Science, Society and Virtue: Scientific Neutrality and Social Engagement in 21st century

Oscar Eliezer Mendoza-De Los Santos[1]

Abstract

The image of a science concerned with social issues raises worries about the loss of neutrality and the possibility of bias in scientific research. In this text, I argue for socially engaged science from a virtue theoretical approach, particularly by resorting to the concept of intellectual virtue. I point out that the link between this type of virtue and scientific enterprise is fundamental, not only because of their relevance when doing rigorous scientific research but also because of their role in judging the impact of scientific knowledge on society and contributing to its fair and inclusive use. Such a proposal faces considerable challenges, especially concerning the system of production and incentives of science, so I suggest some strategies to address these challenges and foster the development of intellectual virtue in formation of scientists.

Keywords: socially engaged science, intellectual virtue, beneficial science, neutrality, autonomy.

[1] Autonomous University of Tamaulipas. Faculty of Law and Social Sciences. Center for Research and Technological Development Applied to Behavior (CIDETAC). Mexico. Correspondence: omendoza@uat.edu.mx

Introduction

The presence of science and technology in diverse areas of human life is undeniable. There is no shortage of examples at hand or just a click away: telecommunications networks, electronic devices, drugs, means of transport, and the increasingly common Artificial Intelligence-Based mobile applications. Some other examples are found in less everyday contexts for the lay public, such as in the military, or large-scale techno-scientific efforts, such as the CERN. Moreover, scientists often provide factual information (e.g., evidence on global temperature rise), as well as recommendations to policy-makers on what needs to be done to achieve specific goals, such as the use of facemasks to mitigate the COVID-19 pandemic (Gundersen, 2023). Society is already too much dependent on science.

Nevertheless, in addition to influencing society, science is, in turn, influenced by society in complex ways. In diverse countries, science is financed with public resources. It is pretty common, for example, that the needs of certain social actors are taken into account when establishing lines of applied research, thus defining the research priorities settings (Grill, 2021); it has also been observed that the industrial sector influences the development of policies and research agendas, even distancing the latter from specific issues that are so relevant to other social sectors such as public health (Fabbri et al., 2018).

Thus, the relationship between science and society is not free of tensions and cannot be identified as a mutually beneficial and direct alliance (i.e., science receives social resources, and society benefits from scientific findings). Indeed, since the 20th century, concerns about the impacts of scientific knowledge on society have been voiced by thinkers such as Frederick Soddy, who warned about the potential impacts of the nuclear science of his time (Guston, 2012). On the other hand, scientists such as Michael Polanyi (1962) have highlighted the need for science to be detached from extra-scientific issues (social and political, for example) to develop research and produce accurate knowledge properly. The latter position allows for justifying the separability view, according to which the role of scientists is normatively distinct from their role as experts in the field of policymaking (Gundersen, 2018).

This tension between the search for scientific neutrality and its relation to social issues continues to be the subject of analysis today, especially regarding the credibility of science in the face of certain major social and environmental problems. On the one hand, some point out that scientists' advocacy for extra-scientific causes, such as environmental conservation, may contribute to affecting the quality of their research and scientific credibility in order to provide some form of warnings or signals about what is right or wrong in this area (Lackey, 2007). In addition to these concerns, the role of the scientist as an expert in social matters has been burdened by the criticisms and suspicions derived from the difficulties that the authorities and the scientific community in various countries faced in addressing the management of the COVID-19 pandemic (Sulik et al., 2021).

The question of conflicts of interest associated with normative science (Lackey, 2007) is not one free of controversy, as empirical inquiries into the possibility that research processes are seriously affected by conflicts of interest associated with environmental or social activism have not yielded substantial results in favor of this hypothesis (Kotcher et al., 2017). However, it must be accepted that the erosion of the image of the scientist and the decline in society's confidence in science are matters of serious consideration. Factors such as inadequate communication of scientific findings can contribute negatively to public distrust of scientific research, so clear, honest (especially concerning uncertainty and the scope of science), and inclusive communication, i.e., open to genuine dialogue between the various stakeholders, can contribute to establishing appropriate relationships of trust between science and society (Curtis et al., 2023).

An adequate bridging between science and society seems crucial today more than ever, as we are facing a scenario characterized not only by environmental but also economic and health crises, which, it is reasonable to admit, can only be understood and substantially addressed with a considerable dose of scientific expertise and knowledge in combination with elements coming from civil, political, business and other sectors of society. Additionally, scientists are citizens with specialized knowledge and should seriously consider their role in responsible and transparent advocacy, using all their intellectual resources (Nelson & Vucetich, 2009).

Finding a solution to this problem is a challenging task. Even if we accept that the scientific community should intervene in matters that affect society in general, the question keeps floating around: How can scientists do so without detriment to the quality of their scientific work, especially in settings characterized by uncertainty, controversy, and the interests of various social actors? Adequate communication, mentioned above, is a fundamental factor, but more is needed to resolve the issue altogether. It is not a minor challenge and implies intellectual responsibilities for those engaged in scientific endeavors. For this reason, the answer to this question requires an approach that takes into account not only the cognitive competence of scientists as experts in their respective fields but also a notable motivational component, i.e., the interest in getting involved in fair causes as actors possessing knowledge and theoretical and methodological tools that can be essential for the benefit of various sectors of society.

In this order of ideas, my aim in this paper is to argue in favor of a socially engaged science —a science attentive to social issues— by resorting to a virtue theoretical approach. To this end, in the second section of this text, I address the subject of the axiological neutrality of science. In the third section of this paper, I argue in favor of the notion of a socially engaged science, resorting to the concept of intellectual virtue. I delve into how some of these virtues can contribute substantially to scientists working together with society to co-production knowledge and informed decision-making. In the fourth section, I reflect on the difficulties that challenge this proposal, so I also provide some suggestions for fostering intellectual virtues in people devoted to scientific endeavors.

A look at the axiological neutrality of science

Generally speaking, the neutrality of science refers to the idea that scientific research does not make judgments about aspects that are not strictly epistemic. In other words, science is limited to knowing what *is* there rather than deciding what *should* be there. This idea is associated with another widespread thesis in the representation of scientific work in the 20th century: the autonomy of science. This last thesis assumes that the processes related to the generation of scientific knowledge are guided solely by considerations concerning the evidence collected on a phenomenon, the justification of hypotheses, relevant analyses, etcetera, while other aspects, for example of an economic and social nature, remain isolated from the scientific sphere.

