UNIT 1 SCIENCE AND PHILOSOPHY, SCIENCE AND PHILOSOPHY OF SCIENCE

Contents

1.0 OBJECTIVES

- This unit tries to introduce philosophy of science to the students;
- It tries to study the relationship between science and philosophy; and
- It undertakes to define philosophy of science and its broad areas of inquiry..

1.1 INTRODUCTION

In this unit, we want to introduce ourselves to the issues, problems, areas of philosophy of science. We first try to understand what science is and what philosophy is. Then we go to study philosophy of science and a second order discipline. Finally we see the relationship between science and philosophy and then we try to understand philosophy of science better.

1.2 SCIENCE AS SUBVERSIVE

In general science may be understood in two ways. First as "the systematic observation of natural events and conditions in order to discover facts about them and to formulate laws and principles based on these facts." Secondly as. "the organized body of knowledge that is derived from such observations and that can be verified or tested by further investigation." (Dictionary of Science & Technology by Academic Press). Science is in fact an intellectual activity carried on by humans that is designed to discover information about the natural world in which humans live and to discover the ways in which this information can be organized into meaningful patterns. So the primary aim of science is to collect facts (data). According to Professor Sheldon Gottlieb the "ultimate purpose of science is to discern the order that exists between and amongst the various facts."

Similarly, Robert M. Pirsig, the author of *Zen and the Art of Motorcycle Maintenance* holds: "The real purpose of the scientific method is to make sure Nature hasn't misled you into thinking you know something you don't actually know."

So science involves more than gaining of information and knowledge. It is the systematic and organized inquiry into the natural world and its phenomena. Science is about gaining a deeper and often useful understanding of the world. So "to do science is to search for repeated patterns, not simply to accumulate facts." (Robert H. MacArthur, *Geographical Ecology).* Therefore science questions things and is not respector of persons. To quote Richard Feynman, Nobel-prize-winning physicist, "science alone of all the subjects contains within itself the lesson of the danger of belief in the infallibility of the greatest teachers in the preceding generation . . .As a matter of fact, I can also define science another way: Science is the belief in the ignorance of experts." Science may be contrasted to art and poetry. A modern poet has characterized the personality of art and the impersonality of science as follows: "Art is I; Science is We." (Claude Bernard) The famous English poet Samuel Taylor Coleridge (1772-1834), will agree: "Poetry is not the proper antithesis to prose, but to science. . . . The proper and immediate object of science is the acquirement, or communication, of truth; the proper and immediate object of poetry is the communication of immediate pleasure." If fiction and poetry deals with the real world and takes us to the imaginary and creative dimension, science enables us to focus on the real world and to retain the doubt and criticism. So James Porter, Professor of Ecology could say: "Fiction is about the suspension of disbelief; science is about the suspension of belief." So we can agree with Richard Feynman: "Religion is a culture of faith; science is a culture of doubt."

The focus of science or scientific research is this empirical world. Therefore, Stephen J. Gould, one of the well-known paleontologist, evolutionary biologist would hold: "As a practicing scientist, I share the credo of my colleagues: I believe that a factual reality exists and that science, though often in an obtuse and erratic manner, can learn about it. Galileo was not shown the instruments of torture in an abstract debate about lunar motion. He had threatened the Church's conventional argument for social and doctrinal stability: the static world order with planets circling about a central earth, priests subordinate to the Pope and serfs to their lord. But the Church soon made its peace with Galileo's cosmology. They had no choice; the earth really does revolve around the sun."

