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REPLY

Objectivist objections to constructing objectivism

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When one writes a paper one hopes that one will not be misunderstood too badly. Though not totally approving, Michael Peters has a clear grasp of my position. He does raise a few points about my paper that were perhaps passed over too quickly and are in need of further clarification. My one disagreement, discussed at the end, concerns the value of some recent sociologically-based studies of science.

Here is one little experiment I try on my classes year after year. I ask "Who believes the Earth rotates daily on its axis and orbits the Sun?" No one says they do not believe this (though a few look puzzled). Then I ask for their reasons for believing this. I am lucky if I can find *one* person who can give a reason that Copernicus, Kepler, Galileo or Newton gave for the Earth's motions. A few mention that astronauts report seeing it rotate; but they quickly recognise that this answer will not suffice for our longstanding know ledge of the Earth's motions.

What this little story shows is that society has at least done its job (but how widely?) in at least instilling in university students beliefs about the Earth's motions. This illustrates a role for the social transmission of beliefs - note *beliefs* and not *knowledge.* When would the students *know,* rather than believe, what the Earth's motions are? A criterion for the correct answer was given clearly for the first time in human thought in Plato's dialogue *Meno.* This is a central aspect of knowledge denied by hardly a philosopher since Plato, viz., that knowledge has to do with those beliefs that are true and for which the knower has a sufficient justification. This is still the case even though most contemporary philosophers reject, as I do, other aspects of Plato's theory of knowledge and may wish, as I also do, to supplement his definition of knowledge in the *Meno.* We can accept Plato 's views on knowledge in the *Meno* for good reasons - and without being Platonists (as Peters seems to suggest).

So what do my students need to do to get knowledge of the Earth's motion? As the *Meno* suggests, it is not enough to have a Socratic teacher who builds on what the pupils know and helps them grasp the reasons for their beliefs; one more crucial step is needed. The pupils have to understand for themselves what the reasons are for the Earth's motions, and how the reasons support the claims about the Earth's motions.

So there is something to what constructivists say about 'letting the pupils construct their own knowledge' and having teachers who can assist them in a non-didactic Socratic style of learning. We cannot expect our pupils to be Galileos or Newtons who discover the reasons by themselves. Teachers are essential as guides along the path to such knowledge. One can admit that teachers, texts and fellow pupils may play an important, sometimes necessary, 'social' role in the acquisition of knowledge by any one pupil. Unless pupils individually take the final steps in grasping the reasons for belief, especially in science, then the pupil will be forever lost to the world of knowledge. Constructivists in science education systematically omit the crucial role played by reason and evidence in acquiring knowledge, in so far as they fail to mention justification. Science is the area *par excellence,* where we are obliged to justify our claims.

In this sense the theory of knowledge outlined in the paper is essential not only for scientific knowledge but also for learning and teaching science. There is thus an important necessary link between knowledge and education, assuming that the acquisition of knowledge is the aim of teaching and learning. One can also learn what is false. I spend some time teaching students in the philosophy of science the Ancient Ptolemaic and the Copernican theories of the solar system because there are some important lessons to be learned from them about the nature of science. No student believes that what they have learned is true; the theories they learn are in fact quite false. Once they have immersed themselves in each of the systems, they are able to think their way around within them. Then they come to appreciate how difficult it is to think one's way out of such systems of thought - thereby sharpening their awareness of the difficulties in advancing human thought. Thus, in one sense one can learn what is quite false - and master it quite effectively.

There is an important sense in which I wish to hold that theories about the nature of scientific knowledge are irrelevant to teaching and learning in science education. This point may not have emerged clearly in the paper. It is also important because many constructivists transport their anti-objectivist views about scientific knowledge into their science education where, I believe, it does serious damage. The leading advocate of radical constructivism, and opponent of objectivism, von Glasersfeld does this. Other constructivists, such as Driver *et. al.* (1994) appear not to (even though they have quite incomplete views about objectivism).

Objectivism is a broad doctrine which includes not only scientific realism but also the idea that there are objective critical methods for adjudicating between scientific hypotheses and arriving at the most probable or the correct hypothesis. 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 theorising about them.[1] 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 theorising about them. Are there such items? Common sense realists maintain that the Sun, cats, water, rocks, 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.[2] 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 idealisations of, or approximations to, what goes on at the level of the observable and the unobservable.[3]

Anti-realists, including constructivists, deny that science makes any 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 theorising or our experience, the allegedly unobservable items postulated in our theories. In a different vein Kuhn (1976: 206) 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". Van Fraassen (1980) 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.[4] Van Fraassen's brand of constructive empiricism involves technicalities and has not found favour with constructivists in science education. Other anti-realists are merely sceptical of 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. Advocates of radical constructivism seem to be in the empiricist's camp. In all of these cases the objective world, which it is commonly said that scientists investigate, disappears behind a veil constructed entirely by us.

