Research Design and Methodology: Keys to Designing Successful Research

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Overview

- Designs and Methods
- Validity and Threats to Validity
- Science as a Social Enterprise

Design and Method

- Science relies heavily on specialized techniques
- Risk: focus on technique rather than question and design
- Mark Twain: "if the only tool you have is a hammer, you are likely to see every problem as a nail."
- Not all problems <u>are</u> nails
- Essential to <u>Define Your Question Clearly</u>

Basic Types of Research Questions

- Exploratory: "what is out there?"
- Descriptive: "what is going on in a given domain?"
  - Search for patterns and frequencies
- Explanatory: "why is it going in?"
  - Search for causal explanations
- Type of Question Affects Design

4 Types of Research Designs

- Experimental
- Longitudinal
- Cross-sectional
- Case Study

Experimental Design

- Focused on causal questions
- Objective: control for all possible causes except the one under consideration

1. Treatment Group
2. Control Group
   - Laboratory Control
   - Randomization
   - Matching ("quasi-experiment")

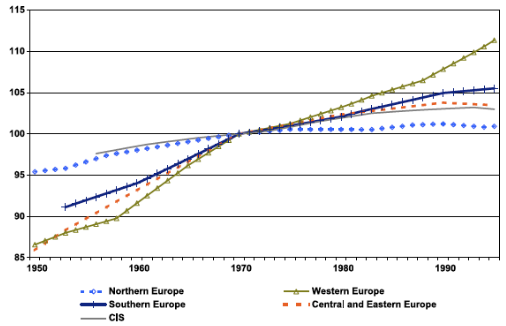
	Time 1 (T_1) Pre-test	Intervention (X)	Time 2 (T_2) Post-test	
Experimental group	E_1 Mean score = 50	'Severe initiation'	E_2 Mean score = 75	$E_{change} = 75 - 50$ $= 25$
Control group	C_1 Mean score = 50	No initiation	C_2 Mean score = 60	$C_{change} = 60 - 50$ $= 10$

Figure 4.3 *Classic experimental design: effect of difficulty of joining a group by perceived desirability of group membership*

Source: David A. De Vaus, *Research Design in Social Research*, Sage Publications, Los Angeles, CA, 2001

Longitudinal Design

- Goal: measure change over time
- Therefore must have at least two successive data points
  - Most longitudinal designs have many more
- Typically lack control groups
  - When have control groups, not randomly assigned
- Try to understand change by observing many successive data points



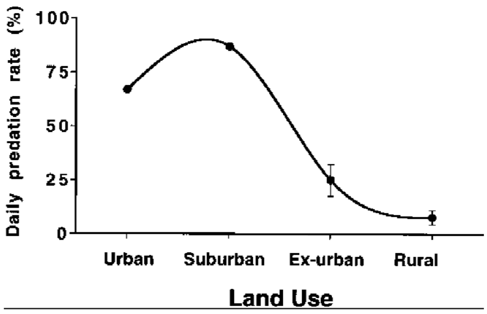
Graph 1. Development of forest area in Europe by regions (1970=100%).

Source: Stefan Gold, Alexander V. Korotkov, Volker Sasse, "The Development of European Forest Resources, 1950 to 2000, *Forest Policy and Economics* 8:183-192 (2006)

Cross-Sectional Design

- Measurements of many units during the same time period
  - No temporal dimension
- Infer relationships based on existing differences rather than from change following intervention
- Grouping based on existing differences rather than random assignment

Egg and seed removal at forest edges



Source: Claudio Russo and Truman P. Young (1997) "Egg and seed removal at urban and suburban forest edges," Urban Ecosystems, 1:171–178

Case Study Design

- Intensive study of a single case
- Goal is to explain and understand the case as a whole
- Case can be: places, organizations, relationships, events, time periods
- Multi-dimensional
- Multi-method
- Usually over time
- Clearly an important design, but thus far under-studies and under-theorized

Design and Method

- Design: logical structure of the inquiry
  - Goal: ensure right kind of evidence is obtained to answer the research question
- Method: strategy for gathering and analyzing relevant information
  - Goal: ensure the evidence collected is consistent, accurate, and amenable to systematic analysis

Research Designs and Methods

(DeVaus 2001)

Experimental	Longitudinal	Cross-Sectional	Case Study
Questionnaire	Questionnaire	Questionnaire	Questionnaire
Interview	Interview	Interview	Interview
Document Analysis	Document Analysis	Document Analysis	Document Analysis
Record Data Analysis	Record Data Analysis	Record Data Analysis	Record Data Analysis

Design vs Method

- "Failing to distinguish between design and method leads to poor evaluation of designs. Equating cross-sectional designs with questionnaires, or case studies with participant observation, means that the designs are often evaluated against the strengths and weaknesses of the method rather than their ability to draw relatively unambiguous conclusions or select between rival hypotheses." (De Vaus 2001)

