Considering Trade-offs

Or What to Think about if You Want Your Research to Make a Difference

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Flow

- Overview of BSCS for context
- An interactive look at concept of trade-offs
- The details of the study BSCS did
A Closer Look at BSCS
Working toward a community of scientifically literate citizens
Mission

To transform science teaching and learning through research and development that strengthens learning environments and inspires a global community of scientifically literate citizens.
History

Founded in 1958 as a curriculum study

Location:
Started in Boulder, CO on the CU campus, moved to Louisville in the 1970s, moved to Colorado Springs in 1983
Who works there today?

- 17 science educators
- 10 technical specialists
- 4 support people
Sources of Revenue

- Government grants (64.4%)
- Contract revenue (32.9%)
- Royalties (1.7%)
- All other income* (1.0%)

Average annual budget 2007-2013 = ~$6,000,000
Funders

Federal Agencies
NSF
US Department of Education
National Institutes of Health
US Department of Energy
NASA
Relationship of Major Working Groups

The Science Exchange

Research & Development

Operations

What the world wants
Taking the mission to the world

What research tells us
Bringing the mission to life
Curriculum Development

• Follows a deliberate process
• Does NOT lead to a collection of activities
• Offers a conceptual and coherent learning experience for students
Professional Development

- Is research-based as well as designed to generate new learning
- Focuses on developing leadership from the classroom
- Added emphasis on PD for PD providers
Research & Evaluation

- Research projects driven by mission-related questions, not individual agendas
- Internal evaluation
- External evaluation for other organizations
We focus on student learning and how the following can improve understanding of science for all.

<table>
<thead>
<tr>
<th>Areas of Emphasis</th>
<th>Types of Studies</th>
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<tbody>
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<td></td>
<td>Exploratory</td>
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<td>Nature of Curriculum</td>
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<td>• Coherence, focus, rigor</td>
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<td>• Delivery mechanisms</td>
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<td>• Reflective practitioner</td>
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<td>• Sustaining change</td>
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<td>• Influence on teaching and learning</td>
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<td>• Professional learning communities</td>
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What does it mean to “make a difference”? 
Studies of Causal Effects in Science Education:
Considering Policy Constraints and Trade-offs Affecting Research in Schools

A paper based on research experiences at BSCS
The Disconnect

While some research policies are encouraging large scale randomized studies of interventions in authentic settings, there are also policies affecting educational systems that create conditions not conducive to implementing these designs as intended.
To Conduct Causal Effects Research, Researchers …

- Need to test “unproven” interventions asking questions that matter
- Must find schools willing to participate in studies that may include taking C&I risks

To Comply with Federal Policy, School Personnel…

- Need to keep a heavy emphasis on accountability for both teachers and students
- Have little incentive, and potentially a high cost for taking C&I risks
Questions of Causality

• How important are these types of questions in science education research?

• What kind of causal relationships do you think are interesting and important?
Conducting Causal Effects Research in a Climate of Accountability

Evidence-based reform in education has often been described as a response to

a. a general lack of evidence regarding what programs or practices are effective;

b. the adoption of programs or practices based on ideology or trends; and consequently

c. the absence of evolution in the field in which more effective programs or practices displace those that are less effective

(Slavin, 2008)
# Requirements of Studies of Causal Effects

1. The Need for Many Clusters
2. Economy of Scale on Outcome Measures
3. Designs that Permit Attribution of Cause and Effect
# Implications of Requirements

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Validity Tradeoffs in the Tension between Methodology and Policy
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An Example of an RCT Study

- Large-scale efficacy trial of the implementation of research-based instructional materials for multidisciplinary science in grades 9 and 10
- 23 schools in 2 cohorts spanning 15 districts in Washington resulting in 67 teachers and 5,358 students participating
- Cluster-randomized trial design
  - schools assigned to treatment (new curriculum and 7 days of PD) or comparison conditions (grade 9 and 10 science curriculum and PD in a business-as-usual (BaU) manner)
- Funded by IES
- 5 year study
## How We Balanced Tradeoffs in this Study

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<td>Choosing a unit of randomization</td>
<td>School level assignment</td>
<td>School level assignment was more expensive but protected us against treatment diffusion (contamination).</td>
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<tr>
<td>Attending to flux in state standards and assessments</td>
<td>Use state assessment</td>
<td>Using a state assessment was less expensive but we ran the risk that it would evolve into one not useful for comparison (too distal? unfair?)</td>
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<td>Addressing informed consent issues</td>
<td>Exempt classification</td>
<td>Is essential to protect the properties of the randomly assigned groups but was very time consuming in pilot, switched to exempt classification</td>
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# How We Balanced Tradeoffs in this Study

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<td>Choosing when and where to working with external researchers</td>
<td>Use external researchers for observations and curriculum analysis</td>
<td>Essential to mitigate experimenter bias (studied our own program), but loss of intimate knowledge fidelity to our program.</td>
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<td>Addressing an array of stakeholder interests</td>
<td>Insisted on random assignment to treatment (e.g., denied self-selection to treatment)</td>
<td>Random assignment was optimal for causal effects studies but often resulted in demoralization for those not assigned to treatment and low fidelity for those who didn’t want the new program.</td>
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Results of the Study

- Students receiving the BSCS science program had higher gains on standardized tests.
- By the end of 10th grade, BSCS students were 4 months ahead of those in the Comparison Group.
- The BSCS program helped teachers use more effective practices.

Ideas for Reducing the Tensions

- Modify federal policies to allow states to develop an opt-out option for school that participate in federally-funded research.

- Shift the emphasis of state-level achievement tests from factual recall to higher order cognitive outcomes. (We’ll see if this happens with the new tests being developed right now.)

- Create a collaborative community of school district personnel and researchers who embrace a spirit of experimentation and scientific inquiry.

- Promote more systematic dialogue among all stakeholders about the tensions and possible resolutions.
Thank you to

The BSCS Research Team

- Joseph A. Taylor, Director of Research & Development
- Susan Kowalski, Science Educator
- Christopher Wilson, Senior Science Educator
- Stephen Getty, Science Educator (now Director of Quantitative Reasoning at Colorado College)
- Karen Askinas, Research Coordinator

the Funders

- Institute of Education Sciences, U.S. Department of Education
  - Grant number: R305K060142
- Kendall/Hunt Publishing
  - Supplied the curriculum materials at their cost