably accept to conclusions we think they could also reasonably accept” (786). As Durant noted, Rawls’s public reason can be grounded in common sense, political principles such as justice and fairness, and “ascertainable evidence and facts open to public view” (786). To permit only those who acquire enough specialist tacit knowledge to participate in technical decision making is to ensure that Western science continues to provide public reason in a pluralist democracy.

Expertise, however, is not *the one and the only* public reason that is of use behind the veil of ignorance. Indeed, Rawls even considers scientific reasoning employed within scientific societies to be *nonpublic reason*, because it is shared only by their members and cannot be a shareable public basis of justification for all citizens in society (Rawls 1997: 800). If anyone wishes to appeal to specialist expertise as a

³ They are the cases of crashing fuel flasks and aircraft respectively in 1984 (Collins and Evans 2002: 263–64).

basis of public justification, it is his or her responsibility to transform it into public reason, and not the other way around. Depriving citizens who do not speak specialist languages of their access to the technical phase does not seem at all compatible with the Rawlsian ideal of democracy as Durant or Collins may have believed. What is more crucial is whether those who do not possess either contributory or interactional expertise can still provide public reason that contributes meaningfully to scientific truth making. This is an empirical question that has largely been ignored and is in need of further investigation.

The second positive proposition bolstering the Third-Wave's prescriptive thesis concerns the disposition of extra-scientific factors in the technical phase. While recognizing that "it is necessary to draw on extra-scientific factors to bring about the closure of scientific and technical debates" (Collins and Evans 2002: 239; Collins and Evans 2007: 125) and that sometimes the "big-p" politics also plays a significant role (Collins and Evans 2002: 245), the Third-Wave scholars insist that a distinction between the inevitable *intrinsic* politics of science and the avoidable *extrinsic* politics has to be made. Politics can only be intrinsic to science and never extrinsic. The concepts nevertheless suffer from significant ambiguity.

In their original 2002 paper, Collins and Evans first mentioned that "politics enters the technical phase intrinsically—it is amalgamated into the science in such a way that its effect is usually *hidden* unless picked out in studies such as Steven Shapin's" (Collins and Evans 2002: 262, emphasis added). Politics that has so entered is still not a legitimate input into scientific decision making (Collins and Evans 2002: 245–46). Thus, even though esoteric judgements can be affected by political judgements, "it remains the duty of scientists to strive to try to exclude political influence on their technical decisions, redoubling the effort if they become aware of such influence" (Collins, Martin, and Evans 2016: 104–05).

All the above paragraphs seem to suggest that intrinsic politics is unavoidable because it involves *unconscious* influences, which are nevertheless *illegitimate* inputs and need to be rooted out from the technical phase once their existence is known to the participants. Yet, if intrinsic politics is never absent from scientific truth making and no politics in the technical phase can ever be deemed legitimate, every scientific truth making regardless of who the decision-maker is would *by default* be illegitimate under such reading of the Third-Wave thesis. Prohibiting those who do not possess specialist tacit knowledge from determining how to dispose of the political influences that bear on scientific truth making and preserving the prerogative only for specialist experts would not transform an illegitimate action into a legitimate one. It is implausible that intrinsic politics should so indiscriminately be understood.

In other occasions, Collins and Evans are inclined to adopt a more lenient position toward the possible legitimacy of at least some intrinsic politics. In the same 2002 paper, they expounded on "the criterion of intrinsicness" in a footnote, stating that "[it] has to be the extent to which scientists, or other commentators, would *willingly endorse* the input of politics into the science" (Collins and Evans 2002: 286n27, emphasis added). In later publications, the Third-Wave scholars further admitted that "intrinsic politics are unavoidable and even *necessary*" (Collins, Weinel, and Evans n.d., emphasis added) and that "small-P politics of the scientific community is bound to enter into the formation of scientific consensus" (Collins and Evans 2007: 125). Now, intrinsic

politics is unavoidable not because specialist experts are unaware of its existence, but because it is integral to the resolution of certain technical questions, which necessitates consideration of extra-scientific factors. Intrinsic politics is *legitimate* as far as propositional questions cannot be resolved merely on mutually agreed technical terms. Extra-scientific judgments are necessary in those situations and thus cannot be ruled out even if they are apparent to everyone. Conversely, extrinsic politics occurs when a decision-maker unnecessarily turns to extra-scientific value judgments even as technical terms alone are sufficient for resolving the propositional questions at issue. The case studies that the Third-Wave scholars provided, such as the MMR vaccine,⁴ the Brent Spar buoy,⁵ and the drug AZT,⁶ are better understood as examples in which selfish, quasi-religious, political, or populist concerns are smuggled into the technical phase when there is a clear consensus among the scientific community as to how to define a technological problem or whether to certify a propositional claim. They are inductive evidence not sufficient to establish that lay citizens who don't speak the specialist language fluently, were they allowed to participate in the technical phase, would definitely introduce extra-scientific value considerations that are *not necessary* in determining and answering propositional questions (positive proposition *b*). The second positive assumption underpinning the Third-Wave's prescriptive thesis therefore is a tempting propositional claim which has yet to be carefully verified.

