SCIENCE, TECHNOLOGY AND SOCIETY

CHAPTER I

General Concepts and Historical Events in Science, Technology and Society

LESSON 1 – THE NATURE OF SCIENCE AND TECHNOLOGY

LEARNING OUTCOMES :

At the end of this lesson, the students should be able to:

1. Define science and technology in terms of its nature.
2. Classify the significance of each branch of science to human enterprise and well being.
3. Apply the scientific method in terms of problem analysis and solving.
4. Develop scientific attitudes and skills among the students.

Nature of Science

According to Carl Sagan, science is a way of thinking much more than it is a body of knowledge. We are very familiar with the etymology of the term science which defines it as a body of knowledge. The word science came from the Latin term ***"scientia"*** that means knowledge and ***"scire"*** which means to know. To look for the baseline definition of science it will lead us to human

knowledge. Science is an understanding and awareness of something. But beyond this definition, science should also be emphasized as a verb as the latter etymology suggests it is to know or the act of acquiring this knowledge. Studying science is not just collections of facts but also involves analysis, problem solving, critical thinking, testing, observing and predicting. These are different essential processes in "doing" science. Just like Sagan had described science as a way of thinking. So as human beings we should not only acquire knowledge but also involve ourselves in the processes of gaining the facts that came from our observations, experiments and experiences.

If we try to trace the genesis of the discipline of science, we will have to consider the basic reasons why the field emerged. By nature human beings are **curious** and this eagerness to know or to learn something will lead to discovery and exploration of the world we are living and its inhabitants. We sometimes ask questions such as why are clouds formed? What causes tsunamis? Why are skies blue? These are some queries in our mind that we need to satisfy. Science played its niche in giving answers to these questions. Human beings also have certain **needs** in order for them to survive. Science aided man to satisfy these necessities by providing the basis of constructing tools, gadgets and processes. Activities such as hunting, fishing, farming, cooking, constructing shelters and clothes making are the processes that satisfy human necessities and involves science in its development. As man explore on satisfying their necessities certain **problems** also evolved such as pollution, overpopulation, climate change, diseases and natural disasters. Science also offers solutions to these predicaments.

Science is an organized body of knowledge based on facts, gathered through observations, experiments and experiences. Science can also be used to construct and verify laws, conclusions and theories about nature. As well, science can also serve as a basis of developing technology for the benefit of man and the environment.

Science is powerful but we also have to remember that it has its limitations too. And to cite these are some. Science can't answer questions about value. For example it is beyond the determination of science which dress is prettier for you. Or which is valuable an ounce of gold or an ounce of steel. Our culture sets values to it. Also the values of these metals depend on how it will be used. Furthermore, science can't answer questions of morality. For example, science can explain the mechanism of contraceptives why it can hinder the process of fertilization but it can't decide for you whether the use of such is right or wrong. Morality is dictated by social rules and culture. Supernatural events can't be explained by science. Adding the prefix "super" it entails that it is beyond the natural laws of the universe, in which science is limited to.

Another definition of science that may help us understand its nature is "Science is present verification without ultimate certainty". It only means that the facts that are verified as true now can be replaced if it is overthrown by a competent theory in the future. For example the phlogiston theory of George Ernst Stahl, at his period it is believed that a certain substance called phlogiston is present in a substance during combustion and is released in the process. But today this theory is already obsolete, since the combustion theory was proposed by Antoine Lavoisier. The theory explained that oxygen is needed in the process of combustion not a certain substance called phlogiston. Today combustion theory is still accepted unless it is challenged by another competent theory.

Science is a tool in order for us to appreciate how omniscient (all-knowing) is our creator. The role of science is just to understand how well ordered the creations are and before we realize it, it is already made by a Supreme Being. To quote Albert Einstein, he said that ***"the more I study science, the more I believe in God."***

Branches of Science

There are three major branches of science, these are:

1. **Social Science –** concerned with the society and the relationships among the individuals within the society. *Sociology, philosophy, humanities, political science, demography, economics, anthropology, history, law, archaeology and linguistics* are among the disciplines under social science.
2. **Applied Science -** is a discipline of science that applies existing scientific knowledge to develop more practical applications, like technology or inventions. *Engineering sciences, medical sciences, industrial technology and architecture* are fields of applied science.
3. **Natural Science -** is a branch of science concerned with the description, prediction, and understanding of natural phenomena, based on observational and empirical evidence. Natural science is further subdivided into *Biological Sciences and Physical Sciences*. The biological sciences pertains to the study of living things that include biology, botany, zoology, anatomy, physiology, ornithology, parasitology and many others. While physical sciences deal with the study of the nonliving things that include physics, chemistry, geology, meteorology, metallurgy and many others.

