**COPY this in your notebook (Handwritten)**

## A. COMMUNICATING

***Communicating*** is the process of presenting and sharing research information, findings, or ideas clearly, accurately, and effectively so that others can understand and use the information.

Communicating is the science process skill of organizing and presenting observations, data, procedures, and conclusions using appropriate verbal, written, visual, or digital formats.

*Why Do We Communicate?*

- To Compare our ideas with others'
- To Organize the information, we have
- To allow others to verify or repeat the study
- To help people make informed decisions
- To share new knowledge
- To encourage improvements or solve problems

*What information Do We Communicate in Scientific Investigations?*

- Research Background
- Research Problem and Questions
- Research Methodologies
- Results and Findings
- Conclusions
- Recommendations

*How Do We Communicate? What Forms*

1. Oral Communications – Uses spoken words to present research findings during **discussions, speeches, or presentations**.
2. Written Communications – Uses words, sentences, and paragraphs to explain research information **in documents such as reports or articles.**
3. Visuals – Uses **pictures, photographs, diagrams, symbols, or illustrations** to help explain research ideas.
4. Tabular/Data Table – Uses **rows and columns to organize and present data** for easy reading and comparison.
5. Graphical – Uses graphs or charts **to present patterns, comparisons, relationships, or trends** in data.

*What **Should NOT** be Included in Research Communication?*

| SHOULD NOT INCLUDE | REASON |
|---|---|
| False or invented information | - Research communication **must be truthful**. |
| Changed or manipulated data | - Data should not be altered just to support the expected result. |
| Irrelevant information | - It can distract the audience from the main research findings. |
| Personal opinions presented as facts | - Research claims should be supported by evidence. |
| Unsupported conclusions | - Conclusions should come from the data collected. |
| Misleading graphs or images | - Visuals should represent information accurately. |
| Plagiarized information | - Other people's ideas or words must be properly acknowledged. |
| Excessive technical terms without explanation | - Communication should be understandable to the intended audience. |
| Private or identifying information unnecessarily | - Researchers should respect participants' privacy. |
| Information that was not actually investigated | - Researchers should communicate what the study actually examined, not make claims beyond the evidence. |



Research communication should be:

**Accurate** – tells the truth.
**Relevant** – includes information related to the study.
**Evidence-based** – supported by data or observations.
**Clear** – easy for the intended audience to understand.
**Credited** – acknowledges sources and other people's work.

## B. FORMULATING GOOD SCIENTIFIC QUESTION

***Scientific Question*** – a question about the natural world that can *be answered through observation, measurement, experimentation, or data collection*.

*Characteristics of a Good Scientific Question:*

1. Clear and Specific
The question should be **easy to understand and focused on one** issue.

Example:
Poor: How does exercise affect people?
Good: How does daily exercise affect heart rate?

2. Testable
The question **can be investigated through experiments or observations**.

Example:
Poor: Why do plants need fertilizer?
Good: How does the amount of fertilizer affect the growth of plants?

3. Measurable
The variables can be measured using numbers or observations.

Example:
Poor: most intelligent, more beautiful
Good: Height in centimeters, temperature in degrees Celsius, or test scores in points.

4. Based on Observation
The question often comes from something **observed in everyday life**.

Example:
Poor: Why do plants like being near windows?
Good: Why do **plants near windows grow taller than** plants placed in dark corners?

5. Relevant and Interesting

The question should be meaningful and worth investigating.

A good scientific question should require an answer supported by explanation, evidence, observation, measurement, or data—**NOT just** "yes" or "no."

Example:
Poor: Why do people enjoy using mobile phones before sleeping?
Good: How does the amount of time spent using a mobile phone before bedtime affect the number of hours of sleep?

*Sources of Scientific Questions:*

1. Personal Observation
   - Things you notice around you.
   Example: Plants near sunlight seem healthier.

2. Daily Experiences and Interests
   - Events encountered in everyday life.
   Example: Some classmates learn faster when listening to music.

3. Problems and Challenges
   - Issues that need solutions.
   Example: Why do some seeds fail to germinate?

4. Books, Scientific Journals and Articles, News and Magazines, and Online Resources
   - Reading often generates new questions.
   Example: After reading about pollution, a student asks: How does air pollution affect plant growth?

5. Previous Research
   - Scientists often build upon earlier studies.
   Example: A researcher wonders if a new fertilizer works better than existing ones.

