The Nature of Science

? How is scientific knowledge created and communicated?

Assumptions of Science

1. The world is understandable; science can discover any pattern in nature
2. The universe is a vast single system in which basic laws are constant
3. There is no such thing as absolute truth
4. Science cannot provide answers to all questions

The Practices of a Scientist

! Science is both a body of knowledge and a way of understanding

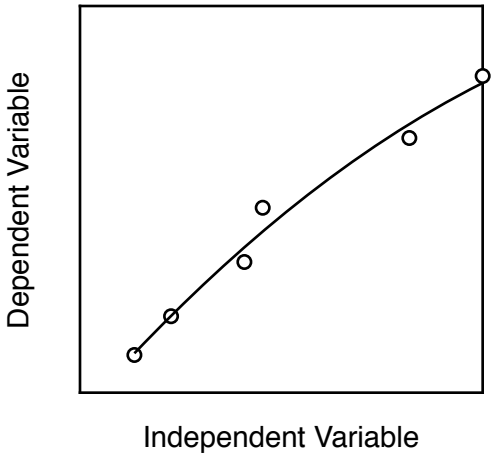
1. Asking questions
   - Scientific questions are ultimately fueled by curiosity about the world
   - There is no single scientific method. Scientists use many methods to uncover the true nature of the world.
   - Scientific questions focus on observation of phenomena, examining models or theories, describing relationships between variables, and challenging the arguments of others.
   - Scientific questions are different from other types of questions because their answers must be supported by empirical evidence.

   - Empirical evidence - knowledge derived from observation and experimentation

2. Modeling
   - Models are simplified representations of parts of nature.
   - Models can include diagrams, physical replicas, mathematical formulas, analogies, and computer simulations.
     - All models have limitations and assumptions
     - Scientific models are based upon evidence. When new evidence is uncovered that the model cannot explain, the model is modified. The goal of modeling is to make predictions.

3. Experiment

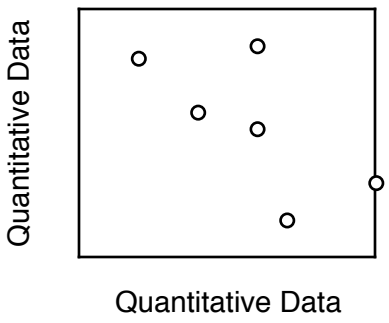
- When scientists want to answer questions, they develop experiments. Experiments are procedures to test whether a claim or explanation is valid.
- Observation - directly gathering information from an object or event
- Inference - logical conclusions based on observation and prior experiences
- Independent Variable - the variable being changed by researchers
- Dependent Variable - the variable responding to the independent variable
- Control - an experiment or observations designed to reduce an experiment to a single variable

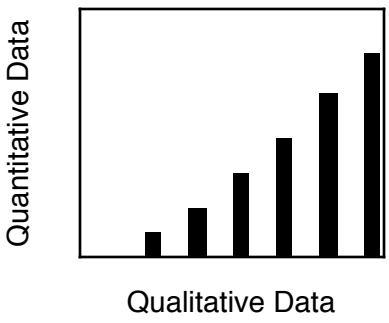


- Control groups are identical to experimental groups, except for one single factor being studied.
- Control groups are insurance against chance or coincidence.

4. Analyzing Data

- The products of experiment are data. Once collected, data are organized to reveal patterns.
- Limitations of data, such as sample size, and measurement error must also be considered
- Qualitative Data - data described in words, but not measured
  - examples: large, brown, many
- Quantitative Data - data that are measured and described with numbers and units
  - examples: 15 kg, 40 cm, 15 pieces





5. Apply Mathematics
    - Mathematics is a tool for organizing data and revealing patterns.
    - Math is also used in science to improve models and make quantitative predictions.
    - Mathematics involves computational thinking, which uses logic and algorithms to create computer simulations.
        - Computer simulations of natural and designed systems have greatly enhanced our ability to answer questions and solve problems
6. Construct Explanations
    - Explanations include claims about the relationships between variables. Claims are made to answer questions, and are supported by evidence.
    - Data become evidence when they are used to support a claim.
    - Hypothesis - a proposed explanation that makes a testable prediction
    - Theory - an explanation that has been tested repeatedly and best explains all known observations
        - The ultimate test of 'truth' in science is experiment
        - The measure of any theory or explanation is its ability to make predictions
7. Argue from Evidence
    - Argumentation is a process of reaching agreements about explanations. The goal is to find the best explanation for a natural phenomenon.
    - No explanation in science is exempt from doubt, critique, or competition.

! The key to science: if it disagrees with experiment, it is wrong