Foundation Course

Semester 3

**SCIENCE IN EVERY DAY LIFE**

**INTRODUCTION**

Science is developed from the need of understanding the natural phenomena. It is a set of complex theories and ideas based on observing, testing, analyzing and then presenting phenomena. Scientists have developed several techniques to achieve this. The general process that has thus been formulated is known as the scientific method.

The scientific knowledge accumulated over the years has helped man to apply rationale and logic to everyday life as well. It has proved several superstitions and blind beliefs as wrong. The most important part of application of science is technology.

**THE SCIENTIFIC METHOD**

The logical process adopted by scientists to develop knowledge of nature and present it as an acceptable fact is known as the scientific method. This method is based on gathering empirical data through observation and experimentation and the formulation and testing of hypotheses.

The scientific method consists of the following four elements:

1. **Defining research problem:** To determine what phenomenon has to be understood, what has to be observed and how it has to be measured.

2. **Hypotheses:** Hypothesis is a logical predictive statement regarding the outcome of the research. Developing hypothesis provides direction to the research. A hypothesis can be proved wrong during the process of research. In this case also it is helpful because it helps to find out other logical steps to reach a certain conclusion.
3. Observation and experimentation: testing characterization, hypothesis, predictions. Verify the empirical data.

4. Conclusions: based on experimentation and logic, derive conclusions to understand the phenomena.

By following this process, new theories can be developed, existing theories can be tested under new hypothesis also existing hypotheses can be verified through new experiments devised to test them.

1- Observation

Observation of a particular element means to notice and study it, in —as it is‖ form. In scientific observation several techniques are applied for investigating phenomena and acquiring knowledge.

The observer does not change anything in the phenomena and remains neutral during the observation process. The empirical data gathered through observation is subjective based on observer. To rule out such errors scientific instruments are used. They help to channelize the sense through a particular channel and help to avoid differences in sensory perceptions like optical illusions. Standard units of measurements are followed during observation. Measuring of qualitative data helps in comparing and testing it.

Since the observer does not interfere in the natural form of the phenomena during observation best of the factual data can be collected during this process. It also becomes a basic step while forming hypothesis.

Observation cannot singularly become the basis of developing a theory. The empirical data collected through observation has to be based on certain strong foundations. For this they should be verifiable. Experimentation of observed information is the best way to quantify data and arrive at conclusions.

2- Experimentation

Experiments are processes devised to verify the validity of the hypothesis and understand the empirical data under selected conditions. An experiment is the test which tests the observations
and brings out such results that add to the knowledge of the phenomena. During an experiment the scientists observes the phenomena in a controlled environment. Some experiments are however such that natural environments are necessary for the elements to function.

The experiments are devised in a manner such that the hypothesis can be tested using various parameters. It should be repeatable to enable further checking by any other scientists. Experiment is not the ultimate step to understand phenomena. It is coupled with observation. Scientists can skip experimentation in certain cases where observational data explains fact, logic, intuition and even sometimes accidents reveal information.

The scientist has to follow basic scientific steps while designing an experiment. Certain experiments do not produce immediate results. In such cases all variables that will remain constant as well as those which will change have to be considered. Errors can occur during experiments. This can lead to false results, biased conclusions or failure of hypothesis. Conducting experiments more than once to verify the results is the best way to understand the phenomena. Experiments answer ‘why’ and / or ‘how’ a certain phenomena occurs. If the experiments bear expected results, it may become a theory. If the experiment fails the method is ruled out for further research or adopted with accepted modifications.

**SIGNIFICANCE OF OBJECTIVITY**

Though intuition and logic are considered to be some of the methods to arrive at scientific conclusion, they are not considered to be valid unless supported by evidences. Empirical data collected through observation and verified through experimentation is the standard basis for scientific knowledge. Conclusions are drawn based on systematic analysis. Such scientific method is devised to rule out any bias on the part of the researcher. Scientists are humans and hence study made by them is subjected to be influenced by their perception.

Scientific objectivity assumes that the experiments have been properly performed and the quantitative data has not been tampered with. If the data is objectively obtained then its results are acceptable and reliable. Sources and experiments can be verified to authenticate the theories presented. Scientific objectivity thus also implies sharing of knowledge available for testing. Hypotheses should be subject to criticism. Only then can they invite further research and development.
It also brings out the element of scientific measurement. Such standard measurement is developed that can be used by other scientists except the originator to further develop the theory. It expects universality of empirical tests.

