## Topic 1: Science and Technology

### Objectives

**After completing this chapter, you should be able to:-**

- Identify the different definitions of science and technology.
- Identify the different between science and knowledge, and the characteristics of Science.

### Science refers to:

- A system of acquiring knowledge based on scientific method.
- The organized body of knowledge gained through such research.
- **Fields of science are usually classified to two major lines:**
  - Natural Sciences and Social sciences.
- **Natural Sciences:** studies natural phenomena. (Such as biological life).
- **Social Sciences:** studies human behavior and societies (e.g. Education, History).
- **These groupings are experiential sciences, which means:**
  - The scientific knowledge must be based on observable phenomena
  - Capable of being experimented for its validity by other researchers working under the same conditions.

### Science and Knowledge

1. Knowledge is expertise and skills acquired by a person through experience or education.
2. It is the theoretical or practical understanding of a subject.
3. It is the skill that a person can apply when in need and which he acquired from the previous experiences and learning.
4. what is known in a particular field or in total; facts and information.
5. The awareness or familiarity gained by experience of a fact or situation.
6. Scientific knowledge has led to remarkable innovations that have been of great benefit to humankind.

   **Goals of Science**
   - Descriptions of how nature behaves.
   - Measurement.
   - Understanding and Prediction.
   - Explanation.
   - Application and Control.
7. By field observation, like animal behavior studies in the wild.
8. In order to understand a phenomenon the second step involves some sort of measurement of the phenomenon.
9. Description tells us what is happening and to whom.
10. But it does not tell us "why" it is happening.
11. Scientists seek to understand why the natural world is the way that it is.
12. As well as how the natural world works.
13. Prediction is often associated to empirical, comparative studies.That Generate patterns and statistical models that describe these patterns.

14. Understanding is often associated to experimental, manipulative studies that address mechanisms, and to analytical, deterministic models that use the mechanistic knowledge for prediction.
15. Find the best possible natural explanations of natural occurrences.
16. If we understand what and why something occurs we have greater control over it.

**Characteristics of Science**

- It is guided by natural explanations.
- It Involves scientific method.
- It has to be explanatory by reference to natural law.
- It is testable against the empirical world.
- Its conclusions are tentative (Not-Finalized)
- It is falsifiable.

- Scientific explanations are based on natural law (physical and chemical laws that govern the universe).
- Observe natural or experimental phenomena.
- Construct hypotheses.
- Collect data to test hypothesis.
- Scientific knowledge must explain what is observed by reference in nature.
- We cannot invoke the explanations based on supernatural deities (ghosts, angels, gremlins, fairies, etc.) miracles, or magic.
- Science must only rely on observable, testable evidence which must either support or not support hypotheses.
- This could be done through observations and experimentations. If we cannot make repeated observations or experiments to gather information, then it is outside the realm of science.• Its conclusions are not necessarily the final word.
  - Science is always a work in progress, and its conclusions are always tentative.
  - Scientific conclusions are well founded in their factual content and thinking and are tentative only in the sense that all ideas are open to scrutiny (Inspection).
- If we draw a conclusion based on some observation or test on some event, we must be ready always to discard or to modify our conclusion, if further observations falsify it.
  - If there is no possibility that the statement can not be correct, then it is not science.
  - It means science seek out errors and correct them.
- It Can not be scientific if you start with a conclusion and refuse to change it regardless of the evidence developed during the investigation.

## Technology

- Technology is the application of knowledge, tools, and processes to solve practical problems and extend human capabilities.
- Science is the accumulation of knowledge, while technology is the application of knowledge.
- Science is the study of WHY natural things happen the way they do.
- Technology is the use of knowledge to turn resources into the goods and services that society needs.
- Technological innovations affect, and are affected by, a society's cultural traditions.

