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8 Scientific Enquiry: A Popperian Account

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Abstract

Popper tries to find out a radically new account of science without making any reference to induction. The object of science, or indeed of any serious response to the world, is not, simply and without qualification, truth. Even in the areas of research, it is futile to set ourselves to discover the truth or even to try to show that a given theory is true. There is historical evidence that any serious hypothesis, purporting to set out exactly the workings of some part of nature, even if it covers all the data currently available, is unlikely to be more than an approximation to the truth or to embody some part of it. Thus, the task of research is also not to seek evidence in favour of the hypothesis, but what is essential to the development of science is the discovery, not of many observational data which support a given hypothesis, but of one which refutes it. Popper substituted falsifiability for verifiability as the criterion of science.

Keywords*: Scientific inquiry, Scientific method, Induction, Verifiability, Falsifiability*

An important aspect of science is its method of inquiry. This is its most permanent feature, which can bring about confident valid conclusions. It is founded on objective observation, logical reasoning, the formulation of hypotheses that fit the data and predict other possibilities, repeatable experiments that can fail as well as succeed, and analysis and review by the scientific community. The scientific method is considered to be a collective effort of scientists to explain the world with accuracy, reliability, consistency and also must be non-contradictory. It is the method which is really permanent about science, which does not change from time to time and the study of which will give an insight into the nature of science. The theory may supersede theory and more accurate analysis may demolish the apparent facts, but there are a unity and continuity about the method that the mind should be able to grasp and that is the very essence of science.

The most important significance of scientific method is that it is not based on any preconceived ideas, i.e., it is not necessary to trust a researcher or a scientist, the experiments can be repeated and analyzed further

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whether the results are correct or incorrect. The conclusions will hold irrespective of the state of mind, or the religious persuasion, or the state of consciousness of the investigator and the subject of the investigation. A scientific theory must not be adopted or discarded on the basis of belief or faith as they are not supported or justified by logical proofs or material evidence. A theory must not be taken into account on the basis of its proponents, but on the results obtained through observations and experiments which anyone can reproduce, that is, the results obtained using the scientific method are repeatable.

As the scientific method is a more general way of scientific inquiry, it belongs to a larger class, i.e., a comprehensive set consisting of theoretical and practical aspects. Both abstract and concrete aspects are there, of which the theoretical or abstract aspect is known as 'methodology' and the practical or concrete aspect is known as 'technique'. There are various techniques of measurement in science. Though the techniques may vary, the methodology will be the same. The methodology will be different for different subjects. But when science is taken as a whole, a common method of inquiry can be noticed. To explain it more, it applies common principles to evaluate the weight of evidence, common rules to judge the sufficiency or consistency of arguments, same criteria will be used to decide between alternative hypotheses, etc. The methodology consists of logic whereas techniques consist of technology and applied science. The techniques of measurement depend on the nature, quality and quantity of the object to be measured, the precision required, availability of requirements, etc. All these techniques follow the fundamental laws regarding matter, electricity, gravitation, etc. These laws are applicable to positive sciences but not to social sciences. (Gupta, 1978, p. 80) But certain techniques regarding mathematics, statistics, etc. are not commonly applicable to all positive and social sciences.

Scientific method is greatly concerned with the nature of science because the nature of an object has got a lot to do with the method of inquiry. There are three complimentary features for the nature of science, the scientific method, the relation of science to physical nature, that is, to know the nature and to change it, and to know or to study the nature in the philosophical aspect of science and the effort to change it in the technological aspect of science. The primary aim of science is the attainment of systematic and reliable law so as to be able to make predictions and to effect changes. For the attainment of systematic and reliable knowledge, the scientific method has got an important part to play.

It is commonly believed that the systematic use of induction is that which distinguishes natural science from other disciplines like pure mathematics and metaphysics. But to Popper, there is no such thing as

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induction and the character of natural science has been long and widely misunderstood. Popper tries to find out a radically new account of science without making any reference to induction. An effective case has been made against one simplistic version of induction – first repetition among observational data and then generalization based on these. The object of science, or indeed of any serious response to the world, is not, simply and without qualification, truth. Even in the areas of research, it is futile to set ourselves to discover the truth or even to try to show that a given theory is true. There is historical evidence that any serious hypothesis, purporting to set out exactly the workings of some part of nature, even if it covers all the data currently available, is unlikely to be more than an approximation to the truth or to embody some part of it. Thus, the task of research is also not to seek evidence in favour of the hypothesis; after simply repeating the experiments which suggested it in the first place all the volume of favourable evidence can be increased. The denial of the role traditionally ascribed to induction amounts then to this, i.e., what is essential to the development of science is the discovery, not of many observational data which support a given hypothesis, but of one which refutes it.