More specifically, the ideas of scientific neutrality and autonomy are often associated with the claim that scientific knowledge is axiologically neutral; this means that scientific knowledge, obtained solely on the basis of evidence and the rationality of the scientific method, is neither good nor bad, but can be used according to the purposes that suit certain actors (political, economic, business, military, among others), which is not something that falls within the competence to those *strictly* dedicated to science. In this sense, the notions of objectivity —understood as the view of no one in particular— and neutrality have been intimately linked since the 20th century (Fine, 1998).

However, it was precisely in the 20th century when the axiological neutrality view of science began to be particularly controversial, largely thanks to the philosophical and socio-historical studies of science (see, for example, Laudan, 1984), which significantly contributed to the focus on the fact that science is guided by multiple values when resolving controversies between scientific theories.

It is not only cognitive and theoretical values — particularly attracted the attention of thinkers such as Kuhn (1977) and Laudan — present in scientific activity. It is increasingly clear that values of an extra-scientific order can come to play a preponderant role in scientific research, especially in areas where variables whose definitions presuppose a moral, prudential, political, or aesthetic value judgment about the nature of these variables are substantially involved (Alexandrova, 2018), such as occurs in the science of well-being and the environmental science.

Recently, however, the ideals of neutrality and autonomy have regained strength in the context of discussions about the responsibilities of the scientific community in the face of far-reaching problems, such as global warming, where recent evidence points to exaggeration bias and selective exposure of statistically significant findings by scientists to emphasize the importance of ecological relationships that are intended to be demonstrated, which undoubtedly affects the ability of ecology to contribute to the development of science, as well as to informed decision-making (Kimmel et al., 2023). Problems such as this assume the value of neutrality as a normative framework rather than an adequate description of how scientists conduct themselves.

It is easy to see why problems such as these are quite pernicious, as they affect the quality of scientific knowledge and the credibility of science as an institution. Moreover, these are not isolated cases, rarely found in the scientific literature. The replication crisis, which is a source of unease and criticism in the social and behavioral sciences, represents the stunning and systematic difficulty the scientific community has faced in replicating the findings of colleagues in other research (Ioannidis, 2005), which is the product of a complex interplay between methodological, statistical and sociological aspects (Romero, 2019), among which Questionable Research Practices and their link to such a crisis stand out (Pickett & Roche, 2018).

Given all this, one could assume as plausible the need for a neutral and autonomous science, free from the influence of values and interests beyond the strictly epistemic that could distort the proper scientific practices. Nonetheless, if shielding science from extra-scientific concerns and values were not the solution (if such a thing is possible)?

First, problems such as the replicability crisis and the researchers' conflict of interest may be closely associated with detectable interests and factors within the scientific community itself. It is so because science, as a dynamic system, is not only influenced by political, economic, and industrial factors but must also adapt to the pressures that accumulate within itself (Ziman, 2003).

In this sense, it is pertinent to note that both the scientific system based on the priority of discovery (which characterizes science as a social institution) and the culture of competition that it has fostered have been the target of criticism and questioning about their impact on the quality of scientific results. While this system rewards the accelerated search for new ideas (which contributes to the acceleration of scientific progress), it can also end up fostering bad practices related to the lack of reliability and validity in different research processes (Uygun-Tunç & Pritchard, 2022).

In addition to being associated with the institutional and normative level, the bad scientific practices that underlie this crisis also have a substantial relationship with individual factors, such as epistemic or intellectual virtues, as character traits that motivate researchers to achieve epistemic goals such as truth and justification, both of which are objectives that usually characterize the scientific enterprise.

On the other hand, it is worth noting that contemporary science has come to constitute, together with the private and governmental sectors, a complex web of values and practices, many of which do not qualify as exclusively epistemic. The so-called post-academic science (Bucchi, 2009) assumes the instrumental value of scientific knowledge and the achievement of diverse purposes, such as economic and political. This efficiency in satisfying the demands of innovation and commercialization plays a fundamental role in ensuring the subsistence of the scientific activity itself, which is currently supported not only by public resources but also by considerable investment from the private sector. It should allow us to question to what extent science can accomplish the ideals of autonomy and neutrality that have been discussed since the 20th century because everything indicates that, at present, the resulting picture is different.

Thus, it is possible to state that pressures not only from outside the scientific system but also from within the system itself, which is complexly entangled with other social systems, can affect the quality of scientific research and its results. Rather than shielding science from non-scientific interests (such as social concerns), it should be ensured that the rigorous pursuit of epistemic objectives is encouraged since science is, first and foremost, an epistemic enterprise. This commitment in no way precludes that, in meeting the epistemic requirements of scientific research, scientists cannot contribute to the achievement of various goals: economic, political, environmental, and so on. It is not only inevitable in a society with highly interconnected subsystems, but, in my view, it is also desirable since scientific knowledge can be fundamental to guiding decision-making in multiple fields.

In other words, the conceptions of autonomy and axiological neutrality are problematic for the following reasons: 1) some pressures bias scientific research not only from outside the scientific system but also from within, which is well exemplified in the causes of problems such as the replication crisis and the very fact that science requires the support of other systems to subsist, 2) since science is a subsystem of society, its contact with other subsystems is inevitable and 3) such isolation, besides being impossible, should not even be desirable, since scientific knowledge is a critical element in the development of multiple sectors and the achievement of multiple goals (e.g., social welfare).

However, it would be naive to think that concerns about biases introduced into scientific research are irrelevant. Moreover, it would be pernicious to think that applying scientific knowledge in matters of an extra-scientific nature (business, military, or political) brings incontrovertible social benefits.

The issue of keeping science free from such pressures has never been a natural one; it is not in the essence of science itself but is imposed as a precautionary measure against factors that may lead science away from purely epistemic purposes. Hence, the problem is more bewildering than one might think. Setting too strict limits runs the risk of steering scientific activity away from other social systems, and this is detrimental to all parties since science requires other stakeholders (e.g., public and private funding), and these, in turn, require significant doses of scientific knowledge for making various decisions. On the other hand, extremely porous (or non-existent) limits could entail, as I have already mentioned, the subjugation of scientific endeavor to conditions or interests that radically deviate it from the epistemic objectives; furthermore, and here I want to be emphatic, it is imperative to meditate about how science in turn impacts on society.

