# Chapter 2

# Scientific Method

## Introduction to Scientific Method

To be termed scientific, a method of inquiry must be based on empirical and measurable evidence subject to specific principles of reasoning. The "scientific method" attempts to minimize the influence of the researchers' bias on the outcome of an experiment. Another common mistake is to ignore or rule out data which do not support the hypothesis. The scientific method is the process by which scientists, collectively and over time, endeavour to construct an accurate (that is, reliable, consistent and non-arbitrary) representation of the world.

## Difference between Scientific and non-scientific Method

The purpose of research is to discover answers to questions through the application of scientific procedures. The main aim of research is to find out the truth which is hidden and which has not been discovered as yet. The scientific approach to knowledge is empirical. The empirical approach emphasizes direct observation and experimentation as a way of answering questions.

When observing phenomena, a scientist likes to exert a specific level of control. When utilizing control, scientists investigate the effects of various factors one by one. Non-scientific approaches to knowledge are often made unsystematically and with little care. The non-scientific approach does not attempt to control many factors that could affect the events they are observing. This lack of control makes it difficult to determine cause-and-effect relationships.

How can two people witness the same event but see different things? This often occurs due to personal biases and subjective impressions. These characteristics are common traits among non-scientists.

## Important Characteristics of Scientific Method

### a). Empirical

Scientific method is concerned with the realities that are observable through "sensory experiences." It generates knowledge which is verifiable by experience or observation. Some of the realities could be directly observed, like the number of students present in the class and how many of them are male and how many female.

### b). Verifiable

Observations made through scientific method are to be verified again by using the senses to confirm or refute the previous findings. Such confirmations may have to be made by the same researcher or others. We will place more faith and credence in those findings and conclusions if similar findings emerge on the basis of data collected by other researchers using the same methods.

### c). Cumulative

Prior to the start of any study the researchers try to scan through the literature and see that their study is not a repetition in ignorance. Instead of reinventing the wheel the researchers take stock of the existing body of knowledge and try to build on it. Facts and figures are to be provided with language and thereby inferences drawn. The results are to be organized and systematized.

### d). Deterministic

Science assumes that all events have antecedent causes that are subject to identification and logical understanding. For the scientist, nothing "just happens" – it happens for a reason. The scientific researchers try to explain the emerging phenomenon by identifying its causes.

## Induction

It is one of the scientific methods. It follows the logical reasoning process. It is a process of reasoning whereby the researcher arrives at universal generalizations from particular facts. In other words, this method involves studying several individual cases and drawing a generalization. Conclusions drawn from induction and tentative inferences and they are subject to further confirmation based on more evidence.

## Deduction

Deductive reasoning is a basic form of valid reasoning. Deductive reasoning, or deduction, starts out with a general statement, or hypothesis, and examines the possibilities to reach a specific, logical conclusion. The scientific method uses deduction to test hypotheses and theories. In deductive reasoning, if something is true of a class of things in general, it is also true for all members of that class. For example, "All men are mortal. Harold is a man. Therefore, Harold is mortal."

## What are the Scope of Scientific Methods?

- **Economic Planning:** Research can be of immense use in economic planning in a given society. Economy planning requires basic data on the various aspects of our society and economy, resource endowment and the needs, hopes and problems of the people, etc. Economic planning is undertaken to achieve certain objectives such as:
  - ✓ To bring about regional development.
  - ✓ To make optimum use of available resources.
  - ✓ To bring out self-reliance.
  - ✓ To generate employment, etc.

  A systematic research provides the required data for planning and developing various schemes or programmes such as employment generation programmes, rural development programmes, etc.

- **Control over Social Phenomena:** Through research, first-hand information can be obtained in respect of the working of institutions and organisation, which in turn provides greater power of control over the social phenomena. The social science research has practical implications for formal and informal styles of managing, organisation structures, and introduction of changes in the organisation.

- **Social Welfare:** Social research can be used to collect the required data on different aspects of social life in a given society, so as to develop social welfare programmes.