In this sense science challenges, criticizes our world-view. It subverts our understanding of ourselves. A long quote from Philip Morris Hauser, a well-known demographer and sociologist will conclude this section: "Science is the most subversive thing that has ever been devised by man. It is a discipline in which the rules of the game require the undermining of that which already exists, in the sense that new knowledge always necessarily crowds out inferior antecedent knowledge. . . . . This is what the patent system is all about. We reward a man for subverting and undermining that which is already known. . . . . Man has a tendency to resist changing his mind. The history of the physical sciences is replete with episode after episode in which the discoveries of science, subversive as they were because they undermined existing knowledge, had a hard time achieving acceptability and respectability. Galileo was forced to recant; Bruno was burned at the stake; and so forth. An interesting thing about the physical sciences is that

they did achieve acceptance. Certainly in the more economically advanced areas of the Western World, it has become commonplace to do everything possible to accelerate the undermining of existent knowledge about the physical world. The underdeveloped areas of the world today still live in a pre-Newtonian universe. They are still resistant to anything subversive, anything requiring change; resistant even to the ideas that would change their basic concepts of the physical world."

1.3 PHILOSOPHY AS RAISING THE DEEPEST AND WIDEST QUESTIONS

With philosopher Ayn Rand, we can hold that **"**Philosophy studies the fundamental nature of existence, of man, and of man's relationship to existence. … In the realm of cognition, the special sciences are the trees, but philosophy is the soil which makes the forest possible." In other words philosophy is a comprehensive system of ideas about human nature and the nature of the reality we live in. It is a guide for living, because the issues it addresses are basic and pervasive, determining the course we take in life and how we treat other people (Thomas 2011).

The topics that philosophy addresses fall into several distinct fields. Among those of fundamental concern are:

- Metaphysics (the theory of reality).
- Epistemology (the theory of knowledge)
- Ethics (the theory of moral values)
- Politics (the theory of legal rights and government)
- Aesthetics (the theory of the nature of art)

In Greek, "philosophy" means "love of wisdom." Philosophy is based on rational argument and appeal to facts. The history of the modern sciences begins with philosophical inquiries, and the scientific method of experimentation and proof remains an instance of the general approach that a philosopher tries to bring to a question: one that is logical and rigorous. However, while today the sciences focus on specialized inquiries in restricted domains, the questions addressed by philosophy remain the most general and most basic, the issues that underlie the sciences and stand at the base of a worldview. They are the more fundamental issues that human beings have to grapple with (Thomas 2011).

Philosophy raises some of the deepest and widest questions there are. Addressing the issues in each branch of philosophy requires integrating everything one knows about reality (metaphysics) or humanity (epistemology, ethics, politics, and aesthetics). Proposing reasonable positions in philosophy is therefore a difficult task. Honest philosophers have often disagreed about key issues, and dishonest ones have been able to slip their own positions into the mix as well. For this reason, there is not one philosophy worldwide, as there is one physics. Instead, there are many philosophies.

Over the course of history, philosophers have offered entire systems that pulled together positions in each of the branches of philosophy. Aristotle, the father of logic, wrote such a system in ancient times, teaching that we could know reality and achieve happiness. In more modern times, philosophers such as John Locke

and Immanuel Kant have written systematic accounts of their thought (Thomas 2011). Most modern philosophers, however, have specialized in one area or another within philosophy, since philosophy itself has become very specalised today.

Check Your Progress I

Note: Use the space provided for your answers.

1) "Science is a subversive activity" Comment.

.....

.....

.....

.....

.....

2) What is the primary function of philosophy?

.....

.....

.....

.....

.....

1.4 PHILOSOPHY OF SCIENCE AS A SECOND ORDER DISCIPLINE

Given the two understandings of science and philosophy as discussed above, we can try to see what philosophy of science means. We may hold that the philosophy of science seeks to describe and understand how science works within a wide range of sciences. This does not have to include every kind of science. But it had better not be confined to a single branch of a single science, for such an understanding would add little to what scientists, on the whole, know. Unfortunately, philosophers and scientists are not in agreement on the nature of their own field of study. Even practising philosophers of science often disagree about the proper subject-matter of their discipline. An example of this lack of agreement is the exchange between Stephen Toulmin and Ernest Nagel on whether philosophy of science should be a study of scientific achievement, or a study of problems of explanation and confirmation through logic.