Apart from measurement the experiment also becomes an element in objectivity. The experiment for validation of hypothesis should be devised in such a manner that it can be repeated. If the experiment performed by other scientists produces same results only then does the theory proposed becomes acceptable. Reproducibility of scientific experiments is required for universal acceptance and objectivity.

Scientific objectivity ensures that no knowledge is imposed in the society which is not verifiable. It also ascertains that personal biases, emotional involvement and personal beliefs do not interfere with formation of scientific knowledge. Scientific knowledge is not only useful in theoretical studies but also for general knowledge and development of education. Stress on objectivity makes sure that scientific results and theories are presented in most unambiguous and simple manner.

**SCIENTIFIC TEMPER**

The attitude which enables man to apply logic and arrive at decisions based on reliable and practical knowledge is said to be scientific temper. It implies application of reasoning and avoidance of preconceived notions as beliefs.

General views and beliefs develop because of traditionally accepted views or because it is believed by important persons or given in religious books. Scientific temper demands scrutiny of a certain idea before believing it. Discussions over it, arguing to prove or disprove its validity are methods used to arrive at scientific knowledge with the application of scientific temper. This attitude helps to dismiss superstitions and blind beliefs. It encourages an open mind which strives to achieve best possible reliable knowledge.

Importance: The progress of a society today is said to depend upon its member's attitude towards critical enquiry. Lack of such critical approach can lead to imposition of unjust rules and dogmatic ideas on the people. Such a society will be weak. Thus, scientific temper is necessary for the establishment of a politically, socially and intellectually strong society.
Pandit Jawaharlal Nehru, the first Prime Minister of India, was a keen advisor of scientific temper. The makers of our Indian constitution also realized its importance and hence have included —the development of scientific temper and spirit of inquiry‖ as one of the Fundamental Duty (article 51 A) of Indian citizens. By developing such attitude humanism can be fostered among the people. It will help in formation of a peaceful and civilized society.

India is a land of long history of tradition and also a land of several religions. Heavy emphasis on both tradition and religion create obstacle in the development of scientific temper in the country. This attitude is a severe need of the society. Superstitions and blind faith has given rise to many social crimes and injustices. It has also become hindrance to development of the society. The importance of religion has also led to tensions among various religious groups. Under the name of worship, rituals and dogmatic religious customs, several sections of the society are exploited. Even when India is making new history with atomic development, space researches and technological advancement, such conditions prevail. To counter such sad condition of Indian society, the development of scientific temper becomes the need of an hour.

Scientific temper can be encouraged through education. A spirit of inquiry should be developed at young age. Answers with proper logic should be provided to questions of the young rather than just dismissing them. Through history, tradition should be taught to develop a sense of identity; they should not be imposed without reasoning. The present generation should become more acceptable to reform. Challenge to tradition should be looked in the light of progress if it is based on strong logical grounds. It should be understood that scientific temper does not mean rejection of faith or imposition of western culture. It implies a logical and proper understanding of one’s culture and nature

SUPERSTITIONS, MYTHS AND PREJUDICES

a. Superstitions

Superstitions have been a part of human society since ancient times. It is known to develop because humans fear that which they cannot explain. By making some beliefs about it they try to avoid or to overcome this fear. It is such a belief which is not based on any reason. Superstitions are linked with traditions and many a times with good and bad omens. Many have come down as traditions. However not all traditions are superstitions.
Many a times superstition induces a man to behave irrationally. For e.g. Because of the superstition of the day goes bad when a cat crosses one’s road, many people get petrified when such incidence happens and lose all confidence. Some people avoid taking new work or things on certain days of the week because they believe these days are unlucky, and sometimes they miss out on good opportunities in life. Superstitions have become sources of social problems also. The belief of a son is needed to carry legacy of family has resulted in female infanticide in the society. Animal and human sacrifice is carried in the name of bringing wealth, prosperity and many a times rains.

Science plays a very important role in the eradication of superstition. Science requires proof and empirical data for coming to conclusions. Superstitions are challenged by scientific method in which they have failed completely. A spirit of inquiry can provide answers to many unexplained phenomena and clear out fears related to it. The superstition of snake drinking milk on naag panchami, or bad omen due to the sight of an owl and many banned activities like not cooking on eclipse days are proved to be baseless through scientific experiments.

