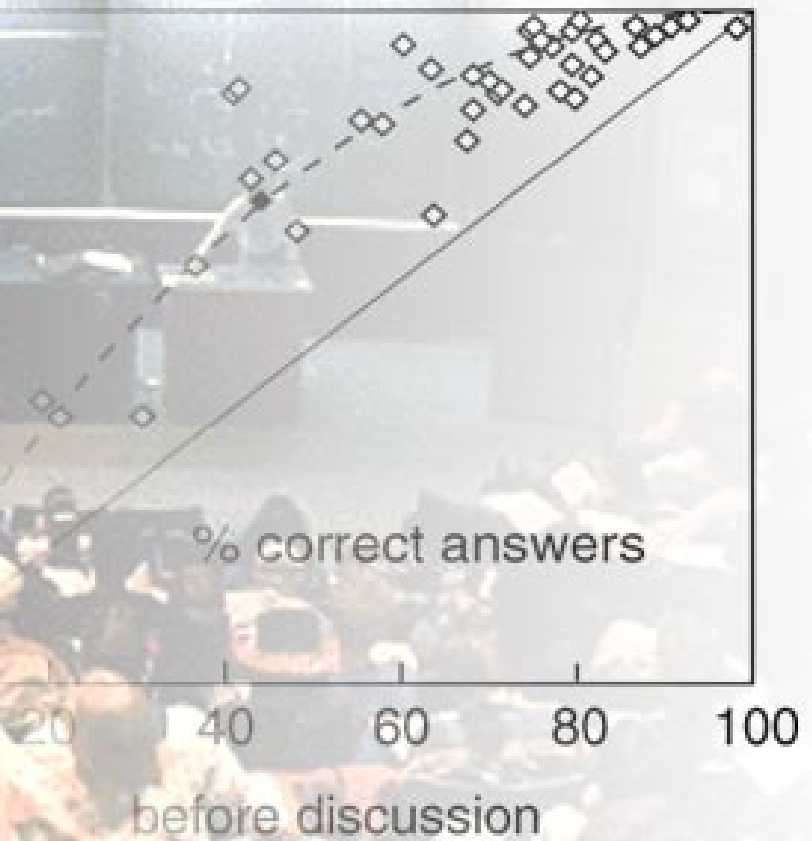


The scientific approach to teaching: research as a basis for course design



12th Annual Cottrell Scholars Conference
Tucson, AZ, 8 July 2006



Innovation?

The road to knowledge begins
with the top of the page.
Lucky Numbers 3, 8, 11, 14, 17, 19

Anyone can memorize things,
but the important thing is to understand it.
Lucky Numbers 6, 7, 19, 24, 26, 29

Education



Education

lectures focus on delivery of information

A photograph of a large lecture hall. A professor is standing at a podium at the front of the room, addressing a large group of students seated at desks. The room has a curved wall and a large screen or chalkboard at the front. The students are mostly seen from behind, looking towards the front of the room.

Education

not transfer but assimilation of information is key

A large lecture hall with a professor at a podium and students seated at desks. The room is filled with students, and the professor is standing at the front, addressing the class. The text "not transfer but assimilation of information is key" is overlaid on the image.

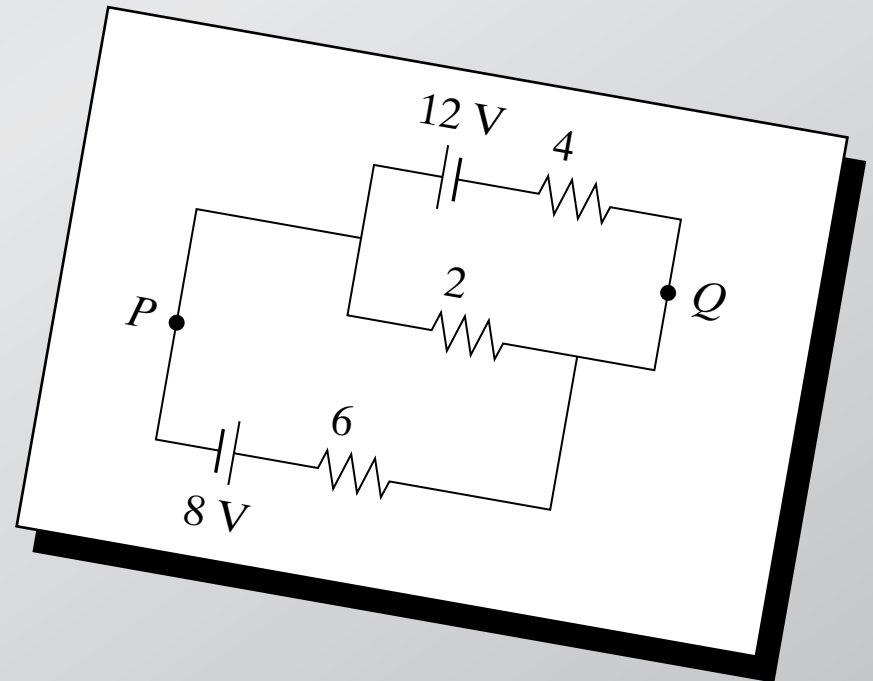
Research: the basis for change

“The plural of anecdote is not data”