Given this scenario, I suggest that it would be more fruitful to give the conception of a neutral science up, which has been at the core of the traditional view of scientific endeavor and which, to a lesser degree, persists to this day (albeit as a merely rhetorical means), and replace it with a more flexible notion: that of a socially engaged science. By this, I mean a science capable of adequately fulfilling its objectives as an epistemic enterprise but aware of its relevance in facing the tricky situations that come about in the different contexts with which it interacts, situations that are often closely related to scientific knowledge.

Walking along these paths, common in the territory of post-academic science, cannot be achieved only by following an algorithmic approach since it is not possible to establish a finite set of rules whose universal application will allow people dedicated to science to face the diverse circumstances that emerge from the complex web of scientific, technological, economic, political and social systems in general, and that involve the attainment and application of scientific knowledge.

Without underestimating the value that rules, standards, and norms can have in decision-making, I will advocate the need to train reflexive scientists capable of taking an active role, cognitively and motivationally, both in the field of knowledge production and in terms of its implications in extra-scientific contexts. In this context, institutions that train scientists, such as universities and research centers, play an essential role as interfaces between science as an institution and multiple systems, such as civil society, the business sector, etc. It is so not only because education centers produce basic and applied scientific knowledge but also because of their significant role in training people dedicated to scientific endeavors.

In other words, these interfaces between science and society should contribute substantially to the training of scientists capable of playing a critical role in the contexts that characterize the field of contemporary research, where diverse systems of values, norms, and objectives coexist, which is due to the result of a profound process of techno-scientific transformation characterized by uncertainty in knowledge production and decision-making (individual and collective), as well as a marked concern for predictions (Bucchi, 2009) in fields as diverse as nanotechnology (Maynard, 2014) and nuclear energy (Moriarty, 2021), to mention a few examples.

Science and Social engagement: An Approximation from the Virtue Theoretical approach

It is true that the current relationship between science and society is not free of tensions, although this is also a positive sign of more significant interaction between the two spheres.

In this sense, the lay public increasingly questions scientific research findings in many areas. It has opened the door to more significant citizen criticism and participation in scientific policy and the production of scientific knowledge. Thus, for example, the British public's distrust of science during the Bovine Spongiform Encephalopathy crisis prompted in-depth reflections on the possibilities of communication between science and citizens, as well as on the complex interactions between both spheres for the attainment of valuable knowledge to face such a crisis (Dora, 2006). Similarly, the Fukushima nuclear disaster in 2011 motivated some people in Japan toward scientific literacy to critically appraise the handling of the crisis by the government and scientific experts, resulting in citizens with skills capable of modifying their relationships with the authorities (Sternsdorff-Cisterna, 2019). During the COVID-19 pandemic, it became clear that scientific expertise is crucial in policy advice. However, it also highlighted the need for a more participatory pandemic management policy (Lavazza & Farina, 2020).

Scenarios involving the forecasting and managing of large-scale crises, such as those mentioned above, as well as the social and environmental impacts of science itself, involve a significant component of uncertainty (Adam & Groves, 2011). This issue, as can be seen, is not addressed by appealing only to the technical expertise of scientists but to the participation of a multiplicity of stakeholders, which does not imply a dilution of the role of scientists in society, even though one could argue that their image as an authority figure has been detached from certain mythical elements: scientists as unbiased inquirers of reality and free from extra-epistemic pressures. In any case, the new links between science and society have brought opportunities for more democratic decision-making. However, at the same time, they impose new responsibilities on the parties involved, including scientists, which is especially relevant to restructuring a view of science decoupled from the commitment to neutrality.

In these new scenarios, scientists still are protagonists for two reasons: 1) they possess a specialized theoretical and methodological repertoire of great utility, for example, in forecasting the impacts of certain technologies on the environment, and 2) a deep familiarity with the scientific knowledge of their respective area, which can contribute to the reflection and study of the implications that this knowledge can have beyond the scientific sphere. Indeed, it is thanks to their knowledge and skills that scientists can establish recommendations for policy decisions, even if they defer value judgments to other actors, such as politicians and civilians, given that there may be multiple objectives and interests.

As Gundersen (2023) argues, scientists, as experts, can make conditional recommendations of the form if you want to achieve A, given our knowledge about a situation, do P, without this implying that the scientist must opt for the interests of specific social actors. Nevertheless, in such contexts, it is fair to require extra-scientific competencies from scientists (e.g., political literacy, ability to value their own competence as an expert) since an adequate relation to issues of a political and social nature is expected.

However, I must emphasize that there is nothing inherent to scientists that ensures their commitment to the conscientious application of their expertise in the assessment of the impacts of science on society, in the responsible use of scientific knowledge, and in the issuance of scientific advice. Nonetheless, one would expect that the role of the scientist in this type of field meets some minimum standards to ensure that it does not harm society and respects democratic processes, appealing to values such as objectivity, impartiality, fairness, and non-maleficence (Gundersen, 2023). Although these questions require a considerable intellectual component, it is still necessary to consider the motivational component required for achieving these goals, which is closely related to the responsibilities of a socially engaged science.

The idea of such a science is, of course, not novel. Verhoog (1983) suggested an image very close to what I consider to be a socially engaged science, pointing out the importance of science becoming involved in social and political issues, where the advice of scientists is fundamental, without this implying the abandonment of the epistemic objectives of scientific research. In this vein, Verhoog points out:

> A large measure of freedom is essential to the pursuit of science. This freedom should also extend to the exercise of a correspondingly large measure of social responsibility by the scientists themselves. Scientists should react when science is misused for purposes which are in conflict with the ethical values for which they have special responsibility (Verhoog, 1983, p. 603).

Thus, from this perspective (called by Verhoog the critical-interactionist view), scientists are responsible for their work not only in the strictly scientific or methodological sphere but also for the implications that the scientific vision of the world can have on nature and society.

Similar ideals have been gaining momentum recently. Since the beginning of the 21st century, interest in conducting responsible scientific research has been in vogue thanks to the advent of the Responsible Research and Innovation framework, within which there is a concern for the social and environmental impacts of scientific research and innovation. From these efforts, the implementation of science with social commitment has been built on the basis of the development of regulatory frameworks (either ethical or legal), as well as the strengthening of institutions and technical competencies for the foresight and assessment of techno-scientific risks.