**They also are a means to develop and project military power.**

**science answers the question… WHY?**

- Why does this chemical react with this one?
- Why do people from Asia look different from people in South America?
- Why does this material release electricity when exposed to the sun?
- Why is the sun hot?
- Why is the average global temperature rising?
- Technology answers the question… How?
- How can we make a non-explosive gasoline?
- How can we best transport people from Asia to South America?
- How can we make electricity with the sun?
- How can we protect ourselves from the sun?
- How can we stop cancer?

| Science | Technology |
|---|---|
| Is the accumulation of knowledge. | Is the accumulation of knowledge. |
| Is the study of WHY natural things happen the way they do. | Is the use of knowledge to turn resources into the goods and services that society needs. |

## Topic 2: The Scientific Method

### Objectives

**After completing this chapter, you should be able to:-**

- Identify the Six steps of scientific method.
- Identify the basic steps that scientists follow in uncovering facts and solving scientific problems by using scientific method.
- Identify The types of scientific methods: deductive reasoning, inductive reasoning, and hypothetic-deductive or hypothesis testing.

### Scientific method

Scientific method is the steps someone takes to identify a question, develop a hypothesis, design and carry out steps or procedures to test the hypothesis, and document observations and findings to share with someone else. In other words, it's a way to solve a problem.

- The scientific method is the only scientific way accepted to back up a theory or idea. This is the method on which all research projects should be based. The Scientific Method is used by researchers to support or disprove a theory.
- Scientist has to take the time to think logically when they are investigating a question or problem.
- They break things down into many steps that make sense.
- Process used by scientists (everyone/anyone) to determine a solution.
- "Method" means there is a consistent and reproducible way of doing something
- If you need to determine a solution then you must have a problem.

### characteristic of the method

- The first characteristic of the scientific method is its conventional nature which serves as a framework of the generation of objective knowledge. That is why multiple characteristics exist according to the perspective with which they are classified, studied, and even named.

- The expression scientific method is used with different meanings, and, very often, abuses it in order to justify a specific personal or social position with relative ignorance about the complexity of the concept. As its very name indicates, it represents the methodology that defines and differentiates scientific knowledge from other types of knowledge.

- The philosophy of science creates the scientific method in order to exclude all that has subjective nature and, therefore, is not capable of forming part of what is called scientific knowledge. In the last analysis, that which is accepted by common sense itself is why it obtains general acceptance by the scientific community and society.

- Clearly not everyone will agree with the previous paragraph as there are various trends of the philosophy of science that are, in turn, derived from the different concepts about reality, perception, theories, etc.
- On the other hand, we know that there are things whose nature is precisely subjective. The scientific approach to these elements is complex and normally carried out through the lesser scientific methods which are designed for specific branches of knowledge.

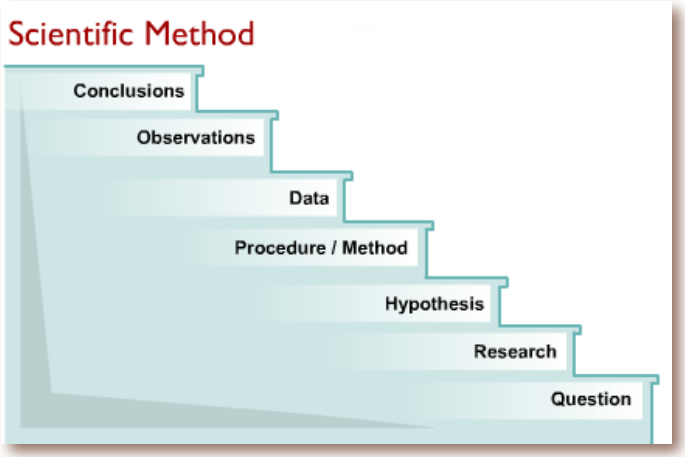
- It deals with those three basic types of scientific method (inductive reasoning, deductive reasoning, and hypothetic-deductive or hypothesis testing) that tend to be applied in the natural sciences (physics, chemistry, biology, etc.) in contrast to the commonly categorized social sciences (economics, politics, etc.) Among these methods we can cite: hermeneutical, phenomenological, dialectical, functionalism, structuralism, etc.

