Unit 3

Science and Hypothesis

Why Hypothesis?

All men, unlike animals, are born with a capacity "to reflect". This intellectual curiosity amongst others, takes a standard form such as "Why so-and-so is such-and-such?". While answering such queries men proceed from ignorance to the path of knowledge, from incomplete to complete knowledge. In the course of this journey 'to know', various hypotheses are formulated or rejected depending upon the accompanying circumstances. A hypothesis is a form of development of knowledge. Hypotheses are advanced to substantiate various assumptions to explain some phenomenon and its connection with other phenomena. Their importance in the growth and development of natural sciences can by no means be underestimated. Nature is a big mystery governed by its own rules but it is man who discovers these rules and formulates laws and theories. Apple always falls on the ground but it was Newton who found the rationale in the form of Gravitational power of earth.

What is a Hypothesis?

A hypothesis is a tentative statement that proposes a possible explanation for some phenomenon or event. Hypothesis is an educated guess. The term educated is highlighted because no good hypothesis can be developed without research into the problem. The need for a hypothesis arises when some novelty or abnormality is observed in some phenomenon which can neither be understood nor explained through prior established laws. To understand such inconsistencies, some tentative statements are formed on the basis of observation and put to exhaustive scientific investigations. These investigations are necessary in order to assess the testability and accuracy of hypothesis. Since a hypothesis is a possible solution, initially its truth is as questionable as its falsity. It may turn out to be true or it may turn out to be false. For example, when I reach home, see the main door opened ajar and the door lock broken, all household things scattered all over the place, seeing this and other accompanying circumstances, I start making conjectures leading to the conclusion that a burglary is the most possible happening. These conjectures are called hypotheses, and the reasoning used to produce them is called hypothetical reasoning. The hypotheses make up for the lack of direct observation in producing the needed explanation. A useful hypothesis is a testable statement which may include a prediction. A hypothesis is not identical with a theory. A theory is a general explanation based on a large amount of data and underlying assumptions. In contrast, a hypothesis is more specific than a theory.

Types of Hypotheses

Depending upon the level of generality, scientific hypotheses may be divided into general, particular and individual.

A general hypothesis is a scientifically substantiated assumption about the causes, laws and rules governing natural phenomena. For example, there is 'Democritus hypothesis' about the atomic structure of substance which subsequently became a scientific theory.

A particular hypothesis is a scientifically substantiated assumption about the causes, origin, regularities and irregularities of a part of objects singled out from a class of objects belonging to Nature. In other words, they are devised to reveal the reasons for the emergence of irregularities in a subset of the given set. For example, while trying to find some remedy for cancer, several particular hypotheses are advanced about the causes of viruses of malignant tumours.

An individual hypothesis is a scientifically substantiated assumption about the causes, origins, regularities and irregularities of individual facts, concrete events or phenomena. For example, a doctor while diagnosing constructs individual hypotheses in the course of treating an individual patient. After detecting the ailment, he not only selects drugs but also their dosage individually.

Stages of constructing a Hypothesis

S1. Identification of some unexpected novel happening in a group of facts which is not covered by prior established laws, and thus is required to be explained by observation, collection, and relevant classification of empirical data by forming a new hypothesis.

S2. Formation of the hypothesis (or hypotheses), i.e., assumptions which would explain the regularities or irregularities in question.

S3. Derivations of all relevant consequences from the hypothesis in question which will further qualify it for verification.

S4. Comparison of all the logical consequences drawn from the hypothesis with the existing observations and established laws of science is a step ahead in its acceptance.

S5. Transformation of the hypothesis as a part of scientific theory if all consequences of the hypothesis are corroborated without any inconsistency.

Conditions of a Good Hypothesis

Every hypothesis is either good or a false one. A hypothesis is good if it finds a secure place in science. In order to be a good or sound hypothesis it must satisfy the following five conditions. These five conditions commonly set the criterion for judging the worth or acceptability of any hypothesis.

1. Relevance

Every hypothesis is an intentional demand for a possible explanation of some fact or the other. Hypothesis is neither proposed for its own sake nor does it come out of nothing. As a matter of fact, it must be relevant to the fact it is trying to explain. The fact demanding explanation must be deducible from the proposed hypothesis, together with certain assumptions about particular initial conditions. A hypothesis which is not relevant to the fact it is intended to explain will not be good. It is regarded as having failed in fulfilling its intended function. Thus, a good hypothesis must be relevant. A relevant hypothesis must be based on observed data. Agreement with facts is the sole and sufficient test of a relevant hypothesis. A hypothesis which fails to distinguish relevant from the irrelevant data while ordering facts, is far from satisfactory.

