

Title: Scientific Processes

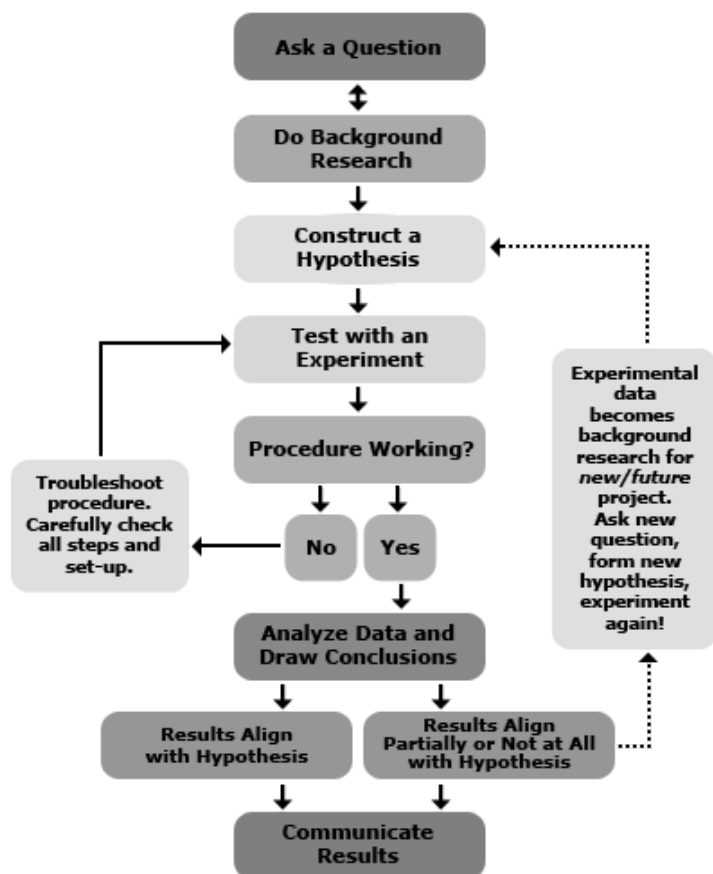
Benchmark: SC.912.N.1.1, SC.912.N.2.1, & SC.912.N.2.2

Employ appropriate methods for accurate and consistent observations.

Conduct and **record** measurements at appropriate levels of precision.

Identify what is science, what clearly is not science, and what superficially resembles science (but fails to meet the criteria for science).

Identify which questions can be answered through science and which questions are outside the boundaries of scientific investigation, such as questions addressed by other ways of knowing, such as art, philosophy, and religion.



HYPOTHESIS: tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation

VARIABLE: to vary or change

INDEPENDENT VARIABLE: a manipulated variable in an experiment or study whose presence or degree determines the change in the dependent variable

DEPENDENT VARIABLE: the observed variable in an experiment or study whose changes are determined by the presence or degree of one or more independent variables

CONTROL: a standard against which other conditions can be compared in a scientific experiment

SOURCES OF ERROR IN EXPERIMENTS:

- Instrumental error (lack of calibration)
- Personal error (inaccurate observations)
- Sampling error (sample size too small or not random)
- Replication error (lack of consistency and accuracy)
- Experimental design
- Measurement error (lack of accuracy and precision)

TYPES OF OBSERVATIONS:

Qualitative – described by words or terms rather than numbers and including subjective descriptions in terms of variables such as color, shape, and smell; often recorded using terms, photographs, or drawings

Quantitative – numerical values derived from counts or measurements of a variable; frequently require some kind of instrument use in recording

BASIC STEPS FOR AN EXPERIMENT:

1. plan the research including determining information sources, research subject selection, and ethical considerations for the proposed research and method,
2. design the experiment concentrating on the system model and the interaction of independent and dependent variables,
3. summarize a collection of observations to feature their commonality by suppressing details (descriptive statistics),
4. reach consensus about what the observations tell us about the world we observe (statistical inference),
5. document and present the results of the study.

REPLICATION OF EXPERIMENTS: WHY?

- shows how variable the response can be
- limited resources may affect results; need to determine a compromise between resources and methods
- need to show a difference between pairs of means
- reliability of results
- consistency of methods and procedures and equipment
- analysis of data and interpretation of data to form conclusions
- ability to form a scientifically literate viewpoint with valid supporting data