

# Introductory Remarks Based On: *Scientific Research In Education*

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Workshop on Random Assignment  
Experimentation in Education

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# Overview

- Background to Workshop: Committee on Scientific Principles for Education Research (CSPER)—Much to be filled in!
- Committee's vision of:
  - Guiding principles for scientific inquiry
  - Features of education and education research
  - Designs for scientific research in education
- Designs for scientific research in education: Role of randomized trials
- Concluding comment

# Key Themes:

## Nature of Scientific Inquiry

- Science is fundamentally the same across all disciplines and fields
- All fields are characterized by a range of legitimate methods and specialization depending on objects of inquiry and context
- Some differences between social and natural sciences
- As in other fields, features of education shape inquiry

# Guiding Principles for Scientific Inquiry

- Pose Significant Questions that Can Be Investigated Empirically
- Link Research to Relevant Theory
- Use Methods that Permit Direct Investigation of Question
- Provide Coherent, Explicit Chain of Reasoning
  - Rule out counter-interpretations to the preferred interpretation
- Replicate and Generalize Across Studies
- Disclose Research to Encourage Professional Scrutiny and Critique
  - Role of scientific culture and community organizing idea for report

# Features

- Of Education
  - Values and Politics
  - Human Volition
  - Variability in Educational Programs
  - Organization of Education
  - Diversity
- Of Education Research
  - Multiple Disciplinary Perspectives
  - Ethical Considerations
  - Relationships

# Reality of Features: Implementing A Randomized Experiment

- E-mail 8/4/03: Hi R [RA]. Just talked to B.A. She was confused about the letters... [Experimental Group]
- E-mail 8/6/03: Dear Erin, Something horrible has happened. My son, T., has testicular cancer. He had an operation yesterday... [E Group]
- E-mail 8/18/03: Hey E. Just wanted to drop you a message...
  - You noted on 8/12 that you are videotaping all of your classes since we have not chosen a focus class yet.
  - We are waiting to receive the pretests within a day ... to let you know which period to use... [E Group]
- E-mail 8/22/03: Just wanted to give you an update... Imagine my surprise when I pulled up to the school to see “Welcome Erin Furtak, Stanford University” on the sign in front of the school ....” [E Group]
- E-mail 8/22/03: We understand that you [teachers in control and experimental groups—wanted to keep them separate] and J. [science coordinator] will meet with parents on September 4.... As you know, we would have preferred to keep the two [teachers/ groups] separate. [E & C Groups]
- E-mail 9/4/03: Sorry to bother you but I can’t get the sound to record [for the video camera]. I’ve changed batteries but it still doesn’t work. Can someone knowledgeable contact me? [C Group]

# Designs for Scientific Education Research Depend on Research Question

- What Is Happening?
- Is There a Systematic Effect?
- How or Why Is It Happening?

# Designs for the Conduct of Scientific Education Research

- What is Happening?
  - Estimates of Population Characteristics
  - Simple Relationships
  - Descriptions of Localized Educational Settings
- Is There a Systematic effect?
  - Causal Relationships When Randomization Is Feasible
  - Causal Relationships When Randomization Is Not Feasible
- How or Why Is It Happening?
  - Mechanism When Theory Is Fairly Well-Established
  - Mechanism When Theory Is Weak

# What's Happening?

- Question: Why did so few women who began their college careers in nontraditional majors end up working in those fields?
- Method: Ethnography of two groups of women at two public, residential colleges (n=23):
  - Volunteers planning traditional and nontraditional careers
  - Groups on each campus matched on demographics
- Result: Model built to describe how the 23 women participated in college life:
  - Views about value of schoolwork
  - Reasons for doing school work
  - Perceived financial and opportunity costs
- **Validation:** Researchers predicted from model what each woman would do after college:
  - In *all* 23 cases, predictions based on commitment to schoolwork were confirmed
  - In all cases, model a better predictor than precollege preparation (grades and courses taken)

# Is There A Systematic Effect?

## A Question of Causality

- The question of “A Systematic Effect” has at its roots an intent to establish causality
- The simple question, does  $x$  cause  $y$ ? involves establishing
  - A relationship between  $x$  and  $y$
  - A time precedent— $x$  occurred before  $y$
  - **A demonstration that all possible rival hypotheses have been ruled out**
  - Confidence increases in the proposed interpretation when rival hypotheses are ruled out
  - A number of different research designs can address the question (e.g., randomized trial, correlational modeling, computer simulation of human performance) but if properly conducted and interpreted, randomized trials provide the most trustworthy evidence
- Strong theory as well as empirical support (see above) are required

# Is There A Systematic Effect?

## (Note Interplay of Theory & Modeling)

- Question: If teacher quality affects student achievement, why do studies that predict student outcomes from teacher wages produce weak results?
- Method: Econometric modeling
- Test: Two competing models tested:
  - Production function which predicted outcomes (dropouts) from expenditures
  - Modified production function that incorporated opportunity costs (non-monetary job characteristics and local job market)
- Results: After adjusting for opportunity costs, raising teacher wages by 10% reduced high school dropout by 3-4%.

# Why or How Is It Happening (Fairly Well-Established Knowledge)?

- **Question:** How did Catholic high schools function better than public high schools?
- **Methods:** Statistical longitudinal modeling combined with *case studies*
- **Competing Models:**
  - Sector effects only (private and spiritual effects of Catholic schools)
  - Compositional effects (composition of Catholic school student body)
  - School effects (features of school operation)
- **Results:** The coherence of school life in Catholic schools most clearly accounts for its relative success. Nonetheless, issues of controlling for family differences in choice and policy implications abound.

# Concluding Comments

- Research questions, not methods, should drive scientific research in education
- For questions of effect, randomized trials logically provide the strongest evidence of causal effects
- Nevertheless, questions arise, *for example*, about:
  - Fidelity of treatment implementation when (say) teachers apply new teaching techniques (implemented treatment  $T^*$  --somewhat different from intended  $T$ )
  - Variability of treatment implementation across sites ( $T$ ,  $T^*$ ,  $T^{**}$ , etc.)—context x treatment interaction vs. main effect of treatment
  - Overlap between control and treatment conditions—say some control teachers look like experimental teachers
    - In their treatment implementation
    - Outcome effects
  - Multiple treatment interference
  - Adequacy of outcome measure
  - Relevance of control condition to policy issue

# Concluding Comments (Continued)

- Implementation and case studies should be conducted alongside randomized trials:

“The only way the PSC [policy shaping community] can exercise judgment about future programs bearing the same label as the *T* studied is to understand the process by which the treatment works. Understanding is required to make use of even a well-grounded formal conclusion” (Cronbach et al., 1980, p. 275)
- Lee Cronbach, doctoral advisor, colleague and friend, in hearing of CSPER’s work,
  - Urged caution, as do I, about wholesale adoption of randomized trials
  - Supported them, as I do, when feasible and implemented well
- Quite clearly, this Workshop is timely