Problem Selection

IUFRO-SPDC

Snowbird, UT September 29 – Oct 3, 2014

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“No scientific problem is ever answered by rushing to the laboratory [or field]” M. Bunge

Problem Selection and Question Generation

- Typology of problems in general
- Exercises vs Problems
- Classes of Scientific Problems
- Identifying/Generating Scientific Problems
- Problem Solving Heuristics
- Characteristics of a Good Scientific Question
- Research Hypotheses

Typology of Problems

- Ordinary life problems (Exercises?)
  - Feel better
  - Lose weight
  - Save more money

  - Posed against issues of survival, self-satisfaction, personal well being
  - Results are personal
  - outcomes may mean different things to different people

- Scientific problems
  - posed against a scientific background – as found in published literature
  - are investigated with scientific means – that lead to valid inferences.
  - purpose is increasing public knowledge.

Exercise versus Problem

(Polya. 1971. How to Solve It)

- Exercise
  - An exercise is a situation where you don't know the answer, but have an algorithm for finding it
  - What is the cross-sectional area of a tree with diameter 16.7 cm
  - CSA = $(\pi/4)D^2$
- Problem
  - A problem is a situation where you not only don't know the answer, but you also don't have an algorithm for finding it
  - What is the turn over rate of fine roots in Gmelina plantations

Classes of scientific problems

- Substantive or (real) object problems
- Strategy or procedure problems
- "Nothing" problems
- Assigned problems

‘Location’ of scientific problems:

This cycle is schematically represented in Fig. 1.1.

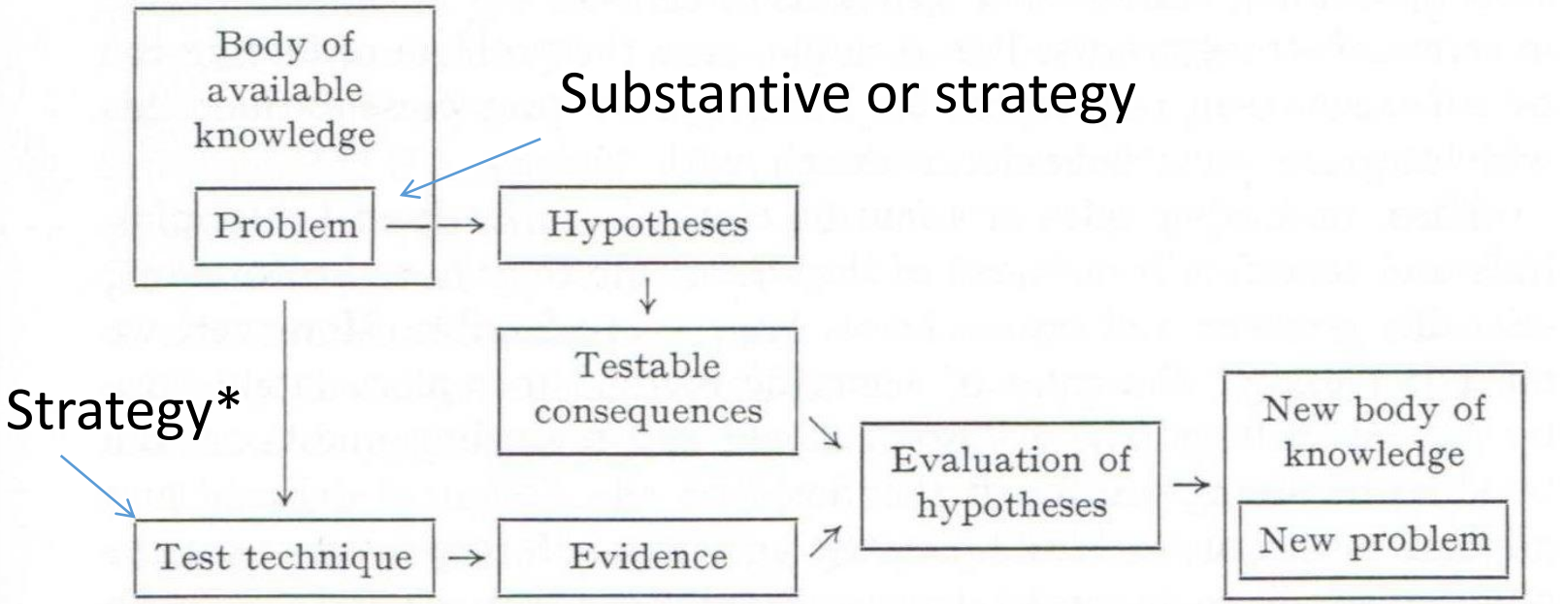


Fig. 1.1. A research cycle. The importance of a scientific investigation is gauged by the changes it induces in our body of knowledge and/or by the new problems it poses

Substantive problems

- Empirical
  - Data finding (observing, counting, measuring)
  - Making (instruments, devices – construction…)
- Conceptual
  - Describing, arranging, elucidating
  - Deducing
  - Inventing ideas