Lee Shulman

Research: the basis for change

conventional problems misleading



Research: the basis for change

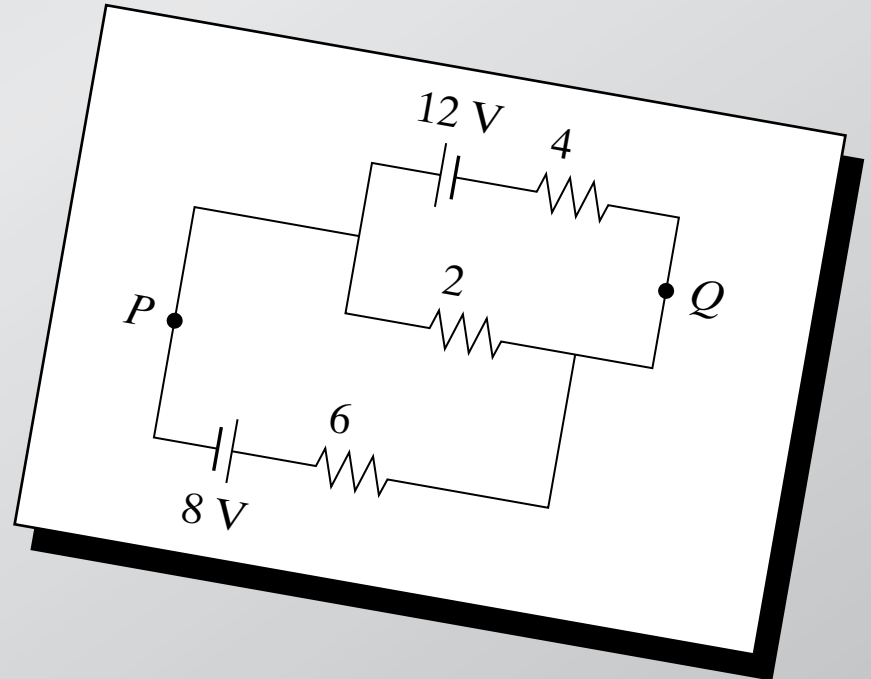
conventional problems misleading

Calculate:

(a) current in $2\text{-}\Omega$ resistor

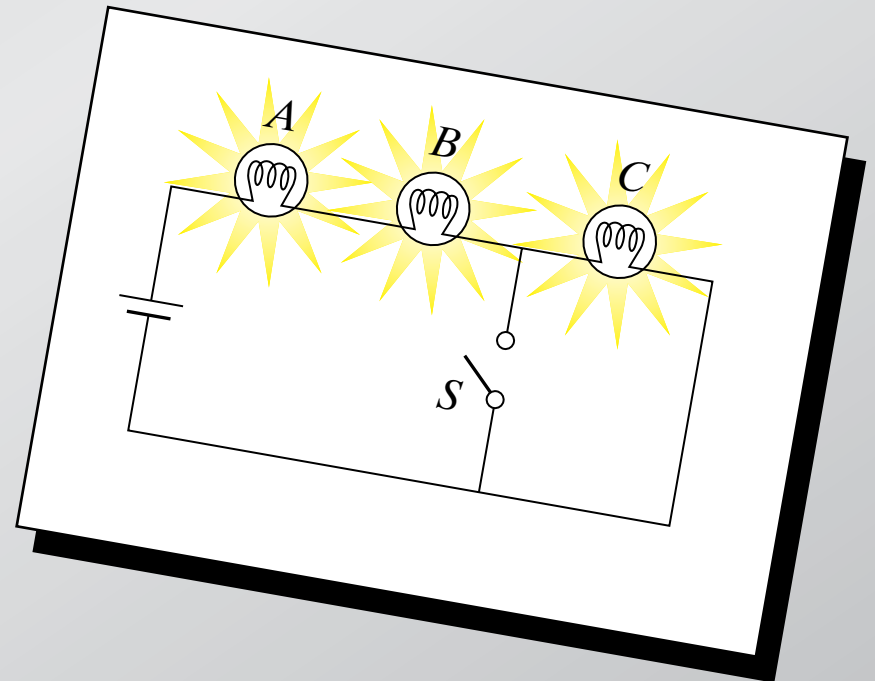
(b) potential difference

between P and Q



Research: the basis for change

are the basic principles understood?

