Summary Slide

Scientific Inquiry in Education
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Report of the NRC Committee on Scientific Principles in Education Research

Richard J. Shavelson and Lisa Towne, editors

An Overview

NERPPB Meeting 11/30/01
Background

- NERPPB sponsored; began fall 2000
- Prompted by Castle bill, ongoing skepticism and debate about quality of education research
- Committee of experts authored ‘consensus’ report released yesterday
- Timeline quick by NRC standards
Goals

- Inform OERI reauthorization
- Inform ongoing push for ‘evidence-based policy & practice’ and ‘scientifically-based education research’
- Spark self-reflection in field
Committee Membership

- Richard J. Shavelson (Chair), Stanford University
- Donald I. Barfield, WestEd
- Robert F. Boruch, University of Pennsylvania
- Jere Confrey, University of Texas at Austin
- Rudolph Crew, Stupski Family Foundation
- Robert L. DeHaan, Emory University
- Margaret Eisenhart, University of Colorado at Boulder
- Jack McFarlin Fletcher, University of Texas, Houston
- Eugene E. Garcia, University of California, Berkeley
- Norman Hackerman, Robert A. Welch Foundation
- Eric Hanushek, Hoover Institution
- Robert Hauser, University of Wisconsin-Madison
- Paul W. Holland, Educational Testing Service
- Ellen Condliffe Lagemann, The Spencer Foundation and New York University
- Denis C. Phillips, Stanford University
- Carol H. Weiss, Harvard University
Charge and Approach

- To consider scientific nature of education research and how a federal agency could support high quality science
- Did not comprehensively evaluate existing research, researchers, or agency
- Approach is forward-looking, informed by history and clear about roles of stakeholders
What are the principles of scientific quality in education research?

- 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.
How can a federal research agency promote and protect scientific quality in the education research it supports?

- Organized around conception of scientific culture
- Focused on articulating core infrastructure (people, structures, funding, flexibility)
- Emphasizes roles of policy, practice, and research communities
Framing Questions & Key Themes (cont.)

How can research-based knowledge in education accumulate?

- Science is never finished, but improves certainty of knowledge over time
- Nature of progress common in all fields:
  - Science advances in ‘fits and starts’ as researchers debate findings through norms enforced by field of researchers
  - Progress enabled by time, money, and public support
- Research-based knowledge in education has accumulated in this way, but not to the same degree as other scientific endeavors
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Chapter Summaries

NERPPB Meeting 11/30/01
Chapter 1
Historical and Philosophical Context

- Scholars have debated nature of science for centuries, nature of science in education for more than 100 years
- Skepticism about education research evident since its inception
- Report takes its cue from evolved ideas regarding models of human nature, progress in science, contested nature of education, understanding about method, and conceptions of scientific rigor
Core Assumptions

- No one definition of science
- Some lines of inquiry may never pan out
- Possible to describe physical and social world
- Scientific quality one aspect of overall value of education research
- Science can uniquely contribute to understanding, and is powerful when combined with insights from other forms of inquiry
Chapter 2
Accumulation of Scientific Knowledge

- Has scientific knowledge in education accumulated? Yes, and in much the same way as other fields. Trace examples in:
  - Assessment
  - Early reading
  - Resources

- Enabling Conditions
  - Time, money, public support

- Common Characteristics
  - Advances in ‘fits and starts’
  - Contested
  - Interdependence and cyclic nature of empirical findings, methods, and theory
  - Studying humans inherently complex
Chapter 3
Guiding Principles for Scientific Inquiry

Guiding Principles
- Embody notion of ‘warrant’
- Not algorithmic
- Code of conduct enforced by norms of community
Chapter 3
Guiding Principles for Scientific Inquiry (cont.)

- **Scientific Principle 1**: Pose Significant Questions That Can Be Investigated Empirically
  - Significance
  - Empirical Nature

- **Scientific Principle 2**: Link Research to Relevant Theory
  - Conceptual framework
  - Theory-laden observations
Chapter 3
Guiding Principles for Scientific Inquiry (cont.)

Scientific Principle 3: Use Methods That Permit Direct Investigation of Question
- Wide range of legitimate methods available
- Multiple methods often strengthen inferences
- Measurement often key aspect
Chapter 3
Guiding Principles for Scientific Inquiry (cont.)

Scientific Principle 4: Provide Coherent Chain of Rigorous Reasoning

- Basic logic of inference the same for quantitative and qualitative research
- Assumptions clearly stated
- Estimates of error provided
- Consider competing explanations
  - Selection
  - History
  - Measurement error
Chapter 3
Guiding Principles for Scientific Inquiry (cont.)

- **Scientific Principle 5:** Replicate and Generalize Across Studies
  - Replication and generalization strengthen scientific theories and conjectures
  - Generalization achieved through use of statistical tools, triangulation, etc.
  - Generalization in social world affected by its rapidly changing nature
Chapter 3
Guiding Principles for Scientific Inquiry (cont.)