- **Helps to Solve Problems:** Research can be undertaken to find solutions to solve specific problems. For instance, an organization may initiate research to find solution to the problem of declining sales of their products in the market. An educational institution can undertake research to find out the causes of low attendance or poor results. A government organisation may undertake research to solve the problem or to ascertain the impact of slums on the quality of life in a particular city, and such other research activities. The research enables to find appropriate solutions to specific

problems which in turn helps to improve the quality of performance in various organizations or institutions.

- **Verifies and Tests Existing Laws:** Research may be undertaken to verify and test existing laws or theories. Such verification and testing of existing theories help to improve the knowledge and ability to handle situations and events.

- **Develops New Tools and Theories:** Research helps to develop new tools, concepts and theories for a better study of an unknown phenomenon. For this purpose, exploratory research is undertaken to achieve new insights into such phenomenon.

- **Helps to Predict Events:** Research may be undertaken to predict future course of events. For instance, research may be undertaken to find out the impact of growing unemployment of educated youth on the social life of the society in future.

- **Extends Knowledge:** Researchers undertake research to extend the existing knowledge in physical sciences (such as physics, chemistry, mathematics, etc). as well as in social sciences (like sociology, management, psychology) etc. The knowledge can be enhanced by undertaking research in general and by fundamental research in particular.

## What are the scopes of the scientific research?

The scope of scientific research is vast and encompasses a wide range of disciplines and fields. Scientific research aims to expand our understanding of the natural world, solve problems, and improve our lives. Here are some key scopes of scientific research:

- **Basic Research:** Investigating fundamental principles and phenomena to enhance our understanding of the natural world. Often exploratory, with the goal of expanding scientific knowledge without immediate practical applications.

- **Applied Research:** Focusing on solving specific problems or developing new technologies. Applies scientific knowledge to address practical issues and improve existing processes or products.

- **Interdisciplinary Research:** Collaborating across different scientific disciplines to address complex challenges. Involves integrating knowledge and methodologies from multiple fields to gain a comprehensive understanding of a topic.

- **Medical and Health Research:** Conducting research to understand diseases, develop new treatments, and improve healthcare practices. Involves clinical trials, epidemiological studies, and biomedical research.

- **Environmental Research:** Studying the environment, ecosystems, and the impact of human activities on the planet. Research in this scope aims to address environmental challenges, such as climate change, pollution, and biodiversity loss.

- **Space and Astronomy Research:** Exploring the cosmos to understand celestial bodies, the universe's origins, and the possibilities of extraterrestrial life. Involves astrophysics, cosmology, and space exploration.

- **Social Science Research:** Investigating human behavior, societies, and social systems. Research in this scope includes psychology, sociology, economics, political science, and anthropology.

- **Technological Research:** Developing and improving technologies to address societal needs. Involves research in fields such as computer science, engineering, nanotechnology, and materials science.

- **Educational Research:** Studying teaching and learning processes to improve educational outcomes. Research in education aims to enhance educational methods, curriculum design, and student engagement.

- **Psychological Research:** Exploring the mind and behavior of individuals. Research in psychology covers areas such as cognitive psychology, behavioral psychology, and clinical psychology.

- **Economic Research:** Investigating economic systems, markets, and policies. Economic research informs decision-making, policy development, and understanding economic phenomena.

- **Energy Research:** Developing sustainable and efficient energy sources. Research in energy encompasses renewable energy technologies, energy storage, and energy efficiency.

- **Biotechnology and Genetics Research:** Advancing knowledge in genetics and applying biotechnological techniques. Research in this scope includes genetic engineering, genomics, and biopharmaceuticals.

- **Cultural and Historical Research:** Examining cultural practices, historical events, and societal developments. Research in this scope contributes to our understanding of human history and cultural evolution.

- **Philosophical and Ethical Research:** Exploring philosophical questions and ethical considerations related to scientific advancements. Research in this scope addresses the broader implications of scientific discoveries and technological innovations.