⁴ The MMR vaccine protects against measles, mumps, and rubella. In the late 1990s in the UK, there began a revolt against the administration of the MMR vaccine for fear that it may cause autism in children. Worrying parents demanded research be conducted to investigate the varied possible links between autism and MMR vaccines in typical child populations so that they would know if their particular child might be at more risk than others from MMR before agreeing to the vaccination. The revolt resulted in a drop in MMR vaccination rates and may have been a factor contributing to measles outbreaks in 2008 and 2009. The Third-Wave scholars accused the parents of using the framing of a technological problem to disguise their selfish, unproductive, or even dangerous conduct (Collins 2011: 92; Collins, Weinel, and Evans 2010: 196; Collins and Evans 2015: 121).

⁵ The debate over the disposal of the Brent Spar oil storage and transfer buoy occurred after the platform reached the end of its life and its owner Shell oil company proposed to dump it in the North Sea. Brent Spar was eventually cut up on land because of strong opposition from environmental groups for fear that its dumping could have opened up the floodgates, allowing ocean dumping of various industrial or even nuclear wastes. The Third-Wave scholars (Collins, Weinel, and Evans 2010: 189-91; Collins 2011: 99) lamented that the actual polluting potential of the buoy itself and possible benefits of sinking such equipment in the sea, including providing an artificial reef for fish-breeding and enhancing species diversity, were not fully explored because discussion of those relevant issues were bypassed by a populist appeal to the absolute purity of the sea.

⁶ In 1999, the then-President of South Africa Thabo Mbeki decided not to distribute the anti-HIV/AIDS retroviral drug AZT to HIV-positive pregnant women, even though the mainstream scientific community at that time had already concluded that the anti-retroviral drug is able to prevent mother-to-child transmission of HIV. Some reported that Mbeki's decision was made based on reasoning that, given the multifactorial nature of AIDS etiology, investing in expensive drugs rather than improving poverty-related conditions that exacerbate the causal progression from HIV to full-blown AIDS may not be the most cost-effective way of controlling the epidemic in the country (Wynne 2008). However, the Third-Wave scholars faulted Mbeki based on his speech to his parliament, for pretending that it was based on the technical decision that *the safety of the drug was uncertain*. Mbeki's insinuation of the drug's danger to health in the public address along with his unspoken political concerns gave the impression that the political dimension of a policy decision had been preempted by a technical decision. To the Third-Wave scholars, Mbeki "was involved in fostering the technocracy of the worst sort" (Collins 2014: 98-104; Collins 2011: 94-95; Collins, Weinel, and Evans 2010: 193-94).

Notwithstanding the important normative question raised by the Third-Wave thesis, there remain very critical empirical questions left unanswered. Further investigation is needed to construct a more sensible theory about citizens' roles in the making of public knowledge. The following three cases involving nonexperts in scientific truth making shed some light on our journey to that end.

3 Cases Involving Nonexperts in Scientific Truth Making

Nonexperts include lay citizens and experts of an area other than the one recognized as relevant by those who possess the authority to formulate the technical question at issue. Both do not speak the specialist language of the targeted domain. However, engagement in public reasoning regarding the resolution of a propositional question may legitimately require less from participants than the Third-Wave scholars thought. The cases below involve nonexperts in scientific truth making. The first two exemplify situations in which lay citizens with aptitudes different from contributory or interactional expertise may still have something useful to offer to the making of public knowledge beyond providing merely "support and facilitation" (Collins, Evans, and Weinel 2016: 107). On the other hand, refusing to listen to the propositional claims that nonexperts made simply because they were not expressed in specialist language resulted in wrongful exclusion of an otherwise legitimate participant in the third case. All three cases together provide a chance to glimpse into the limitations and the possible harms of relying merely on expertise to draw the line between legitimate and illegitimate lay participation.

3.1 Roadkill Society: Without My Formulation, You Wouldn't Know It

Initiated in 2011 by a couple of concerned citizens, the Taiwan Roadkill Observation Network (Roadkill Society) is a social-media-based community with a simple proclaimed mission to reduce roadkill by recording and analyzing roadkill incidences. Members of the society are all voluntary participants from a variety of different places with different educational levels and backgrounds. To participate, a member only has to report dead wild animals found on roads. Photos of the carcasses are taken together with location information and then shared with other members through a social media platform. The species of the animals are then identified by or discussed among interested members. Roadkill hot spots, high seasons of occurrence, and road conditions are also important factors collectively analyzed for the purposes of finding out the causes of roadkill and the solutions to mitigate its occurrence.

Although the Roadkill Society is not an intentionally planned citizen-science project, its expanding mission and the way in which its members interacted with each other and with formal scientific authorities foretold that the local wildlife conservation activity would bloom into a classic case of citizen science. Soon after the number of roadkill reports came to a sizable scale, members reached a consensus to observe not only reptile roadkill but all deaths of terrestrial vertebrates in accessible wild fields, including mammals, birds and amphibians, and even invertebrate land crabs. Such an expanded scope of observation turned the Roadkill Society into a project capable of

detecting more general environmental problems rather than just roadway mortality. Because members are later asked to collect the carcass and send it to a centralized database in addition to uploading photos and location information, a large number of specimens also provides an opportunity for the collaboration of certified researchers (Hsu, Lin, Fang, and Liu 2018: 3611).