For science what is required is that to some degree the theory should be something of general interest and the testing should be disciplined and systematic. Thus, the prediction as Popper notes, 'It will rain or not rain here tomorrow' will not be regarded as empirical, simply because it cannot be refuted; whereas the statement, 'it will rain here tomorrow' will be regarded as empirical and will be considered as a contribution to science. However, the most immediate advantage of substituting falsifiability for verifiability regarding the criterion of science lies in the lack of equality or equivalence between verifiability and falsifiability and this lack of equality or equivalence is due to the logical form of universal statements. As upheld by Popper, universal statements can be contradicted by singular statements but they cannot be derived from singular statements. (Popper, 1959, p. 41) Hence, by using deductive inferences, particularly with the method of modus tollens in traditional logic, it is possible to falsify universal statements with the help of singular statements.

Science thus becomes logically respectable and has to abandon all claims to tell the general truths about the world. Even if assumed that to establish beyond question of the truth of some singular statements, these still enable to show only that some of the generalizations which for various reasons have interested scientists are false, never that any of them are true. Scientific knowledge is that body of theories which have thus for survived systematic testing and the progress of such testing, and the modifications of theory made in response to it mean that the scientific knowledge is in the constant progress of self-change and

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self-renewal. Indeed, given the ever-increasing volume of scientific research and the number of workers in the field, the life expectancy of promising theories has presumably decreased; it seems unlikely that any of them will ever again approach the longevity of Newtonian Physics. Even those theories which no scientists at the moment seeking to refute, and which are ordinarily treated and taught in departments of science as though they were established truths, can still logically lay claim to no title stronger than that of conjecture – conjectures, it may be, that are very well corroborated, in the sense of having survived many tests, but conjectures none the less, which future research may well find reason to replace. (Popper, 1959, p. 25)

A genuine scientific theory then will be insecure because it puts itself at risk by ruling something out, forbidding something to happen. The more it forbids, the better it is; if it rules out everything but one quite specific and prima facie unlikely outcome in a specific set of circumstances, and gets away with it, this is a genuine scientific triumph. This according to Popper was the supreme merit of Einstein's theory over those of the other intellectual heroes of his student years, Marx, Freud and Adler. It was not because Einstein had established or was on the way to establishing the truth of his theory and the others had failed. But Popper was critical about Marxism and the theories of Psychoanalysts because his contemporaries found only what is admirable about them due to their apparently limitless explanatory power. Marxists and Psychoanalysts always stressed the evidence in favour of their theories and ignored or explained away counter-evidence. (Burke, 1983, p. 53) These theories seemed to manifest itself everything that happened within the fields to which they were discussing. These reviews resulted in an intellectual transformation or disclosure, throwing light into new hidden truths that were not yet initiated. Confirming instances could be seen everywhere since the world was full of verifications of the theory. Whatever happened always confirmed it. On the other hand, Einstein used his novel gravitational theory to predict what would be observed during an eclipse of the sun, by no means everything that could happen would confirm it. Einstein made a bold and highly improbable prediction in his theory of gravitation, about the path of light being bent by the presence of a heavy body just as material bodies could be. This prediction was not tested until 1919, some years after having been made when a total eclipse of the sun made testing possible. Popper is of the view that had this test gone against the theory, Einstein would have renounced it. Indeed, every finding other than precisely the one predicted would refute it. According to Popper "the impressive thing about this case is the risk involved in a prediction of this kind. If observation showed that the predicted effect is definitely absent, then the theory is simply refuted. The theory is incompatible

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with certain possible results of observation, in fact with results which everybody before Einstein would have expected." (Popper, 1963, p. 36) Einstein's prediction became a major landmark in the history of science and it was at the same time the falsification of a body of theory that until then had commanded universal assent. But the point to be noted here is that while getting away with such a risk did not make Einstein necessarily right; there are always further tests to be faced, and taking such a risk made him a genuine scientist.

A genuine non-tautological statement whether it belongs to science or not rules something out. A statement which ruled out nothing, which left all possibilities open, would fail to fulfil the essential function of a statement. To tell that things are this way rather than any other and hence it might fairly be called, in the idiom of logical positivism, a 'pseudo-statement', or 'meaningless' or 'non-sensical' is that, even though it may be grammatically impeccable and made up of familiar words, it is only verbal lumber and serves no purpose in discourse. Falsifiability might be taken as a criterion of meaningfulness, or the distinguishing mark of a genuine statement as opposed to pseudo-statement. Popper has always been misunderstood as a logical positivist. When the ideas of falsifiability were first put forward, it was in fact widely supposed that Popper was using it in the same task as contemporary positivist, had given to verifiability. However, Popper had never intended anything of the kind and emphatically denied it. A general criterion of meaning was never offered and never claimed that statements which were unfalsifiable were, therefore, pseudo-statements or meaningless. (Popper, 1959, p. 278) Popper maintained that incompatibility with certain possible results of observation is simply the criterion of being a scientific statement, not of being a genuine or meaningful one. A statement as such is essentially a statement of results, the results of some process of inquiry or finding out and hence presumably there would be some inquiry, i.e., results incompatible with any given statement. But even if this is indeed a general condition of statement-making, there is a need of justification and such inquiry must always be reducible to observations, or contain observation as an essential part.