While some have recognized that for this approach to be meaningful, the addressing of scientific practices must be considered at different levels, including the individual (Stilgoe & Guston, 2017), relatively less attention has been paid to the psychological dimension of scientific endeavor, which involves both motivational and cognitive aspects, factors capable of accounting for the individual and collective behavior of scientists when conducting scientific research and efforts to understand its potential social impacts.

Furthermore, procedural methods, such as public surveys, fail to ensure that diverse social groups' social experiences and value perspectives (particularly marginalized ones) are integrated into socially responsible science (Rolin, 2021). Scientific/intellectual movements could be a much more appropriate alternative for developing a general orientation towards social engagement insofar as such movements contribute to understanding a certain general value orientation for a society in terms of research problems, methods, and so on (Rolin, 2021), or, in other words, particular social experiences become more visible and understandable in a research program or project.

One can accept that such strategies are valuable in pursuing a more socially engaged science; likewise, procedural methods and standards play a meritorious role in guiding certain practices in a socially responsible manner. Nevertheless, it is necessary to consider the active and conscious role of scientists when interpreting and adhering to these norms and implementing this or that strategy, as well as adapting them to the relevant contexts and making decisions sensitive to the differences that the latter may present.

This means that it is not only enough to recognize that scientists have responsibilities inherent to their role as experts and that it is necessary to configure a socially responsible science but also to understand how scientists, as human beings, are to be integrated into this complex dynamic. All these issues involve psychological aspects, such as those already mentioned (cognitive and motivational). That is why the concept of intellectual virtue can provide us with a way to address these issues.

Intellectual virtue and its relation to socially engaged science

Generally speaking, a virtue is an acquired excellence of a person, which involves a characteristic motivation to produce desired ends and successfully achieve them (Zagzebski, 1996). As far as intellectual virtue is concerned, it is a cognitive excellence. More precisely, intellectual virtue has three components: 1) cognitive, 2) motivational, and 3) behavioral (King, 2021). An intellectually virtuous individual considers knowledge valuable, is motivated to achieve it, and is reliable in achieving this goal. It is worth noting that intellectual skills alone do not constitute intellectual virtues (although they correspond to the cognitive component of virtue) since the former are associated with highly specific contexts, and their use may or may not be motivated by the search for truth, think, for instance, of a highly skilled data analyst who would use her knowledge and skills to falsify data (Mendoza-De Los Santos, 2023). Therefore, intellectual virtues are not innate dispositions but acquired and have a marked motivational component that impels individuals to behave in a certain way to achieve diverse epistemic ends.

The role of intellectual virtues in science has become increasingly relevant in contemporary literature. In this vein, Tang (2024) has pointed out that a deficit in intellectual virtues can lead to bad and questionable research practices. For their part, Uygun-Tunç and Pritchard (2022) consider that, although intellectual virtue at an individual level may not be sufficient to eliminate bad research practices, a significant number of intellectually virtuous scientists is essential for the constitution of a virtuous scientific community, that is, one capable of achieving the fundamental epistemic outputs that characterize the scientific enterprise.

In a similar line of argument, Mendoza-De Los Santos (2023) has suggested that intellectual virtues play an essential role both for the resolution of research tasks (e.g., hypothesis testing, data collection, etc.) and as substantial elements for the application of highly diverse methodological norms whose character, it is necessary to note, is not universal. In addition, and this is a central aspect, Mendoza-De Los Santos considers that the intellectual virtues of scientists can play a noteworthy role in foreseeing the impacts that scientific knowledge can have on society. In this way, he understands scientific endeavor not only as research activities fundamental to the production of knowledge but also as those related to monitoring the impacts derived from the applications of scientific knowledge. This perspective is particularly relevant to my proposal. From this point of view, the responsibilities inherent to producing and possessing scientific knowledge (linked to the tasks of research and surveillance, respectively) are not disarticulated. The scientist, as a producer and possessor of specialized knowledge, is responsible not only for generating such knowledge but also for contributing to its adequate use.

One might question whether it is not enough for scientists to be concerned only with the scientific and technological applications of such knowledge. After all, is it not too much to ask that they be concerned with the impacts that these applications might have on society? Even one could argue that it is complex to predict the social derivations of scientific applications in detail, so worrying about it before having all the puzzle pieces is counterproductive to scientific progress. It occurs, however, that the concern for the social impacts of science is not only confined to anticipating the possible impacts of science on society (which is already praiseworthy in itself) but also includes actively participating in the construction of better social and techno-scientific futures.

In this context, scientists are fundamental pieces that can provide elements for the foresight and construction of such social scenarios. It is not surprising, considering the theoretical and methodological tools they have acquired throughout their training, as well as their awareness of the research field in which they work and the problems they have addressed. But, although this level of expertise is essential for such tasks, it is necessary to point out once again that scientists still need genuine motivation to engage in this type of work. Let us recall that intellectual virtue has a motivational component that directs the individual to attain epistemic values such as truth, justification, and certainty.

Thus, valuing the implications that scientific knowledge has on society is a matter that requires intellectual resources as well as the willingness to apply the latter to the tasks of monitoring, forecasting, and foresight regarding the impacts of knowledge on the world. If we add to this matter the erosion of techno-scientific rationality and greater participation of diverse social spheres in the production and implementation of science, the role of intellectual virtue becomes even more relevant. I will discuss some specific examples.

As I have already mentioned, the co-production of knowledge between the lay public and scientists has been making headway throughout the 20th and 21st centuries, especially on such crucial topics as healthcare. There are intellectual virtues essential in this regard: intellectual humility, epistemic collaborativeness, perspective-taking, and phronesis.

Intellectual humility is the willingness of individuals to acknowledge both the limitations of their knowledge and cognitive competencies, and the possibility that their beliefs may be incorrect (Porter et al., 2022). This virtue is valuable for scientific practice because it increases belief generation by motivating people to seriously consider opinions and information other than their own ideas (Lepock, 2011). I argue that this virtue is meaningful for the articulation of an adequate dynamic between science and society because it is a quality that also contributes to the recognition of the intellectual strengths of other people (Porter & Schumann, 2018), a valuable aspect in facilitating dialogue between diverse social stakeholders and scientists concerned with issues as diverse as making predictions about the social impacts of science, evaluating public policies, designing intervention strategies in health, environmental and economic matters, etc.