At the early stage of the project, members had found that every year beginning in October, there was an unusual number of deaths of ferret badgers around the country. The intact bodies and the places of occurrence all suggested that they were not the victims of road kill. Although no one in the Society is an expert in epizootology, the phenomenon unnoticed by the general public and the expert community still caught the attention of curious members who speculated on the possible causes of death. Pesticide poisoning and deadly canine distemper were two theories proposed by the members to explain the sudden deaths of these seldom seen wild animals. They sensed the need to engage outside experts to prove their hypotheses. Nobody, including the veterinarians whom the members first consulted, ever suspected rabies to be the cause, because Taiwan had been recognized by the World Organization for Animal Health (OIE) as a rabies-free country since 1961. Results of the tests on two carcasses sent to an animal health research laboratory in 2013, however, disproved their original conjecture. More thorough testing on all carcasses of ferret badgers previously collected later confirmed that the disease once thought eradicated was the culprit and had already existed in Taiwan for many years. The finding made the official authority re-classify Taiwan as a rabies-infected area.⁷

In the case of the Roadkill Society, members acquired specialist tacit knowledge of the roadkill causes and specialist expertise in collecting animal carcasses through their practical experience. They nevertheless did not possess any contributory expertise in the diagnosis of epizootic disease or in running the serological tests. The language they used to communicate with the epizootic experts was only of a *ubiquitous* nature (Collins and Evans 2007: 18–23). Neither did they consciously exercise specialist meta-expertise to judge the trustworthiness and the quality of the epizootic experts who provided assistance in verifying the members' theories. However, members of the Society who submitted the carcasses for testing in order to find out the answer to their technical (propositional) question of what caused the death of ferret badgers cannot be dismissed as merely supplying technical services or other “deliverables” to epizootic experts, since it was not the experts who initiated the investigation and then recruited the volunteers to collect specimens. What the members did more significantly is not that they *politically framed* or chose at the upstream a technical question that they, as wildlife conservationists, environment educators, or passionate civil engineers, believed worth pursuing, that is, why so many ferret badgers died. What should be particularly noted is that they *technically formulated* several propositional hypotheses to *explain* the phenomenon they uncovered, even though they did not speak the specialist language. While their hypotheses may have relied merely on “beer-mat knowledge” or a “popular understanding” of epizootiology, and their theories eventually all proved wrong, the discovery of the long-existent but unnoticed virus would not have been possible or would have been further delayed if members had not postulated

⁷ Please refer to Taiwan Roadkill Observation Network for information: roadkill.tw/en/campaign.

animal diseases or pesticide poisoning as the possible cause of death and thus submitted the animal carcasses previously lying quietly in the wild fields for testing.

Their serendipity, rather than the ability to speak fluently the language of epizootiology or actually taking part in the practices of the technical domain, in the end contributed to the technical revision of the formerly certified public knowledge that Taiwan is a rabies-free country. The case of the Roadkill Society illustrates that fluency in the specialist language or acquisition of specialist tacit knowledge is not a prerequisite for meaningful contribution to the technical phase even though the contribution is mainly in the context of discovery. To underplay the contribution of Roadkill Society members who do not speak fluently the specialist language as mere political actions, that is, political framing, does not seem to conform to what the form-of-life of Western science would demand. All that matters is a due process that is able to properly settle disputes, if any, over conflicting propositional claims that sometimes involve different schemes of values. For that reason, we need to further examine the role of language speaking skill in the context beyond scientific discovery.

3.2 KKPC-White Dolphins: I Don't Speak the Language, but I Know No Less than You Do

If the Roadkill Society stands as an affirming example in favor of a more tolerant approach to lay participation in technical decision making, the Kuo-Kuang Petrochemical Corp (KKPC) development project serves as a contrasting case to expose the danger of relying on whether one speaks specialist language to determine if one should be allowed to participate in technical decision making.

The KKPC development project was a part of a grand national investment program strongly promoted by the Taiwan government as its economic development policy. The government promised a large reward to Yunlin County, where the petrochemical plant was first planned to be located in order to gain local support. Yet, the original project, proposed in 2005, faced strong local opposition because an unfairly heavy burden of petrochemical pollution costs had been long placed on people in Yunlin. KKPC finally decided to withdraw the 2005 project after it was determined by the Environmental Impact Assessment Committee (EIAC) to be likely to produce a major impact on the environment and the health of nearby residents, thus necessitating a full-blown impact assessment. Alternatively, a coastal wetland together with new land to be reclaimed in Changhua County was chosen by KKPC in 2008 to be the new site for the development project. Aging and emigration of the population of the nearby small coastal town made the proclaimed economic benefits brought by the development project seem more appealing to the local community. However, the potential negative impact on the environmentally fragile place and the health of the population in the adjacent area still raised great concerns. At the center of the debate about the environmental impact of the new project were, *inter alia*, whether the land reclamation work would harm the critically endangered Taiwanese white dolphin (*Sousa chinensis*) and whether air pollution, especially fine particulate matters $PM_{2.5}$, would impose unbearable risk to human health.

