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Science Skepticism, Science Education, and the Elephant in the Room

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ABSTRACT

Science skepticism has become a prominent issue in public as well as in scholarly discourse. In turn, focusing on education and science literacy in attempts to deploy strategies aiming to deal with the issue of science skepticism seems to be a plausible option. However, interdisciplinary research points out that the relationship between educational attainment and science skepticism is arguably too complex to allow us to simply call for enhanced science literacy as a remedy. Furthermore, science skepticism is arguably a kind of Gordian knot of theoretical engagements with the scientific endeavor in its various aspects, since it gets even more perplexed in every step that metascientific studies attempt to make. The elephant in the room may become apparent and not negligible: it is the epistemological premises that inform our conception and image of science. This paper intends to suggest that there is a need to confer novel insights on the ongoing discussion on science skepticism with regard to both metascientific studies and science education by delving deeper into the development of the epistemological underpinning of stances regarding the scientific endeavor, addressing its social impact and their intertwining with science skepticism.

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INTRODUCTION

It has become commonplace that science is attributed an ever-growing decisive role in policy decision-making, bearing significant and multifold socio-economic impact. Therefore, it is not surprising that science skepticism has become a prominent issue in public as well as in scholarly discourse. In turn, focusing on education and science literacy in attempts to deploy strategies aiming to rebut science skepticism, once it is acknowledged as a problem that needs to be solved, seems to be a plausible option.

This rather intuitive choice presupposes that a relationship between educational attainment and science skepticism is established. Indeed, poor reasoning skills and science literacy have been identified as antecedents of science skepticism (McPhetres et al., 2019; Pennycook et al., 2020). However, there are several research findings that cast reasonable doubt on whether this relationship is as straightforward as it seems prima facie.

For example, a study on U.S. survey data from 1974 to 2010 showed that the public's trust in the scientific community has been decreasing while education levels have been increasing (Gauchat, 2012). Other research findings point to the fact that highly educated people are no less likely to doubt science than people with lower levels of education (Kahan et al., 2012). These and other similar findings indicate that the relationship between educational attainment and science skepticism is arguably too complex to allow us to simply call for enhanced science literacy as a remedy.

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Social psychologists would probably agree with that, at least if the history of relevant fields of research is taken into account. Research on public understanding of science between the 1960s and 1980s used to focus mostly on scientific literacy, considering a public deficit of scientific knowledge as the main problem and calling for increased efforts in science education. However, theoretical approaches have moved forward thereafter, and in recent years they focus mostly on science and scientists' relationship with the populations they served, on the so-called 'social contract' between science and society, and on public engagement with and trust in science and scientific institutions (Bauer, 2009).

Besides the complexity of the relationship between educational attainment and science skepticism, an arguably more profound problem should also not be overlooked. For, if science literacy is meant to be a remedy for science skepticism, then it should be clear which conception of science should be promoted via educational means to achieve this goal. One may think that it should be the conception of science that is shaped as a resultant by the various outcomes of theoretical engagements with the scientific endeavor in its various aspects. Nevertheless, there are plentiful results from such efforts that do not necessarily counterargue science skepticism.

Science Skepticism as a Gordian Knot of Theoretical Engagements with the Scientific Endeavor

In fact, science skepticism is arguably a kind of Gordian knot of theoretical engagements with the scientific endeavor in its various aspects, since it gets even more perplexed in every step that metascientific studies (history/philosophy/sociology/psychology of science and technology, STS, etc.) attempt to make.

Who tied this knot, though? In my humble opinion, it is the contradictions and antinomies that are inherent in our society that are embedded in the development of science and reflected in public understanding thereof and in the heterogeneity of stances and attitudes with regard to the scientific endeavor and its products.

Therefore, if one is to get engaged in the discussion on how science education could or even should address the issue of science skepticism, it may be rather useful not to deny that our understanding of what is common in these two terms—that is, their first part, 'science'—should also be scrutinized. Thus, the elephant in the room may become apparent: the epistemological framework(s) and premises that inform our conception and image of science in both metascientific studies and science education. Accordingly, a reconsideration of them may open the way for strategies that make it possible to cut this Gordian knot.

In this vein, this paper intends to suggest that there is a need to confer novel insights on the ongoing discussion on science skepticism with regard to both metascientific studies and science education by delving deeper into the development of the epistemological underpinning of stances regarding the scientific endeavor, addressing its social impact and their intertwining with science skepticism.

