Introduction to Research

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An enquiry from an FTEP/FTEPV Trainee

A colleague received an email from a FTEP trainee in response to initial instructions to think about a research topic (paraphrased).

Hi Dr. M,

I have started asking around my office about good research ideas. One question that came up was:

Is a research only testing/experiments that you have to do, or do you research others' research and put all of that into a compilation? Or is it a little of both?

Introduction to Research

- The posed questions are excellent.

Is research

testing and experiments that are done?

OR

gathering others research and compiling it?

OR

a little of both?

Research is NOT

- Research is not rummaging for information.
  - "rummaging" connotes a lack of systematic searching for information

- Research is not a catchword used to get attention.
  - "years of research" in an advertisement is an example

Research is NOT

- Research is not just information gathering.
  - This is information discovery

- Research is not transporting facts from one location to another.
  - This is fact discovery.
  - This is compiling others' research

    - Compiling facts and others' research constitutes a first step in a ***review*** of the current literature.

Research Is

Research is characterized by eight features.

1. An origin
2. A goal
3. A plan
4. A scope
5. A guidance system
6. A starting point
7. A data requirement
8. A helical nature

Feature: Origin

- Research originates with a question or problem.

  The unanswered question or unsolved problem must be interesting and important to you because you will be investing a considerable amount of time in the research endeavor.

Feature: Goal

- Research requires a *clear* articulation of a goal.

The *clear* articulation requires an unambiguous statement to answer this question:

What problem do you intend to solve?

- Hint: Force yourself to use a grammatically correct sentence or two. It is amazing what happens when one is forced to put it on paper!

Feature: Plan

- Research follows a specific plan.

The specific plan can be called “a carefully planned attack.”

HOW are you going to answer your question or solve your problem?

Feature: Scope

- The principal research problem is usually divided into more manageable sub-problems.

Sub-problems are solved in order to solve the overall research problem

or

Sub-questions are answered in order to answer the overall research question

Feature: Guidance System

- Research is guided by the specific research problem, question, and related hypotheses.

So, state the problem or question; state the sub problems or sub questions; then formulate one or more hypotheses.

- A hypothesis is an educated guess about what the answer to the problem/question or sub problems/question will be.

Feature: Starting Point

- Research accepts certain critical assumptions.

  Assumptions are self-evident "truths" **that must be valid** or the research is meaningless!
  - Assumptions must be stated up front.

Feature: Data Requirement

- Research requires the *collection* and *interpretation* of data in an attempt to resolve the problem or answer the question that initiated the research.

The collected data must be appropriate and organized meaningfully to aid interpretation.

Feature: Helical Nature

- Research is, by its nature, a cyclical or, more exactly, helical process.

Different disciplines follow the same research “cycle” with different tools.

The Research Cycle

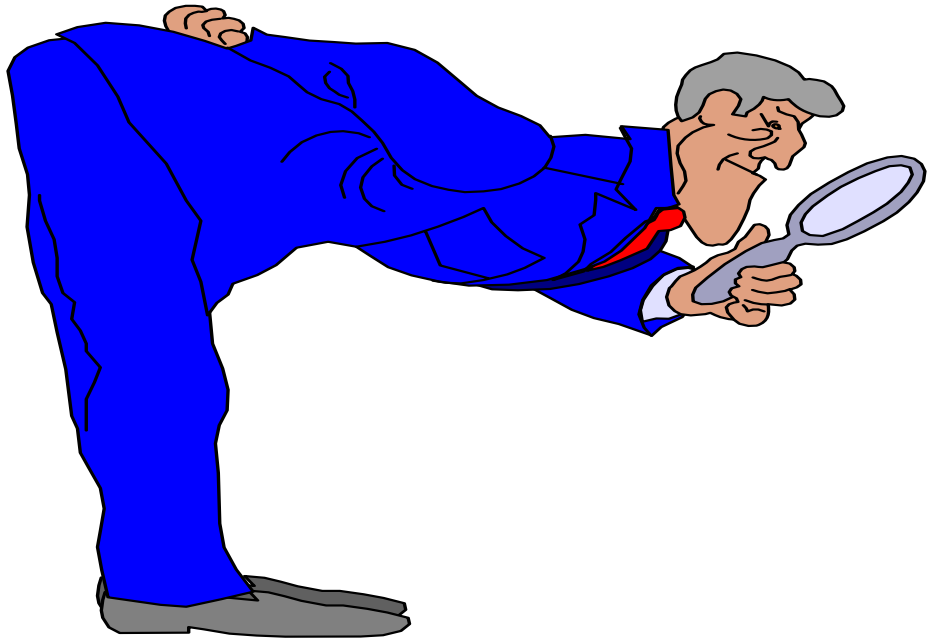
- A problem or unanswered question
- Goal definition: clear problem statement
- Problem subdivision
- Hypothesis formulation
- Data collection and organization
- Data interpretation: answering question
  - New questions or problems emerge