One view regarding the philosophy of science is that it the formulation of worldviews that are consistent with, and in some sense based on, important scientific theories. According to this view, it is the task of the philosopher of science to elaborate the broader implications of science (Losee 2001).

A second view is that the philosophy of science is an exposition of the presuppositions and predispositions of scientists. The philosopher of science may point out that scientists presuppose that nature is not capricious, and that

there exist in nature regularities of sufficiently low complexity to be accessible to the investigator. Further, he may uncover the preferences of scientists for deterministic rather than statistical laws, or for mechanistic rather than teleological explanations. (Losee 2001).

A third view is that the philosophy of science is a discipline in which the concepts and theories of the sciences are analysed and clarified. This is not a matter of giving a semi-popular exposition of the latest theories. It is, rather, a matter of becoming clear about the meaning of such terms as 'particle', 'wave', 'potential', and 'complex' in their scientific (or physics) usage.

A fourth view is that philosophy of science is a second-order discipline. It goes more than science and critically reflects on the very discipline of science itself.The philosopher of science seeks answers to such questions as:

- What characteristics distinguish scientific inquiry from other types of investigation?
- What procedures should scientists follow in investigating nature?
- What conditions must be satisfied for a scientific explanation to be correct?
- What is the cognitive status of scientific laws and principles?

To ask these questions is to assume a vantage-point one step removed from the practice of science itself. There is a distinction to be made between doing science and thinking about how science ought to be done. The analysis of scientific method is a second-order discipline, the subject-matter of which is the procedures and structures of the various sciences. (Losee 2001)

Level	Discipline	Subject-matter
2	Philosophy of Science	Analysis of the Procedures and Logic of Scientific Explanation
2	Science	Explanation of Facts Facts

The fourth view of the philosophy of science incorporates certain aspects of the second and third views. For instance, inquiry into the predispositions of scientists may be relevant to the problem of evaluating scientific theories. In addition, analyses of the meanings of concepts may be relevant to the demarcation of scientific inquiry from other types of investigation (Losee 2001). The distinction which has been indicated between science and philosophy of science is not a sharp one.

1.5 HISTORICAL SIGNIFICANCE OF PHILOSOPHY OF SCIENCE

Philosophy of science is an old discipline. Both Plato and Aristotle wrote on the subject, and, arguably, some of the pre-Socratics did also. The Middle Ages, both in its Arabic and high Latin periods, made many commentaries and disputations touching on topics in philosophy of science. Of course, the new science of the seventeenth century brought along widespread ruminations and manifold treatises on the nature of science, scientific knowledge and method.

The Enlightenment pushed this project further trying to make science and its hallmark method definitive of the rational life. With the industrial revolution, "science" became a synonym for progress. In many places in the Western world, science was venerated as being the peculiarly modern way of thinking. The nineteenth century saw another resurgence of interest when ideas of evolution melded with those of industrial progress and physics achieved a maturity that led some to believe that science was complete. By the end of the century, mathematics had found alternatives to Euclidean geometry and logic had become a newly re-admired discipline (Machmer 2002).

But just before the turn to the twentieth century, and in those decades that followed, it was physics that led the intellectual way and garnered the attention of the philosophers. Mechanics became more and more unified in form with the work of Maxwell, Hertz and discussions by Poincaré. Plank derived the black body law in 1899, in 1902 Lorenz proved Maxwell's equations were invariant under transformation, and in 1905 Einstein published his paper on special relativity and the basis of the quantum. At the same time, Hilbert in 1899 published his foundations of geometry, and Bertrand Russell in 1903 published his principles of mathematics. The development of unified classical mechanics and alternative geometries, challenged by the new relativity and quantum theories made for period of unprecedented excitement in science (Machmer 2002).

Then came the era of computer and information technology, including artificial intelligence. But today life-sciences (biology, biotechnology) have taken over. So 21st century is rightly considered as the century of biotechnology and philosophy of science has to confront the possibilities and challenges offered by it. The emergence of postmodernity and relativity has also challenged the way philosophy of science is practiced today.

