Overview of Scientific Research

What is research?

- Some people will say that they *routinely research* different **online websites** to find the best place to buy goods or services they want.
- **Television news channels** supposedly *conduct research* in the form of viewer polls on topics of public interest such as forthcoming elections or government-funded projects.
- **Undergraduate students** *research the Internet* to find the information they need to complete assigned projects or term papers.

- **Graduate students** working on research projects for a professor may see research as *collecting or analyzing data* related to their project.

- **Businesses** and **consultants** *research different potential solutions* to remedy organizational problems such as a supply chain bottleneck or to identify customer purchase patterns.

However, **none of the these** can be considered **“scientific research”** unless:

(1) it contributes to a **body of science**

(2) it follows the **scientific method.**

What is science?

- The word **“science”** is derived from the **Latin word “Scientia”** meaning knowledge.

- Science refers to a **systematic and organized body of knowledge** in any area that is acquired using **“the scientific method”.**

Science can be grouped into **two** broad categories:

1. **Natural science**

2. **Social science**

Natural science is the science of **naturally occurring objects or phenomena**, such as light, objects, matter, earth, celestial bodies, or the human body.

Natural sciences can be **further classified** into:

1. **Physical sciences**
2. **Earth sciences**
3. **Life sciences**

- **Physical sciences** consist of disciplines such as physics (the science of physical objects), chemistry (the science of matter), and astronomy (the science of celestial objects).

- **Earth sciences** consist of disciplines such as geology (the science of the earth), and geography (study of places).

- **Life sciences** include disciplines of biology (the science of living organisms including humans).

In contrast, **Social Science** is the science of **people or collections of people**, such as groups, firms, societies, or economies, and their individual or collective behaviors.

Social sciences can be classified into disciplines such as:

Psychology (the science of human behaviors)

Sociology (the science of social groups)

Economics (the science of firms, markets, and economies).

The **natural sciences** are **different** from the **social sciences** in several respects.

The **natural sciences** are:

- **very precise**
- **accurate**
- **independent of the person making the scientific observations**

- For instance, a scientific experiment in physics, such as **measuring the speed of sound through a certain medium** should **always yield the *exact* same results**.

- This is **irrespective** of the **time or place** of the experiment, or the **person** conducting the experiment.

- If **two students** conducting the same physics experiment obtain **two different values** of these physical properties, then it generally means that one or both of those students **must be making a mistake.**

- However, the same **cannot** be said for the **social sciences**, which tend to be **less** accurate.

- For instance, if you measure a **person's happiness** using a hypothetical instrument (some questionnaire etc), you may find that the same person is more happy or less happy (or sad) on different days and sometimes, at different times on the same day.

- One’s happiness may vary depending on the **news** that person received that day or on the **events** that happened earlier that day.

- Furthermore, there is **not a single instrument or metric (measurable method)** that can **accurately** measure a person’s happiness.

- In other words, there is a **high degree of measurement error** in the **social sciences.**

- So there is **considerable uncertainty** and **little agreement** on social science policy decisions.

Sciences can also be classified into **basic** and **applied** based on their purpose.

Basic sciences, also called **pure sciences**, are those that explain the most basic objects and forces, relationships between them, and laws governing them.

Examples include physics, mathematics, and biology.

Applied sciences, also called **practical sciences**, are sciences that **apply scientific knowledge from basic sciences** in a physical environment.

For instance, **engineering** is an **applied science** that applies the laws of physics and chemistry for practical applications such as building stronger bridges or fuel-efficient combustion engines.

Similarly, **medicine** is an **applied science** that applies the laws of biology for solving human ailments.

- **Both** basic and applied sciences are required for human development.

- However, **applied sciences** need the **basic knowledge** provided by basic sciences for progress.

- Of course, the industry and private enterprises tend to **focus more** on applied sciences given their practical value, while **universities** study **both basic and applied sciences**.

Scientific Knowledge

- The purpose of science is to **create** scientific knowledge.
- Scientific knowledge refers to a **generalized body of laws and theories to explain a phenomenon or behavior of interest** that are acquired **using the scientific method**.
- **Laws** are **observed patterns of *phenomena* or *behaviors*.**
- **Theories** are **systematic explanations** of the **underlying phenomenon or behavior.**

- The **Newtonian Laws of Motion** describe what happens when an object is in a state of rest or motion (**Newton's First Law**), what force is needed to move a stationary object or to stop a moving object (**Newton's Second Law**), and what happens when two objects collide (**Newton's Third Law**).

- Collectively, the three laws constitute the basis of **classical mechanics** – a theory of moving objects.

- The goal of scientific research is to **discover laws and postulate theories that can explain natural or social phenomena**, or in other words, build scientific knowledge.

- We must understand that the **theories**, upon which scientific knowledge is based, are only **explanations** of a particular phenomenon, as suggested by a scientist.

- As such, there may be **good or poor explanations**, depending on the extent to which those explanations fit well with reality, and consequently, there may be good or poor theories.

- The **progress of science** is marked by our **progression over time from poorer theories to better theories**, through better observations using more accurate instruments and more informed logical reasoning.

For example, it was accepted for a long time that sun moves around the earth because it rises from East and sets in West, but when it was known that earth is round and moving itself, this theory was changed and now we know that earth moves around the sun.

- We arrive at scientific laws or theories through a **process of logic and evidence.**

- **Logic (theory)** and **evidence (observations)** are the **only two pillars** upon which scientific knowledge is based.

- In science, theories and observations are **interrelated** and cannot exist without each other.

- **Theories** provide **meaning and significance** to what we observe, and **observations** help **validate or refine** existing theory or construct new theory.

- Both theory and observations are **essential** components of scientific research.

- **Any other means of knowledge acquisition, such as faith or authority cannot be considered science.**

Depending on a researcher’s training and interest, **scientific inquiry** may take one of two possible forms:

- **inductive**
- **deductive**

- In ***inductive research***, the goal of a researcher is to form **theoretical concepts and patterns** from observed data.

- In ***deductive research***, the goal of the researcher is to **test concepts and patterns** known from theory using new empirical data.

- Hence, ***inductive research*** is also called **theory-building** research, and ***deductive research*** is **theory-testing research**.

- The goal of theory-testing is not just to test a theory, but possibly to **refine, improve**, and **extend** it.

- **Theory building** and **theory testing** are **particularly difficult** in the **social sciences**, given the imprecise nature of the theoretical concepts, inadequate tools to measure them, and the presence of many unaccounted factors that can also influence the phenomenon of interest.

- It is also very **difficult to challenge** theories that do not work.

- Unlike theories in the natural sciences, social science theories are **rarely perfect**, which provides numerous opportunities for researchers to improve those theories or build their own alternative theories.


Thank You!