**Testable and Non-Testable Questions**

| Testable Questions | Non-testable Questions |
|---|---|
| - can be answered through experiments or observation | - involve beliefs, values, opinions, or feelings that cannot be measured scientifically |
| Examples:<br>1. How does water temperature affect the dissolving rate of sugar?<br>2. How does the amount of fertilizer affect plants growth?<br>3. How does the length of study time affect students' test scores? | Examples:<br>1. What is the best movie ever made?<br>2. Is kindness more important than intelligence?<br>3. Which song is the most beautiful? |



**C. IDENTIFYING VARIABLES**

***Variable*** – any factor, characteristic, or condition that can change or have different values in an Investigation

**Independent Variable**

The independent variable is the factor that the researcher *intentionally changes or manipulates.*

The condition of an experiment that is systematically manipulated by the investigator. *(Penslar & Porter, 2001).*

Example
Question: How does the **amount of water** affect plant growth?

- The researcher can manipulate the amount of water.

**Dependent Variable**

The dependent variable is the *factor that is measured or observed.*

The outcomes that are measured in an experiment. This variable is expected to change as a result of an experimental manipulation of the independent variable(s). *(Penslar & Porter, 2001).*

Example
Question: How does the amount of water affect **plant growth** (height in centimeters)?

- Plant growth depends on the amount of water provided.

**Constant Variable**

A constant variable is a factor that kept the same throughout the experiment.

Example
Question: How does the amount of water affect plant growth?

- When testing water's effect on plant growth, other variables that kept the same are **Plant species, Pot size, Soil type, Amount of sunlight**

- Keeping these factors the same ensures a fair test.

**Extraneous Variable**

An extraneous variable is *any uncontrolled factor that may affect* the results.

Example
Question: How does the amount of water affect plant growth?
- A plant receives **extra sunlight** because it is near a window.
- Humidity
- Occurrence of Pests

**Control Variable**

A control variable *serves as a standard for comparison*.

a. Positive Control – A group ***expected to produce a known result***.

In Testing a new fertilizer:
- Plants given a proven fertilizer

b. Negative Control – A group **NOT** expected to show the effect being studied.

In Testing fertilizer effectiveness:
- Plants receive no fertilizer.

## D. RELATIONSHIPS BETWEEN VARIABLES

1. Linear Positive Relationship
   As one variable **increases,** the other variable also **increases**.
   * **SAME** result to both variables

   Example:
   The more hours a student studies, the higher the test score may become.

   Simple Illustration:
   Study Time ↑ → Test Score ↑

2. Linear Negative Relationship
   As one variable **increases**, the other variable **decreases**.
   * **OPPOSITE** result: one increase, other decrease

   Example:
   The faster ice melts, the less ice remains.

   Simple Illustration:
   Temperature ↑ → Ice Amount ↓

3. Unrelated Relationship
   Changes in one variable **DO NOT AFFECT** the other variable. *(No relationship)*

   Example
   A student's shoe size and favorite color.
   - **NO** meaningful relationship exists between these variables.

## E. FORMULATING HYPOTHESES

Hypotheses (plural); Hypothesis (singular)

**Hypothesis** – an educated prediction about the relationship between variables that can be tested through research or experimentation.
- It is not merely a guess. It is based on observations, prior knowledge, and logical reasoning.

Parts of Hypothesis:
- Independent Variable
- Dependent Variable
- Scientific Reason

Basic hypothesis uses the "**If – Then – Because**" statement format.



Formula:
If (***independent variable changes***), then (***dependent variable*** will respond), because (***scientific reason***).

Examples:
1. **Question:** How does water affect plant growth?
   **Hypothesis**: If the *amount of water* given to plants increases, then *plant height* will increase, because water is necessary for photosynthesis and nutrient transport.

2. **Question:** How does study time affect test scores?
   **Hypothesis**: If students *spend more time studying*, then their *test scores* will increase, because they will have more opportunities to understand and remember information.

3. **Question:** How does sunlight affect plant growth?
   **Hypothesis**: If plants receive *more sunlight*, then they will *grow taller*, because sunlight provides energy needed for photosynthesis.

*Steps in Writing Hypothesis:*

Research Question:
How does the amount of sunlight affect plant height?

Step 1: **Identify the Independent Variable.**
Amount of Sunlight

Step 2: **Identify the Dependent Variable.**
Plant Height

Step 3: **Predict the Relationship.**
Less sunlight may result in slower plant growth

Step 4: **Provide a Scientific Reason.**
Sunlight is needed for photosynthesis.

Step 5: **Write the Complete Hypothesis.**

**If** plants receive enough sunlight, **then** they will grow taller, **because** sunlight is needed for photosynthesis.