Unlike the environmental impact assessment (EIA) in most countries where political decision-makers are required to evaluate by themselves the environmental consequences

when deciding whether or not to proceed with a plan or a development project, Taiwan's EIA system adopts a somewhat different approach that seems to formally separate political decision-makers from impact assessors. The EIAC, which is an independent body in charge of reviewing the environmental impact statement (EIS), is institutionally separated from the administrative authority that has the power to determine whether or not to undertake the project.⁸ While the composition of the EIAC is required by law to be a mix of technical specialists, government officials, and in some cases public representatives, the evaluation process is in EIAC's practice deliberately divided into the stage of risk assessment and the stage of risk management. It further demands that only specialist experts be admitted as formal participants in risk assessment so as to maintain a purely technical nature of the process. Citizens, who are at stake and wish to express their opinions in the experts' meeting, are allowed to recommend representing specialist experts to EIAC; but they themselves are kept away from the process. Once the environmental impact is objectively assessed, it is up to the full committee to decide whether the risk is substantial enough to outweigh the benefits of the development and whether there are feasible means to manage the risk. The institutional design of Taiwan's EIA system, at least in theory, echoes the Third-Wave thesis to separate the political and the technical phase of technological decision making and to reserve the technical phase only for those with specialist expertise or at least those who speak the specialist language. Such an institutional design, however, plants the seeds of discontent.

To prepare its environmental impact statement, KKPC hired a cetacean ethologist to study possible impacts of land reclamation on Taiwanese white dolphins, a species of less than 100 in number that had been listed as critically endangered by the International Union for Conservation of Nature (IUCN) since 2008.⁹ The findings of the study confirmed that the nearshore area along southern Changhua County where the KKPC development project reclamation was planned is an important transit corridor connecting two subpopulations of the white dolphins. Almost at the same time, citizen-based conservation groups began to gather information about negative impacts of past reclamation projects around the world, such as the Hong Kong airport, on dolphins. They mobilized their citizen members to read and examine the KKPC's expert report. The lessons they learned from cases in other countries prompted them to worry that the blockage of the corridor would further isolate the two already withering groups of dolphins and might lead to their functional extinction in decades. KKPC's expert report, however, concluded that the planned reclamation land would not entirely cut off the passageway for the dolphins because the depth of the project's offshore breakwaters left more room under the sea than the breakwaters of nearby harbors where no obvious blocking effect was observed.¹⁰ Also, KKPC contended that dolphins know how to change directions when they encounter obstacles, or else, they can be trained to bypass the blocking structure and reach their destination through a "dolphin channel."

⁸ Article 14 of the Environmental Impact Assessment Act of Taiwan provides that the administrative authority overseeing a development project may not grant permission for a development activity in cases where the environmental impact assessment authority determines through review that the adverse impact of the development activity outweighs its benefits.

⁹ See <http://www.iucnredlist.org/details/133710/0>.

¹⁰ The First Draft of Environmental Impact Statement of KKPC, at page 7-105 (2010).

Whether KKPC's land reclamation project would block the travel path of Taiwanese white dolphins and result in their extinction remains a technical question. The answer any specialist expert could provide given the state of knowledge at the time, however, had to rely on ordinary reasoning, which was susceptible to inspection by one with common knowledge. The comparison of the depth of breakwaters under the sea between the KKPC development project and the nearby harbors is relevant evidence, if all that is likely to obstruct the movement of the white dolphins is breakwaters. It is not very difficult to see that the comparison should not be used to infer the impact of KKPC's reclamation project on the white dolphins because the landfill itself, unlike breakwaters, does not leave any room for dolphins to pass under the sea. Also, it is one thing to train a dolphin in a well-equipped facility to do tricks, as many may have watched in an aquarium. It is quite another to train a group of wild dolphins to travel through a narrow waterway, when no successful record of such training exists so far. Those were the questions raised against the KKPC report both by the experts invited by the EIAC to participate in the risk assessment and by the concerned citizen conservationists, who did not speak fluently the specialist language but knew enough to challenge the conclusion of KKPC's report. Concerned citizen conservationists even contended that the precautionary principle, under which scientific uncertainty about a negative effect should be treated as if it exists when damage is likely to be serious and irreversible, should apply to the current case. Many experts echoed the views of the concerned citizens that it is KKPC's burden to prove, to a higher degree of belief, that the reclamation project would not block the travel route of the critically endangered species.

In this case, it is clear that lay citizens' propositional claims were no less useful than those of experts, who also relied mostly on ordinary reasoning to answer the technical question under the state of non-knowledge. Even though lay citizens were not fluent in the specialist language, the probative value scheme they adopted to temporarily answer the technical question, whose resolution inevitably requires value judgments, is what the equally ignorant experts were willing to endorse. The situation may look at first similar to the "public-use technologies" or "local-interest technologies" (Collins and Evans 2002: 266–67), where many citizens have skills or knowledge on a par with specialist experts when non-knowledge of experts exists. But at second glance, it becomes clear that the prediction of white dolphins' possible response to land reclamation has nothing to do with any public-use technology. The questions that citizen conservationists raised against the KKPC report also bear little resemblance to the characteristic of locality. Under the standard Third-Wave thesis, lay citizens would have to first establish that a state of "non-knowledge" exists. This is a challenge often lying at the center of a technical dispute before lay citizens can overturn the presumption that those who do not fluently speak the specialist language would spout only incomprehensible gibberish. That is a mission hardly possible.

3.3 KKPC-PM_{2.5}: You Wrongfully Banished Me, but I Bear the Cost?

The consequence of embracing the Third-Wave presumption about nonexperts, however, was fortunately not so detrimental to the resolution of the white dolphin controversy, as lay citizens' propositional claims and value judgements were also raised and shared by experts who were admitted in the risk assessment procedure. Another dispute over the environmental impact of KKPC's development project nonetheless suffered

harm from the Third-Wave's insistence on making specialist language skill the admission threshold for membership in the technical phase.