For anyone engaged in metascientific studies, adopting a critical stance toward the scientific endeavor, the (sometimes self-claimed) scientific authority, and the status assessed to the results that are produced by scientific practice is something like a statutory obligation. Indeed, a large portion of scholarly works in metascientific studies deals exactly with the exposure of the complexities and setbacks associated with scientific practices. For example, the following, by no means exhaustive, list of reasons that have been identified as prompting scientific skepticism includes issues that have come forth due to research on the several fields of metascientific studies:

- historical pessimism: the proven falsity of past scientific theories, regardless of their success, casts reasonable doubts on the truth of our current theories
- justified doubt on impartiality and the ideal of objectivity in science
- bias against marginalized social groups in scientific research
- utilization and/or instrumentalization of science to advance ideological/political agendas and economic interests.

Does the adoption of a critical stance with regard to the scientific endeavor in light of research findings on the aforementioned fields of inquiry amount to adopting an 'anti-science' stance prompted by science skepticism? Of course not. However, this is quite a different issue than exploring how public engagement with the scientific endeavor can be when critical publics engage with science but are not necessarily informed by scientific reasoning, let alone the question regarding if they should be. Moreover, even if one takes for granted that public engagement with science should be informed by critical reasoning, the question regarding how such a stance should be shaped in terms of educational policies is open to more than one answer. Especially since, as it may be argued, one should first learn to understand how scientific processes work and what scientific results mean in order to learn to critically assign credibility to properly conducted science (whatever this may mean).

The Vagueness of 'Science Skepticism'

Assuredly, it is not only the intricacy of science as a social phenomenon and a special kind of social activity that obscures the understanding of science skepticism. It should also be acknowledged that the meaning of the term 'science skepticism' is far from being well-defined. A quick overview of the relevant literature suffices to show that science skepticism is a complex and varied social phenomenon that has been attempted to be identified with features such as unwillingness to accept the scientific consensus, resistance to evidence-based scientific messages, proclivity to reject scientific expertise and/or authority and established science, and mistrust in science and scientists.

While at least some of them may be indicative of a stance that could indeed be labeled 'science skepticism,' it is arguably problematic to attempt to define a phenomenon by appealing to rather contentious notions such as 'consensus,' 'evidence-based science,' 'expertise,' 'authority,' 'trust'/'mistrust,' etc.

One should also take into account that there are several varieties of anti-science sentiment, covering a wide range from skepticism to denialism, while at the same time, as relevant research indicates, a person can accept science—or even 'the' science—on one issue but reject it on another. In fact, it seems that science acceptance and rejection have different ideological roots, depending on the topic of investigation (Rutjens et al., 2018). Furthermore, it may be the case that denialism could be identified relatively easier than skepticism, since the former expresses itself with considerable homogeneity irrespective of which scientific fact is being targeted (Diethelm & McKee, 2009; McKee & Diethelm, 2010; Oreskes & Conway, 2010), while skepticism may contribute to a more accurate differentiation between truth and falsehood (Lewandowsky et al., 2005, 2009). There are also interesting case studies illustrating that public skepticism with regard to science is actually able to contribute to science (Lewandowsky et al., 2016).

Moreover, it should be acknowledged that we are also faced with a genuinely contradictory situation, in which science skepticism seems to grow—or, at least, to become more impactful—while at the same time people in our societies rest more and more on various science-based technologies and artifacts in our everyday lives, something that suggests that science as a whole is not consciously dismissed even by its critics.

Furthermore, studies in the history of science and its public understanding and perception show that science skepticism is not a novel social phenomenon and that its persistent yet fluctuating influence in societies does not impede either the development of science and its impact on the development of technologies that influence almost every aspect of social reality or the credibility that our societies and institutions tend to attribute to science. Indeed, the history and philosophy of science account for the cultural dependence and socio-historical variance of the perceived legitimacy of scientific authority and its statutory guarantee. Crease (2019) has shed new light on how the idea of scientific expertise was articulated and why the scientific process becomes questioned in several socio-historical and intellectual contexts. It has also been pointed out that the socio-economic impact and consequences of scientific development fostering scientific controversies may result in diminished credibility for science (e.g., Beck, 1992; Yearley,

2000). Indeed, Collins (2014) suggests that controversies related to science have undermined the cultural authority of science, or the credibility of the scientific community to explain and address problems citizens encounter in their day-to-day lives.

These may suffice to show that science skepticism is quite a complex issue for one to attempt to philosophically address. Hopefully, several philosophers of science seem to be willing to address this challenge, and their auspicious efforts may also inform attempts to address problems regarding the relationship between science literacy and science skepticism. For this latter discussion brings forth the need for an epistemological breakthrough as a rather interesting philosophical challenge.

Indeed, all that has been said thus far points to the need for a philosophical account of scientific skepticism that would simultaneously:

- rescue legitimate critical engagement with the scientific endeavor
- defend epistemic optimism with regard to scientific cognition
- address social concerns that influence public understanding of science
- inform education and pedagogy strategies to cope with science skepticism.