**Within the three basic types of scientific method (inductive reasoning, deductive reasoning, and hypothesis testing or experimental study) each one:**

- Has its own steps or stages.
- Depends more or less on each author or form of describing and presenting them.

**There are seven steps to the Scientific Method:**

**1.** Problem or question.
**2.** Research and Information.
**3.** Observations.
**4.** Hypothesis.
**5.** Procedure method( experiment).
**6.** Analysis the Data.
**7.** Conclusion.




- **Problem/Question:**
  - Develop a question or problem that can be solved through experimentation.

- **Research:** to research your topic of interest.

- **Observation:** Make observations, that means you to read all available material on your topic you can find.

- **Formulate a Hypothesis:** Predict a possible answer to the problem or question.

**steps of the Scientific Method:**

- The deductive reasoning, inductive reasoning, and hypothetic-deductive or hypothesis testing are the three scientific methods, which are referred to by the generic name of the scientific method.

- This type of the scientific methods caught my attention was the fact that the first two scientific methods have a problem as the name is difficult to distinguish, given that in a language context they can represent just one concept with two statements: reasoning in one direction or the other, from general to specific, or vice versa.

- Logically, the problem derives from the conceptual difficulty of clearly separating the elements of a scientific reasoning from the other; obviously, the chosen terms do not help retain these two concepts of scientific method or scientific reasoning in the memory. The first name of the third scientific method does not help much either.

- Both deductive reasoning and inductive reasoning can go from general to specific and vice versa, in one direction or the other. Both use logic and arrive to a conclusion. As a last resort, they always have philosophic substratum elements. Both tend to be susceptible to empirical testing.

- Although the deductive reasoning or deductive logic is more appropriate of the formal sciences and the inductive reasoning of the empirical sciences, nothing prevents the indiscriminate application of a scientific method, or any other method, to a particular theory.

- In my opinion, without trying to create a controversy on this subject, the fundamental difference of the deductive method and the inductive method is that the first aims to indicate, through pure logic, the conclusion in its entirety based on a few premises. So that the veracity of the conclusions is guaranteed; that is, if the applied logic is not invalidated. It is about the axiomatic model proposed by Aristotle as the ideal scientific method.

**The inductive method…**

- On the contrary, the inductive method creates laws based on the observation of the facts, by generalizing the observed behavior; actually, what achieves is a type of generalization without obtaining a demonstration of the aforementioned laws or set of conclusions through logic.

- Such conclusions could be false and, at the same time, the partial application of logic carried out could maintain its validity. For that reason, the inductive method needs an additional condition; its application would be valid if there is no case that does not fulfill the proposed model.

- The hypothetical-deductive method, or the hypothesis testing, does not raise any problems in principle, given that its validity depends on the results of the appropriate empirical testing.

- The hypothetical-deductive method tends to be used to improve or clarify previous theories according to new knowledge where the model's complexity does not allow logical formulations. Therefore, it has a predominantly intuitive character and needs, not only in order to reject a theory but also to impose its validity, the contrasting of its conclusions.

- One could suggest the deductive reasoning, intuitive reasoning, and hypothesis testing as denominations for the three main variants of the scientific method, or for that matter, any set of words that refer to their fundamental differences or elements and do not raise any problems for the linguistic memory. However, in the exposition I will stick to the nomenclature generally used.

**The hypothetical-deductive, or hypothesis testing method**

- The General Theory of the Conditional Evolution of Life fits in perfectly with a theory based on the hypothetical-deductive, or hypothesis testing method.

- Darwin's theory of evolution, on the other hand, would fit in the inductive reasoning; but despite finding opposing examples, the scientific community does not invalidate it but adapted to square off any triangle. **Why would it be?**

- As was previously mentioned, every theory should be able to withstand refutation; however, a theory that does not allow refutation by any conceivable fact is not scientific. The impossibility of disproving a scientific theory is not a virtue but a defect.