2. Testability

One of the most distinguishing features of a hypothesis is its testability. That is to say, it must be able to withstand all the possibilities of making observations which can confirm or disapprove any scientific hypothesis. A scientific hypothesis has not only been testable for its truth but also for its falsifiability. There must be a way to try to make the hypothesis fail. Science is often more about providing a scientific statement wrong rather than right. If it does fail, another hypothesis is tested usually one that has taken into account the fact that the last hypothesis failed. One more thing which is very clear about the testability of hypothesis is that it excludes all supernatural explanations. By supernatural we understand 'all the events and phenomena which cannot be perceived by empirical senses or which do not follow any natural rules or regularities.' Thus, all supernatural explanations cannot find any place in science as they cannot be scientifically tested. That is to say, they must be verifiable. They must be such that we can deduce consequences from them in order to compare them with the actual facts. A hypothesis from which nothing can be deduced is of no value whatever. It may be tested directly or indirectly. As in the case of earlier scientifically established hypotheses, it must also be connected in some way with empirical data or facts of experience.

3. Compatibility

This is yet another simple requirement of the acceptability of any hypothesis. It must be compatible or consistent with other hypotheses which have already been well confirmed or have gained reasonable acceptability. Ideally when scientists hope to make progress by gradually expanding the scope of their hypotheses, they comprehend more and more facts and a scientific system is built. This way scientific progress of any system is possible. For such progress can be made only if the new hypothesis is consistent with those already confirmed. The occurrence of an incompatible hypothesis shows that a given region of fact has not yet been sufficiently organized.

4. Predictive Power

Any sound hypothesis should contain a prediction about its verifiability. The predictive or explanatory power of a hypothesis amounts to the range of observable facts which can be deduced from it. Often this condition is related to another condition, viz., testability. A hypothesis is testable if some observable fact is deducible from it. When we confront two testable hypotheses [H1 and H2] of which [H2] has a greater number of observable facts deducible from it than from [H1], then [H2] is said to have greater predictive or explanatory power. The greater the predictive power of a hypothesis the more it explains, and the better it contributes to human understanding of the phenomenon under examination.

5. Simplicity

Though this condition is difficult to define, yet it is invoked intuitively. It is very natural that one is inclined towards the sheer simplicity and elegance of a hypothesis. Suppose there are two competing hypotheses trying to explain some phenomenon, the chosen hypothesis will automatically be the one which explain facts in the simplest terms. Historically, the most famous pair of such hypotheses is (a) Heliocentric (Copernicus) and (b) Geocentric (Ptolemy), both were interested in explaining the centre of the universe so that the movement of other heavenly bodies around it could be understood. According to Ptolemy, the earth is the centre of the universe and the heavenly bodies move about it in paths that require a very complicated geometry to describe it. On the contrary, Copernicus described sun as the centre of the universe. Though both systems require some complicated accounts of epicycles for some observed positions of various heavenly bodies, yet Copernican system was much simpler. This simplicity made Copernicus' theory more acceptable than the other advanced by Ptolemy.

Hypothesis and Crucial Experiments

A scientific inquiry attempts to provide proper justification for accepting or rejecting a hypothesis as true or false. Sometimes it also happens that two different hypotheses fully explain some set of facts and both are testable, both are compatible with the whole body of already established scientific theory. In such situations, it may be possible to choose between them by deducing from the incompatible propositions which may be tested directly. Thus, to deal with such a situation, we set up a crucial experiment to decide between the competing hypotheses. It may not be easy to carry out the task as the accompanying circumstances of these hypotheses may be difficult or impossible to obtain now.

Note : Hypothesis - Singular; Hypotheses - Plural

Questions

1. Define hypothesis. What is the utility of hypothesis in science? Explain
2. Give a brief account of different types of hypothesis?
3. Discuss various stages of constructing a hypothesis.
4. What are the conditions of a good hypothesis? Give a brief account.
5. When is the need for crucial experiments arise in scientific inquiry? Is it always possible to have crucial experiment? Discuss