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The Distinction Between Epistemic and Non-Epistemic Values in the Natural Sciences

Maria Pournari

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Abstract In this paper I examine the particular question of the meaning of the distinction between epistemic and non-epistemic values in the natural sciences and, if this would make sense, the possibility to transcend this distinction. I claim that the distinction between epistemic and non-epistemic values maintains its necessity as long as a certain sort of unity between the theoretical and the practical sides of the scientific endeavour has not been achieved. The distinction in question would cease to have meaning only from the perspective of such a unity, since in this manner the normative dimension of science would become an internal term for its historical construction.

One of the most significant problems in the philosophy of science is that concerning whether, and consequently in what manner and to what degree, values participate in the formation of theories in the natural sciences. The relevant line of enquiry is connected to the investigation into the guarantees of epistemic propriety of the theories in question; guarantees that range from the appropriate application of the *rules of syllogism* to the evaluation of *scientific hypotheses*, either as *heuristic terms* or as *first principles*. Within an historical framework, we examine the particular question of the meaning of the distinction between epistemic and non-epistemic values[1] in the natural sciences and, if this should have meaning, the possibility to transcend this distinction. Needless to say that the transcendence in question could also be relevant in science education as a presupposition for the theoretical construction of the relations between science and school science.

[1] The terms epistemic and non-epistemic values are used interchangeably with the terms cognitive and non-cognitive values.

M. Pournari (✉)
Department of Primary Education, School of Education, University of Ioannina, Ioannina 451 10, Greece
e-mail: mpurnari@cc.uoi.gr

1 Syllogistic Rules and Scientific Hypotheses

The modern philosophy of science has emphasised the importance of *rule following as a guarantee of epistemic validity*. Descartes,[2] along with Aristotle,[3] utilised deductive logic as the means to preserve and transfer truth from the premises in point to the conclusion being drawn.[4] He considered that, given that the rules of logic retain universal power, the problem of epistemic propriety lies mainly in preserving the truth of the premises, which, being the basic propositions of the syllogism, must be "*αληθή και πρώτα" (true and first).* On the other hand, defenders of induction,[5] despite being aware of the problem that inductive generalisations were flawed in the search for the truth, also based their work on the rules of inference, this time attempting to draw universal laws from particulars. The advantages of the rules of the former kind are obvious. The rules of formal logic can be applied in a more or less automatic manner, and ensure an effective procedure to control whether these were applied correctly.

This image of science, however powerful, did not for long exist without being cast into doubt. Already in the seventeenth century, it started to become clear that seeking the effect of one of the, usually multiple, probable causes could not possibly constitute an endeavour to *apply syllogistic rules*. This line of enquiry led Kepler, Boyle and Huygens, among others, to transfer their interest from the rules of syllogism to verifying scientific hypotheses.[6]

The question would now concern the kind of criteria that are appropriate for the evaluation of hypotheses in question, as well as the degree of certainty with which these could be guaranteed. Kepler emphasised that the successful discovery of a scientific hypothesis does not constitute solely a method for *saving the phenomena.* The hypothesis must explain the phenomena. In other words, it must supply the appropriate causal explication. Consequently, in order to justify the truth of such a hypothesis, additional limitations would have to be placed on the conditions under which this is formulated. The evaluation of an explanatory hypothesis could not be similar to the application of a rule, as it would be possible to utilise a variety of criteria, each of which would be satisfactory to a different degree. The extent to which the criteria are consistent with accepted physical theory and their success in predicting novel results would be included in these. Thus the relativism of the criteria once more would bring the Sceptic problem *of the criterion* to the foreground.

In retrospect, Newton's unwillingness to accept *hypothesis* as an appropriate constituent of science may be considered retrogressive. The man who introduced gravity had difficulty in interpreting this concept in explanatory terms, which led him to overlook methodological issues connected to the causal explanation. He thus presented his conclusions from the fundamentals of mechanics as a "deduction" from the phenomena, and subsequently justified their generalising nature by "induction". Physical science was constructed with reference to laws, which constitute empirically designated regularities; and develops

[2] See R. Descartes (1937, *Discourse on the Method*, part II., pp. 116–22).

[3] See Aristotelis (1964, 1958, *Analytica Priora et Posteriora*, A, 25. 42a32–33, and 1958, *Topika et Sophistici Elenchi*, A, I, 100a25–30).

