

The Limits Of Science

Dr. M.C.M. Iqbal

Senior Research Fellow, NIFS

mcmif2003@yahoo.com

The early quest for knowledge

The earliest known seekers of knowledge were the Greek philosophers – and since they were concerned with the natural environment, they were known as natural philosophers. They were concerned with some of the most basic questions which still continue to trouble laymen and scientists alike, even after 2600 years: the purpose and origin of life and the universe! Their observations on the environment were based purely on their senses. They were looking for the underlying laws of nature, to understand the natural processes around them. Thus philosophy was the first step from liberating the seeking of knowledge from the prevailing religious autocracy – and the natural philosophers were the pioneers of using reason to acquire and understand the natural environment.

The ultimate objective of science is to advance knowledge. The output from the scientific process is knowledge, but at the core of science lie's a logical process – the scientific method - to provide answers. These answers are always open to doubt and criticism.

Methodologies in science

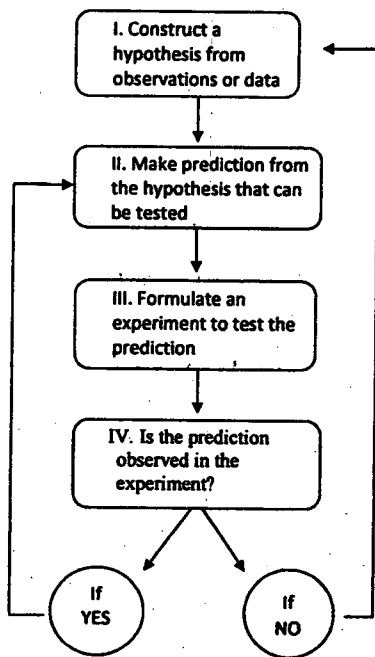
The scientific method has evolved over time in to a powerful means of acquiring knowledge. A clear understanding of the scientific process is necessary to determine if a particular issue is scientifically valid or not. The philosophy in science has refined this methodology to establish a common set of criteria and thereby establish what is and what is not scientific.

The scientific process of investigation is an open transparent process following an accepted method. The outcomes of an investigation should be supported by reasons within the existing framework of knowledge in science. The methods used are explicitly described and available to anybody to repeat and establish what is claimed. It is through this process of open verification that a claim is established universally by independent and different peers in the field.

The scientific method is initiated with a hypothesis. A hypothesis is a speculation, based on observed facts, put forward to explain a phenomenon. It is the first step to explain the cause of an effect, which requires experimental testing to determine the validity of the proposed hypothesis.

Natural phenomena, for which we seek explanations, come in two forms: those directly observable (apples falling, birds flying, ocean tides etc.) and those that are not directly observable (e.g. cause of certain diseases, global warming, atoms and molecules etc.). The former can be directly tested by experiments, but the latter requires indirect experiments to explain the observations. This is where the ingenuity of the scientist is called upon to formulate a hypothesis and design experiments that can prove or disprove the proposed hypothesis. Thus the scientist has to test the unobservable by their observable outcomes.

The scientific method consists of the following steps:



Facts, Theories and Laws of Science

Science and scientific methodology associated with certain terms which are sometimes confused with their everyday usage. The apple that supposedly fell on Newton's head is a *fact*. The theory that Newton formulated to explain this fact is the *theory* of gravitation. In the Galapagos Islands, Darwin observed that the beaks of birds were adapted to the food they consumed. From this and other facts that he observed on the gradation of complexity in life he formulated the *theory* of evolution by natural selection. Scientific *theories* are thus attempts to explain natural phenomena. Scientists propose a theory to explain a phenomenon. It allows predictions to be made and is the source of knowledge if used carefully. Such a theory is testable by independent repeated observations and experimentation by other scientists. The scientific method helps us to determine the truth or validity of a theory. A theory is rejected fully or partly if it is unable to explain the observations. Based on experimental observations the original theory is modified or a new theory is proposed and tested.

The limitations of science

Does science have answers to all the questions? No. Science is limited to the observable universe which is the world we live in. Science does not and is incapable of answering questions of religion such as: is God behind the Theory of Evolution and the Theory of Gravitation? Did God create the universe and life etc? Answers to these questions are based in belief, faith and individual reasoning.

Science operates on factual data or empirical evidence. It cannot be applied to subjective judgments' such as evaluating what is good or bad, deciding on ethical implications of an outcome in science (e.g. genetic engineering, nuclear energy, stem cells etc.) or the morality of human actions etc. Today, science has not only understood many of the phenomena in our environment, but is able to manipulate previously unthinkable changes: plants can be engineered to deliver products not in their original genomic blueprint, babies are produced in test tubes, and the energy binding sub-atomic particles within the atom can be unleashed, to name a few. From this it is obvious that science does not tell us what we *ought* to do, particularly the ethical implications of its methods and their outcome. Thus it is necessary to be clear on the limits of science and its methodology.

Technological innovations in the last couple of decades in the sciences have enabled scientists to conduct experiments that have pushed the frontiers of knowledge into previously uncharted areas. An example is the transfer of human genes to animals to study human diseases, routinely practiced in many laboratories. However, advances in genetic and stem cell technologies have now given scientists the theoretical possibility of creating animals with human characteristics and behaviours. To regulate such research at the human-animal interface the Academy of Medical Sciences in the UK conducted a study and produced a comprehensive report. Some sensitive areas considered were: modifications of the animal brain leading to human-like cerebral functions; experiments leading to functional human gametes in the animal, and modifications to an animal to create features perceived as uniquely human such as facial shape, skin texture or speech (Bobrow 2011). The scientific method does not tell us where such research should stop and when the ethics and governance of research should take over.

Philosophy in Science

The purpose of philosophy in the sciences is to establish the correct foundations of science, the ethics and morality in the undertaking of science, and determine the methods of investigation.

These are the responsibility of philosophy, which by a process of discussions, arguments and evaluations can point the way to possible answers. Thus, in essence, the scientific process tells us what “*is*” and not what “*ought*” to be. The philosophy of science contributes to identify what is science and thereby exclude disciplines that do not belong to science or where the methods in science cannot be successfully applied.

Science may be regarded as a vast enterprise which, since its origins in the 17th century, has transformed the society irrevocably. This transformation has meant improved standards of living, giant strides in the acquisition of knowledge and our comprehension of the universe. However, on the negative side, science has also been misused: there is enough firepower in the global arsenal to destroy this planet many times over, the irrational use of our natural resources, industrial accidents causing environmental pollution on an unprecedented scale, and now global warming is presenting unknown challenges.

Further reading

Bobrow, M. (2011). Regulate research at the animal-human interface. *Nature* 475:448.