Scientific Attitudes and Skills

Here are some attitudes that someone who studies science must possess:

1. The desire to know.
2. Patience
3. Perseverance
4. Objective
5. Don't easily jump into conclusion.
6. Open-mindedness
7. Systematic and orderly
8. Critical thinkers
9. Honesty
10. Humility

The figure below suggests the skills one must have in order to do science.

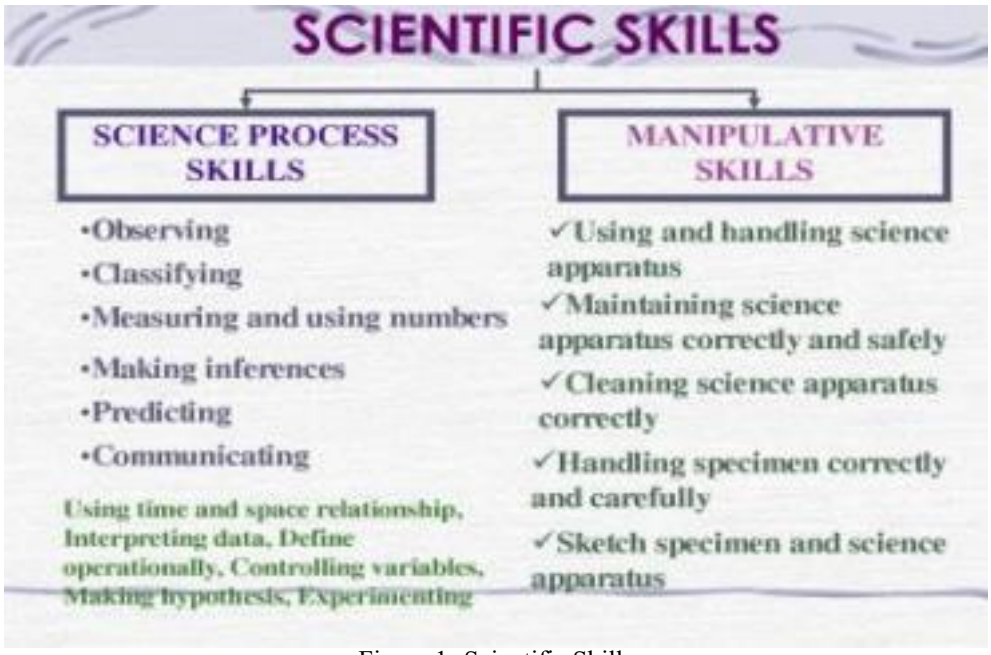


Figure 1- Scientific Skills

The Scientific Method

In order for science to be systematic, scientists and other people who study and do science follow a step by step procedure in gathering, investigating and analysing information to come up with conclusions and theories. The systematic approach in solving a problem is called the ***scientific method.*** To summarize the procedures to be followed in scientific investigations here are the six basic steps.

1. ***Observing and stating the problem.*** Observation is a process of utilizing your five senses. There are two types of observation, first is **qualitative observation** which does not involve measurements. For example your friend asked you to observe the color of an apple and you said green. So color, taste, texture and odor can be classified as qualitative observations because you don't need to measure anything. The second type of observation is **quantitative observation** which involves the process of measuring. For example you have observed by using a speedometer that your car runs 40 kph faster than your friend's car. Quantitative observations are aided by measuring tools for you to get a collection of quantitative data.

