

Creative and Scientific Thinking

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CRE252

Information Technology Department

Lecture 5



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Learning Objectives:

- Scientific thinkers and intellectual standards
- Sources of Knowledge
- Elements of Science
- Measurements
- The Scientific Method
- The Many Roles of Theory

Scientific thinkers and intellectual standards

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Scientific thinkers and intellectual standards:

There are seven Intellectual Standards we use to assess thinking:

1. Clarity
2. Accuracy
3. Precision
4. Relevance
5. Depth
6. Logic
7. Fairness

1.
Clarity

A thinker must be clear in how to communicate thoughts, beliefs, and reasons for beliefs.

2.
Accuracy

Make sure that all information is correct and free from error. If the thinking is reliable, then it has Accuracy.

3.
Precision

Goes one step further than Accuracy. It demands that the words and data used are exact. If no more details could be added, then it has Precision.

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4.
Relevance

Means that everything included is important, that each part makes a difference.

5.
Depth

If an argument includes all the degrees necessary to make the point, it has Depth.

6.
Logic

Means that an argument is reasonable

7.
Fairness

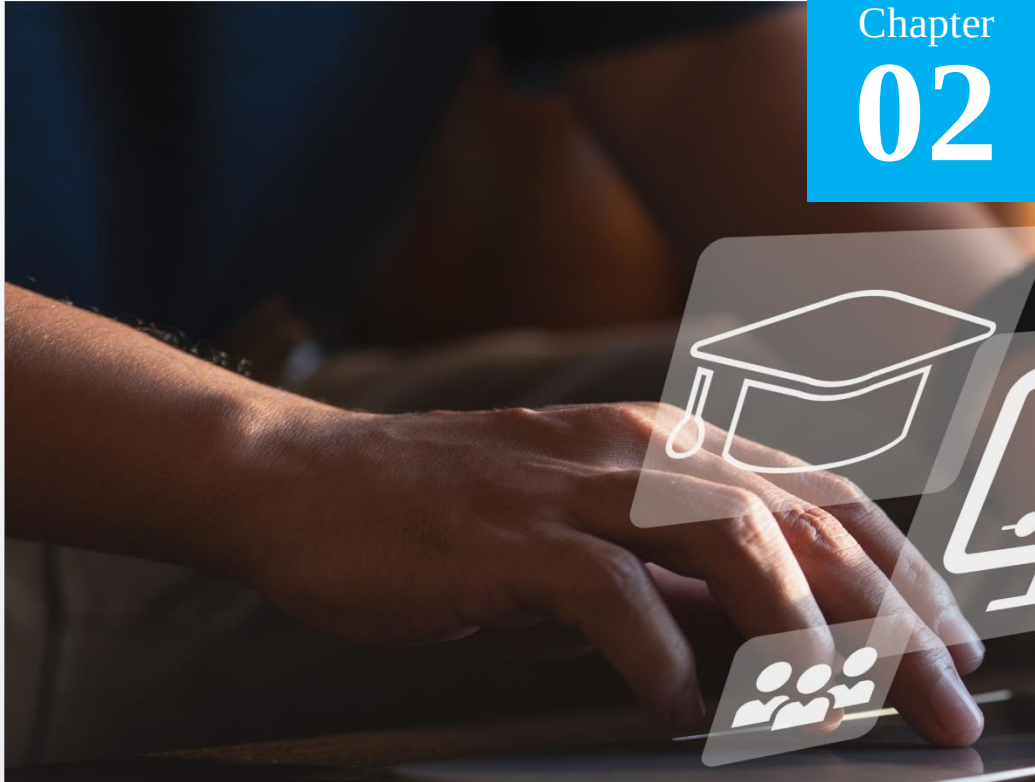
Means that the argument is balanced and free from bias.

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Sources of Knowledge



Sources of Knowledge:

Gather information: Sources of Knowledge

- Primary Sources
- Secondary Sources

Primary Sources

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Sources of Knowledge: *Primary Source*

- A primary source provides direct firsthand evidence about an event, object, person, or work.
- Primary sources provide the original materials on which other research is based and enable students and other researchers to get as close as possible to what actually happened during a particular event or time period.

Sources of Knowledge: *Primary Source*

- Primary sources can be written or non-written(sound, pictures, artifacts, etc.).In scientific research, primary sources present original thinking, report on discoveries, or share new information.