Strategy problems

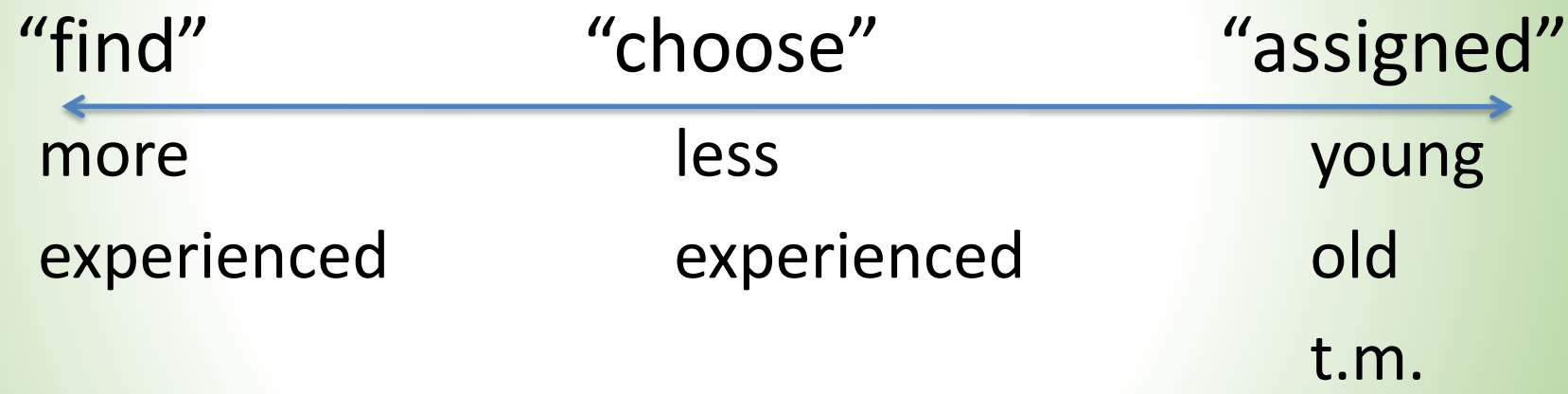
- Methodological
  - How to problems
- Valuational
  - Weighing alternative data, methods, test results, etc.

‘Nothing’ problem

- ‘Nothing’ problem characteristics?
  - Needs to get done so results can be used by others
  - Needs done so you can obtain your results
  - Little prospect for results to be publishable
  - The ‘best and the brightest’ scientists can/will refuse to work on them
  - Typically are very poorly defined and poorly documented
- Are usually assigned to old or young scientists

‘Find’ or ‘choose’ or ‘assigned’

- Tends to be career-stage-specific



Identifying/Generating Scientific Problems (Bunge)

Criticize currently accepted 'solutions'

- Look for flaws
- Articulate all …. assumptions, and
- Identify the logic used BY OTHERS in generating their 'solution'

If *A* then *B*

B

Therefore *A*

A expresses the "claim"

B expresses the "evidence"

"A" includes

Scientific hypothesis + Auxiliary assumptions +

Initial conditions

This logic is invalid.

Commits error of 'affirming the consequent'.

If *A* then *B*

Not *B*

Therefore not *A*

A expresses the "claim"

B expresses the "evidence"

BUT, "A" includes

Scientific hypothesis + Auxiliary assumptions +

Initial conditions

Identifying/Generating Scientific Problems (Bunge)

- Apply known techniques/solutions to new situations
  - How well do they work?
  - E.g., when a scientist switches from a more advanced discipline to less advanced.

Robert May (physics to ecology) in 1980s

Vito Volterra (mathematics to fisheries) in 1920s

Identifying/Generating Scientific Problems (Bunge)

- Generalize old problems/solutions
  - Scour the literature all the way back to first introduction
  - Try new potentially explanatory variables
  - Invent new concepts and test them

Identifying/Generating Scientific Problems (Bunge)

- Look outside
  - Search for relationships/techniques in new/different fields.
  - Apply new technologies to old problems.

Practical ways of finding problems

- Rolfe's tips
  - Pay attention to "off hand" remarks of colleagues, i.e., listen up !
  - "See what others have seen, but think what no one has thought" [A. Szent-Gyorgyi]
  - 'Tweak' vs. 'Shift' your view point
  - When things get really confusing, ask: "What is the fundamental unit of .....?"
  - Check out your Mother-in-law's cupboard like I did: "...help yourself to anything you can see. All the good stuff is hidden." [Eleanor Buckett]
- JAKs tips
  - Read outside your field ("You'll never change if you only read what interests you." – Bill Gates)
  - Attend seminars, presentations outside your area
  - Volunteer to review manuscripts/research proposals
  - Listen to the news
  - Visit science news websites
  - Try things and try them again
  - Develop a running list of questions

Whatever problem type & however ‘received’