During the days when KKPC's development project was introduced in 2005 and 2008, the notion of the fine particulate matter $PM_{2.5}$ was relatively new to most people in Taiwan, and the understanding about its health effects was limited even around the world. It was not until 2012 that the first ambient air quality standard for $PM_{2.5}$ was set in Taiwan. Although KKPC's environmental impact statement did not even mention $PM_{2.5}$, because particulates were all grouped under the category of total suspended particles (TSP) at that time, the potential health impact of $PM_{2.5}$ likely to be produced by KKPC's future operation still became a concern of local environmental groups and many citizens. Being unsatisfied with KKPC's underestimation of the impact of air pollution on health, Ben-Jei Tsuang, an environmental engineering professor specializing in atmospheric dispersion modeling, used the open data of plume dispersion collected by the Environmental Protection Agency (EPA) from a nearby petrochemical plant to develop a trajectory model to simulate the long-term country-wide distribution of fine particulates from KKPC's future operation. The atmospheric dispersion modeling expert then applied his exposure estimates to a set of risk ratios between the elevation of $PM_{2.5}$ air pollution and increased health risks discovered by a US-based longitudinal cohort study, which was published in the *Journal of the American Medical Association* (Pope 2002).

Tsuang's own assessment generated a shocking result, that KKPC's future operation would cause at least 1,356 excess deaths in Taiwan every year. The terrifying number soon drew the attention of the media. Worried environmental groups requested that the EIA appoint Tsuang as their "representing expert" for health risk assessment. The request was rejected by the EIA on the ground that Tsuang is neither an epidemiologist nor a qualified health risk assessment expert. While Tsuang was still given a five-minute slot, as were other concerned citizens, to present his opinion, he was not allowed to engage in discussion with other experts. The EPA later held a special meeting to refute Tsuang's assessment without his presence. The EPA appointed experts who criticized Tsuang for using a non-EPA certified trajectory model to simulate KKPC's air pollution effects. Tsuang was also accused of overestimating the adverse health outcomes because the average ambient concentration of $PM_{2.5}$ in Taiwan is two to three times higher than that of the US cities, but the cancer incidence rate in Taiwan is only half of that in the US. Using the exposure-response ratios based on the US study to predict the health effects in Taiwan was inadequate. In the end, the health impact of $PM_{2.5}$ from KKPC's future operation was left unanswered in the expert meeting's 2011 conclusion as if it were unresolvable. It was not until 2013 that the airborne particulates were designated as Group 1 carcinogens by the IARC and WHO (2013), as studies also confirmed that there is no safe level of exposure to $PM_{2.5}$, at least for lung cancer (Raaschou-Nielsen 2013).

Tsuang is no doubt an expert in atmospheric dispersion modeling. His unrefined knowledge about the risk ratio between $PM_{2.5}$ exposure and adverse health outcomes came from a primary source and made him a lay citizen in the domain of health risk assessment. Tsuang's judgment, which was based on the coarse learning about the harm of the fine particulate matter together with his high-end dispersion modeling, however, should still be understood as a sincere proposal to look into the negligence in the technological decision making. More important is that Tsuang's adoption of his

atmospheric dispersion simulation was actually a direct challenge to the EPA-approved model, which the modeling expert felt failed to simulate long-term distribution of fine particulates in a much broader region. Expertise in atmospheric dispersion modeling is indeed relevant and necessary for a more comprehensive health risk assessment of air pollution, even though it did not seem germane to the core scientists who obtained authority to formulate the technical questions in the assessment process. Under the Third-Wave thesis, Tsuang's expertise in atmospheric dispersion modeling should have been regarded as "technical referred expertise." Not including him in the health risk assessment would have been a "technical mistake" (Collins, Evans, and Weinel 2016: 105n5) because he was not given an opportunity to prove that the EPA's dispersion model was wrong during the procedural phase in which the EIAC thought only real experts were entitled to participate, that is, the technical phase under the Third-Wave thesis. However, the Third-Wave thesis also posits that "technical referred expertise requires both source and target expertise to be understood so the expert must have at least, interactional expertise in the target domain" (Collins, Evans, and Weinel 2016: 106) and that "the decisions about which domains of expertise are relevant ought to be made by technical experts [rather than political actors]" (Collins, Evans, and Weinel 2016: 105). Tsuang's rejection as an expert in KKPC health risk assessment because he did not speak the specialist language correctly would still be considered a legitimate decision according to the Third-Wave's prescriptive rule. The only recourse for him was either to bring his own translator who speaks the specialist language (Collins and Evans 2002: 256), to wait for the arrival of "the Owls" (Collins, Evans, and Weinel 2016: 106) to save and bring the mistreated expert back from exile, or to have himself pass the language test held by the core scientists.