Tracing the Roots of our Current Epistemological Dystopia

Oreskes (2019) argues that the social character of scientific knowledge is its greatest strength and the greatest reason we can trust it. In her account, the trustworthiness of scientific claims derives from the social process by which they are rigorously vetted, and consensus is a crucial indicator of when a scientific matter has been settled and when the knowledge produced is likely to be trustworthy. Oreskes proposes an interesting way for us to try to escape from the pitfall that the mixture of postmodernist beliefs in subjectivism, in epistemic relativism, and in the particularism of culture has forced science studies to enter in order to grow up as a field of inquiry.

However, despite its significant merits, Oreskes' account—and several others that employ similar lines of reasoning—arguably fails to address some core issues that are put forth by the history of the philosophy of science and, in a broader sense, of metascientific studies.

Since philosophical jargon is susceptible to several interpretations, it should be clarified that here the label 'subjectivism' is used to subsume under it the various expressions of the epistemological standpoint according to which there is no truth beyond one's own experience, resulting in the idea that reality is a fluid, plastic, indeterminate realm. In the same vein, 'epistemic relativism' is the label used for the thesis that there are no epistemic norms over and above the variable epistemic norms operative in different (local) cultural settings or contexts, where these local contexts are defined as always including at least a system of beliefs and a set of norms. Whether a belief is justified or counts as knowledge depends on epistemic norms, and so, given that different epistemic norms can operate in different contexts, the same belief might be rational/justified/knowledge relative to one context and not to another (Sankey 2012). Finally, by 'particularism of culture' it is meant that cultures (including scientific cultures, as well as cultures within which scientific endeavors are performed) should be understood and described in their own terms.

Regardless of how one could critically assess these views, one can hardly deny that they are actually consonant with what could be deemed to be the epistemological framework within which the majority of scholars in modern science studies work.

In order to elaborate on the arguably needed epistemological breakthrough with regard to our understanding of science and its social implications, one should take into consideration the historical development of philosophical debates on science and their impact on the development of metascientific studies. A very short and rather sketchy reconstruction of the history of philosophy of science in the 20th century may be informative.

Under the dominant influence of logical positivism/empiricism, which in its various varieties and versions left a strong imprint on the development of the analytic philosophy of science in the first half of the century, scientific theories were understood as sets of hierarchically

ordered propositions formulated in the symbolic language of formal logic. Discussions on the very nature of whatever is expressed in the language of science were regarded as irrelevant to philosophy and science, since this kind of metaphysical question corresponded to the pre-scientific stage of philosophical inquiry. The so-called 'historical turn' that occurred in the 1950s was an irreparable blow to the dominance of positivist thought, highlighting the importance of studying the history of science for the philosophy of science. Despite the lasting debate on the efficacy of a historicist theory of scientific rationality, it could be argued that the positivist indifference (or even denial) to the knowledge-reality relation was merged with doubts cast on the objectivity of scientific knowledge in terms of its (relative) truth. The epistemological relativism that characterized the 'historical' turn was not contrasting the substitution of truth for practical utility propounded by pragmatism.

The outcome of these blendings was systematically formulated from the mid-1970s onwards with the so-called 'sociological' turn, and theoretical inquiries thereafter focused on the understanding of science as practice and on shedding light on the cultural dimensions of the scientific endeavor. Henceforth, the growing emphasis on the social determination(s) of science leads to overwhelming attention on socio-cultural features of the formation of the beliefs that constitute the body of scientific knowledge, rendering indifferent for its truth or falsity the inquiry on whether this knowledge somehow corresponds to the objective reality that is external to the subject of knowledge, since the latter is not attributed a different epistemological status from the object of knowledge and even knowledge itself.

On these grounds, science studies enter the field and replace the quest for truth with regard to the objective world with the Foucaultian conception of 'regimes of truth' in the context of discourse analysis and/or with post-truth accounts.

In this context, metascientific interpretations of science and its influence upon various aspects of human social life gave rise to two phenomena at opposite extremes: scientism and the struggle against it (Kopnin 1971). Scientism is the belief that science, especially natural science, is the most valuable part of our culture (Sorrell, 1994). It has also been described as an exaggerated kind of deference towards science, an excessive readiness to accept as authoritative any claim made by the sciences, and to dismiss every kind of criticism of science or its practitioners as anti-scientific prejudice (Haack, 2009). It is obvious that the debate on scientism is underdetermined by the stance one adopts with regard to the scientific endeavor, which is usually informed by the aforementioned currents of philosophical reasoning about science.