Check Your Progress II

Note: Use the space provided for your answers.

1) Describe philosophy of science as a second order activity.

.....

.....

.....

.....

.....

2) Briefly elaborate the historical significance of philosophy of science?

.....

.....

.....

.....

.....

.....

1.6 RELATIONSHIP BETWEEN SCIENCE AND PHILOSOPHY

The relationship between science and philosophy has always been problematic, ever since science itself slowly evolved from "natural philosophy" during the 16th and 17th centuries. Because of the work of people who thought of themselves as philosophers but were in fact scientists, philosophy of science became a distinct disciple. Names like Francis Bacon, Galileo Galilei and Isaac Newton are examples.

It may be noted that philosophy is the mother and science is the daughter. Earlier they both existed together. But as science developed, it becomes distinct from philosophy. As in any parent-offspring relationship, things can get problematic, with the offspring claiming its territory while denying the parent's relevance or contribution, and the latter having a difficult time letting go of the now adult and independent offspring. (Pigliucci 2008)

We believe that both scientists and philosophers can give more thought to the relationship between science and philosophy. There are many areas where meaningful bridges can be built, and where the two disciplines can operate largely independently of each other. This is neither an apology on behalf of philosophers nor an invitation to scientists to become philosophers. The first is not needed because philosophy is an autonomous area of scholarship, which certainly does not need any more justification than, say, literary criticism or quantum electrodynamics. The second would be missing the point since, scientists may benefit from a better acquaintance with philosophy. But scientists normally do not have the time to learn philosophy (Pandikattu 2003).

Now we are in a position to see what philosophy of science actually does. We may first what philosophy of science is and is not (Pigliucci 2008).

1.7 WHAT PHILOSOPHY OF SCIENCE IS AND IS NOT ABOUT

Nobel-laureate and physicist Steven Weinberg (1992) took the rather unusual step of writing a whole essay entitled "Against Philosophy." In it, he argued that not only is philosophy not useful to science, but that, in some instances, it can be positively harmful. The example he provided was the alleged slow acceptance of quantum mechanics, due to the philosophical school of positivism endorsed by so many scientists in the early 20th century, beginning with Einstein.

Positivism is a now abandoned philosophical position that takes a rather narrowly naýve view of what counts as science. Most famously, positivists thought that science had no business dealing with "unobservables," i.e., with postulating the existence of entities that cannot be subjected to experimental tests. Quantum mechanics is rife with such unobservables, including electrons and forces, and positivists were indeed highly skeptical of the whole affair, which smelled too much of metaphysics (a bad word, according to them) (Pigliucci 2008).

It is also true that some scientists, first and foremost Einstein, were rather uncomfortable with the wildest implications of quantum mechanics (as in

Einstein's famous statement that "God doesn't play dice") and resisted them while searching for alternative interpretations of the theory. But Einstein himself was a philosopher.

A diametrically opposite view to Weinberg's is the one expressed by Daniel Dennett (perhaps not surprisingly, a philosopher), in his *Darwin's Dangerous Idea*: "There is no such thing as philosophy-free science; there is only science whose philosophical baggage is taken on board without examination". This will strike most scientists as preposterously arrogant, but a moment's reflection shows that Dennett, of course, is right. For example, scientific practice requires the assumption of naturalism, i.e., the idea that natural phenomena are indeed natural, and, therefore, scientists do not need to invoke the supernatural to explain them. It is interesting to note that scientists themselves invoke naturalism as a postulate of science (Pigliucci 2008).

The important thing to realize is that naturalism is not an empirically verifiable position, and, therefore, it is by definition outside of science itself (if science is about anything at all, it is about empirically verifiable statements about the world). Attitudes such as Weinberg's are largely the result of ignorance of what philosophy of science is about, and I am convinced that such ignorance hurts science. It certainly does not help to bridge between science and philosophy.