What has the venerable philosophical debate between realists and anti-realists about scientific knowledge to do with the teaching and learning of science? In my view, nothing. Constructivists in science education often wrongly assume that the debate can tell us something about the teaching and learning of science. Constructivist teaching and learning is another matter, best contrasted with didacticism. It is commonly assumed by constructivists that a realist account of science goes with a didactic 'tell it how it is' approach to teaching and learning while a non-realist account goes with a more personal constructivist approach. Any person who wishes to teach science should be aware of the philosophical debate. They may present theories in either a realist or an anti-realist fashion to their students. For example, Copernicus understood his theory realistically as did Galileo who said 'the Earth really moves'. Many contemporaries of Copernicus and Galileo (eg., scientifically-minded members of the Catholic Church) understood the theory non-realistically as merely a new set of models for explaining the observable motions of the planets. Many contemporary quantum physicists find their theories so puzzling that even they are at a loss to know what a realist understanding of them might be like (Feynman, 1985). Which interpretation one should adopt and what interpretation is finally adopted is a purely philosophical matter having no necessary bearing on the teaching and learning of science.

As it turns out most scientists are (unreflective) realists about their theories. In contrast most constructivists adopt a non-realist interpretation of all scientific theories (though I think their arguments for this are bad) (Nola, 1994 and 1996). From this they appear to infer that all knowledge in the context of teaching and learning must be understood as a construction. It is this inference I wish to question. In fairness it should be pointed out that not all constructivists infer this from their understanding of scientific knowledge; instead they argue for it independently from, for example, Piaget's theory of learning (for a critique see Nola 1996). Whatever the case, often both their view of science and of science teaching and learning is constructivist.

Objectivism also concerns objective methods of test for scientific claims. They are objective in two senses: there are proofs of the correctness of the use of the methods in specified areas, and the methods can be used by anyone with the requisite reasoning skill. Such objective methods are used in all the sciences, from Anthropology to Zoology; moreover their use helps characterise science from non-science. Many constructivists downplay the role of objective methods and talk about the social factors which allegedly determine the very content of science itself. In this respect they are influenced by recent sociological studies of science in which it is alleged that objective methods are not used in science and that scientific know ledge reflects social interests or, as Driver *et. al.* (1994: 5-6) tell us, scientific knowledge is "socially negotiated" or is "socially constructed". This is not the place to enter into a debate about such alleged non-rational means for establishing scientific 'knowledge'[5]. Many of the authors that Peters cites approvingly in the final section of his paper adopt views which are akin to those sociologists of science who hold non-objectivist views about method in science (except Feyerabend who is notorious for claiming that in science 'anything goes', even things contrary to the sociologists' processes of 'social negotiation'!).

Finally, Peters raises a question about the link between knowledge and power. Knowledge, as defined in my paper has nothing to do with the powers that science may give us humans to control and shape the world and other people. What knowledge we obtain through science may be only contingently, and not essentially, linked to power and its exercise. This is a matter for social studies of science to investigate case by case and not a matter on which one can pronounce in *a priori* fashion. In talking of constructivist science education I restricted my self to the content of science and to the practical know how it may require from mathematical calculation to experimental skill.

The content of the various sciences is quite distinct from the uses knowledge of that content can be put to, if any. In my paper I assumed that one was concerned in science education with the learning of science itself. I take this to be quite distinct from the moral evaluation of the impact and use of science, the students' understanding of which ought to be accompanied by courses on values and ethics, amongst other things.

Some in science and science education say the constructivist stance helps free us from an all too dominant view of the nature of science and its role in society. Constructivism, they believe, is an antidote to crude scientism (Sorell, 1991). One can also be an objectivist about science and yet share some of the concerns (perhaps not all) that constructivists have about the dominant character of science in our age. In throwing out the dirty · bath water of scientism, some constructivists also throw out the baby of objective science as well. In science education, we need to come to terms with the objective character of science. In my view constructivism is not a helpful view either of science itself 6 or of the nature of science education. What good there is in constructivism is also shared by rival theories of knowledge and of teaching and learning.

Notes

1. The discussion here concerns only the physical and the life sciences. For a realist non-constructivist view of the social sciences see Searle, 1995.
2. On the difference between metaphysical realism and a realism defined in terms of truth see Devitt 1991, Part II.
3. On idealisation see Cartwright 1983; on approximation to the truth or verisimilitude see Popper 1963, chapter 10 and Addenda 6 and 7.
4. See Van Fraassen, 1980, Chapter 2, §1. For an evaluation of van Fraassen's position see the papers in Churchland and Hooker (eds.), 1985. For a more general criticism of constructivism see Boyd 1992 and Rosen 1994.
5. For a critique see Nola 1994.

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