Developing Research Topics

- Four basic ways to develop a research topic
  - Replication
    - Conducting an identical study but using a different, but similar, sample
  - Quasi-replication
    - Same topic…different design
  - Original idea
  - Recommendation from adviser/supervisior

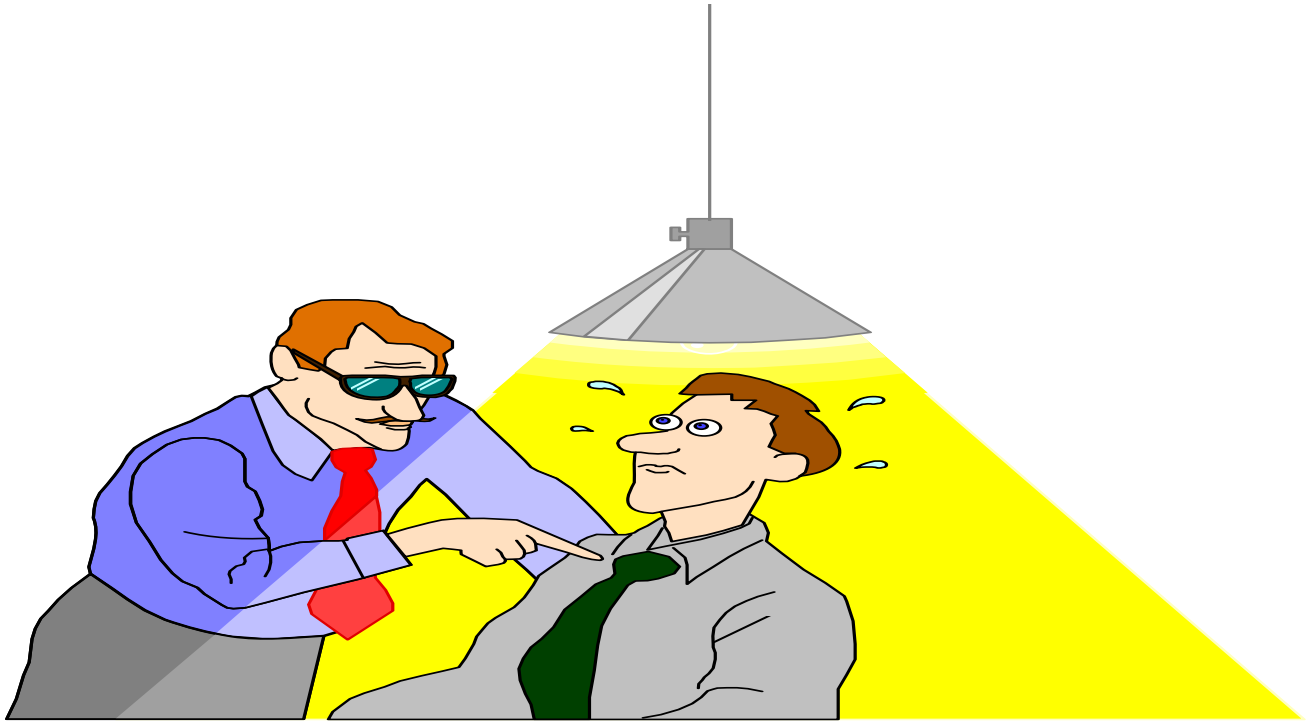
The Three Spectrums of Research in Biological Sciences:

- 1. Experimental and Basic Science Studies - Bench Style



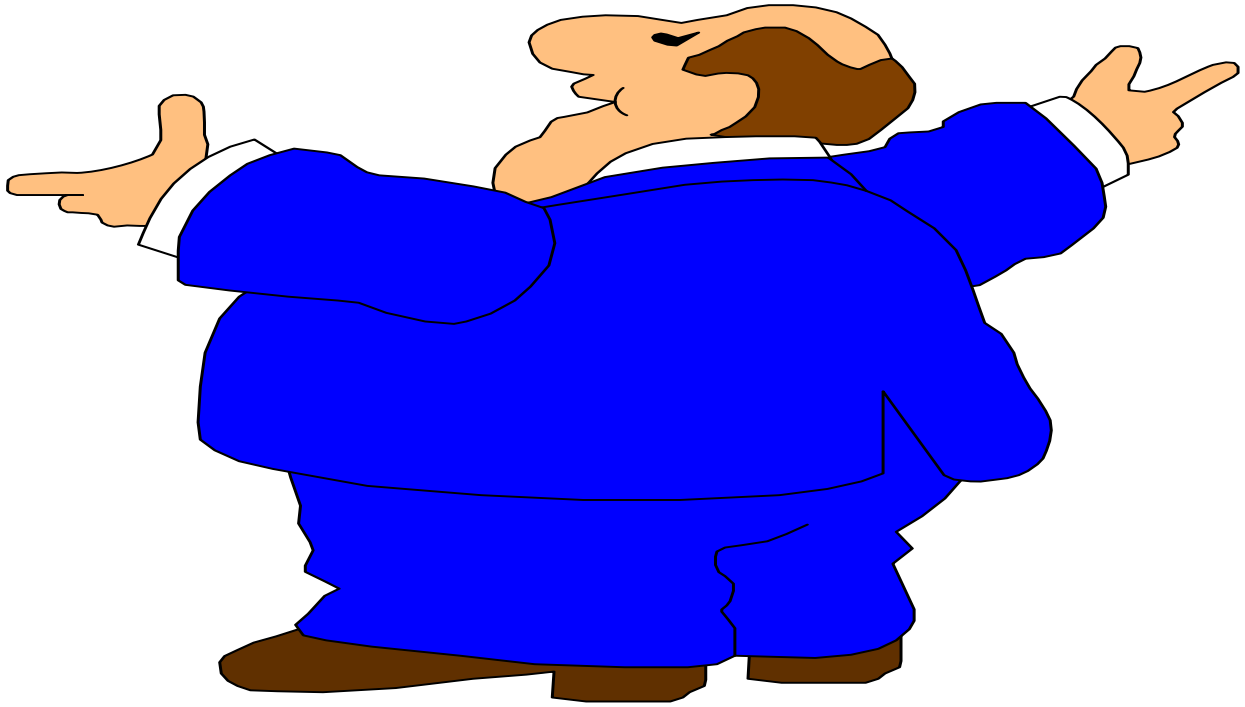
The Three Spectrums of Research in Biological Sciences:

- 2. Applied Sciences Studies - Clinical and Field Trials



The Three Spectrums of Research in Biological Sciences:

- 3. Observational Studies - Epidemiologic Studies



The Spectrum of Making Inferences from Research in Biological Sciences:

