Genesis of and Exploration of an Idea

Where and When Ideas

Experience
  Becoming an Expert

Creativity
  Lateral Thinking

Testing Ideas

Hypothesis Testing

Potential Pitfalls

Strong Inference

External Validity
  Facing Complexity
  Challenge of Applications

Distinguishing Science From Pseudoscience

Ten Criteria

A Real Example

Initial Promising Results

Meta-Analysis

Continued Practice
  Time on Task
The real purpose of [the] scientific method is to make sure Nature hasn't misled you into thinking you know something you actually don't know.

R. Pirsig, Zen and the Art of Motorcycle Maintenance
Barriers to Critical Thinking

• Direct Experience can be Misleading
  – Clever Hans
  – Mystery Spot

• Overconfidence
  – Medical Judgments vs. Weather
FIGURE 19.2
This figure contains calibration curves for weather forecasters’ predictions of precipitation (hollow circles) and physicians’ diagnoses of pneumonia (filled circles). Although the weather forecasters are almost perfectly calibrated, the physicians show substantial overconfidence (i.e., unwarranted certainty that patients have pneumonia). The data on weather forecasters comes from a report by Allan Murphy and Robert Winkler (1984), and the data on physicians comes from a study by Jay Christensen-Szalanski and James Bushyhead (1981).
I know that most men, including those at ease with problems of the greatest complexity, can seldom accept even the simplest and most obvious truth if it be such to oblige them to admit the falsity of conclusions which they have delighted in explaining to colleagues, which they have proudly taught to others, and which they have woven, thread by thread, into the fabric of their lives.

What a man believes upon grossly insufficient evidence is an index into his desires -- desires of which he himself is often unconscious. If a man is offered a fact which goes against his instincts, he will scrutinize it closely, and unless the evidence is overwhelming, he will refuse to believe it. If, on the other hand, he is offered something which affords a reason for acting in accordance to his instincts, he will accept it even on the slightest evidence. The origin of myths is explained in this way.

Bertrand Russell. "Proposed roads to freedom: socialism, anarchism and syndicalism" (1919)
Science Game

• There is a rule that generated 2 4 6
• Generate sequences to test the rule
Genesis of and Exploration of an Idea
Where and When Ideas
  Experience
    Becoming an Expert
Creativity
  Lateral Thinking
Testing Ideas
  Hypothesis Testing
    Potential Pitfalls
    Strong Inference

External Validity
Facing Complexity
Challenge of Applications
Distinguishing Science From Pseudoscience
  Ten Criteria
A Real Example
  Initial Promising Results
  Meta-Analysis
  Continued Practice
    Time on Task
Caveat: Confirmation Bias

• Seek Positive Evidence
• Ignore Negative Evidence
• View Ambiguous Evidence as Positive
• With Multiple Sources, Overweight the Positive Relative to the Negative
• Einstein was not Immune
Confirmation Bias
Imposing More Order Than Appropriate

Ambiguous Evidence Taken as Support for Beliefs

Francis Bacon
Inconsistent Scientists

• Physicists and Uri Geller
  – Ideal Scientific Minds
  – Fooled by Alleged Paranormal
Confirmation Bias in Einstein’s Advocacy of Communism

Time Magazine's "Person of the Century"

– Presented Socialism As a Non-falsifiable "Truth”

– Strong advocate of universal freedom, but accepted that freedom had to be temporarily suspended in the Soviet Union in order to build up the country.
Genesis of and Exploration of an Idea

Where and When Ideas

Experience
  Becoming an Expert

Creativity
  Lateral Thinking

Testing Ideas

Hypothesis Testing
  Potential Pitfalls
  Strong Inference

External Validity
  Facing Complexity
  Challenge of Applications

Distinguishing Science From Pseudoscience

Ten Criteria

A Real Example

Initial Promising Results

Meta-Analysis

Continued Practice
  Time on Task
Testing Hypotheses

• Many Safeguards
  – Random Sampling
  – Double Blind Procedure

• Fast ForWord
  – Behavioral Science Findings
  – Extrapolate to Application
  – Test in Application
I believe that one of the greatest moral reforms that lies immediately before us consists in the general introduction into social and civic life of that habit of mental procedure which is known in investigation as the method of multiple working hypotheses.

Thomas Chrowder Chamberlin, 1890

(Repinted, 1965, p. 759.)
Fast ForWord

• Initial Support
  – Empirical Studies
  – Endorsements
    • Former UC president & renowned scientist
      – “Check it out. It helped my grandson.”

– Appropriate Controls
  • Always an Issue
Fast ForWord

• Appropriate Controls
  – Always an Issue

• Confoundings
  – Time on Task
  – Value of MetaAnalysis

Meta-analysis

- In statistics, a meta-analysis refers to methods focused on contrasting and combining results from different studies, in the hope of identifying patterns among study results, sources of disagreement among those results, or other interesting relationships that may come to light in the context of multiple studies.[1] In its simplest form, this is normally by identification of a common measure of effect size, of which a weighted average might be the output of a meta-analysis. The weighting might be related to sample sizes within the individual studies.
Example of Fast Forward

Survey of Psychological Literacy

- Basis of Short Course
I am just as deaf as I am blind. The problems of deafness are deeper and more complex, if not more important, than those of blindness.

Helen Keller
Language Tutoring with a Virtual Teacher

Direct Vocabulary Instruction
Language Tutoring with a Virtual Teacher

Direct Vocabulary Instruction
“I like Baldi because... I can hear him... He understands me... He doesn’t get mad at me... He sounds good... He knows about everything... I learn from him... He teaches me how to say words... He helps me remember... He lets me do my lessons many times...”

–Responses from multiple Tucker-Maxon students
Exercise: Propose Test For:

- Whether Baldi tutoring is responsible for learning.
Hard of Hearing First Grader

Multiple Baseline Procedure
Each child receives
3 sets of words
Test all words
Train 1 set at a time
Vocabulary Learning

• Occurred with Baldi as Tutor
• Questions Remain
  – Is Baldi actually responsible?
  – Assess retention and transfer?
Baldi is helping children with autism learn language and emotion
Learning Plurals
Multiple Baseline Procedure

Each child receives 3 sets of words

Test all words

Train 1 set at a time
School F-258, Renaca, Chile

Deaf Children Learning Spanish Vocabulary
Baldi Guides
Vocabulary Learning
The hypothesis is:
If children are immersed in written language, they will learn to read naturally.
You observe the following 4 situations. What conditions have to be observed to test this hypothesis?

1. children immersed in written language
2. children not immersed in written language
3. children who are readers
4. children who are not readers
How do conclusions differ between deductive reasoning and inductive reasoning.

In deductive reasoning, the conclusion follows logically from the observations.

In inductive reasoning, the conclusion goes beyond the observations and new observations can always falsify the conclusion.