Tsuang's plight is similar to what the Cumbrian sheep farmers (Collins 2011: 14; Collins, Evans, and Weinel 2016: 105) encountered. More inclusive technical formulations would have included from the beginning the banished experts who did not speak the specialist language of the target domain. But how could a denial of admission in the technological decision making be a technical mistake and at the same time a prescriptive requirement? Third-Wave scholars would lament that both Tsuang and the sheep farmers' inability to speak the specialist language in each of the target domains is to blame (Collins, Evans, and Weinel 2016: 105). But such a prescriptive rule unilaterally imposes the liability on those who do not speak the specialist language to correct the wrong at the expense of a more comprehensive consideration that the technological decision makers should have taken.

4 An Alternative Normative Theory

If relying on expertise and the specialist language speaking skill to determine membership for participation in technical decision making may unnecessarily discredit the contribution of nonexperts and result in wrongful exclusion of otherwise legitimate participants, a more sensible theory about citizens' roles in the making of public knowledge is urgently needed. Such a normative theory would need to make revisions to what we currently have at least in the following five aspects.

First, the problem with using the language speaking skill as a proxy for the comprehension of specialist tacit knowledge is that the two are separable. While the Third-

Wave scholars correctly point out the separation of language and practice, they fail to further recognize that understanding a language and the way it produces meaning, as well as the external world it represents, requires mainly the perceptive ability of reading or listening. It does not go hand in hand with the ability to communicate through speaking or writing. Communication requires additional bodily capacity and skill. Lack of the ability to speak or write is certainly an impairment regardless of the ability to read and listen. But an impairment in itself does not entail any normative implication.

Based on the work of Norman Daniels and Christopher Boorse, Allen Buchanan and his colleagues make a distinction between impairment and disability. For them, as impairments or diseases are the descriptive notions of adverse departures from “species-typical functioning,” they may not necessarily result in disability, which is a normative judgment mostly contingent on social or historical environments (Daniels 1985: 29–30; Buchanan, Brock, Daniels, and Wikler 2000: 285–87). This is because only when the social environment demands certain abilities does lack of those abilities become a disability. Dyslexia, a condition in which an individual with normal vision is unable to properly interpret written language, results in no disability in a pre-literate hunting and gathering society. But for the assistance of a computer program called the “Equalizer,” the great scientist Stephen Hawking, who lost his ability to write and speak due to a motor neuron disease, would not have been considered a qualified participant in producing knowledge of quantum mechanics. The ability to speak specialist language therefore cannot serve as a proper benchmark to judge whether one can make propositional claims based on reasoning that every participant can mutually accept.

Prescriptive rule 1: *Lay citizens should not be denied participation in technical decision making simply because they do not speak the specialist language.*

Second, acquiring a specialist language speaking skill certainly facilitates the daily operation of the form-of-life of Western science. The form-of-life of Western science does not sanction automatically a prescriptive rule that excludes anyone who does not speak the specialist language from being a member in the technical phase of technological decision making. It has to derive from some other political decisions and social arrangements. A choice to prioritize expediency and efficiency over tolerance and solidarity constructs a social cooperative system different from one that is willing to change its social environment to allow more people to participate (Buchanan 2000: 284–87). It must be admitted that the Third-Wave scholars once recounted the ways to increase the participation of those who do not speak specialist language, for instance, “encouraging such groups to look for spokespersons with interactional expertise in the science in question, or to encourage the growth of intermediary groups to speak for the scientific knowledge of the uncertified, not as campaigners, nor as experts themselves, but as translators” (Collins and Evans 2002: 262). The Third-Wave scholars fell short of recognizing that it is a particular political philosophy or a determined political decision that entails the prescriptive rule which they proposed. An alternative is a rule that imposes *obligation* on the society that lives the scientific form-of-life to provide translation service to those who wish to speak but are unable to speak the language of a specialism.¹¹

¹¹ The obligation to provide translation service also implies a concomitant obligation to train enough qualified interpreters.

Unlike the Third-Wave scholars, who insist on excluding stakeholders who do not speak the specialist language from the technical phase of technological decision making, the new rule would see those who have stakes as the parties to whom the society is most obliged to provide the translation service. Just as courts must appoint a qualified interpreter for a party or a witness whose functional language differs from what is used in the court or who has impairment that inhibits their comprehension or communication,¹² the new rule obliges a society living in the scientific form-of-life to take into consideration the propositional claims, regardless of the language used, of the parties whose interests would be affected by the technological decision making. The purpose is not to let impairment in language become a disability without just cause.

Prescriptive rule 2: *The society that lives the form-of-life of Western science has an obligation to provide translation service to those who have stakes and wish to speak on technical questions but do not speak the language of a specialism.*

Third, the provision of translation service, however, only promises that the propositional claims of anyone who wishes to speak are taken into consideration. It does not amount to guaranteed certification of those claims. The translation service allows those who do not speak the specialist language to present their arguments, to question the opposing claims, to defend their case, and in the end to receive an explanation of why and how the final decision is made on terms and rules mutually accepted by all parties. Thus, the new rule does not intend to overthrow the form-of-life of Western science and replace it with something else. It extends the membership to those who agree on at least a limited set of ground rules about reasoning through evidence. Adopting a more restrictive rule for fear that widening the technical-phase participation would open a Pandora's box for creationists who "repetitively raise the issues once seriously discussed within the scientific community and were carefully resolved" or simply disregard evidence "so lucidly expounded" (Kitcher 2011: 227–30) is to throw the baby out with bathwater. It unnecessarily and illegitimately excludes not only Cumbrian sheep farmers and Tsuang as technical referred experts proper, but also the selfish parents who pointed to possible non-knowledge pertaining to the safety of a particular vaccine, and the zealous environmentalists who made a propositional claim that sinking the oil buoy may open up a floodgate, allowing ocean dumping of various industrial or nuclear wastes.

