Inclusive Science and European Democracies

What it means for non-professional scientists 'to understand' specific knowledge products, and to what extent this type of understanding entails both an epistemological and a political type of assessment.

Discussion Paper
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What should citizens understand about science to participate in democratic life (so called civic science literacy problem)? Against the prevailing approach, we argue that ''what'' a public understanding of science is about strongly depends on the specific epistemological nature of the science-related issues considered in the different contexts and circumstances. We identify three specific categories of such issues and show how, equally, specific models of public understanding are required to address them. Only by endorsing such an alternative approach citizens will arguably be able to form sound opinions about those very issues, as well as to rationally discuss and deliberate about them.

Figuring out *what* laypeople are to understand while addressing science related questions is crucial to finding an answer to the problem as framed above. And indeed, this has been a concerning question for many of those engaged with public understanding of science over the last few decades.

Phillips et al. 2018, for example, argue that understanding 'science' can be applied to at least one of the following items (p. 9): science content (with reference to 'subject matter, i.e., facts or concepts'), science processes ('the methodologies that scientists use to conduct research'), and the nature of science ('the epistemological underpinnings of scientific knowledge and how it is generated. This last category refers to both classical characterizations of scientific practices (for instance the link between theories and scientific laws, or between experimentation and data) or to post-positivist perspectives on science being an inherently social, contextual, value-laden endeavour (Durant 1994). Keren 2018 adds a further referent of understanding. Citizens, he claims, are not required to use first-hand scientific evidence to form their beliefs (this is the type of understanding that professional scientists engage themselves with), but to acquire a second order understanding based on 'information about patterns of agreement and disagreement among purported experts and authorities' (p. 785). In this sense Keren refers to a 'division of scientific labour' between scientists and citizens.

Other authors insist on the need for citizens to understand the 'social structure of science' (Slater 2019), or 'science as a social enterprise' (p. 257), for example grasping in what sense and for what reasons scientific activity brings scientists to be at the same time competitive and cooperative with one another (p. 256).

Given the multiplicity of approaches, can a unique, general answer to the civic science literacy problem be found, independently of the type of science issues that are at stake in the different domains and circumstances? Not much philosophical attention has been given to the epistemic diversity of the 'science related issues' addressed in the literature on public understanding of science, and on how this very diversity might significantly affect the types of understanding of science citizens should acquire and pursue.

In the literature engaged with civic science literacy, issues as diverse as climate change, vaccines, evolution

biology, GMOs are generally considered equivalent instances of 'science related issues.' For example, Miller (2010) puts on the same level of the 'public policy agenda' a rather heterogenous range of scientific issues: global climate change, the use of embryonic stem cells, the future of energy research, nuclear power, viral pandemics, genetically modified food (p. 241). The same appears to be the case in Gerken's study on the role of the journalists in communicating scientific results: no distinction is made among debates between creationism and evolutionary biology, or risks associated with GMO crops, vaccine-autism link, gun control (Gerken 2019, p. 5). Duncan, Chinn, and Barzilai (2018), in questioning 'what students should understand about how experts work with evidence' and 'how laypeople can use evidence reports themselves' (p. 907), consider as part of a same ensemble 'current social and political controversies about scientific claims regarding climate change, vaccination and evolution' (p. 930).

We argue that the different approaches of public understanding of science in current literature make sense, and can be best appreciated, by making a distinction among the specific types of science-related issue which are tacitly or ideally taken, in turn, as a model issue. In order to test our claim, we articulate a typology of 'science related issues', and then elucidate for each type which model of understanding appears more suitable.

A first class in the typology includes issues which are characterized by ***large consensus*** within the scientific community, for example the benefits of vaccines or the reality of human-driven climate change. A second class refers to issues where ***intra-disciplinary disagreements*** exist among conflicting results, data, or approaches. Most often these disagreements reflect, and are fuelled by, divergences of values. Suitable examples of these issues can be found in the field of chemical risks to the public and their management. A third class refers to issues that entail yet another type of rational disagreement, namely ***inter-disciplinary disagreements***. In this case disagreements are due to clashes among different scientific disciplines or domains of inquiry dealing with the same issue or core of issues. For instance, the choice to promote or reject GMOs crops raises ecological, health, economic and social problems that often conflict with each other. In the three following sub- sections we will describe each class more in detail and point out which among standard models of public understanding of science best addresses each class. Both classes deal with so-called 'deep' disagreements, that is with disagreements which are epistemically grounded (in a sense that will be qualified below).

In the case of issues that attract scientific consensus we suggest that Keren's (2018) 'scientific division of labour' (SDoL) model seems to be well suited to solve the civic science literacy problem for issues that benefit from large scientific consensus – though not for issues (widespread in public debate) where such a consensus pattern is more difficult to identify. These are cases where SDoL would at best allow to withhold one's judgement. However, withdrawing from forming a sound opinion is not an ideal position to be in vis a vis active participation in democratic life.

In the case of issues that attract intra-disciplinary disagreements, it is rational for a lay individual to follow the advice of experts who explicitly share the same values as the lay individuals themselves. This is because there are reasons to think that these experts manage inductive risks (that is, evaluate the consequences of making a mistake) in the same way as these individuals would do (Douglas 2017). The kind of understanding which is needed here is then quite demanding: citizens should understand how their values enter the scientific process, and jointly with facts produce the kind of results they themselves defend as most relevant to guide policy making. This kind of understanding recalls what Phillips et al. 2018 labels under the model "understanding the Nature of Science" in the specific sense of understanding the influence of social and cultural values as epistemological tenets of the scientific endeavour.

In the case of issues that attract inter-disciplinary disagreements, it appears that a minimum requirement

for citizens to form a sound opinion is an ability to identify what the different disciplines involved in the debate are, and what objects of inquiry they deal with for the purpose of the debate itself. This kind of understanding would find an adequate description by resorting to a mixed model, which includes reference to both the "Nature of Science" and the "Science process" as identified by Phillips et al. 2018. Understanding the "Nature of Science" entails, among other features, understanding the role of values in assessing scientific hypotheses. In the case of this third class of science-related issues, values play a role in choosing the kind(s) of proofs (coming from one specific discipline) which ought to be favored in defending a particular solution to a given politically relevant science-related issue. Nonetheless, public understanding in this case also refers to the diversity of methods, belonging to different disciplines, that can be used to solve a given issue. In that sense, it also amounts to understanding the "science processes" as equally described by Phillips et al. 2018.

	Type I issues	Type II issues	Type III issues
Focal epistemological feature	Wide scientific consensus	Rational disagreement within one discipline	Rational disagreement between different disciplines
Examples	● Is current climate change due to human activities? ● Are recommended vaccines safe?	● Is chemical A (resp. neonicotinoid/endocrine disruptors) dangerous for species B (resp. bees/human beings) ?	● Should GMOs culture be limited?
Referent of public understanding	Understanding of the *pattern of (dis)agreement* among experts	Understanding of the *role of values* in balancing inductive risks	Understanding of the *cross-disciplinary structure of the debate* as informed by specific fields of scientific inquiry
Links to existing model(s) of public understanding of science	Scientific division of labour model (akin to Keren 2018)	Nature of science model (akin to Philips 2018)	Nature of science model and Science process model (akin to Philips 2018)

Table 1. **Summary of models of public understanding of science vis-à-vis a typology of politically relevant science-related issues.**