In a country of beliefs like India, complete eradication of superstitions is still not achieved. However with the greater spread of scientific knowledge it will not be distant dream.

b. Myths

Myths are stories which may be or may not be true. It is based on tradition or legend. They have deep symbolic meaning in it. They are often used to explain beginnings of supernatural beings. It is generally believed that myths were formed to explain some natural phenomena. They are passed down from one generation to another. Myths often convey misleading or wrong knowledge. Therefore scientists work towards proving these myths wrong with various experiments and theories. Myths have importance in history but are mixed with lies. They make interesting stories but cannot be completely believed.

Almost all cultures over the world have their own myths. Some myths have become part of religious explanations. For example the earliest known myth supported by the Bible was, the earth revolved around the sun and the earth was flat. Scientists since the 13th century have found evidence and tried to explain that the earth was round. The sun is stationery, while the earth and other planets revolve around it. It was only by the 17th century that the church accepted this fact.
There are varied theories which explain the creation of the universe. Many of these including the Greek and Hindu mythology explain that the creation of the universe was a gradual process and some order was brought in this world by supernatural forces. While much of it might be unreal, the essence of it may be the same as the Big Bang theory given by the scientists. As new scientific knowledge was gained, gradually many other such myths were broken. There is therefore an opposite relationship between myth and science. Science is progressive, while myths are incorrect knowledge disguised as truths.

c. Prejudices

Prejudices are unfavorable or negative opinions held by people without any knowledge or examination of facts. Prejudices are created in minds of people because of certain stereotypes associated with religion, caste, region, sexuality or nationality of a person. There might be some negative experiences behind development of such attitudes. Such attitudes also pass from one generation to another. For e.g. the phrase of kanjus Marwari in colloquial has developed because of the strict business attitude of the Marwari's. There is general prejudice among urban people that rural people are uneducated, backward minded and poor.

Such negative attitudes have become problems in societies. They lead to disruption of social peace. Such prejudices also bring divide among the people, thus hampering unity in the nation. Minority communities especially suffer inequality and injustice due to prejudices.

Science has helped establish facts among human beings that entire human kind is the same. It emphasizes on knowledge. It accepts the fact that society's progress is based on new theories and laws which are based on facts and not beliefs. Science has proved that any person from any region or cultural background has equal right to exist and respect in the society. Thus, scientific knowledge and scientific temper is necessary for social harmony and development. Scientific temper helps to develop harmonious relationship among people. This spirit of scientific temper can be spread through the medium of education, media and youth.

TECHNOLOGY
In simple words technology is the application of scientific knowledge. It means production of such machinery, arrangements and procedures meant to achieve a certain goal or perform a function. Today every field of human work, from industry to medicine, is affected by and improved with technology. The first stone tool created by man was a technological production at that time since it was a product of man’s knowledge.

1. Features of technology

Technology is not confined to use in one sector only. With more and more developed scientific knowledge a better is induced. New technology makes the earlier one inadequate. As technology is productive it also has its demerits. Following are the important features or characteristics of technology; It has value: Technology has a lot of utilitarian value to mankind. It has made even day to day jobs simpler with machines such as the fan, calculator, water pump etc. technological progress was responsible for the Industrial Revolution in Europe, which changed the economy as well as the political conditions of the world. Product of creativity:Technology is the product of scientist's creative ideas based on scientific theories and laws. For e.g. the kitchen microwave is based on the use of electromagnetic waves. Electricity is produced using the kinetic energy of water. The imagination of men combined with advancing mechanical science has led to the creation of humanoid robots.

Problem solving: Right from the problem of survival during the Stone Age to the problem of sustainable living in the modern age, technology has the power to solve problems. The technology of dam building helped man save and utilize water even apart from rainy season. Technology has helped solve agricultural problems in India as well as in smaller nations.

It has demerits: Every technological product has a negative effect on humans as well as on nature. With industrial progress the problem of pollution increased. Nuclear energy is a great alternative for non-renewable resources but it has health hazards for humans as well as other living organisms on the planet. Several technological devices are also expensive. Theology is not foolproof. Systems can fail, some damages can be irreparable. The impact of damages done by technology can be reduced but failures cannot be avoided completely.

Social change:Technology has completely—and irreversibly—changed the way people meet, interact, learn, work, play, travel, worship, and do business. It has brought people from various
regions around the world together through better communication, travelling and networking. This has made exchange of cultures possible. The world has turned into a ‘global village’ in the 20th century due to technology.