1.8 THREE BROAD AREAS OF INQUIRY

Generally speaking, philosophy of science deals with three broad areas of inquiry, which Pigliucci refers to as nature of science, conceptual and methodological analysis of science, and science criticism (Chalmers 1999).

Regarding Nature of Science: Most scientists, if they are familiar with philosophy at all, have some acquaintance with philosophical studies of the nature of science. Names such as Karl Popper and Thomas Kuhn even make it into the occasional biology textbook, and one can argue that falsificationism and paradigm shifts—the most important respective contributions of these two philosophers—are among the few concepts in modern philosophy of science that are ever mentioned in the halls of science departments. Popper and falsificationism are representative of a *prescriptive* way in philosophy of science; that is, they exemplify a tradition of philosophers seeking to tell scientists how they ought to carry out their work. Popper was motivated by the so-called demarcation problem, the difficulty in distinguishing science from pseudoscience (he included in the latter Freudian psychoanalysis and Marxist theories of history). He was also bothered by Hume's problem of induction, the idea that science is based on inductive reasoning, and yet the only reason we have to trust induction is because it worked in the past (which is itself a form of induction, making the whole thing perilously close to circular). Popper thought he solved both problems with the idea of falsification: science is really based on deductive logic, not induction. This solves Hume's difficulty, but, since deduction cannot truly establish proof of natural phenomena (although it works fine for mathematical proofs), it turns out that science can never prove anything but can only disprove (i.e., falsify) theories. (Pigliucci 2008)

It is rather ironic that many science textbooks have essentially adopted Popper's view of science as an enterprise dealing in falsificationism, with many scientists actually *defining* science in Popperian terms. Popperian falsificationism has long

been superseded in philosophy of science, partly through the work of one of Popper's own students, Imre Lakatos , who argued that falsificationism does not work because it is often possible to "rescue" a given theory from demise by modifying some of the ancillary assumptions that went into building it. This is a good thing too, and indeed a reflection of how science really works. Just think of the fact that the original Copernican theory did not actually fit the data very well, and yet it was not rejected as "falsified." Rather, scientists gave it some time to develop because it seemed a promising approach. Subsequently, Kepler modified an important, though not central, assumption of the theory, thus producing results that correlated very well with the data: the sun is indeed (almost) at the center of the solar system, but the planets rotate along elliptical, not circular, orbits, of which the sun occupies not exactly the center, but one of the foci (Pigliucci 2008).

Kuhn's (1970) ideas as developed in *The Structure of Scientific Revolutions*, are an example of the *descriptivist* approach to the study of the nature of science. Kuhn did not pretend to tell scientists how to do their work but was interested in figuring out how science, as a process of discovery, actually proceeds. His idea of paradigm shifts was based on historical studies of astronomy and physics (arguably, biology has never undergone a paradigm shift after Darwin).

Regarding methodological analysis of science: The second major area of inquiry in philosophy of science the conceptual and methodological analysis. It deals largely with tracing the historical use and clarifying the meaning of fundamental ideas and practices in the sciences. Hume (1748) was among the first ones to take this approach, inquiring about what we mean when we talk about causality. (His analysis, still surprisingly challenging today, was not very encouraging.) More recently, critical work on the conceptual foundations of evolutionary theory and the practices of quantitative genetics falls into this group.

Regarding science criticism: The third major type of philosophy of science is what I term science criticism, and it directly addresses the interface between science and society. For example, philosophical issues surrounding the nature-nurture debate are relevant to the uses and, more importantly, the misuses, of genetic engineering. Here the philosopher becomes a critic not just of how the science is being conducted and its findings interpreted, but, primarily, of how such findings are understood by the public and used to guide social policies.