[4] For an historical analysis of the problem, see. J. Losee (1972. See Aristotelis (1964, 1958, *Analytica Priora et Posteriora*, A, 25. 42a32–33, and 1958, *Topika et Sophistici Elenchi*, A, I, 100a25–30) pp. 5–15 and 54–83).

[5] See F. Bacon (1620) and J. S. Mill (1843, pp.185–205).

[6] See R. Westfall (1977–90), and E. McMullin (1982).

progressively, causing these laws, to the extent possible, to be exact renditions of empirical data. In this manner, this simple picture of science satisfies the defenders of reason, as well as those of sense experience, and it will be adopted over the two following centuries.[7]

However, as structural explanations made their appearance in a variety of scientific fields, first Whewell[8] and then Peirce[9] would emphasise the fundamental logical differences as constructions and evaluations between, for example, Boyle's Law, as an empirical generalisation made using induction, and the explanatory hypothesis of the kinetic theory of gases. Peirce would give the latter a new designation, *abduction*, or *inference to the best explanation*, as it would later come to be known, in order to distinguish this from the simpler generalising inference, which would retain the traditional term induction. The criteria used to characterise *inference to the best explanation* would be considered to be much more complex and the estimation of the value of competing explanatory theories a much more complicated undertaking compared to the evaluation of an empirical generalisation, which arises from a limited number of data, often using statistical terms.[10]

However, the significance of this difference and the problem of evaluating hypotheses would come to the forefront decisively in the twentieth century, when the issue concerning the meaning of unobservable entities within the framework of the "linguistic turn" in science would be considered. Logical empiricists focused their interest, at least initially, on the inductive method, because of their fixation on the use of empirical data as a foundation. Carnap[11] based inductive logic on a single criterion: The degree to which a hypothesis is substantiated through its observable consequences. These consequences would have to be extrapolated in a deductive manner and be reported in protocol sentences, which would be perceived as unproblematic foundations.

However, the distance of this idealised logical schema from the real practice of science could not be overlooked. Popper[12] yet again set Hume's challenge on the problem of induction and pointed out that the designation of a good observation could not help but presuppose an element of decision. Carnap, correspondingly recognised that the decision on whether to apply mathematical or language formalism contains "external" factors, which determine the truth of one specific physical theory over another. Influenced by the early conventionalism of Poincaré, Popper went on to describe the decision as a matter of "convention", a term that was considered unfortunate due to the fact that it overemphasises the arbitrariness which a decision may contain.[13] While Carnap underlined the pragmatic character of selection criteria, both would agree with respect to the individual character of the relevant decision. Instead of impersonally applying a rule, scientists could not help but trust to personal estimations concerning the relevancy of factors, on the basis of which they would form their value judgements. However, reconciling this position with the ideal of scientific objectivity and universality would constitute a problem that would be the source of fertile discussions on the meaning of rationality in the natural sciences.

[7] See E.J. Dijksterhuis (1961, pp. 386–492), and B. Gower (1997, pp. 109 ff).

[8] See W. Whewell (1851, pp. 139–47).

[9] C.S. Peirce (1931, vol. 5, pp. 180–9).

[10] See R. Blake et al (1960, pp. 183–217 and 248–262). See also E.A. Burtt (1967, pp. 155–201).

[11] See R. Carnap (1966, pp. 19–47).

[12] See K. R. Popper (1959, ch.V. §27–30).

[13] K.R. Popper, (1963, pp. 37, 74n, 95, 240, 266, 407).

2 Rationality and Other Values

Kuhn[14] observed that the selection of a theory involves typically different considerations, which operate as values and acquire the status of maxims rather than rules that must be satisfied. He asserted, however, that the use of maxims of this sort does not necessarily undermine the value of the objectivity of the selections. Even though pragmatic values like self interest enter into the decision, these values are appropriate to promote the objectivity of the selection: They define the meaning of objectivity within the specific theoretical framework similarly with values as accuracy, consistency, demarcation, simplicity or fertility. Preserving the position of his early work, he went on to add that it is preferable to describe the transference of trust from one theory to another as a "conversion", rather than a "choice". According to Kuhn, the values that characterise a good theory do not verify the potential truth of this theory, or the reality of the theoretical entities that it postulates. In any event, opponents of Kuhn's theory considered that this position can be regarded as weakening the objectivity of a theory, which would lead to relativism.[15]

