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OPINION PIECE

The benefits of studying philosophy for science education

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The benefits of studying philosophy for science education

> Good philosophy must exist, if for no other reason, because bad philosophy needs to be answered.
>
> C. S. Lewis, *The Weight of Glory*

INTRODUCTION

Almost every educated person knows that science, understood here as a systematic study of the natural world through observation and experimentation (Stevenson, [2010]), has been extremely valuable in helping us understand our world. Less well known are the benefits of studying philosophy. These include broadening and deepening one's perspective of reality, developing critical and analytical thinking, becoming more sensitive to the underlying assumptions of one's views, and helping one interpret the implications of scientific findings, clarify concepts, make distinctions, determine what is and is not relevant, perceive possibilities, think more creatively and imaginatively, and to become more balanced and holistic in the formation of one's worldview. Many eminent scientists throughout history have valued the study of philosophy, including physicist Sir Anthony James Leggett (Nobel Prize [2003]) who testifies to this in his contribution to this volume. Sadly, there is presently a small but outspoken group of scientists whose views have been characterised by an overestimation of science and a disparagement of philosophy, and whose arguments are ironically based on bad philosophical reasoning which demonstrates a lack of the above mentioned qualities, as the rest of this article will show. It should be emphasised at the onset that the views of this group, which include Stephen Hawking, Peter Atkins and others, are by no means representative of scientists in general. On the contrary, they have been criticised by eminent colleagues, examples of whom will be mentioned below. Nevertheless, the views of Hawking et al have been influential on the public – including university undergraduates – through their writing of popular science books, and therefore it is important that their views concerning philosophy be addressed.

DISTINGUISHING BETWEEN SCIENCE AND SCIENTISM

The successes of modern science have led Atkins ([1995], p. [97]) to claim that "There can be no denying the proposition that science is the best procedure yet discovered for exposing fundamental truths about the world...There appear to be

no bounds to its competence." In the minds of many, science's achievements have made philosophy looked like an outmoded discipline by comparison. Hawking expressed this sentiment when he infamously declared that "Philosophy is dead. Philosophy has not kept up with modern developments in science, particularly physics. Scientists have become the bearers of the torch of discovery in our quest for knowledge" (Hawking & Mlodinow, 2010, p. 1-2). People with this mindset regard scientific evidence as the only kind of evidence they would accept for any item of knowledge. Such views are known as scientism[1].

Other eminent scientists have pointed out that, while Hawking is highly knowledgeable within his area of specialisation in physics, his views concerning the broader implications of science are often based on ignorance of other academic disciplines, including philosophy. For example, commenting on Hawking's recent remarks about there being no need for God in order to explain creation, Sir Martin Rees, Britain's Astronomer Royal and colleague of Hawking at Cambridge, said "I know Stephen Hawking well enough to know that he has read very little philosophy and even less theology, so I don't think we should attach any weight to his views on this topic."[2]

The fact that many scientists do not share Hawking's view should raise a red flag about making any simplistic identification of his view with that of science. Science educators need to point out that scientism is not science per se, that is, scientism is not a statement of, say physics, chemistry, biology, etc, unlike statements such as "$E=mc^2$", "water is H_2O", "smoking causes genetic damage". Rather scientism is a philosophical view of science and of reality. It is important to make the distinction between science and scientism. Scientists who are philosophically well-informed, such as Cambridge's distinguished physicist-turned-theologian John Polkinghorne (Templeton Prize 2002), have pointed out that advocates of scientism, ironically, have relied not merely on scientific but also on philosophical premises for their arguments. For example, Polkinghorne explains that "the physical reductionist who claims that there is nothing but matter and energy, and no truth but the truth of science, is making a metaphysical statement" and that "the metaphysical belief that science tells us all that can be known or is worth knowing, must clearly be distinguished from science itself which, owing to its intrinsic limitation to only a certain kind of encounter with reality, is far from being in a position to make such a an overblown claim" (Polkinghorne, 2011, p. 23).

Polkinghorne is targeting Ontological Scientism, the view that the only reality that exists is the one science has access to (Stenmark, 1997). This view

1 For a helpful description of various forms of scientism, see Stenmark (1997).

2 http://www.independent.co.uk/news/people/profiles/martin-rees-we-shouldnt-attach-any-weight-to-what-hawking-says-about-god-2090421.html

presupposes that only natural entities which can be studied by science exist, but as Polkinghorne has explained, this presupposition is a philosophical presupposition, and it cannot be proven by science itself.