Therefore, within the context of this debate, science is understood narrowly as a set of facts connected to each other by definite logical rules and admitting of a variety of interpretations, and the scientific form of cognition thus understood is treated as if it were the only one that should be attributed the authoritative status that would enable it to guide and inform the multifaceted social activity in its various manifestations. One could argue that the polarization of the views on scientism, in this context, anteceded the current debate on science skepticism.

In a roughly schematic manner, it could be argued that throughout the 20th century, philosophy of science proved itself unable to find a coherent and efficient way to render science capable of conveying rationally justified truth claims with regard to objective reality while incorporating in its accounts the historicity of science and the determining influence of the social relations in the context of which scientific knowledge is being developed. This dystocia also affected all the related fields that contribute to the theoretical appropriation and interpretation of the development of scientific knowledge and inform education and pedagogy strategies, as well as public understanding of science.

Outlining the Needed Epistemological Breakthrough

The aforementioned challenges arguably call for an epistemological breakthrough with regard to our understanding of science and its social implications in order to inform our strategies to address the issue of science skepticism and its relationship with science literacy.

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By philosophically reflecting on the various points highlighted in the aforementioned discussion, it may be argued that what is needed is to articulate an account addressing:

a) how science historically advances towards a better understanding of the growing domain of objective reality, which is transformable by the development of social activity
b) how the development of scientific knowledge interacts with the social-historical context within which it occurs
c) how the socio-historical conditions under which the development of the scientific endeavor occurs are embedded in both scientific knowledge and the formation of the criteria by which it is critically assessed by the various relevant agents and stakeholders.

From an epistemological and methodological perspective, this suggests that what is needed is to confirm the epistemological differentiation between the subject and the object of scientific cognition and to account for scientific knowledge as the product of their interaction, which takes place in any given social relations, so that the socially produced scientific knowledge becomes related with the essence of the social whole. Thus, the logic of the development of scientific knowledge is not contrasted with the dependence of its development on social relations; on the contrary, both these aspects jointly contribute to an understanding of the production and development of scientific knowledge as a result of the complex interaction of the given social environment and the particular "micro-environment"—the influence of a network of institutions, agencies, and specific social relations within which the production of scientific knowledge occurs upon its development.

One might argue that the call for such an epistemological breakthrough does not pay justice to the fact that nowadays science education literature usually considers the epistemology of science under the NOS ('Nature of Science') umbrella or, even more precisely, the nature of scientific knowledge (Lederman, 2007). In a certain sense, such a criticism seems to be reasonable, since besides the traditional contents "of" science (facts, laws, theories, processes, inquiry, etc.), NOS embodies knowledge "about" science (Osborne, Collins, Ratcliffe, Millar & Duschl, 2003). Therefore, it could be argued that NOS captures what has been described thus far in this paper as the reasons why such an epistemological breakthrough is needed, its main premises and expected outcomes, and, moreover, it has already been quite successfully employed in the development of science education curricula and the deployment of relevant pedagogical strategies.

However, the NOS field is acknowledged as complex, controversial, multifaceted, and changing over time, although these disagreements do not impede researching or teaching NOS issues (Erduran & Dagher, 2014; Matthews, 2012), and there is an ongoing interesting debate about specifying the NOS and appropriate pedagogies and approaches to researching the NOS (Brock & Park, 2022). Moreover, numerous studies on the evaluation of student and teachers' conceptions about NOS and epistemology have found a broad collection of deficits in epistemology views, since, for example, neither students nor teachers understand the role that theories, laws, hypotheses, models, creativity, technology, tentativeness, and scientific methods play in science (Vázquez-Alonso et al., 2016). Therefore, while it could be argued that the aforementioned epistemological breakthrough may address these epistemological deficits within the NOS conception and thus contribute to it, it may also be argued that it could be seen as a call for reform of the NOS conception that transcends its inherent limitations and contradictions.
This is not the proper venue to address these issues in detail. Within the scope of this paper, it suffices to highlight that the discussion on NOS brings forth the same core of issues that prompted the discussion to which this paper attempts to contribute.

In Lieu of a Conclusion

This paper is meant to argue for the need for deployment of an epistemological framework that meets the challenges of science skepticism and which may also be employable in the development of educational strategies. Such a framework should account for the development of scientific knowledge as a social process and address how scientific processes work and what scientific

results mean by simultaneously prompting critical reasoning. It has also been attempted to sketch a brief outline of the prerequisites for such an epistemological framework.

Undoubtedly, there is much work that should be done. As usual, the first step is to acknowledge that it is needed to move in this direction, although this may result in placing many of us who are engaged in metascientific studies of any kind in an uncomfortable position, since we may need to move away from our comfort zone and our habitual mode(s) of inquiry.

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