The debate regarding the role of values in sciences would also focus on the *unifying power*[16] and *explanatory success* of a theory, but within the broader issues of its epistemic nature: Do these values relate to the truth of a theory which is to be evaluated, or are they simply pragmatic criteria, in other words, merely an issue of practical utility? Are they independent criteria, or are they satisfied by means of a repetitive application of the initial inductive criterion of "saving the phenomena"? Logical empiricists focused their attention on the criterion of simplicity. It was important for them to recognise the epistemic nature of other criteria beyond the established induction criterion, otherwise, if viewed pragmatically, the criterion of simplicity would not be easy to maintain. In contrast, van Fraassen[17] argued that "super-empirical virtues", which may be connected with the choice of a theory, in other words all other virtues besides empirical adequacy and logical consistency, would have to be viewed pragmatically.

It becomes clear, I believe, that the dispute in question is related to the problem of scientific realism. Critics of realism would not concede to attribute an epistemic nature to values such as explanatory power and fertility, if these were to be applied above and beyond the fundamental value of empirical adequacy. Defenders of scientific realism rely on the fact that scientific theories, when successful, in reality display various kinds of explanatory virtues: The success of a scientific theory is a guarantee that it will provide a realist interpretation under specific circumstances. Anti-realists respond that these virtues—if they were to be formulated in terms of criteria—may be reduced to the criterion of empirical adequacy. The confirmation of a novel prediction does not necessarily corroborate a theory, except if this datum is included in the data on which the theory was originally based. In turn, realists responded that, if a theory does nothing more besides "saving the phenomena" which it was designed to save from the start, then it does not guarantee the existence of the entities which it axiomatically postulates. If, however, it displays virtues which it would be expected to display in the explanation of the underlying structures whose existence it supports, then a realist interpretation of these structures may

[14] See T.S. Kuhn (1962/1970, pp. 72–110, and 1974, pp. 320–39).

[15] See L. Laudan (1984, pp. 67–102). See also E. McMullin (1982, pp. 3–28, and 1993, pp. 55–78).

[16] See P. Oppenheim, H. Putnam (1987, pp. 296–316).

[17] B. C. van Fraassen (1980).

be the only reasonable interpretation.[18] The discussion, of course, is ongoing within the framework of critical theory, phenomenology, and the sociology of science.[19]

3 Values and the Ultimate Goal of Natural Sciences

Despite the general accepted view that natural scientists, in the most critical stages of their research, base their work on value judgements, no agreement exists as to which are, or should be, the core values influencing their judgements. There are several philosophers of science, like Laudan or McMullin, holding that epistemic values must prevail, because using these as a basis of their research, it increases the probability that scientific decisions will be true. This view, however, does not come into conflict with the assertion that other values,—namely, non-epistemic ones—, also participate in the construction of science. In any case, the problem of distinguishing between different kinds of values in the natural sciences is necessarily connected with the unavoidable issue of their ultimate goal, which has always been a topic of lively debate.

For Aristotle,[20] the goal of natural science was to understand the world in terms of causation. From another viewpoint, the goal of science is truth, defined as correspondence of the human mind with external reality. In this sense, science is basically contemplative. Bacon,[21] describing the idols that could mislead scientific research, thought that these arose from external limitations. He believed that when the idols were identified, they could be overcome. Much later, in the nineteenth century, the term ideology would be utilised to underline the threat to the objectivity of science due to the intrusion of values which are foreign to "proper science".

At the end of the seventeenth century, the purpose of science was the knowledge of nature; authentic knowledge that would permit the natural forces to be used for the benefit of mankind. Despite the fact that science strives to comprehend the causes of things, it is not limited to providing pleasure, or to satisfying curiosity; instead, its intent is to reform nature itself. However, knowledge of the underlying causes turns out to be much more laborious than it had been usually considered, and for this reason the formulation of hypotheses, and their verification through the results they supply, is the best that can be accomplished. In this manner, the prime goal is accurate prediction. Tracing the potential consequences does not constitute merely a means to verify the validity of hypotheses; instead, it becomes a goal in itself.

As contemporary physical science penetrates ever further into the latent processes of nature, it builds constructs that appear counterintuitive. There is an ongoing discussion on whether quantum theory provides an authentic understanding of basic physical processes, or whether it simply constitutes a convenient and powerful predictive tool. What propels the scientific endeavour towards specific areas of investigation is practical values of technological usefulness, rather than epistemic values connected to understanding nature.