Verificationism is a position that was popular in the early 20th century; it affirms that only statements that can be confirmed or disconfirmed by sensory experience are meaningful. It has since been widely rejected, its fallacy being that the statement of Verificationism itself *viz.* the statement that "only statements that can be confirmed or disconfirmed by sensory experience is meaningful" cannot be confirmed or disconfirmed by sensory experience. Thus the verification principle itself cannot be verified according to its own principle. While its proponents claim that the principle could be regarded as an axiom, this fails to meet the challenge of why we should adopt such an axiom. The principle cannot meet its own demands (Trigg, 1993, p. 20). Likewise, while confirmation by observation and repeated experiments is one way of demonstrating certain things, it would be wrong to think that this is the only way to demonstrating anything, for the view that "confirmation by observation and repeated experiments is the only way to demonstrate anything" is a view which cannot be confirmed by observation and repeated experiments. While science can study natural entities, it cannot prove that only natural entities exist, since it cannot exclude the existence of entities which by their nature cannot be accessed by science. Given that science cannot do this, it is not true that there are no bounds to the competence of science, and we need to consider other forms of evidences such as philosophical and historical, as I shall argue below.

THE IMPORTANCE OF PHILOSOPHICAL REASONING

Furthermore, the scientific method cannot avoid the need to presuppose certain philosophical assumptions. For example, science requires various forms of deductive[3], inductive, abductive, statistical and causal reasoning for its explanations. However, the justification of these methods of reasoning which are assumed by science is philosophical rather than scientific. The distinguished cosmologist George Ellis has observed, with respect to the criteria for good scientific theories themselves (internal consistency, the ability to make testable predictions, etc), that "These criteria are philosophical in nature in that they themselves cannot be proven to be correct by any experiment. Rather their choice

3 For example, deduction is required for scientific predictions. To illustrate, quantum theory is often heralded as a scientific theory that is well-confirmed by experiments, such as those that reveal quantum entanglement. The confirmation would take the following form:

1. If the experiment reveals quantum entanglement, then the prediction of quantum physics is confirmed.
2. The experiment reveals quantum entanglement
3. Therefore, the prediction of quantum physics is confirmed.

This form of valid reasoning is known as *modus ponens* (1.If A, then B 2.A 3.Therefore, B), which is a form of deductive reasoning.

is based on past experience combined with philosophical reflection" (Ellis, 2007, Section 8.1). Given the importance of philosophical assumptions, it would be useful to include a compulsory course on this topic in science curriculum.

Moreover, science cannot answer "why scientific results should be valued"; the answer to this question is philosophical rather than scientific. While science is rightly prized for its ability to make testable predictions that have been proven to work, "why the power to make testable predictions should be valued for our understanding of reality" is a question that cannot be answered by science, but must be answered philosophically. In addition, physicist Stephen Weinberg (Nobel Prize 1979) observes that the issue of morality is beyond science itself. While scientific discoveries can provide inputs for moral considerations, these inputs by themselves are insufficient for morality for, as Weinberg (2009) notes, "science can never explain any moral principle" (p. 21-22). Weinberg also notes that it is beyond the realm of science to prove whether its most fundamental laws have explanations or not, because whatever theory unified all observed particles and forces, science cannot explain why it is that theory that describes the real world and not some other theory (p. 240-241). Finally, Polkinghorne and others have observed that science cannot answer how the unintelligent physical entities of our universe could have consistently behaved in an orderly manner describable by elegant and intricate mathematics, without which science could not have made the predictions necessary for its success (Polkinghorne, 2006, p. 62-64). The arguments of Ellis and Polkinghorne imply that, while science can answer many questions concerning how natural processes work, there are other kinds of questions which cannot be answered by science, including questions concerning the possibility and justification of science itself, but must be answered by other disciplines such as philosophy and history.

The following two points should be noted.

First, the argument here is not that philosophy is THE way to the truth, but that philosophy is another way of knowing things in addition to science. This does not deny that science is also a way of knowing things. Which way is the best depends on what we want to find out. If we want to investigate how energy and mass work, how particles interact with each other, how cancer can be cured, etc, we should use science. Philosophy is not a discipline that concerns itself with discovering these kinds of things, i.e. discovering how natural processes which can be investigated by physical experiments work. Rather it is concerned with the analysis, clarification, criticism and justification of the concepts, underlying assumptions and principles (logic, induction, causality, ethics, etc) that all disciplines (including science) require, as well as the fundamental nature of existence and issues concerning ultimate explanations[4]. While science

4 I address the later issue in Loke (2012a; forthcoming).

should be valued for bringing about progress in understanding of how natural processes work and its practical usefulness, it would be superficial to think that our knowledge of reality is limited to these aspects. Neither science nor philosophy is sufficient in itself, and they need to work with each other and with other fields of inquiry. Interdisciplinarity is the way to go for 21st century tertiary education.

Second, the conclusions of science cannot be more certain than the philosophical principles on which science is based (Craig & Moreland, 2003, p. 347-348). Hence, the results of sound philosophical reasoning should not be dismissed as useless speculation, but should be recognised as evidences just as scientific results are. One needs to realise that philosophical reasoning underlies every concrete answer, including those provided by science itself. While proponents of scientism like to ask "What has philosophy given us that is monumental and comparable with the achievements of science", it can be retorted that philosophy has given us the assumptions that made science possible.