Epistemic collaborativeness is closely related to the joint work that characterizes enterprises such as science. For Kotsonis (2021), an individual who possesses this quality is highly motivated to engage in epistemic collaboration, is competent in collaborative activities, and has good judgment regarding when and with whom it is appropriate to engage in epistemic collaboration. Kotsonis considers that this virtue has a place only in intellectual activities directed to epistemic ends. It is easy to see how this relates to scientific tasks that encompass the production of knowledge; however, about the aspects related to the monitoring of scientific impacts on society, the situation may need to be clarified. This problem becomes more evident when we realize that these activities largely involve the achievement of epistemic goals such as the justification of hypotheses and forecasts (e.g., on the impacts of artificial intelligence on the labor displacement of the workforce), activities that, as I have been pointing out, require the collaborative work not only of scientists but also of society as a whole.

On the other hand, perspective-taking is intimately linked to the virtue described above and is a quality that allows the individual to consider a situation from the perspective of another individual or group. As Schwartz (2022) suggests, joint scientific work requires this virtue, but, in addition, it is a particularly relevant trait in cases where experts must interact with the lay public. Though scientific experts possess specialized knowledge that is essential for assessing the scope of scientific implementations, the ability, and motivation to consider the perspectives of other social actors critically is also essential for shaping a much clearer picture of the present and future landscape resulting from scientific and technological impact.

In this line of argument, it is essential to emphasize that these virtues can substantially contribute to avoiding the over-imposition of the scientific dimension to the general social dimension (which frequently occurs from the technocratic view of governance) by contributing to realizing the role that the lay public can play in the production of knowledge and the assessment of the risks and benefits derived from its implementation.

Another virtue, perhaps much more general than the previous ones, is phronesis (also called practical wisdom). There are many discussions about the nature of this virtue and its relation to other virtues. These questions, although relevant to a theory of virtue, go far beyond the scope of this text. Nevertheless, it can be agreed that phronesis is an intellectual virtue that enables individuals to do what is right in order to achieve good ends. This virtue contributes directly to the appreciation of the possible consequences of a given action in a particular context, taking into account the specific characteristics of this context (Hursthouse & Pettigrove, 2018).

Thus, in order to act correctly according to the demands of a context, scientists must develop a virtue that positions them as genuine actors motivated to interact with multiple social actors in highly diverse normative contexts, which do not always coincide with "local" scientific norms, such as the principle of randomization in experimental contexts.

This matter is well exemplified in cases where the evidence regarding an issue is not the product of rigorous experimental processes (the gold standard from paradigms such as Evidence-Based Practice) but of correlational studies, which, however, has not prevented scientific communities from seeking to intervene in such issues. Thus, we have early warnings about the relationship between tobacco use and lung cancer, based initially on population-based studies (Proctor, 2012); the relationship between the overconsumption of resources and social, environmental and economic aspects, which since the 1970s has been studied using techniques such as linear regression (Wiedmann et al., 2020); or the warning about the behavioral crisis leading to ecological overshoot, which positions human maladaptive behaviors as the cause of multiple environmental problems such as climate change (Merz et al., 2023).

It should not lead one to think scientists have abdicated their epistemic responsibilities. Quite the contrary! Experts often play a crucial role in situations of great complexity, where even direct measurement of variables is impractical and assessment of the situation requires informed judgment and intuition guided by expertise, especially when empirical sources of information are challenging to judge (Victor et al., 2022). When weighing certain risks, the arguments and evidence respond to appropriate scientific standards and the judgment of scenario characteristics that imply a potential social impact. Therefore, highlighting the role of phronesis in situations of this nature is unavoidable.

In this sense, for Flyvbjerg et al. (2012), this virtue is one of the most important concerning social and political issues, as it allows the prudent administration and application of scientific and technological knowledge (Flyvbjerg, 2001). Hence, this virtue can help scientists to serve as a bridge between the scientific sector itself and various social sectors, thus contributing to the epistemic empowerment of different social actors in the field of science governance, where certain forms of knowledge often acquire dominance over others (Mejlgaard et al., 2019; Valkenburg et al., 2020).

The intellectual virtues allow scientists the responsible and reflexive transition between diverse and highly uncertain contexts, such as the strictly scientific, with the political, social, and so on. In this way, an appropriate exercise of scientific research is strengthened while promoting the conscientious and responsible assessment of the impacts (potential or actual) of scientific knowledge, as well as the search for epistemic and technological alternatives (for example, cleaner sources of energy), which requires the genuine collaborative work of the scientific sector and society as a whole. That being said, it is crucial to understand that what I have argued so far is eminently normative in nature. Being a scientist does not automatically guarantee a virtuous character. Thus, the scientific system should promote the nurturing of intellectual virtue (I will return to this issue in the next section of this text), and this is the main challenge for this approach to the relationship between science and society.

The Challenges for a Socially Engaged Science

It is reasonable to claim that during their training and professional life, scientists acquire knowledge and skills that allow them to test theories about their object of study rigorously and even assess the consequences that this knowledge has for society (Bird, 2014). However, there is nothing to ensure that these intellectual skills are put to use for the common welfare. As I have argued, motivation, characteristic of intellectual virtue, is an essential component in a view of science framed within the present proposal. Scientists motivated to pursue knowledge, interested in its adequate implementation in the world, as well as in the careful and competent assessment of the impacts (foreseen or already manifested), are not a direct product of technical and methodological scientific training because although it is recognized that intellectual skills and competences are an essential part of an integral virtuous character, intellectual virtues are the basis for cultivating and deploying a variety of cognitive skills according to the standards of certain epistemic practices (Streeter, 2006).

Therefore, a socially engaged science should be driven by intellectually competent scientists who are also motivated to engage reflexively and use all their training in such work, with those derivations of the implementation of scientific knowledge. However, science, as a complex social system, is not reduced to the individuals that compose it but involves various institutional and normative aspects in which these individuals are embedded. Cultivating virtue in the scientific field requires a redesign of the training model for scientists and a profound reconsideration of the implications of the current system of incentives for science. Thus, in addition to the concern about not reducing scientists' training process exclusively to acquiring technical skills, it is essential to make another point.