The Third-Wave scholars relentlessly criticized the parents for questioning the safety of MMR with respect to any single child and demanding more research be done to understand whether their particular child might be in the group at more risk than others, and pointed out that this would not produce any policy except resistance to all vaccination (Collins 2011: 20–25). The Third-Wave scholars, however, did not

¹² 28 U.S.C. §1827(d)(1) ("The presiding judicial officer, with the assistance of the Director of the Administrative Office of the United States Courts, shall utilize the services of the most available certified interpreter, or when no certified interpreter is reasonably available, as determined by the presiding judicial officer, the services of an otherwise qualified interpreter, in judicial proceedings instituted by the United States, if the presiding judicial officer determines on such officer's own motion or on the motion of a party that such party (including a defendant in a criminal case), or a witness who may present testimony in such judicial proceedings—(A) speaks only or primarily a language other than the English language; or (B) suffers from a hearing impairment (whether or not suffering also from a speech impairment) so as to inhibit such party's comprehension of the proceedings or communication with counsel or the presiding judicial officer, or so as to inhibit such witness' comprehension of questions and the presentation of such testimony.").

directly refute parents' propositional claims on any technical ground. Similarly, the Third-Wave scholars lamented that in the Brent Spar case, the environmentalists' demand to take into account the wider framing of global environmental issues had led to an undesirable result, in which the actual polluting potential of Brent Spar and possible benefits of sinking oil equipment in the sea were not taken as lines of inquiry worth pursuing. Their discontent was directed at the *consequence* of environmentalists' propositions rather than any *propositional* error therein. If what concerned the Third-Wave scholars were social and political impacts of the propositional claims, lay citizens should not be blocked from participating in the technical decision making on the pretext that they do not speak the specialist language. At least, according to the Third-Wave's own normative thesis, the value of a propositional claim must be based only on probative grounds.

Prescriptive rule 3: *Lay citizens who make propositional claims with the assistance of translation are only entitled to present their arguments, to question the opposing claims, to defend their case, and in the end to receive an explanation of why and how the final decision is made on terms and rules mutually accepted by all parties.*

Fourth, the Third-Wave's phased approach has obscured and prevented a more dynamic interaction between science and politics. The recognition of *framing* as a political matter represented a process in which value judgments once wrongly kept exclusively to core scientists in the technical phase were later permissively placed within the purview of the general public. Resorting to the consideration of social impact and social utility of a line of investigation to determine whether the propositional question raised is a problem worth pursuing in a society is surely a political action. It involves a debate over what human good a certain investigation would serve and what issues and concerns should enjoy priority public attention. All that is needed is to make a measurement of what Philip Kitcher called the scientific significance of a particular line of inquiry (Kitcher 2011: 105–11). If any technical question is to be investigated and answered as part of the collective enterprise of producing public knowledge, such a political action is inevitably needed beforehand.

It is true that the Third-Wave scholars graciously admitted that “any problem has to be set in a frame . . . and setting it in a frame is often the very essence of the political phase” (Collins 2011:12; Collins, Evans, and Weinel 2016:105). However, if setting the propositional questions to be answered, and thus necessarily relinquishing others, is a legitimate action in the political phase, which should be open to all including those who do not speak the specialist language, why did the Third-Wave scholars still find fault with the selfish parents in the MMR case and the zealous environmentalists in the Brent Spar case? The Third-Wave scholars apparently blamed the lay citizens for trespassing into a domain that does not belong to them. Later, the Third-Wave scholars were more lenient to an imaginary party they contrived for argument's sake, who demanded further research into the detection of high fluxes of gravitational waves for fear that high fluxes of gravitational waves may cause an increase in the incidence of cancer (Collins and Evans 2015: 121). The Third-Wave scholars were ready to accept that the cautious request of the worried citizens to conduct more research on the existence of cancer-causing radiation may be justified in consideration of the levels of uncertainty and the potential loss of life so long as such a request is not made to

Table 1 The relation between intrinsic political decisions and specialist expertise

	Propositional questions whose resolution inevitably requires extra-scientific value judgments	Propositional questions whose resolution does not depend on extra-scientific value judgments
Value judgments made by core scientists	Legitimate intrinsic politics	Illegitimate extrinsic politics
Value judgments made by nonexperts	?	Illegitimate extrinsic politics

determine the future of gravitational wave physics (Collins and Evans 2015: 121). However, the parents and the environmentalists, whose propositions are of a similar nature to that of the imaginary party, did not intend to change the mind of any specialist expert about the safety of the MMR vaccine or the polluting potential of oil equipment, either. The *intentions* of their claims were to engage in public-domain technological decision making rather than to produce the content of esoteric science. They did not even specify in which phase of the technological decision making their propositional claims were to be presented. It is the meticulously made label of technical or political phase that the Third-Wave scholars chose to attach to lay citizens' propositions with regard to the scientific significance of a particular line of investigation that determined the different fates of each case.