Examples of primary sources:

- Interviews, surveys, observation as well as fieldwork.

Secondary Source

Sources of Knowledge: *Secondary Source*

- Secondary sources describe, discuss, interpret, comment upon, analyze, evaluate, summarize, and process primary sources.
- A secondary source is generally one or more steps removed from the event or time period and are written or produced after the fact with the benefit of hindsight.

Sources of Knowledge: *Secondary Source*

- Secondary sources often lack the freshness and immediacy of the original material.

Examples of secondary sources:

- Reference books, including dictionaries, encyclopedias, and atlases
- Articles from magazines, journals, and newspapers after the event
- Literature reviews and review articles (e.g., movie reviews, book reviews)
- Books
- Textbooks

Elements of Science:

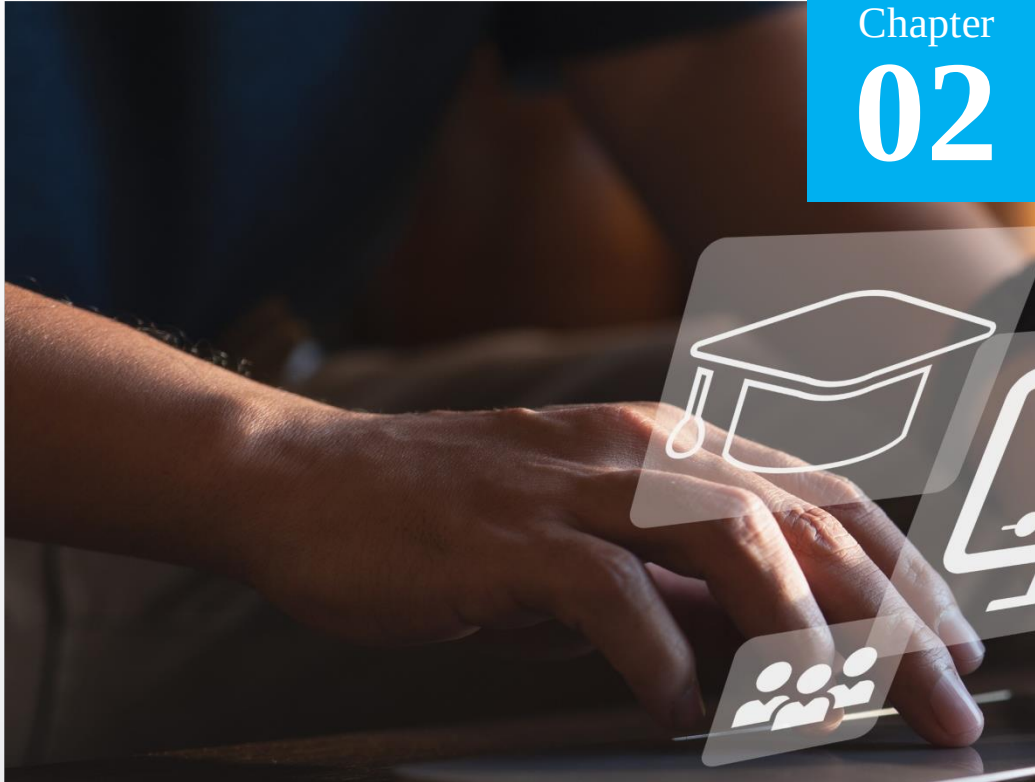
They are:

- Concepts ,
- Variables ,
- Hypotheses ,
- and theories.

The way in which these elements are combined constitutes the **scientific method**.

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Scientific method



Definition:

- A concept is a verbal abstraction (a name) drawn from *observation of a number of specific cases*.
- Reality *testing is built right into the process of naming things, one of the most elementary transactions of existence*.