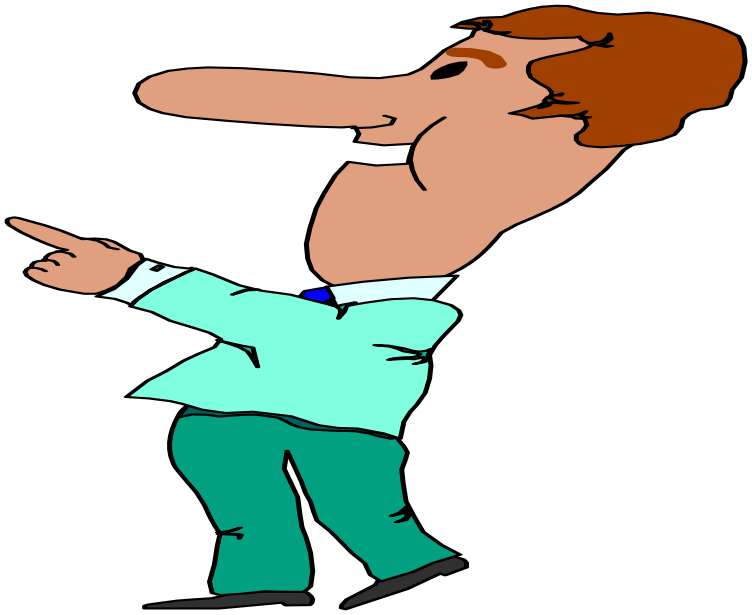
- Controlled - Simple Statistics
- Uncontrolled - Sophisticated Statistics

A Systematic Investigation of a Field of Knowledge Would Require:

- A conceptual hypothesis
- A statement of objective
- At least one operational hypothesis

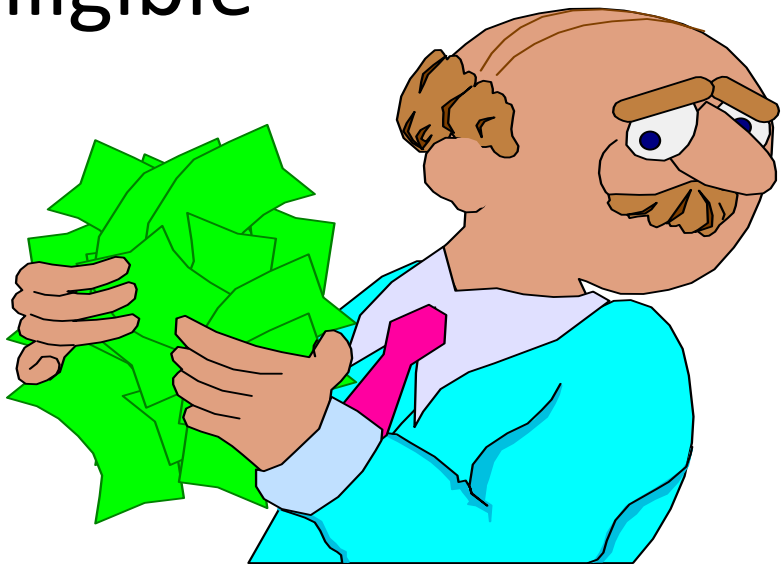
What Is a Conceptual Hypothesis?

- A problem
- A general or broad statement of thesis
- Usually not statistically testable