Design, Method and Validity

- No combination of design and method can guarantee valid inferences
- Always possible to come up with alternative description or explanation of body of evidence
- Good researchers must:

1. Adopt a skeptical mindset
2. Treat all knowledge as provisional, always subject to revision
3. Constantly search for and anticipate alternative explanations
   - Plausible Rival Hypotheses (Campbell and Stanley 1963)

Validity

- "approximate truth of an inference"

1. Empirical evidence
2. Consistency with other sources of knowledge

- Always based on fallible human judgment
- Property of inferences, rather than of designs or methods
- Shadish, WR, TD Cook and DT Campbell, *Experimental and Quasi-Experimental Designs for Generalized Causal Inference* (2002)

Types of Validity

- Statistical Conclusion: whether measurements of two variables co-vary
- Internal: whether the relationship between two variables is causal
- External: whether an inference holds over variations in subjects, settings, treatments, and measurements outside the study
- Construct: degree to which inferences are warranted from a study to the constructs the study seeks to represent

Sample Threats to Statistical Conclusion Validity

- Low statistical power
- Violated assumptions of the test statistics
- Fishing and the error rate problem (multiple analyses will find significant correlations by chance)
- Unreliability of measures
- Restriction of range
- Etc.

Sample Threats to Internal Validity

- Selection
- History
- Maturation
- Regression Artifacts
- Testing
- Instrumentation
- Ambiguous temporal precedence
- Etc.

The Problem of Construct Validity

- All thinking, understanding, and communication involves the use of categories
- Research is impossible without constructs (formally defined categories)
- Construct development and revision is a fundamental task of science
- Constructs are inevitably somewhat fuzzy and contestable
- Tree: tall, woody plant with distinct main stem or trunk that lives for ≥ 3 years (but still exceptions)
- Constructs are usually shaped by research context and problems to be addressed

Sample Threats to Construct Validity

- Inadequate explication
- Construct confounding
- Mono-operation bias
- Mono-method bias
- Treatment diffusion
- Etc.

Sample Threats to External Validity

Science inevitably seeks to make inferences to as-yet unstudied situations

- Interaction of causal relationships with settings
- Interaction of causal relationships with units
- Interaction of causal relationship over treatment variations
- Context dependent mediation
- Etc.

Relationships Among Types of Validity

- Interdependencies
  - Good construct validity can aid external validity
  - Conversely: improving external validity can help clarify constructs
  - External validity suggests sampling diverse situations
- Tradeoffs
  - More internal validity can come at the cost of external validity
  - Internal validity central to causal studies; external often more important to descriptive ones

Some Small Suggestions

- Seriously look into the possibility of using experimental designs, even in policy research: it may be possible to persuade the powers that be to implement them
- Try to develop constructs that are robust across disciplines
- Try where possible to do multi-method research

Science as a Social Endeavor

- To be successful, science must be accepted and used
- Science is typically judged by other scientists
  - →But increasingly by other types of actors as well (investors, citizens, governments, NGOs, etc.)
- Successful scientific work requires having one's science acknowledged, used, and passed on

Scientific Communities: the Dark Vision (Kuhn)

- Self-perpetuating mutual admiration societies
- Highly resistant to new ideas, particularly those inconsistent with the work of senior scientists
- Suppression of disconfirming evidence
- Exclusion of others through exclusive private languages and initiation rituals
- Only change in response to 'earth shaking' science

(See: Thomas Kuhn, *Structure of Scientific Revolutions*, 1962)

More Optimistic Vision

- Social system is necessary is necessary for production and deployment of science, but
- Can adopt and enforce norms of openness, innovation, etc.
- Cannot survive unless provides science that "works"
- Young scientists: look for communities that organized to do science that really works, effectuate openness and debate, and can figure out how to perpetuate themselves

Current Trends – 1

(See, e.g., Nowotny, et al, 2003)

- Increasing 'steering of research'
  - EU, National, Science Funders: set priorities
  - Therefore scientists must advocate in multiple forums for their views of what is important
- Increasing commercialization of research
  - Importance of private funding
  - Intellectual property
  - Both at odds with openness

Current Trends - 2

- Rapid growth of accountability mechanisms
  - External evaluation of universities and other research organizations
  - Also: internal evaluation within universities and other science organizations; growing administrative power
- Growing proportion of science is developed in applied (problem driven) contexts
  - Yet frequently generates basic insights
- Increasing 'transdisciplinarity'
  - Often a team product that can't be embodied by any individual
  - (Prior presentation: genetic diversity, functional diversity, demography)

Current Trends - 3

- Increasing complexity of scientific communities: transdisciplinary, transnational, including: universities, research organizations, NGOs, corporations, government ministries, private funding foundations
- Growing disagreements on priorities, standards, accountability, openness, etc.
- Designing successful research is not getting any easier!