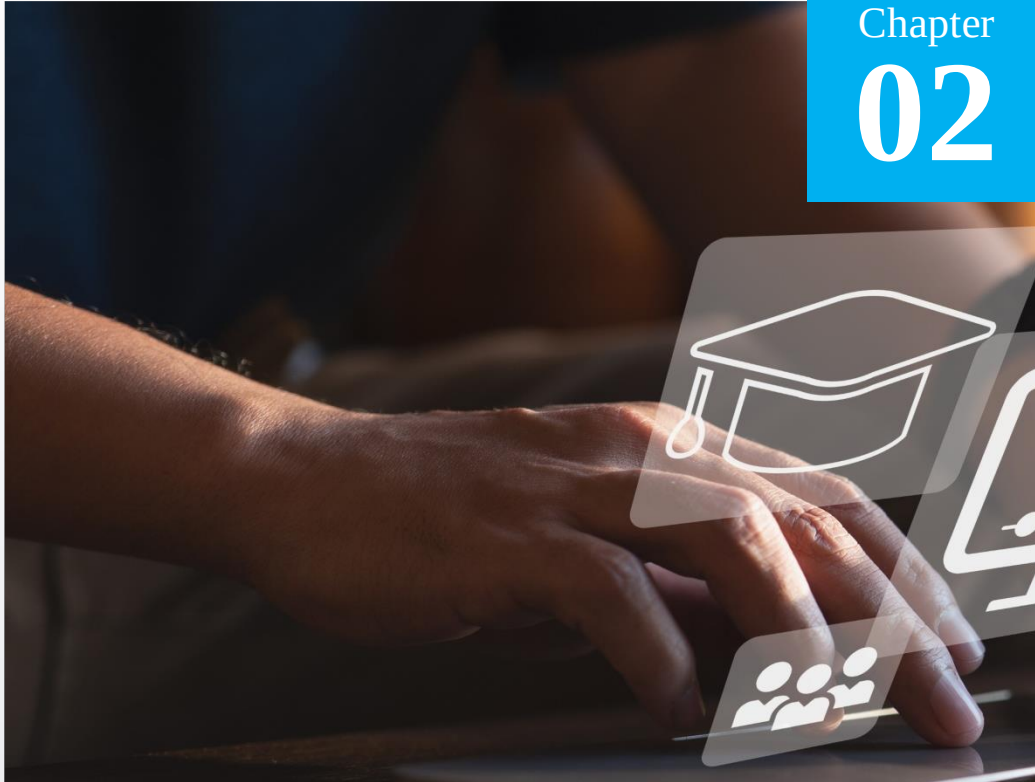
Definition:

- concepts—names for things, feelings, and ideas generated or acquired by people in the course of relating to each other and to their environment.

- Science is a way of checking on the formulation of concepts and of testing the possible linkages between them through references to observable phenomena.
- The next step is to see how scientists turn concepts into something that can be observed. When concepts are defined as variables, they can be used to form a special kind of sentence, the hypothesis.

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What is a Variable



What is a Variable:

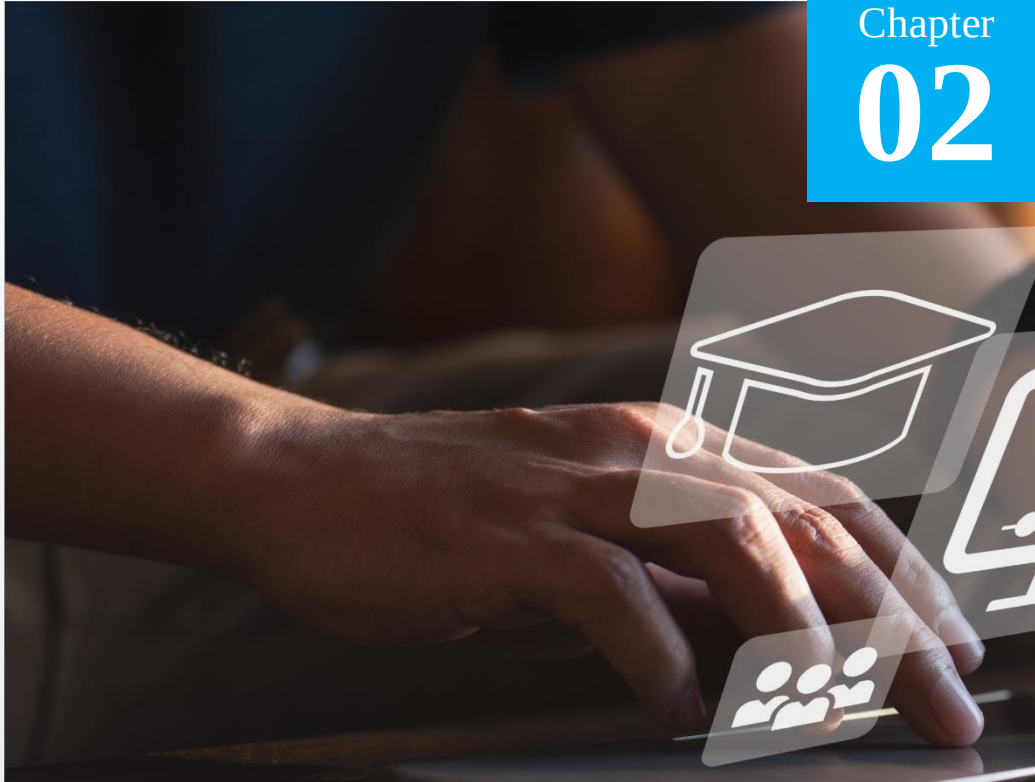
- As the name suggests, variables are things that vary.
- A variable is a special kind of concept that contains within it a notion of degree or differentiation.