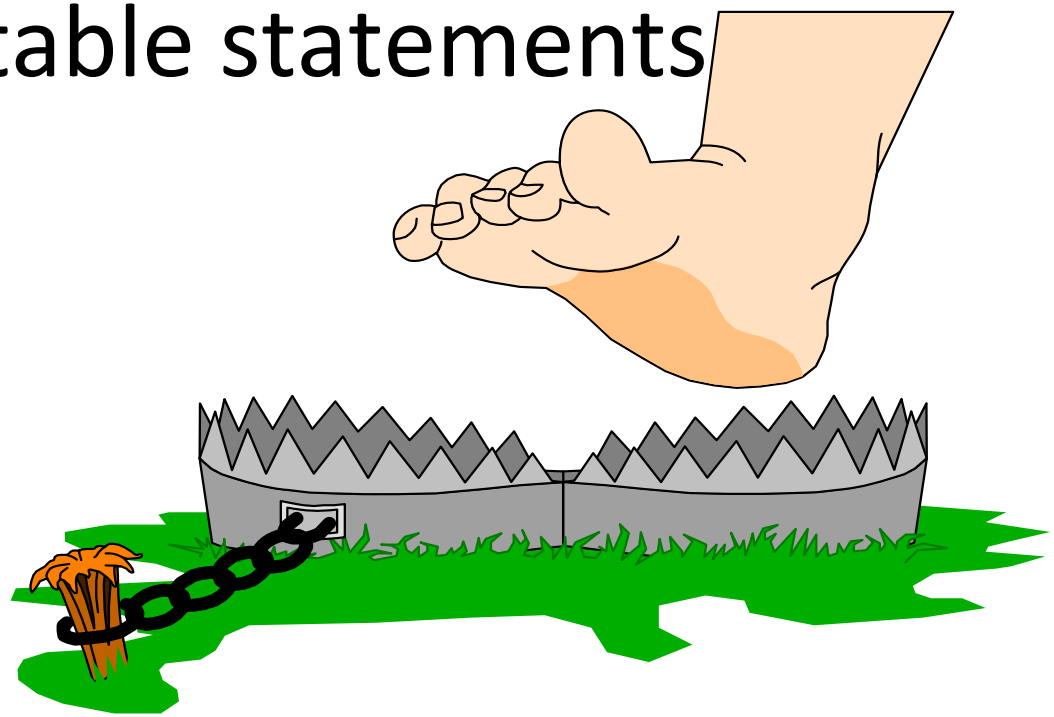
What Is an Objective?

- It has a more narrow focus than a conceptual hypothesis - Subproblem
- Stated as things to accomplish.
- Should be clear and intelligible



What Is an Operational Hypotheses?

- Very specific statements
- Determined by study design
- Statistically testable statements