I want to draw attention to the fact that, at present, the instruction of scientists explicitly or implicitly carries a strong burden of value associated with a system of scientific production characterized by an overwhelming demand for publication and citation. The number of published articles and citation-based indicators have become the unit of measurement of the quality of scientists. Much of contemporary academic culture is based on an economy based on production and dissemination indicators (e.g., citations, impact factor) that translate into various incentives (e.g., economic or prestige), which may have repercussions on the selection or reinforcement of certain behaviors aimed at meeting production quotas rather than at the construction of accurate knowledge and, possibly less, at the intervention on socially responsible use of it. This could be summarized with the idea suggested by Hendrik van Dalen: "universities have achieved to select and educate members with a 'taste for publication' and not necessarily those with a 'taste for science'" (van Dalen, 2021, p. 1690).

Likewise, it is worth noting that academic selection and promotion processes (often based on the indicators mentioned above) can have a negative impact on the topics and methods chosen for research (Akerlof, 2020), which could contribute, in some cases, to reduce interest in prioritizing areas such as vigilance and reflection on the social impacts of science. Moreover, the current incentive system, when it emphasizes the valuation of scientists for their individual contributions (e.g., articles published as first author, h-index, and so on), contributes to encouraging selfishness and competition among scientists while discouraging cooperation (Tiokhin et al., 2023).

All of the above highlights critical difficulties for a virtue approach, such as the one I have been outlining so far. If it is assumed that intellectual virtue is not an innate trait, as sight would be, but one that flourishes with proper habituation, it must be accepted that the present system could not contribute to a science in which virtue plays a leading role. The option is to refrain from being content to wait for certain scientists to sporadically show a disposition towards intellectual virtue as if this could not be deliberately aspired to. Instead, the shaping of a culture where intellectual virtue is central should be actively pursued.

Notable reform at multiple levels needs to be reconsidered concerning the incentive system. Tiokhin et al. (2023) have suggested that this system could be reformed in such a way as to encourage cooperation and solidarity among researchers, for example, by considering the achievements of research teams, providing funds for scientists whose central role is helping to improve the research results of other scientists, as well as facilitating the monitoring of inappropriate behavior within the scientific community.

Although these strategies are aimed at the context of knowledge production, they could be particularly valuable in fostering substantial intellectual virtues for the joint work between science and society, such as intellectual humility, already mentioned, under the rationale of encouraging the mobilization of the intellectual resources of scientists towards contributing to social welfare.

In addition to what I have already mentioned, education is an unavoidable aspect that must be addressed to cultivate virtue in scientists. In this order of ideas, some alternatives have been proposed. From an educational point of view, Lapsley and Chaloner (2020) point out three families of educational strategies: an Aristotelian pedagogical approach that prioritizes the analysis of cases and examples; meta-cognitive strategies that promote reflection and the critical skills of inquiry activities, and strategies for promoting scientific identity, that is to say, the identification of the individual in training with the values and norms of science.

These types of strategies promote the reflective exercise of scientific practice while contributing to the flourishing of appropriate motivations to the extent that they enable students to identify with the values and norms of science. It should be noted, of course, that scientific identity is not a static construct impervious to historical and social conditions. As I have already discussed, the scientific endeavor encompasses the production of scientific knowledge and the surveillance that such knowledge can have on society, which implies a dynamic vision of scientific identity sensitive to particular socio-historical contexts. It is crucial since, with the participation of the bulk of society, it is possible to construct and implement scientific knowledge thoroughly and inclusively.

In this way, the educational strategies mentioned above could be adapted to promote a virtuous approach to the activities of monitoring the social impacts of scientific knowledge, for example, by promoting as part of a comprehensive scientific education the observation, analysis, and even active involvement in situations of dialogue (e.g., public forums) between the scientific sector and various social actors interested in particular scientific impacts. I admit, however, that the design and study of these adaptations is a pending but promising issue.

I must emphasize that the development of intellectual virtues should not be seen in an individualistic way but as something that occurs in a social context since only through the appreciation of the social context in which the virtue is developed is it possible to shape environments conducive to the formation of virtues (Smith, 2023).

This observation is compelling, for while I consider intellectual virtues to be individual traits, I do not advocate an individualistic approach to developing intellectual virtues. Relationships of social interdependence and solidarity are inherently social aspects that contribute fundamentally to the flourishing of intellectual virtues since these traits not arise in a social vacuum but in interaction with peers and role models that serve to cultivate appropriate dispositions of character. Moreover, intellectual virtues are not competencies whose value is weighted according to their power to position the individual in some state of intellectual, moral, or political superiority. Decontextualizing intellectual virtues from the social sphere entails not only the risk of developing ineffective formative strategies but also of cultivating an individualistic notion of intellectual virtue far away from the search for the common welfare.

Concluding remarks

In this text, I aimed to argue for a socially engaged science, i.e., attentive to social problems, especially those with a noticeable scientific component. For this, I have resorted to a virtue approach, emphasizing the role that intellectual virtue plays in the link between science and society. In the following, I will briefly reconstruct my path for this purpose.

The axiological neutrality of science is a difficult (if not impossible) ideal to attain and, to a large extent, undesirable if we assume the plausibility of a socially committed science. In the face of such proposals, a frequent concern is that the loss of scientific neutrality may lead to biases in the processes of scientific research since science is, above all, an epistemic enterprise. However, it is essential to note that the deviation of the scientific enterprise in the pursuit of epistemic objectives is a frequent problem in scientific practice and, on many occasions, responds to the very nature of the scientific production and incentive system and not to its commitment to political and social values external to the scientific system.

Thus, the crux of the matter lies in scientists' dispositions for the adequate development of the activities that characterize scientific endeavor: producing knowledge, implementing it, monitoring its impact on society, and intervening in it. Intellectual virtues are fundamental for the resolution of this type of task. Moreover, as I have argued, intellectual virtues are essential scientist’s traits for a socially engaged science. The monitoring of scientific impacts on society, as well as the implementation of science for beneficial purposes, are issues that could benefit from intellectual virtues since they require the joint work of the various scientific and social systems in activities with epistemic aims, such as the collection of evidence on the experiences of users of treatments, the forecasting of the impacts of technological projects, and so on. Intellectual virtues such as intellectual humility, epistemic collaborativeness, and phronesis can help these exercises be carried out competently, inclusively, and fairly.