Popper suggested that a confrontation between imaginative theory and observed facts makes a given inquiry or piece of research a contribution to science. While the proposing and testing of theories is undoubtedly an important part of the scientific enterprise, it is only a part. For science, the theory is essential but the observations must be allowed the last word. It is opposed to the earlier view of science that the primary purpose of science is to establish general truths by the systematic use of observation. Science must also increase positive knowledge and give theories that can be relied on for practical

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purposes. Moreover, it should be seriously over-simplified and in its turn open to refutation and replacement. In the development of the philosophy of science, the main effects of Popper's work have been to turn attention away from the 'problem of induction' and to stimulate a notable variety of attempts to diagnose and correct the oversimplifications of his own. Science consists of a whole range of activities and their results, a range with ill-defined and disputed boundaries, and with complex and varied relations between its elements. Actually, Popper puts forward the criterion for demarcation of science, i.e., to make a proposal for an agreement or convention. (Popper, 1959, p. 27)

Science is concerned itself with pragmatic issues as well as with truth and falsity and claims that it's systematic sorting out of the false from the true (or possibly true) among theories serves the purposes of providing guidance as to future experience. Test situations will recur and the record of how various theories fared in the past is a guide to how they will fare in the future. Otherwise, science would have merely historical interest and science have always made stronger claims for itself than that. Popper opined that it would be ideally logical and rational to move ahead on the assumption that the future also will be following the past in many respects and even the well-tested theories and laws will still hold on. Similarly, it is also logical and rational to believe that these assumptions may, in turn, lead to intense problems difficulties as certain heavily relied theories and laws can easily be proved unreliable. A conclusion can never be reached from previous experience and from the general scientific knowledge that the future will be similar to the past, in innumerable ways it can be proved to be wrong. (Popper, 1963, p. 56) To judge from past experience is to treat such experience as a ground for looking forward to a certain measure of continuity, punctuated without a doubt with novelties and surprises, extending into future.

Popper is insistent that testing scientific theories are very rarely a simple matter as explained in the example 'All crows are black'; where all that is needed is an alert and honest observer. Devising tests is often a very roundabout affair, requiring considerable technical ingenuity as well as familiarity with, and reliance on, a complex of other theories. Checking theories against the facts of observations is only rarely a matter of keeping eyes opened and recording faithfully what is perceived. The terms ordinarily used for recording commit far beyond the content of any finite set of sense-experiences. The experimenter, as well as the theorist, has to live with the permanent possibility of falsification, there is no question of simply contrasting speculative theories with infallible observation statements.

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There can be no final or absolute refutation of any given theory, and hence no absolute scale by which scientific progress can be measured. Certain theories and certain basic statements are mutually inconsistent and any of them has not been shown conclusively to be true or even false. Popper outlined the logic of science where it is possible to avoid using the concepts 'true' and 'false'. Logical considerations about derivability relations must be taken into account. It is not necessary to mention that the theory is 'false' but, must be substituted by mentioning that it is contradicted by a certain set of accepted basic statements. Basic statements are not required to be stated as 'true' or 'false', but their acceptance must be interpreted as the result of a conventional decision, and the accepted statements as results of this decision. (Popper, 1959, pp. 273-74)

Popper insists on the importance of science for its rigorous and systematic testing of statements, if such tests are never logically sufficient to establish the truth of any statement, then they never entitle to say since the truth of 'a, b and c has been established, x must be rejected as false' but only, 'if accepted a, b and c as true, the x must be rejected as false'. No theory can then be conclusively falsified any more than it can be conclusively verified; and scientific progress, in any absolute sense, is no more than the illusion of those naive enough to overlook the role of convention in the establishment of basic statements. It is only provisional that any of the scientific statements whether generalization or basic statement, can always be tested further, should the need or demand for such testing arise. Popper emphatically claimed that science ought to operate, i.e., in the realm of discovery.

According to Popper, to discuss thus the effectiveness of science for this or that purpose in the dealings with the world is to obscure what is for its primary commitment, i.e., to the quest for the truth about the world. And similarly with all that has been said about scientist's opinions between holdings on to a theory in the face of contrary evidence, showing it up with the supplementary hypothesis, or making a bold revolutionary shift to an entirely new theory. This is the source of Popper's impatience with all such theorizing about science. Granted this, the quest for truth must always be an unended quest, it does not follow that it is a mistaken one; rather the idea of truth serves as the standard of which may fall short. Every available test, which would fail if they were not true and thus endeavour to expose and eliminate falsehood, is the real business of science. Popper does not allow that science might properly tolerate indefinitely several mutually inconsistent theories, or leave us free to choose between them on grounds of internal consistency, simplicity, interest, practical utility or anything else but truth or falsity. The only

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genuinely scientific reason for discarding a theory is that it is not true; the only one for holding on to it is that it might be true.

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