



Academic Writing II – Question & Hypothesis

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Formulating a research question or research hypothesis



Research methodology can be grouped as **empiricism, inductivism, and hypothetism.**

Arguments among hypothetical-deductive approach, inductive or empirical approach, and anti-empiricism have been raised in the past decades.

Compared to inductivism and hypothetism, empiricism has been a common methodological background assumption in ecology.



The hypothetical-deductive method was widely applied in the modern ecology (Tuomivarra et al. 1994).



Controlled scientific experiment:

identify and control as many factors as possible that may affect the outcome of the study.

Correlational:

compare two or more different variables to determine if any predictable relationships exist among them.

Survey questionnaires:

deal with information obtained from survey questionnaires or from case studies.

Computer-generated models:

explain or predict phenomena observed in the laboratory or in nature.



The research question is the basis on which the study is planned and carried out.

After researchers have focused on a specific topic of investigation, they formulate a question that addresses a specific aspect of the topic in which they are interested.

Prepare to answer referees/opponent the research question.



In formal research work, it is necessary to formulate a statement of expected results. This is called the hypothesis.

The purpose of the experiment is to determine whether the hypothesis can be rejected or not.

The hypothesis is a possible response to the research question.

When the hypothesis is stated in this negative way, it is called the null hypothesis.



Giere (1991). Understanding Scientific Reasoning

The 6-step program for evaluating **theoretical hypotheses**

The 6-step program for evaluating **statistical hypotheses**



The 6-step program for evaluating **causal hypotheses**



Step 1. The 1st step is to identify the real world **object**.



Step 2. And the 2nd step is to identify a **theoretical model** used to represent the real world.



Step 3. The 3rd step identifies **data** that obtained by observation or experiment involving the real world objects of study.



Step 4. Based on the model, the 4th step, a **prediction** is conducted, the prediction says what data should be obtained if the model actually provides a good fit to the real world.

Step 5. The next part is **evaluation**. Giere (1991) divided the evaluation part into two steps.

The first step of evaluation part answers whether or not the data agree with the prediction.

If not, conclude that the data do not fit the real world. If the data do agree with the prediction, go on the next evaluation step.



Step 6. The second **evaluation** step checks the validity of prediction by answering the following question:

“Was the prediction likely to agree with the data even if the model under consideration does not provide a good fit to the real world?”

If the answer is “no,” then the data do provide good evidence that the model does fit the real world.

If the answer is “yes,” then the data are inconclusive regarding the fit of the model to the real world.



Step 1. Firstly, the **real world population** which is the intended object of the study should be identified.

Step 2. Secondly, we need to identify the real world **sample and** the particular **data**.



Step 3. The third step is to identify the **statistical model** of the population, the relevant variables and the values of these variables.

Step 4. **Random sampling**, provides answers to the question – “How well does a random sampling model represent?”

Step 5. By **evaluating** the strength of the correlation, step 5 analyzes the random sampling model, whether or not it is applicable. In this step, the statistical model in step 3 is checked if a correlation is possible.



Step 6. Finally, the last step **summarizes** the statistical hypotheses, particularly by reviewing analyses in steps 4 and 5.



Step 1. The real world population and the **causal hypothesis population**.

Step 2. Identify the real world sample and particular **data**.

Step 3. Experimental or non-experimental **designs**.

Step 4. **Random sampling**. How well does it represent.

Step 5. **Evaluating** the hypothesis. Evaluate effectiveness.

Step 6. **Summary**. Review steps 4 and 5. Give a summary statement.

There are three **types of experimental designs**, i.e., **prospective**, **retrospective**, and **randomized** experimental designs. Compared to prospective and retrospective designs, randomized experimental designs provide the best evidence for the existence of a genuine causal factor.



“One of the most common mistakes in statistical reasoning is inferring the existence of a causal connection from a known correlation.” (Giere 1991).

In fact, causation and positive correlation are very different.



Correlation is symmetrical relationship, causation is not.



A symmetrical relationship means, “if A is positively correlated with B, then B will be positively correlated with A, and vice versa.”



However, “if being an A causes you to be a B, it does not follow that being a B would cause you to be an A.”



Many ecologists use 'age' as a dependent variable very often (e.g. Lehtonen 2005).



For example, in a forest growth model, tree growth can be formulated as a function of time.

The volume growth of forest is **positively correlated with age**.



However, **age does not cause growth!**



- Peter Checkland, *Systems Thinking, Systems Practice*. New York: John Wiley & Sons 1981.
- Eugene S. Ferguson, *Engineering and the Mind's Eye*. Cambridge: The MIT Press 1992.
- James H. Fetzer, *Philosophy of Science*. New York: Paragon House 1993
- J.C. Gibbings, *The Systematic Experiment. A Guide for Engineers and Industrial Scientists*. Cambridge: Cambridge University Press 1986
- Ronald N. Giere, *Understanding Scientific Reasoning*, third edition. Chicago: Holt, Rinehart and Winston Inc. 1991
- Frederick Grinell, *The Scientific Attitude*. Second ed. New York: The Guidford Press 1992.
- Ernst Mayr, *This is Biology – The Science of Living World*. 1997. Elliot Sober, *Philosophy of Biology*. 1993.
- Steward Richards, *Philosophy & Sociology of Science. An Introduction*. Oxford: Basil Blackwell 1985.
- Timo Tuomivaara, Pertti Hari, Hannu Rita, Risto Häkkinen, *The Guide-Dog Approach: A Methodology for Ecology*. Helsingin yliopiston metsäekologian laitoksen julkaisuja 11. Helsinki 1994.