Scientific Method

A. Background
1. Process of inquiry
   a. Make observations
   b. Develop testable explanations
      i. Hypothesis
   c. Systematically evaluate the proposed explanations
      i. Objectively analyze
2. Observations
   a. Gathering information
      i. Data
   b. Must be observable using senses and tools that extend the capacities of our senses
   c. Types of data
      i. Qualitative
      ii. Quantitative
3. Types of reasoning
   a. Inductive
      i. Set of observations are used to reach a general conclusion
   b. Deductive
      i. Extrapolation from general premises to specific results

B. Characteristics of hypothesis
1. Tentative explanations for an observed natural phenomenon
   a. A single observation may give rise to multiple hypotheses
2. Must be rational and lead to testable predictions
3. Predictions are assessed using experimentation
4. Hypothesis are NOT proven
   a. Experiments may support the view that there is a low probability of the observations being the result of chance
   b. Experimentation can reveal whether the hypothesis is true or false

C. General process of the scientific method
1. What inspires the question?
   a. Experience in the natural world
   b. Interactions with other members of the scientific community
      i. Shared data and ideas
   c. Published information
2. Develop and test hypothesis
   a. Requires testable predictions
   b. Predictions are assessed using experimentation
   c. Data and observations are measured and tested
3. Data generated in experiments may support or contradict hypothesis
   a. May require revisions to the hypothesis or alter prior assumptions
4. Findings generated by experimentation are shared and analyzed by the scientific community
   a. Peer review
   b. Offers opportunity for study to be replicated
   c. Data and its interpretation may be published can contribute to the broader understanding of a phenomenon
   d. Accumulated knowledge may lead to the formation of “Theory”
      i. Highest level of confidence in the correctness of an explanation
5. Finding of experimentation may contribute to the broader society
   a. Technology, policy, authoritative knowledge

D. Experimentation
1. Controlled experiment
   a. Systematically manipulate one or more variable to observe the effect of that change
   b. Control group
      i. Not subject to the manipulation
   c. Experimental group
      i. Subject to manipulation
2. Types of variables
   a. Independent variable
      i. The variable that is manipulated
   b. Dependent variable
      ii. The variable that is measured
3. Discrete verses continuous variables
   a. Discrete have a limited number of possible values
      i. Gender, geographical location, etc.
   b. Continuous have infinite possible values
4. Correlational verses experimental research
   a. Measure naturally occurring variables
      i. Assess whether the variables are related
      ii. CANNOT attribute cause and effect
   b. Systematically manipulate independent variable and measure its effect on the dependent variable

Scientific Skills Exercise (Campbell, Page 22)

1. What is the question?
   *Does contrast between surrounding and coat color affect nighttime predatory success for owls?*
   *Would contrast effect on predation be affected by moonlight?*

2. Experimental design
   *Pairs of mice differing in coat color (light verses dark coats) were simultaneously released into one of two enclosures each containing a food deprived owl. The enclosures had either light-colored or dark-colored soil and were either illuminated by moonlight or not. The researched recorded which mouse, dark coat or light coat was caught. The experiment was conducted with multiple sets of mice.*
3. What were the dependent and independent variables?

Dependent: Number of mice caught
Independent: Coat color, soil color and lighting (i.e., contrast)

4. How do you represent the data graphically?
   a. Graph elements
      i. X and Y axis
      ii. Figure title
      iii. Bars or lines?
      iv. Legend
   b. Construct the graph

5. Interpretation
   a. How does the data tell us?
   b. How do you know that the apparent differences are “REAL”
      i. Statistical analysis
      ii. ANOVA