Constructivism in Science and Science Education: A Philosophical Critique

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Two or three times in this author's arguments I have noticed that in order to prove that matters stand in such and such a way, he makes use of the remark that in just this way do they accommodate themselves to our comprehension, and that otherwise we should have no knowledge of this or that (data) or that the criticism of philosophy would be ruined; as if nature first made the brain of man, and then arranged everything to conform to the capacity of his intellect. But I should think rather that nature first made things in her own way, and then made human reason skilful enough to be able to understand, but only by hard work, some part of her secrets.


ABSTRACT: This paper argues that constructivist science education works with an unsatisfactory account of knowledge which affects both its account of the nature of science and of science education. The paper begins with a brief survey of realism and anti-realism in science and the varieties of constructivism that can be found. In the second section the important conception of knowledge and teaching that Plato develops in the Meno is contrasted with constructivism. The section ends with an account of the contribution that Vien (as understood by constructivists), Kant and Piaget have made to constructivist doctrines. Section three is devoted to a critique of the theory of knowledge and the anti-realism of von Glasersfeld. The final section considers the connection, or lack of it, between the constructivist view of science and knowledge and the teaching of science.

1. VARIETIES OF CONSTRUCTIVISM

'Constructivism: A Paradigm for the Practice of Science Education' is the heading to Tobin’s ‘Preface’ to his collection of papers by educationalists largely committed to the cause of constructivism in science education. He begins by saying that ‘currently there is a paradigm war raging in education’ in which some have ‘argued for a change in epistemology’, evidently with some success for he claims ‘there is evidence of widespread acceptance of alternatives to objectivism, one of which is constructivism’. But what are constructivism and its alternative objectivism?

The contrast between realism and anti-realism, of which constructivism is a variety, is an old one in the theory of scientific knowledge. Objectivism is a broad doctrine which includes not only scientific realism (a doctrine discussed in this paper), but also the idea that there are objective critical methods for adjudicating between scientific hypotheses (an aspect of objectivism only obliquely mentioned here). Does science make discoveries
about a human-independent world, including the world of unobservable entities such as gravitation or electric charge? Scientific realists say 'Yes' while admitting that we are fallible and may not always be right about what exists in the unobservable realm. Common sense realism and scientific realism maintain that there exists objects, events and processes in the world which are independent of all human perception and all thought or theorizing about them. They are independent in the sense that if there were no humans around to perceive or think about them then they would still exist. Such items are not constructs of ours, or projections onto the world by us; nor do we constitute them in some way by our thought or theorizing about them. Are there such items? Common sense realists maintain that the Sun, cats, water, etc exist in a mind-independent way (though we have been mistaken about some items in the past such as witches, goblins, etc.). Scientific realists maintain that science has discovered (not invented or constructed) items such as electrons, viruses, tectonic plates, galaxies, etc (though scientists have been mistaken about some items in the past such as epicycles, electromagnetic ether, phlogiston, polywater, etc.). It is an additional matter to also say that our theories of science are true. Some realists resist this saying either that it is not necessary to claim truth for our theories as well as the commonsense and scientific realism just defined; or they say that at best our theories are idealizations of, or approximations to, what goes on at the level of the observable and the unobservable.5

Anti-realists, including constructivists, deny that science makes discoveries about a human-independent world, including the world of unobservable entities – but they qualify this in various ways. Constructivists allege that it is we who constitute or construct, on the basis of our theorizing or our experience, the allegedly unobservable items postulated in our theories. In a different vein Thomas Kuhn expresses scepticism about our ever being able to get at the truth about what is 'really there' saying: 'the notion of a match between the ontology of a theory and its real counterpart in nature now seems to me illusive in principle'. (Kuhn 1970, p. 206) Bas van Fraassen is a leading philosopher of science who embraces what he calls 'constructive empiricism', the view that in science we aim for models which are only required to fit the observable phenomena. Realists, he says, illegitimately aim for more: they want theories which not only fit the observable phenomena but are also true of unobservable reality. Van Fraassen's brand of constructive empiricism involves technicalities; since it has not found favour with constructivists in science education it will not be discussed here. Some anti-realists are merely sceptical of any claims that we can know anything beyond experience; hence an empiricism with respect to the entities postulated in science made famous in various ways by the eighteenth century empiricist philosophers Hume and Berkeley and twentieth century logical positivists.

What has the venerable philosophical debate between realists and anti-realists about scientific knowledge to do with the teaching and learning