[18] For the problem of scientific realism, see Y. Baloshov, A. Rosenberg (ed.) (2002, pp. 193–284).

[19] For the shift from cognitive values to *contextual values* which consist a form of background beliefs about the scientific evidences, see H. Longino (1990, pp. 62–82). For a defence of a version of feminist empiricism on the problem of the *contextual values*, see K. Okruhlik (1994, pp. 21–42). For an extending commentary on the problem of values in science, see M. Curd, & J.A. Cover (ed.) (1998, pp. 211–79). See also St. Richards (1983).

[20] See Aristotelis (1950, *Physica*, B, 194b 17–22).

[21] See F. Bacon (1620, *Aphorism*, Book 1, LXXIII-XXIX.

However, even today, there are fields of research, like paleontology or cosmology, where the temptation of technological benefit does not reign supreme, and where the Ancient Greek perspective of scientific rules continues to be applied, according to which, knowledge has value in and of itself.

In that way, the normative dimension of science is connected with the concept of truth, not only as an epistemic, but also as a normative concept, and, moreover, as a evaluative principle for assessing the epistemic value of our beliefs. From this angle, on the one hand, we elucidate the normative dimension of science, and, on the other, we explicate that the concept of belief, in its own right, aspires to truth. *Belief* derives its normative character from the par excellence normative conception of knowledge, which aims at truth. Only within a normative epistemic context we may be asserting that *I know* and *I believe*. The normative bond between truth and knowledge constitutes the criterion of distinction between epistemic and non-epistemic values.[22]

The abandonment of this distinction, on account of the unity between the theoretical and the practical side of the scientific endeavor, implies: first, that the difference in question, that is to say, the difference between the theoretical and the practical side of the science, legitimizes the distinction between epistemic and non-epistemic values. Second, that the difference in question (upon which the legitimacy of the distinction between epistemic and non-epistemic values depends) is regarded as a normative ideal in the Kantian sense: it constitutes the limit towards which our research efforts converge. Even if we do not reach it, it is what we are aiming at; consequently, *truth* is exactly what constitutes the horizon of our research.

We are discussing the distinction between epistemic and non-epistemic values, while referring to the difference between the theoretical and the practical side of science, exactly because we are concerned with knowing this difference. Within the prospect that such knowledge opens up for us, it becomes possible to pose the question regarding the truth of these values: in what ways are they distinct and different. Even within the narrow context of scientific research, we keep a wider target in sight: the discussion regarding the unity of the theoretical and the practical element delineates this very target, towards which our efforts are directed and converge. This target is the horizon of our inquiries.

4 Conclusion

The distinction between epistemic and non-epistemic values is maintained of necessity for as long as unity has not been achieved between the theoretical and the practical sides of the scientific endeavour. Only from the perspective of such a unity would the distinction in question cease to be meaningful, because in this manner the normative dimension of science would become an internal presupposition for its historical construction.

If scientists' science is considered as an inherently values-oriented activity, then the gap between the internal and the external origin of its goals is to be bridged, thus making sense for the dependence-of-school-science thesis.[23] The elaboration of the argument that justifies the overcoming of the distinction in question, also clarifies its semantic status. Therefore, if the concept "science" is examined from the perspective of the above

[22] For different approaches, see H. Lacey (1999, pp. 13–35), and P. Machamer, & H. Douglas (1999, pp. 45–54).

[23] See D. Allchin (1999) and P. Dayson-Galle (2002).

distinction, then the conditions under which this concept is different from that of "school science" may become easier to understand. This differentiation contributes to the determination of the criteria for the constitution of school science and, along with that, of the educational theory which is a necessary precondition for this constitution.

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Author Biography

Maria Pournari Assistant Professor of Philosophy, Department of Primary Education, School of Education, University of Ioannina. Ph.D. from Department of Philosophy, B.A. from Department of Mathematics and from Department of Philosophy, University of Ioannina. Field of Expertise: Epistemology, Metaphysics, Philosophy of Science, Cognitive science, Epistemology of Education, Modern Philosophy. Books: David Hume: Critique of Causation as an Attempt towards a "True Metaphysics", Ph. D. Thesis, University of Ioannina, 1994. (in Greek), David Hume, A Treatise of Human Nature, Of The Understanding, Introduction-Translation in Greek, Patakis Publication, Athens 2005