Recovering the idea that intellectual virtues are not innate but acquired traits is essential. It is not enough to recognize that intellectual virtues can be fundamental elements in the configuration of a socially engaged science. It is necessary to understand how to cultivate them in scientists. Perhaps this is the greatest challenge facing the present proposal since it presupposes a considerable reconfiguration of the scientific system. As I already discussed, the system of scientific production and incentives, far from fostering intellectual virtues and searching for epistemic values fundamental for scientific research and society, encourages questionable or even plainly inadequate dispositions and practices (e.g., falsification, p-hacking, plagiarism).

In conjunction with this, the little emphasis that the education of scientists usually places on the development of intellectual virtue makes it necessary to reconfigure the systems of scientific training, pursuing not only the search for reliable technical and methodological skills but also the appropriate motivations for the implementation of scientific knowledge in a critical and socially responsible manner.

The challenge is not minor and requires considerable joint work by various parties. However, I believe what I presented in this text constitutes a solid case for a socially engaged science and a proposal, albeit modest, for achieving it.

References

Adam, B., & Groves, C. (2011). Futures Tended: Care and Future-Oriented Responsibility. *Bulletin of Science, Technology & Society*, *31*(1), 17–27. https://doi.org/10.1177/0270467610391237

Akerlof, G. A. (2020). Sins of Omission and the Practice of Economics. *Journal of Economic Literature*, *58*(2), 405–418. https://doi.org/10.1257/jel.20191573

Alexandrova, A. (2018). Can the Science of Well-Being Be Objective? *The British Journal for the Philosophy of Science*, *69*(2), 421–445. https://doi.org/10.1093/bjps/axw027

Bird, S. J. (2014). Socially Responsible Science Is More than "Good Science." *Journal of Microbiology & Biology Education*, *15*(2), 169–172. https://doi.org/10.1128/jmbe.v15i2.870

Bucchi, M. (2009). *Beyond Technocracy: Science, Politics and Citizens*. Springer.

Curtis, C., Gillespie, N., & Okimoto, T. (2023). Establishing Trust in Science Communication. In S. Rowland & L. Kuchel (Eds.), *Teaching Science Students to Communicate: A Practical Guide* (pp. 39–47). Springer.

Dora, C. (2006). Introduction: seeking lessons from BSE/CJD for communication strategies on health and risk. In C. Dora (Ed.), *Health, hazards and public debate: lessons for risk communication from the BSE/CJD saga* (pp. 1–10). World Health Organization.

Fabbri, A., Lai, A., Grundy, Q., & Bero, L. A. (2018). The Influence of Industry Sponsorship on the Research Agenda: A Scoping Review. *American Journal of Public Health*, *108*(11), e9–e16. https://doi.org/10.2105/AJPH.2018.304677

Fine, A. (1998). The Viewpoint of No-One in Particular. *Proceedings and Addresses of the American Philosophical Association*, *72*(2), 7. https://doi.org/10.2307/3130879

Flyvbjerg, B. (2001). *Making Social Science Matter*. Cambridge University Press.

Flyvbjerg, B., Landman, T., & Schram, S. (2012). Introduction: new directions in social science. In B. Flyvbjerg, T. Landman, & S. Schram (Eds.), *Real Social Science* (pp. 1–12). Cambridge University Press.

Grill, C. (2021). Involving stakeholders in research priority setting: a scoping review. *Research Involvement and Engagement*, *7*(1), 75. https://doi.org/10.1186/s40900-021-00318-6

Gundersen, T. (2018). Scientists as experts: A distinct role? *Studies in History and Philosophy of Science Part A*, *69*, 52–59. https://doi.org/10.1016/j.shpsa.2018.02.006

Gundersen, T. (2023). Trustworthy Science Advice: The Case of Policy Recommendations. *Res Publica*. https://doi.org/10.1007/s11158-023-09625-z

Guston, D. H. (2012). The Pumpkin or the Tiger? Michael Polanyi, Frederick Soddy, and Anticipating Emerging Technologies. *Minerva*, *50*(3), 363–379. https://doi.org/10.1007/s11024-012-9204-8

Hursthouse, R., & Pettigrove, G. (2018). Virtue Ethics. In *Stanford Encyclopedia of Philosophy* (Winter 201). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/entries/ethics-virtue/

Ioannidis, J. P. A. (2005). Why Most Published Research Findings Are False. *PLoS Medicine*, *2*(8), e124. https://doi.org/10.1371/journal.pmed.0020124

Kimmel, K., Avolio, M. L., & Ferraro, P. J. (2023). Empirical evidence of widespread exaggeration bias and selective reporting in ecology. *Nature Ecology & Evolution*. https://doi.org/10.1038/s41559-023-02144-3

King, N. L. (2021). *The Excellent Mind. Intellectual Virtues for Everyday Life*. Oxford University Press.

Kotcher, J. E., Myers, T. A., Vraga, E. K., Stenhouse, N., & Maibach, E. W. (2017). Does Engagement in Advocacy Hurt the Credibility of Scientists? Results from a Randomized National Survey Experiment. *Environmental Communication*, *11*(3), 415–429. https://doi.org/10.1080/17524032.2016.1275736

Kotsonis, A. (2021). Epistemic Collaborativeness as an Intellectual Virtue. *Erkenntnis*. https://doi.org/10.1007/s10670-021-00384-y

Kuhn, T. (1977). *The Essential Tension: Selected Studies in Scientific Tradition and Change*. The University of Chicago Press.

Lackey, R. T. (2007). Science, Scientists, and Policy Advocacy. *Conservation Biology*, *21*(1), 12–17. https://doi.org/10.1111/j.1523-1739.2006.00639.x

Lapsley, D., & Chaloner, D. (2020). Post-truth and science identity: A virtue-based approach to science education. *Educational Psychologist*, *55*(3), 132–143. https://doi.org/10.1080/00461520.2020.1778480

Laudan, L. (1984). *Science and Values. The Aims of Science and Their Role in Scientific Debate*. University of California Press.

