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What is the method of Science?

Philosophers and historians have varied in their accounts of how to characterize the nature and practice of science. The issue of placing the method of Science in the larger framework of epistemology is central to the analysis of what is known as’ the demarcation problem.’ While there are Philosophers like Polkinghorne that completely disagree to there being a unique scientific method at all, the scientific community has – over the course of its evolution since the birth of modern science – in fact recognized certain fundamental features of what qualifies as the Scientific method. When seen in practice, these fundamental features reduce to a unique methodology based upon deductive reasoning that governs all scientific practice.

Science, while not divorced from the general scaffold of epistemology, has its own independent and particular method of arriving at conclusions about nature. This essay will take the view that deductivism as postulated by Popper is the most suitable approach towards categorizing the methodology of Science, and this methodology is completely independent of the socio-cultural or historical context in which Science operates. What is sometimes termed as the psychology of Science, may influence the propagation and the impact of Science on society, but is not directly linked to the method of Science. The following sections of this essay will elaborate on the thesis by explaining the sequential steps that constitute deductive reasoning towards a scientific theory, including examples from the history of Science and at the same time emphasizing the more or less universal nature of this methodology.

A scientific understanding of nature is irreversibly tied to observation. Any systematic study of the universe has to begin with a neutral act of observation, which in modern scientific practice translates into the professional usage of recording instruments, diligent data-keeping and quantification of observables etc. The extent or the level of sophistication involved in the act of observation may vary from one epoch to another but the idea remains the same. Recording the spectrum of light from a distant star would count as an observation. The working of the spectroscope used to make the observation is not affected by any pre-conceived notions that a scientist may have about the particular star she is observing.

Having made the observation, a scientist will move on to formulate a hypothesis to explain the particular observation made. An example of a hypothetical statement would be “the probability of lung cancer is directly proportional to the number of cigarettes smoked daily.” At this point, a hypothesis is no more than a rudimentary conjecture of a scientist – something that will dictate the subsequent course of her investigation which will essentially comprise of testing the hypothesis by experiment. But before moving on to the idea of testing, it is perhaps pertinent to introduce what a scientific theory is. “A theory is a grand conceptual scheme that lies at the core of thinking and which provides a complete picture in its domain of validity.” Such a scheme must possess both explanatory as well as predictive power – and it is the later that is at the core of logical deduction as will be explained later. The General theory of relativity is an example of such a framework which elegantly explains gravitation and the nature of space-time at the cosmic scales, and also makes predictions about the behavior of light around massive bodies etc.

Once a theory has been formulated, refined and put forward by its proponents – a process in which at each stage the theory is under strict scrutiny for its logical consistency as well as Mathematical elegance – the theory is put to the ultimate test of falsifiability. This particular test, in essence, involves the empirical verification of the theory’s predictions. If the conclusions that can be derived from a particular theory hold true after experimental testing, the theory stands corroborated. On the contrary, if the conclusions from a theory do not stand the test of empirical verification and are falsified, “then their falsification also falsifies the theory from which they were logically deduced.” In other words, for a theory to qualify as scientific, one should be able to ask the following question: “Under what circumstances this theory could be falsified?” This question can only be asked of a theory that predicts something besides explaining it.

By these standards, quantum mechanics holds as a scientific theory because besides explaining many phenomenons such as the photoelectric effect, it also makes predictions like tunneling of electrons – something which has been experimentally tested. On the other hand, a practice such as astrology does not qualify as scientifically valid, because it’s predictions about people’s day-to-day lives have been repeatedly falsified.

Now, let’s have a holistic assessment of the entire procedure leading up to the falsification or corroboration of a theory and argue that it is indeed deductive in nature as opposed anything established through inductive reasoning alone. The formulation of a theory is followed by scientists arriving at different conclusions about the systems that fall in the theory’s domain of validity; for example the theory of electromagnetism can allow a Physicist to draw certain conclusion about a conductor placed in a magnetic field. The process is deductive in nature as it involves reasoning from the general to the specific. And once, the specific prediction has been proved to hold true by experiment, it only corroborates the theory rather than establishing its truth. In other words, the process is not inductive: a scientist does not use the truth of a singular statement to establish an entire theory as true. Falsification criterion only determines whether a theory is powerful enough to dictate future endeavors in a particular area of Science.

While falsification has largely come to be recognized as the corner stone of scientific method, scholars have pointed out flaws in it. For instance, most of the Physics’ theories aimed at the unification of forces, such as String theory or the M-theory are practically untestable. This is because, the predictions these theories make are for a scale of mammoth energies such as those that existed at the time of the big bang. Yet, the theories in question are too mathematically elegant to be given up. This is a dilemma for the scientific method. One possible response to this dilemma is that, practical constraints should not be a reason to discard complex theories; rather the scientific community can always work towards the development of experimental facilities that may allow the testing of a theory years after it was first proposed. In fact, such is the motivation behind building and operating large-scale experimental facilities such as the LHC.

In the light of the above arguments, it can be concluded that the basic structure of scientific method does not only rest upon deductive reasoning, but it is also more or less universal – equally applicable to all theories and all practitioners of Science regardless of their social and/or temporal circumstances.

# Bibliography

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