Examples

- Heat is one variable in making water boil.
- Age has been established as an important variable in voting.
- There are many other more significant variables : race, gender,
- region of residence, and so on.

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Types of variables



Independent variable:

Independent variable is the part of the experiment that is manipulated or changed by the scientist or person performing the experiment.

Dependent variable:

Dependent variable is the part of the experiment that is affected by the independent variable.

Independent variable

The variable the researcher changes.

Application of fertilizer 'x' in this experiment

vs

Dependent variable

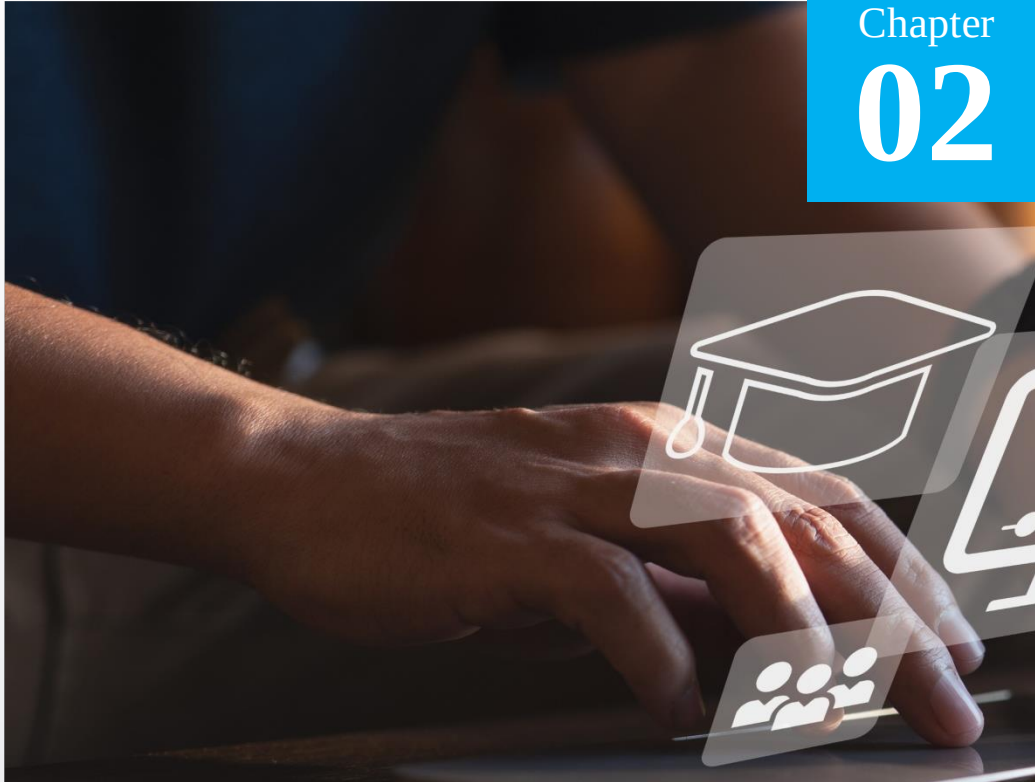
Variable affected by change in independent variable

- Plant growth
- No. of leaves,
- No. of fruits etc in this experiment.