Lavazza, A., & Farina, M. (2020). The Role of Experts in the Covid-19 Pandemic and the Limits of Their Epistemic Authority in Democracy. *Frontiers in Public Health*, *8*. https://doi.org/10.3389/fpubh.2020.00356

Lepock, C. (2011). Unifying the Intellectual Virtues. *Philosophy and Phenomenological Research*, *83*(1), 106–128. https://doi.org/10.1111/j.1933-1592.2010.00425.x

Maynard, A. D. (2014). A decade of uncertainty. *Nature Nanotechnology*, *9*(3), 159–160. https://doi.org/10.1038/nnano.2014.43

Mejlgaard, N., Christensen, M. V., Strand, R., Buljan, I., Carrió, M., Cayetano i Giralt, M., Griessler, E., Lang, A., Marušić, A., Revuelta, G., Rodríguez, G., Saladié, N., & Wuketich, M. (2019). Teaching Responsible Research and Innovation: A Phronetic Perspective. *Science and Engineering Ethics*, *25*(2), 597–615. https://doi.org/10.1007/s11948-018-0029-1

Mendoza-De Los Santos, O. E. (2023). Intellectual Virtues and Scientific Endeavor: A Reflection on the Commitments Inherent in Generating and Possessing Knowledge. *Bulletin of Science, Technology & Society*, 027046762311713. https://doi.org/10.1177/02704676231171318

Merz, J. J., Barnard, P., Rees, W. E., Smith, D., Maroni, M., Rhodes, C. J., Dederer, J. H., Bajaj, N., Joy, M. K., Wiedmann, T., & Sutherland, R. (2023). World scientists' warning: The behavioural crisis driving ecological overshoot. *Science Progress*, *106*(3). https://doi.org/10.1177/00368504231201372

Moriarty, P. (2021). Global nuclear energy: an uncertain future. *AIMS Energy*, *9*(5), 1027–1042. https://doi.org/10.3934/energy.2021047

Nelson, M. P., & Vucetich, J. A. (2009). On Advocacy by Environmental Scientists: What, Whether, Why, and How. *Conservation Biology*, *23*(5), 1090–1101. https://doi.org/10.1111/j.1523-1739.2009.01250.x

Pickett, J. T., & Roche, S. P. (2018). Questionable, Objectionable or Criminal? Public Opinion on Data Fraud and Selective Reporting in Science. *Science and Engineering Ethics*, *24*(1), 151–171. https://doi.org/10.1007/s11948-017-9886-2

Polanyi, M. (1962). The Republic of science. *Minerva*, *1*(1), 54–73. https://doi.org/10.1007/BF01101453

Porter, T., Elnakouri, A., Meyers, E. A., Shibayama, T., Jayawickreme, E., & Grossmann, I. (2022). Predictors and consequences of intellectual humility. *Nature Reviews Psychology*, *1*(9), 524–536. https://doi.org/10.1038/s44159-022-00081-9

Porter, T., & Schumann, K. (2018). Intellectual humility and openness to the opposing view. *Self and Identity*, *17*(2), 139–162. https://doi.org/10.1080/15298868.2017.1361861

Proctor, R. N. (2012). The history of the discovery of the cigarette–lung cancer link: evidentiary traditions, corporate denial, global toll: Table 1. *Tobacco Control*, *21*(2), 87–91. https://doi.org/10.1136/tobaccocontrol-2011-050338

Rolin, K. H. (2021). Objectivity, trust and social responsibility. *Synthese*, *199*(1–2), 513–533. https://doi.org/10.1007/s11229-020-02669-1

Romero, F. (2019). Philosophy of science and the replicability crisis. *Philosophy Compass*, *14*(11). https://doi.org/10.1111/phc3.12633

Schwartz, B. (2022). Science, scholarship, and intellectual virtues: A guide to what higher education should be like. *Journal of Moral Education*, *51*(1), 61–72. https://doi.org/10.1080/03057240.2020.1772211

Smith, C. A. (2023). The Pedagogy of a Classroom for Intellectual Virtues. *Episteme*, 1–11. https://doi.org/10.1017/epi.2023.17

Sternsdorff-Cisterna, N. (2019). *Food Safety After Fukushima. Scientific Citizenship and the Politics of Risk*. University of Hawai'i Press.

Stilgoe, J., & Guston, D. H. (2017). Responsible Research and Innovation. In U. Felt, F. Rayvon, C. Miller, & L. Smith-Doerr (Eds.), *The Handbook of Science and Technology Studies* (pp. 853–880). The MIT Press.

Streeter, G. (2006). Virtues of Inquiry and the Limits of Reliabilism. *Social Epistemology*, *20*(1), 117–128. https://doi.org/10.1080/02691720500512408

Sulik, J., Deroy, O., Dezecache, G., Newson, M., Zhao, Y., El Zein, M., & Tunçgenç, B. (2021). Facing the pandemic with trust in science. *Humanities and Social Sciences Communications*, *8*(1), 301. https://doi.org/10.1057/s41599-021-00982-9

Tang, B. L. (2024). Deficient epistemic virtues and prevalence of epistemic vices as precursors to transgressions in research misconduct. *Research Ethics*. https://doi.org/10.1177/17470161231221258

Tiokhin, L., Panchanathan, K., Smaldino, P. E., & Lakens, D. (2023). Shifting the Level of Selection in Science. *Perspectives on Psychological Science*. https://doi.org/10.1177/17456916231182568

Uygun-Tunç, D., & Pritchard, D. (2022). *Collective epistemic vice in science: Lessons from the credibility crisis*. http://philsci-archive.pitt.edu/id/eprint/21120

Valkenburg, G., Mamidipudi, A., Pandey, P., & Bijker, W. E. (2020). Responsible innovation as empowering ways of knowing. *Journal of Responsible Innovation*, *7*(1), 6–25. https://doi.org/10.1080/23299460.2019.1647087

van Dalen, H. P. (2021). How the publish-or-perish principle divides a science: the case of economists. *Scientometrics*, *126*(2), 1675–1694. https://doi.org/10.1007/s11192-020-03786-x

Verhoog, H. (1983). The responsibilities of scientists. *Minerva*, *19*(4), 582–604. https://doi.org/10.1007/BF01096194

Victor, D. G., Lumkowsky, M., & Dannenberg, A. (2022). Determining the credibility of commitments in international climate policy. *Nature Climate Change*, *12*(9), 793–800. https://doi.org/10.1038/s41558-022-01454-x

Wiedmann, T., Lenzen, M., Keyßer, L. T., & Steinberger, J. K. (2020). Scientists' warning on affluence. *Nature Communications*, *11*(1), 3107. https://doi.org/10.1038/s41467-020-16941-y

Zagzebski, L. (1996). *Virtues of the Mind. An inquiry into the nature of virtue and the ethical foundations of knowledge*. Cambridge University Press.

Ziman, J. (2003). *Real Science: What it is, and what it means*. Cambridge

University Press.