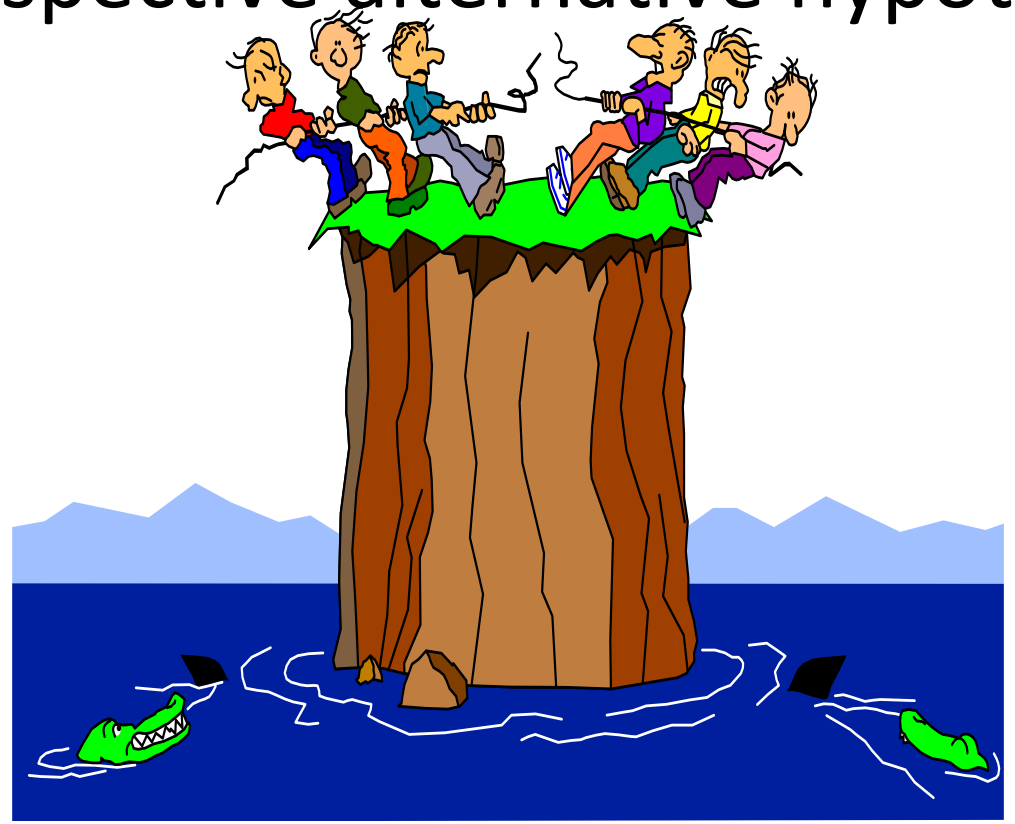


Null (Ho) vs Alternative (Ha) Hypotheses

- Usually the alternative hypothesis is the operational hypotheses (i.e., what you want to show)

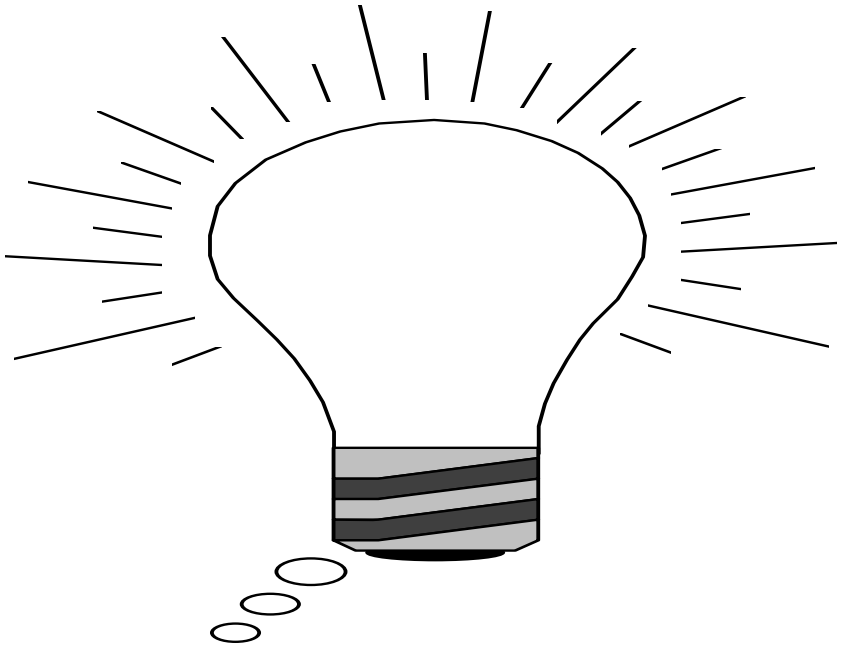
Null (Ho) vs Alternative (Ha) Hypotheses

- The null hypothesis is the converse of the respective alternative hypotheses



Null (Ho) vs Alternative (Ha) Hypotheses

- All statistical tests are based on the idea of null and alternative hypotheses



Null (Ho) vs Alternative (Ha) Hypotheses

- Statistical tests are designed to tell you how likely the difference you observed is due to chance rather than what is real (p-value)

How to Start?

- To delve into research
  - Think about an unsolved problem or unanswered question that has occurred to you or is associated with your workplace
  - Talk to your colleagues/supervisors/mentors
  - Read and *evaluate* journal articles in your area of interest

Research Article Evaluation

- Practice reflective thinking by asking the question:
  - What does it all mean?

- Is the article from a refereed journal?
- Does the article have a stated research question?
- Does the article describe data collection of data?
- Is the article organized logically?

Research Article Evaluation

- Does the article contain a section that reviews previous studies? Are the studies relevant?
- Are procedures described in enough detail so you could repeat the work?
- Can you describe how data were collected and analyzed? Do you agree with what was done?
- Do you agree with the interpretation of the results?
- What is most important in the article? What are its strengths and weaknesses?

To Conclude

- Is research

testing and experiments that are done

OR

researching others research and compiling it

OR

a little of both?