What is a scientist to do with all this? Scientists may largely and safely ignore what philosophers say about how science does or should work in broad terms—after all, scientists want to *do* science, not to think about how it is done (except occasionally, when they are close to retirement). They do, however, have a responsibility to update their understanding of philosophy when it comes to writing science textbooks or teaching the nature of science in the classrooms. Also, philosophers clearly have the intellectual right to pursue such inquiry into the nature of science without having to justify themselves to scientists by defending the "utility" (implicitly, to science) of what they do. (Pigliucci 2008)

When we move to the second and third areas of philosophical inquiry, we come closer to the borderland between science and philosophy, to the point where, in some cases, philosophy may be thought of as "the continuation of science by other means" (Chang 2004). Indeed, in areas from evolutionary biology to

quantum mechanics, it is sometimes difficult to tell whether a theoretical paper is written by a scientist or by a philosopher without directly checking the author's institutional affiliation. Here the word "theory" takes on its original and broader meaning of formulation of concepts, not just mathematical treatment (although there are examples of philosophers engaging in the latter as well). What makes this blurred line between philosophy and science interesting is that the two disciplines bring different backgrounds and approaches to the study of the same issues—i.e., this is not just a matter of science-envy by philosophers (or the even more rare phenomenon of philosophy-envy by scientists) (Pigliucci 2008)

1.9 LET US SUM UP

This unit introduces the philosophy of science and takes up some of the basic issues related to it. We have seen how science and philosophy are related and different. Then we saw the specific role of philosophy of science.

Check Your Progress III

Note: Use the space provided for your answers.

1) What is Weinberg's idea of philosophy?

.....

.....

.....

.....

.....

2) Explain philosophy of science as "science criticism"?

.....

.....

.....

.....

.....

1.10 KEY WORDS

Falsificationalism : Falsifiability or refutability is the logical possibility that an assertion could be shown false by a particular observation or physical experiment. That something is "falsifiable" does not mean it is false; rather, it means that if the statement were false, then its falsehood could be demonstrated.

Natural philosophy : The study of nature and the physical universe before the advent of modern science.

Naturalism : A theory denying that an event or object has a supernatural significance. It assumes that nature can be explained by itself.

1.11 FURTHER READINGS AND REFERENCES

Chalmers A F. *What Is This Thing Called Science? An Assessment of the Nature and Status of Science and Its Methods.* Berkshire (UK): Open University, 1999.

Dennett D. *Darwin's Dangerous Idea: Evolution and the Meanings of Life*. New York: Simon & Schuster, 1995.

Hume D. *Enquiry Concerning Human Understanding*. [1748 reprint.] Chicago (IL): Gateway Editions, 1956.

Kuhn T. *The Structure of Scientific Revolutions*. Chicago (IL): University of Chicago, 1970.

Losee, John. *A Historical Introduction to the Philosophy of Science*. 4th ed. Oxford England ; New York: Oxford University Press, 2001.

Machamer , Peter 2002 "A Brief Historical Introduction to the Philosophy of Science" in Peter Machamer and Michael Silberstein The Blackwell Guide to the Philosophy of Science, Oxford: Blackwell Pub, 2002. 1-17.

Okasha, Samir. *Philosophy of Science: A Very Short Introduction.* Oxford; New York: Oxford University Press, 2002.

Pandikattu, K. "Dialogue between Science and Religion for Preserving and Fostering Life." In *Science, Technology and Values: Science-Religion Dialogue in a Multi-Religious World*, edited by Job Kozhamthadam, 35-48. Pune: ASSR, 2003.

Pigliucci M. *Denying Evolution: Creationism, Scientism, and the Nature of Science*. Sunderland (MA): Sinauer. Weinberg S. 1992.

Pigliucci, Massimo. "The Borderlands Between Science and Philosophy: An Introduction" *The Quarterly Review of Biology,* 83/1 March 2008, 7-15.

Press. Lakatos I. *The Methodology of Scientific Research Programmes*. Cambridge (UK): Cambridge University Press, 1977.

Thomas, William R. "What is Philosophy" The Atlas Society. Avaialable at http://www.atlassociety.org/what_is_philosophy. Retrieved on July 2, 2011.

Wilson E O. *Consilience: The Unity of Knowledge*. New York: Alfred A. Knopf/ Random House, 1998.