Skepticism towards philosophical arguments is often based on the claim that these arguments are merely based on "common sense" and "everyday intuitions", which the history of science in recent centuries has shown to be highly unreliable. For example, while "common sense" might regard it impossible that something can be a particle and a wave at the same time, quantum physics has shown that it can. However, we need to distinguish between "common sense" and "everyday intuitions" from philosophical principles of reasoning (e.g. various forms of deductive, inductive, abductive, statistical and causal reasoning) which are undeniable for knowledge and which underlie the construction of scientific theories themselves, including the theory of wave-particle duality. In other words, we need to distinguish between "common sense" and "everyday intuitions" from philosophical principles of reasoning by which we show "common sense", "everyday intuitions" to be highly unreliable. While wave-particle duality is certainly "strange", one can conceive of an entity that is neither wave nor particle but which can appear to be like a wave under certain conditions and appear to be like a particle under other conditions. It should also be noted that various alternative interpretations for quantum phenomenon are possible (Goldstein, 2013). Thus, while wave-particle duality may appear foreign to our daily experience and therefore appears strange, it does not violate the philosophical principles of reasoning that underlie quantum theory itself[5], and we need to differentiate strangeness from the violation of these principles.

5 Quantum physics does not provide adequate justification for violating classical logic. On the one hand, quantum physics' apparent violation of classical logic can be interpreted operationally rather than ontologically (Wilce, 2012), but on the other hand, an ontological violation of classical logic would undercut quantum physics itself (see footnote 3) and is unaffirmable (e.g. consider "shapeless cube": "shapeless" and "cube" cancel each other out; it is like writing something and then immediately erasing it).

Incidentally, an item of knowledge which any person can be most certain about is his/her own existence, which he/she cannot reasonably deny; for one to deny it, one would have to assume one's own existence in the process. This reasoning is philosophical in nature and, similar to necessary truths such as "red is a colour" or "shapeless cubes cannot exist", cannot be overturned by future discoveries of science. While the discipline of philosophy allows for controversies about almost everything (including whether the external world exists) – and such controversies may explain why many have mistrusted philosophy and taken refuge in the apparent certainties of science (Trigg, [1993], p. [15]) – the above examples indicate that philosophical reasoning – when done properly – is capable of yielding items of knowledge which we can be even more epistemically certain about than the discoveries of science.

By contrast, scientific theories, in their attempts to explain a connected sequence of phenomena by postulating an entity as a cause, face the difficulty that there may be other underlying causes for these phenomena which we have not yet discovered. In this way, scientific theories are underdetermined by the observations that purportedly supported them, and other theories for these observations remain possible. This is not to say that we cannot judge which theory is more probable or reasonable than others, but what this implies is that science can never achieve the kind of epistemic certainty that philosophical reasoning is capable of yielding.

Moreover, many scientific views are in the process of changing, and many scientific theories are incomplete. For instance, scientists have not yet figured out the relationship between quantum theory and relativity theory. This indicates the incompleteness of these theories, and it is highly probable that some aspects of these theories would be overturned by future discoveries and that major adjustments or qualifications would have to be made.

Of course, this does not imply that all scientific discoveries are unreliable, neither does it imply that all scientific theories are merely relative as some radical postmodernists have claimed, for if that were the case, then the evident technological advancement over the last few centuries cannot be adequately explained. We need to examine the purported items of scientific knowledge case by case, and see how strong the evidences are for each case. When we do that, we would realise that some scientific discoveries, such as "the earth is spherical", are plainly facts, for to believe that such discoveries might be overturned by future scientific discoveries are unreasonable in view of the evidences for them. Although the statement "the earth is spherical" might not be true for certain groups of people living thousands of years ago, nevertheless it was still a fact back then regardless of what people at that time believed; thus, the truth concerning the shape of the earth is absolute rather than relative,

and people who denied it were absolutely wrong. Therefore, while Hawking et al have rightly been criticised for making overblown claims about science, it would be unwise to go to the other extreme and embrace the views of radical postmodernism which, interestingly, is also based on bad philosophical reasoning (Kitcher, 1998, p. 38).

CONCLUSION

While science must be valued highly for the progress it has brought to humanity, it would be naïve to ignore its limitations. For science is not the only way of knowing, nor is it necessarily the best way. Rather, philosophy is another way, and science and philosophy should complement each other. With regard to various aspects of our knowledge of reality – such as concerning causality, time, free will, morality and ultimate explanations – philosophy has important contributions to make, and philosophical evidences need to be treated seriously as has been shown above. A better understanding of foundational philosophical issues would lead to better knowledge and may even motivate scientific enquiries[6]. In view of the prevalence of misconceptions concerning philosophy and bad philosophical reasoning in popular science writing, there is a greater need than ever before for philosophy to be properly taught to science students. It would therefore be beneficial to have courses on the complementary roles of science and philosophy in tertiary science education. This would help students develop a holistic and integrated approach necessary for addressing the complex multidisciplinary problems of the 21st century.

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