   In **stating the problem** make sure that it is clear and specific. Without a clear and specific statement, you will find it difficult to answer your problem as it may be broad and unclear to you.
2. ***Gathering data on related problems.*** This is an important part of the scientific process to make sure that what you are doing is objective. Collecting information from relevant studies may also ensure that what you are doing is not a duplication of a previous work of others. This gathered information can serve as basis for tentatively answering your problem. To do conduct this step you can read research papers, scientific journals, and books. You may also interview experts, as credible sources, about your problem.
3. ***Forming a hypothesis.*** After gathering pertinent information, based on the researched facts

you may now formulate a **hypothesis** which is a tentative solution to your problem. A hypothesis is said to be an educated guess since it is based on the researched information done in step two. A hypothesis is said to be tentative and not final because it is still subjected to a test. To have a good statement of a hypothesis it should also be clear, specific and can be easily tested.

4. ***Testing the hypothesis.*** To find out whether your hypothesis is correct or not you will conduct an experiment. An experimental set up is usually composed of two groups, an **experimental group** and a **control group**. The difference of the two groups is only one factor. In a control group all factors are held constant. This set-up is important for comparison with the experimental group. The group in which one factor or treatment is varied is the experimental group. A variable is any factor, trait, or condition that can exist in differing amounts or types. An experiment usually has three kinds of variables: independent, dependent, and controlled. The **independent variable** is the one that is changed by the scientist. The scientist focuses his or her observations on the **dependent variable** to see how it responds to the change made to the independent variable. Controlled variables are quantities that a scientist wants to remain constant, and he must observe them as carefully as the dependent variables.

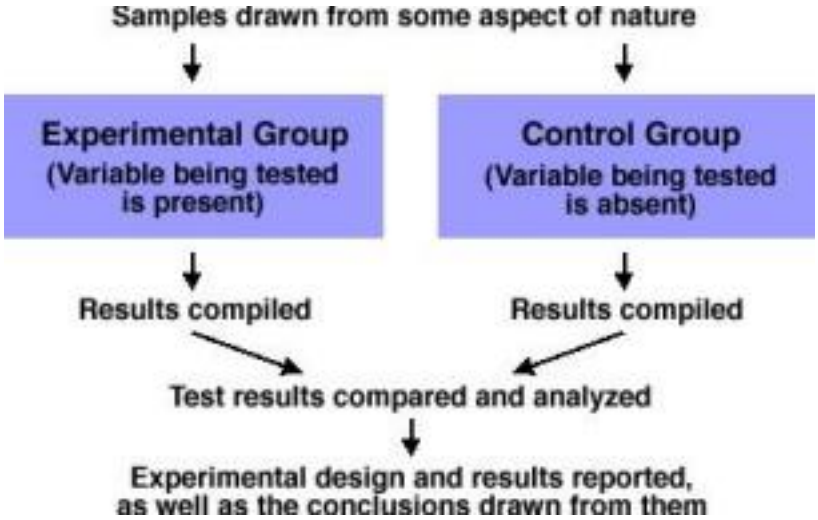
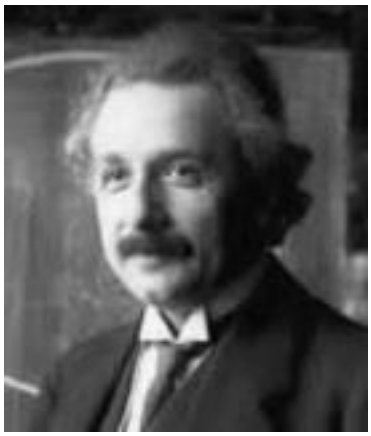
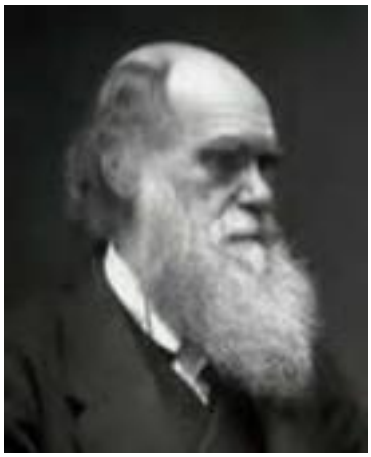