If instead the line can be redrawn between propositional questions whose resolutions inevitably require extra-scientific value judgments and those that do not, it becomes clear that, in addition to framing, other metascientific value judgements may also need to be held politically accountable. The case of the white dolphin shows that the choice of the probative scheme of values, under which metascientific decisions such as allocating the burden of proof and setting the standard of reliability (or so-called degree of proof) are made, has a direct impact on whether a particular propositional claim is accepted or rejected. It seems that the Third-Wave scholars have also recognized that conclusions on the existence of cancer-causing radiation need to be based on a degree of proof that takes into account the context in which the conclusion is put to use. Since the probative scheme of values forms a necessary and integral part of the resolution of a technical decision, unless it is esoteric science that only concerns secluded scientists, the metascientific decisions have to be open to public deliberation regardless of whether they are labeled as intrinsic political decisions in the technical phase or as political-phase questions that need to be addressed in advance.

Prescriptive rule 4: *Intrinsic political decision making that is necessary for the resolution of a technical question should theoretically be open to all, including those who do not speak specialist language, subject only to practical feasibility.*

Now, if core scientists and lay citizens alike are all allowed to participate in making intrinsic political decisions to resolve technical questions, how do we reconcile so many different value preferences? If reinstating lay citizens does not come with a legitimate means to settle value disagreement and fairly adjudicate which prevails, the conflict over whether the parents' request for more research on the safety of the vaccine should be honored would pointlessly endure.

The questions of how consensuses on public affairs are possible and how they should be reached in a pluralist democracy have long been the primary concerns for political philosophy. To develop a full-fledged political philosophy to expound on how to settle the value disputes we face in resolving technical questions is beyond the scope of this article. Suffice it to say that a procedural approach, such as the one proposed by Philip Kitcher, to filter and assess competing schemes of values through *ideal deliberation* under *conditions of mutual engagement* involving all participants of public life (Kitcher 2011: 51–53, 60–61) would be the best available option we have so far. Only those values that emerge as endorsable after this procedure are to be accepted as an integral part of the resolution of a technical question. While some of the conditions of mutual engagement are *epistemic* (Kitcher 2011: 51),¹³ those conditions do not include the possession of specialist tacit knowledge as postulated by the Third-Wave scholars. Instead, more important are *affective* conditions, under which genuine engagement with others would begin from an *expansion of one's sympathies*. It simply requires that “the perceived desires of those with whom one deliberates [be] given equal weight with one's own” (Kitcher 2011: 51). Other public philosophers, such as Amy Gutmann and Dennis Thompson (1996: 2), emphasize the importance of reason-giving in a deliberative democracy and define that as a process in which citizens “seek fair terms of social cooperation for their own sake; they try to find mutually acceptable ways of resolving moral disagreements.” The common feature is that these political philosophers all rely on non-exclusive reciprocity, such as mutual knowledge, mutual understanding, and mutual criticism among all fellow citizens, to settle disputes involving conflicting value judgments. With reciprocity as the minimum requirement for a procedure of ideal deliberation to properly settle value disputes, the skill of speaking a specialist language is apparently not always necessary.

Prescriptive rule 5: *Disputes over values necessary for resolving a technical question should be settled through ideal deliberation under conditions of mutual engagement involving all parties of public life.*

Together, the five new prescriptive rules would allow the nonexpert participation in technical decision making once condemned as illegal to be recognized under terms and conditions that are compatible with both the demands of participatory legitimacy and the form-of-life of Western science to the greatest extent possible.

5 Conclusion

The goal of the Third-Wave thesis, to draw a boundary between the public and experts or politics and expertise in order to prevent technological populism and at the same time make the best use of Western science in pursuing the ideals of democracy, is not only legitimate but also admirable. The cases involving nonexperts in scientific truth making presented in this article, however, suggest that the thesis might actually suffer from several problematic positive propositions and normative inference.

¹³ For instance, participants must not rely on false beliefs about the natural world, they must recognize the mutual consequences of the actions and institutional arrangements under discussion, and they must be able to identify the wishes other participants have and how those wishes evolve in the course of the conversation.)

First, the Third-Wave's positive prong wrongly links the ability to speak a specialist language with comprehension of specialist tacit knowledge and thus mistakenly takes specialist language speaking skill to be a sufficient, useful, and necessary condition for making direct technical contribution. Second, the Third-Wave's prescriptive prong may uncritically turn the impairment in language speaking skill into a disability without considering the possibility of changing social arrangements that cause the politics of exclusion. Third, the Third-Wave's positive prong may wrongly believe that specialist language speaking skill can ensure that extra-scientific value judgement would not be made to resolve those technical questions that could be sufficiently justified or disproved on technical grounds. Fourth, the Third-Wave thesis may also wrongly hold that lay citizens who don't speak fluently the specialist language would definitely introduce extra-scientific value considerations that are not necessary in determining and answering propositional questions were they allowed to participate in the technical phase.

The purpose of this article is of course not to discredit the value of the studies of expertise and experience in any way or to undermine the complexity of any technical debate. It is only intended to point out that the normative theory of whether lay citizens without any expertise in its strictest sense, which may cover most citizen scientists, should be excluded entirely from scientific or technical decision making cannot be derived directly from the descriptive studies of how expertise is acquired and how different kinds of expertise interact with each other. It has to take the political philosophy underlying any sort of normative theory more seriously. The tentative prescriptive rules proposed as an alternative in this article are derived with such an understanding.

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