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Examples of variables



Question	Variable
How much water flows through a valve at different openings?	• Water valve opening (closed, half open, fully open) • Amount of water flowing, measured in liters per minute • Water pressure, or how much the water is "pushing"

Question	Variable
Does heating water allow it to dissolve more sugar?	• Temperature of the water measured in degrees Celsius • Amount of sugar that dissolves completely, measured in grams • Type of sugar

Question	Variable
Does fertilizer make a plant grow bigger?	• Amount of fertilizer, measured in grams • Growth of the plant, measured by its height • Growth of the plant, measured by the number of leaves • See Measuring Plant Growth for more ways to measure plant growth • Same type of fertilizer • Same pot size for each plant • Same plant type in each pot • Same type and amount of soil in each pot

Question	Variable
Does an electric motor turn faster if you increase the voltage?	• Voltage of the electricity, measured in volts • Speed of rotation, measured in revolutions per minute (RPMs) • motor for every test

Components of a well-designed scientific experiment:

- Only 1 variable is being tested.
- All other variables of the experiment are constants.
- There are adequate numbers of trials performed.

Components of a well-designed scientific experiment:

- There is an adequate sample size (number of individuals per group per trial).
- There is sufficient experimental time allowed.

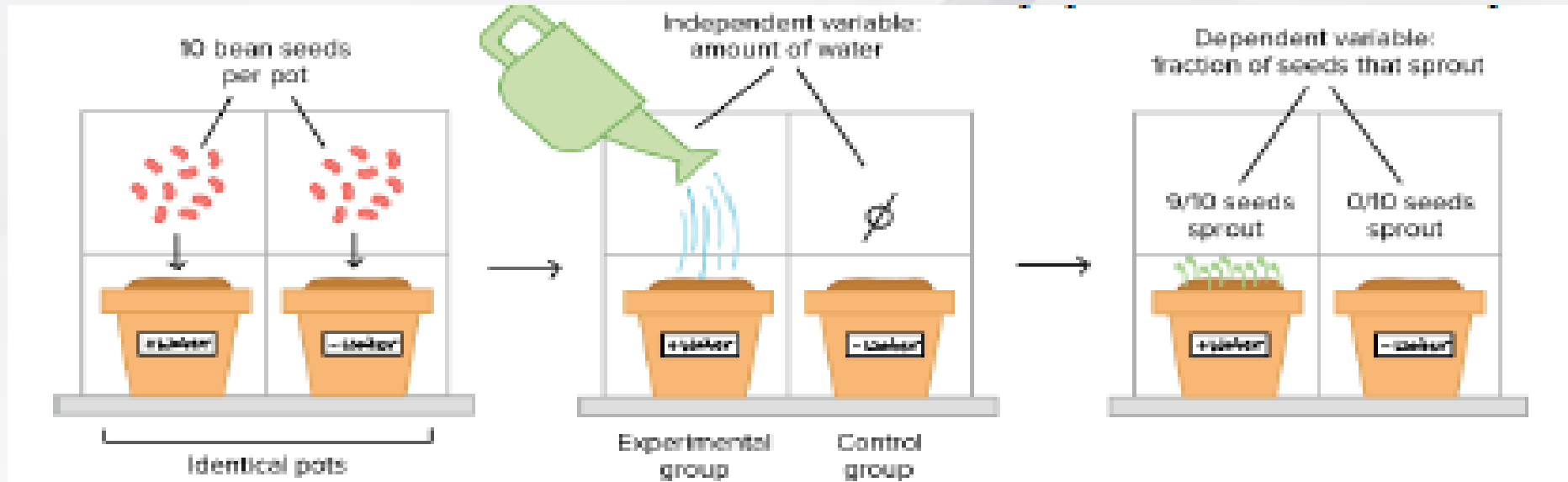
Example for an experiment

To test my hypothesis, I do a controlled experiment. In this experiment, I set up two identical pots. Both contain ten bean seeds planted in the same type of soil, and both are placed in the same window. In fact, there is only one thing that I do differently to the two pots:

- One pot of seeds gets watered every afternoon.
- The other pot of seeds doesn't get any water at all.

After a week:

- nine out of ten seeds in the watered pot have sprouted,
- none of the seeds in the dry pot have sprouted.
- It looks like the "seeds need water" hypothesis is probably correct!





Thank You