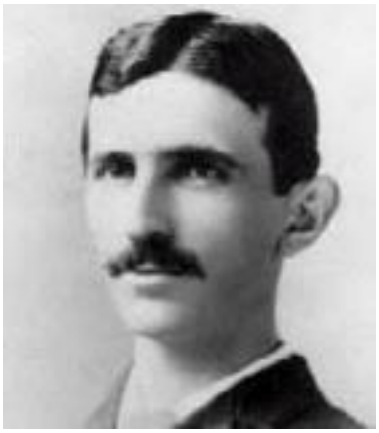
Figure 2- Controlled Experiment

5. ***Recording and analyzing data.*** The results of your experiment should be recorded carefully. Observations and information, called as data, can be presented in tables and graphs. In this manner analysis of the result will be easy to conduct.
6. ***Formulating a conclusion.*** A **conclusion** is the final answer to the problem. If the conclusion supports the hypothesis it is considered as a scientific explanation to the problem. But if it does not, the hypothesis is rejected or can be modified.
7. ***Replicating your work.*** Experiments should not only be done once but several times. That is why a good scientific experiment requires being reproducible or can be replicated. In this manner others can test the reliability of your results.

Famous People and their Contributions to Science

	Sir Isaac Newton (1642-1726) Newton was a polymath who made investigations into a whole range of subjects including mathematics, optics, physics, and astronomy. In his *Principia Mathematica*, published in 1687, he laid the foundations for classical mechanics, explaining law of gravity and the Laws of Motion.
	Louis Pasteur (1822 – 1895) Contributed greatly towards the advancement of medical sciences developing cures for rabies, anthrax and other infectious diseases. Also enabled process of pasteurisation to make milk safer to drink. Probably saved more lives than any other person.
	Galileo (1564 – 1642) Creating one of the first modern telescope, Galileo revolutionised our understanding of the world successfully proving the earth revolved around the sun and not the other way around. His work Two New Sciences laid ground work for science of Kinetics and strength of materials.

	Marie Curie (1867 – 1934) Polish physicist and chemist. Discovered radiation and helped to apply it in the field of X ray. She won Nobel Prize in both Chemistry and Physics.
	Albert Einstein (1879 – 1955) Revolutionised modern physics with his general theory of relativity. Won Nobel Prize in Physics (1921) for his discovery of the Photoelectric effect, which formed basis of Quantum Theory.
	Charles Darwin (1809 – 1882) Developed theory of evolution against a backdrop of disbelief and scepticism. Collected evidence over 20 years, and published conclusions in *On the Origin of Species* (1859).

	**Otto Hahn** (1879-1968) German Chemist who discovered nuclear fission (1939). Pioneering scientist in the field of radio-chemistry. Discovered radio-active elements and nuclear isomerism (1921). Awarded Nobel Prize for Chemistry (1944)
	Nikola Tesla (1856 –1943) Work on electro-magnetism and AC current. Credited with many patents from electricity to radio transmission.
	James Clerk Maxwell (1831-1879) Made great strides in understanding electro-magnetism. His research in electricity and kinetics, laid foundation for quantum physics. Einstein said of Maxwell, "*The work of James Clerk Maxwell changed the world forever*."

	Aristotle (384BC – 322BC) Great early Greek scientist who made many researches in the natural sciences including botany, zoology, physics, astronomy, chemistry, and meteorology, geometry

Nature of Technology

Technology is defined as "purposeful intervention by design", and technological practice as the activity through which technological outcomes are created and have impact in the world. Technological outcomes are designed to enhance the capabilities of people and expand human possibilities. They change the made world in ways that have positive and/or negative impacts on the social and natural world. Technology uses and produces technological knowledge. Technological communities endorse technological knowledge as valid when it is shown to support the successful development of technological outcomes.

All technology exists within a historical context, influenced by and influencing society and culture.

Technological practice is becoming increasingly interdisciplinary, relying more than ever on collaboration between the technology community and people from other disciplines. (http://technology.tki.org.nz/Technology-in-the-NZC/Nature-of-technology/Characteristics-of technology)

ASSESSMENT:

1. Describe the relationship between science, technology and society.
2. How significant is science and technology to the society?
3. Which contribution of science is the most important discovery of man? Explain why.
4. Interpret the saying, "the more I study science, the more I believe in God". 5. If you will be a scientist, what important contribution would you like to invent? Why?

1. Make a collage that will highlight the impact of science and technology to society. 2. Compose a jingle that will focus on the advantages and disadvantages of technology to man.

Rabago, Lilia M., Joaquin, Crescencia C., Lagunzad, Catherine B. (1996). *Science and Technology 2.* Manila: Vibal Publishing House, Inc.
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