- Is critical to do a thorough literature review
- Understand completely the problem’s context

  i.e., the GROUND

Problem Solving Heuristics

- Mario Bunge
- Universal Traveler
- Scientific Method

M. Bunge, 1998: 225-232

- State the problem clearly
- Identify the constituent parts
- Unearth the presuppositions
- 'Locate' the problem (substantive, procedural)
- Select the methods
- Simplify
- Analyze (break into simpler parts)
- Plan (order by priority or difficulty)
- Look for similar solved problems
- Transform the problem
- Export the problem
- Control the solution

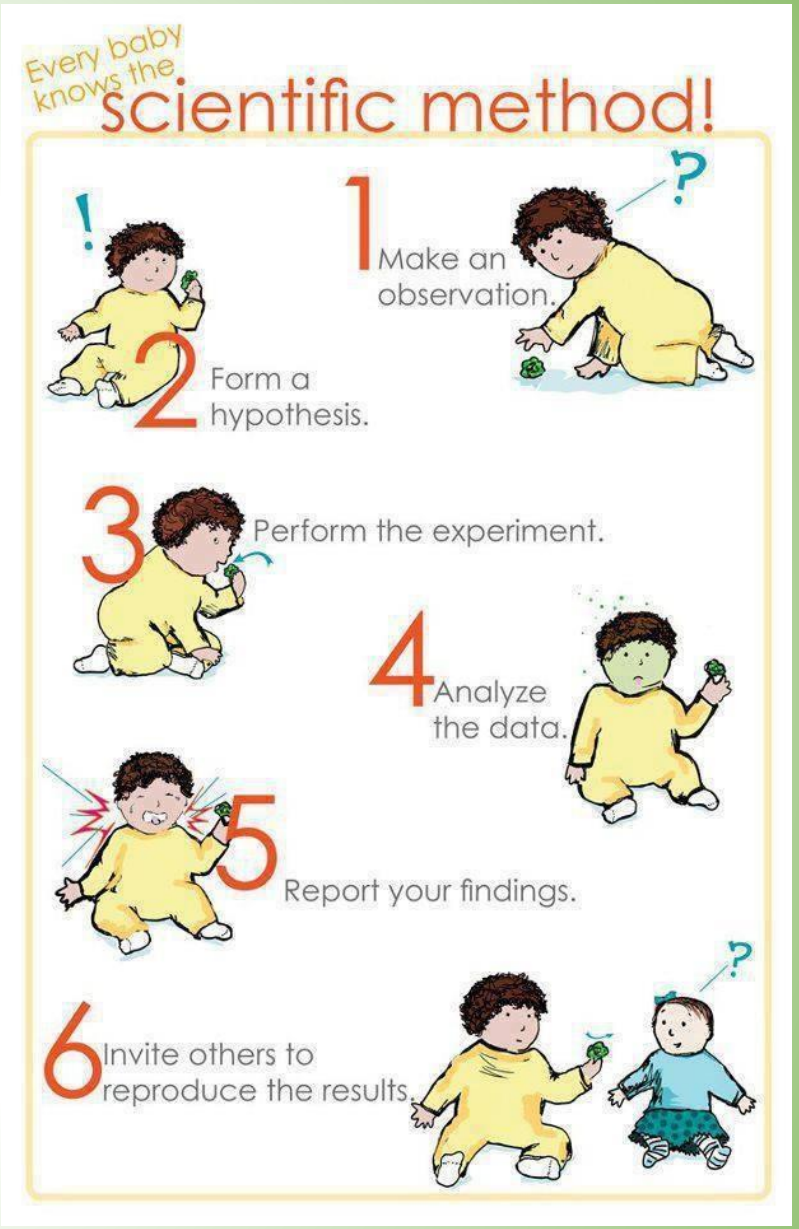
The Universal Traveller

(Koberg and Bagnall. 1990. Crisp Publishers)

- Accept the Situation
- Analyse the Situation
- Define the Problem
- Ideate Solutions
- Select a Possible Solution
- Implement Solution
- EvaluateSolution

Problem Solving Heuristics

- Scientific Method
  - Observations
  - Questioning
  - Hypothesis
  - Testing
  - Explanation



Questions are the fundamental starting point of scientific problem solving

- Scientists ask lots of questions
- Questions comes as we observe phenomenon
- Some questions are scientific, some are not

Questions

- Nonscientific
  - Answers different depending upon who you ask
- Scientific
  - Guides an investigation/experiment

Example

Example

- Is it cold out?

Example

- So how can we ask this question so that it is scientific?

Scientific Question

- Guides an investigation/experiment
- Start with a "BIG" question
  - Why or How questions?
- Narrow questions to something testable
  - A question is testable is it can be answered by observing, measuring, experimenting

What makes a good scientific question/ purpose?

- It cannot be answered with “yes” or “no”.
- It doesn’t use the words “I” or “you” (or any form of them).
- It can be researched through experimentation.

What makes a good (scientific) research question?

- Research Question:
  - Clear, concise, easily understandable, with minimum jargon
  - Must be testable or quantifiable
  - Must be non-trivial
- Science:
  - Must relate to a real phenomenon

- Ideally it should be derived from current knowledge and advance our understanding of the concept or theory

The Researchers Life

(The way it should be)