Scientific Principle 6: Disclose Research to Encourage Professional Scrutiny and Critique

“Open society [of researchers]” key to:
- Debating and (sometimes) incorporating individual findings into corpus of knowledge
- Enabling replication
Chapter 3
Guiding Principles for Scientific Inquiry (cont.)

Application of Principles

- No one set of criteria can clearly distinguish science from nonscience and high-quality science from low-quality science
- Principles can help distinguish
- Examples
Chapter 4
Features of Education and Education Research

- Differences in social and physical/natural phenomena distinguish inquiry in these domains
  - Researcher control more limited in social sciences
  - Researcher objectivity vis-à-vis bias
  - Uses of theory
  - Level of certainty
Chapter 4
Features of Education and Education Research (cont.)

Features of education that shape research
- Values and Politics
- Human Volition
- Variability of Educational Programs
- Organization of Education
- Diversity
Chapter 4
Features of Education and Education Research (cont.)

- Features of Education Research
  - Multiple Disciplinary Perspectives
  - Ethical Considerations
  - Relationships
Chapter 5
Designs for the Conduct of Scientific Education Research

- Designs/methods judged only in terms of relevance to question posed
- Studies are ‘scientific’ when meet principles of science & attend to features of object of inquiry

Types of Questions
- Descriptive (What is happening?)
- Causal (Is there a systematic effect?)
- Mechanism (How or why is it happening?)
Chapter 5
Designs for the Conduct of Scientific Education Research (cont.)

- Descriptive Questions
  - Estimates of Population Characteristics
  - Simple Relationships
  - Descriptions of Localized Settings
Causal Questions

- Causal Relationships When Randomization is Feasible
  - Random assignment best way to ensure equivalence in groups for comparison
  - Frequently used in many disciplines & applied fields
  - Not frequently used in education but many examples demonstrate feasibility
Chapter 5
Designs for the Conduct of Scientific Education Research (cont.)

- Causal Questions (cont.)
  - Causal Relationships When Randomization is Not Feasible
    - In social settings randomization is sometimes infeasible
    - ‘Quasi-experiments’ rely on untestable assumptions and subject to selection bias
    - Quasi-experiments can sometimes be preferable to experiments (e.g., external validity)
Chapter 5
Designs for the Conduct of Scientific Education Research (cont.)

Mechanism Questions

- When Theory is Well-Established
- When Theory is Weak
  - Ethnographies
  - Design Studies/Teaching Experiments
Chapter 5
Designs for the Conduct of Scientific Education Research (cont.)

• Conclusions about state of education research and areas to target
  • Theoretical understanding weak
  • Knowledge of causal relationships weak; in particular, urge expanded use of random assignment
Chapter 6
Design Principles for Fostering Science in a Federal Education Research Agency

Approach

- Did not evaluate OERI
- Forward-looking, focused on ‘first principles’ with suggested supporting mechanisms
- Informed by history of education research agency (NIE & OERI) & comparisons to other agencies (NICHD, NIA, NSF EHR & NSF SBE)

Dilemmas

- Education research grounded in practical problems but close relationship has downside
- Diversity of education research community
Chapter 6
Design Principles for Fostering Science in a Federal Education Research Agency (cont.)

- **Design Principle 1**: Staff the Agency with People Skilled in Science, Management and Leadership
  - Flexibility to hire permanent & temporary staff
  - Engage in interagency collaborations
  - Depends heavily on related issues (funding, reputation)
Chapter 6
Design Principles for Fostering Science in a Federal Education Research Agency (cont.)

**Design Principle 2:** Create Structures to Guide Agenda, Inform Funding Decisions, & Monitor Work

- Governing board with agenda-setting committee
- Standing peer review panels
  - Many structures can work
  - Key is good peers
  - Not perfect, highly dependent on strong field, and tricky in education because field is eclectic
Chapter 6
Design Principles for Fostering Science in a Federal Education Research Agency (cont.)

**Design Principle 3**: Insulate the agency from political interference

- Avoid micromanagement of decision-making, distortion of agenda to be solely short-run, use of agency to promote political positions
- Politics play proper role and agenda should reflect policy concerns
- Budgetary discretion particularly key
- Research be organizationally separate but intellectually linked to improvement mission
Chapter 6
Design Principles for Fostering Science in a Federal Education Research Agency (cont.)

**Design Principle 4**: Develop Focused and Balanced Portfolio of Research that Addresses Short-, Medium-, and Long-term Issues of Importance to Policy and Practice

- Create based on state of development of field
- Organized in programs of studies
- Incorporate syntheses of bodies of work
Design Principle 5: Adequately fund the agency

- Resources must align with scope of agenda
- Given assumption that agenda will be roughly comparable to OERI’s today and knowledge of current appropriation levels, funding must increase
Chapter 6
Design Principles for Fostering Science in a Federal Education Research Agency (cont.)

**Design Principle 6**: Invest in research infrastructure

- Community of researchers (human resources)
- Data development, sharing & access
  - Housing of common constructs
  - Facilitating ethical access to research subjects
- Link to Practice and Policy Communities