2. Role of technology

Technology has helped increasing productivity and efficiency in every field that it is employed. Agriculture: Technology has helped to improve agricultural production all over the world with the use of tractors and other machines. It has improved productivity in low rainfall lands with new methods of irrigation. It has also enhanced food quality with use of fertilizers, pesticides and also new seed qualities. Transport and communication: Man’s travel is not only increased in speed but also in safety owing to technological inventions in transport. Air travel is common today and also safe. Transportation technology has helped develop better trade too. The internet has revolutionized communication among people. Since communication technology is one of the cheaply available modes, it has connected people even from remotest areas. Today the world is at one’s fingertips with ipads, tablets and Smartphones. Industry: Production is made easier with the help of computers which handle much of the work, minimizing the efforts of labourers. In some factories such as car production, the entire production process is run by robots. In many of the industries today, designs and test models are designed on computers completely and viewed with 3D technology before making the actual product. Technology has reduced the cost of production and increased the efficiency in production on a large scale. One of the disadvantages of technology based industry is unemployment especially in labour intensive countries like India.

Services: The service sector has also been improved with technology. Booking tickets, shopping, handling bank accounts and even setting up a business, such works are easily done with the help of computers and internet. Medicine: Advanced medical inventions have helped to cure many diseases. Vaccinations, diagnosis and operation equipments have increased the lives of people by detecting life threatening diseases at early stages and performing microscopic surgeries on highly risky organs like the heart and the brain. Many diseases like polio, chicken pox etc are completely curable today.
Technology has changed media and its forms. Man has reached space and is researching more about the universe with advancing space technology. Many other fields like construction, logistics, education and commerce have also progressed with better technology.

3. Interrelation between science and technology

The very definition of technology explains it as an extension of science. The relationship between the both has several dimensions. Following points explain the interrelation between science and technology:

Technological application:

New scientific knowledge leads to its application in a new field and for a new purpose. For .e. g. the discovery of nano science has lead to advancement not only in computer technology but also in cosmetics and refrigerators. Technology is the way by which scientific knowledge is combined with practical value and put to the benefit of humankind. Both science and technology are based on experimentation and creation.

Exemplary relationship

Scientists explain natural phenomena on the basis of experiments. Many a times such experiments are done on instruments, tools and machines developed through earlier technologies.

Such technological aids help in understanding and explaining scientific concepts better.

Instrumental relationship

Scientists require different machinery to find out, test and present information. They need accurate machinery for this purpose. Technology is aimed to provide sciences with such devices that further increase scientific knowledge. Sometimes machinery produced for one purpose is used for another scientific experiment. For e.g. telescope invented by an optician in Europe, was later used and developed by Galileo for studying space. Skills and knowledge of the technologists can be thus used to advance science.

inspirational relationship
Science and technology take inspiration from one another for further development. Based on basic electrical sciences, engineers develop such machinery which is used in advanced electrical appliances. On the other hand, some technological devices provide science explanation of some unknown phenomena. For e.g. the invention of steam engine later gave basis for the creation of thermodynamics theory in physics. Thus the instrument gave foundation to research in science.

4-. Science and technology are different

Though we have seen that both science and technology are related in many ways, they are different in nature. The following points can better explain the distinction between them:

Purpose:

Science and technology have fundamentally different purposes. The main aim of science is to explain natural phenomenon through scientific method of observation and experimentation. Technology aims at creation of a product through intellect and design based concepts and methods. While science only observes and understands, technology intervenes in nature. Rather than meeting a human need or opportunity, it is primarily driven by curiosity about something.

Aims

Technology aims at the satisfaction of the end users of a product, process or environment. Science aims at discovery or verification of a certain element of nature.

Role of value:

Scientific knowledge is objective. The theories and laws developed as scientific knowledge cannot be termed good or bad. However technological products do have negative implications on human nature. For e.g. nuclear power and its use as scientific knowledge is not bad, however bomb producing technology for terror purpose is surely inhuman.

Evaluation methods

Scientific knowledge is evaluated through analysis of data. Theories are created and they are tested over various experiments and on the basis of several hypotheses. Other scientists have to give validation to the theories as being true so that they can be established as laws or universal
facts. Technological products are not based on assumptions and hypothesis but verified on the basis of analysis of designs. Thus no validation for truth is required in technology.

Science involves formation of theories based on accurate data, while technology involves use of available data to create approximate models. Technology is therefore different from science in its goals, methodology and also final product.