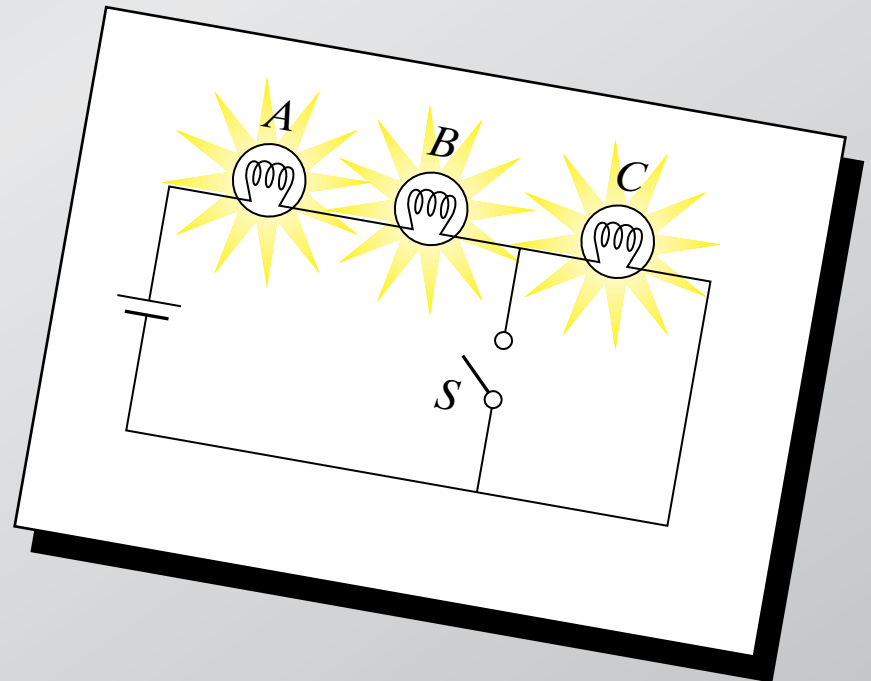


Research: the basis for change

are the basic principles understood?

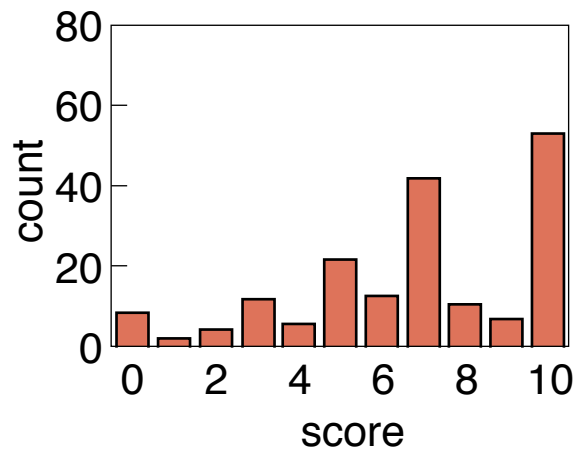
When S is closed, what happens to:

- (a) intensities of A and B ?
- (b) intensity of C ?
- (c) current through battery?
- (d) potential difference across
 A , B , and C ?
- (e) the total power dissipated?

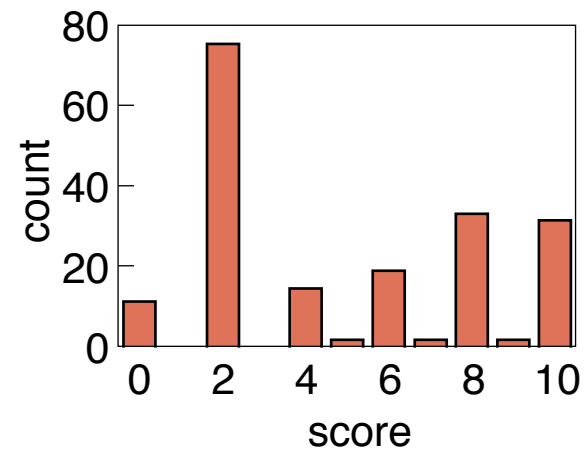


Research: the basis for change

conventional

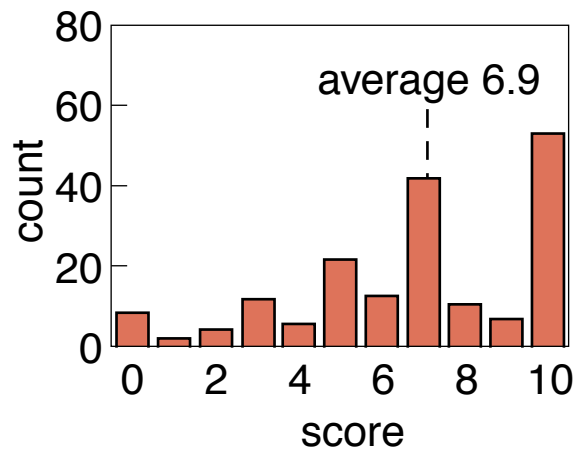


conceptual

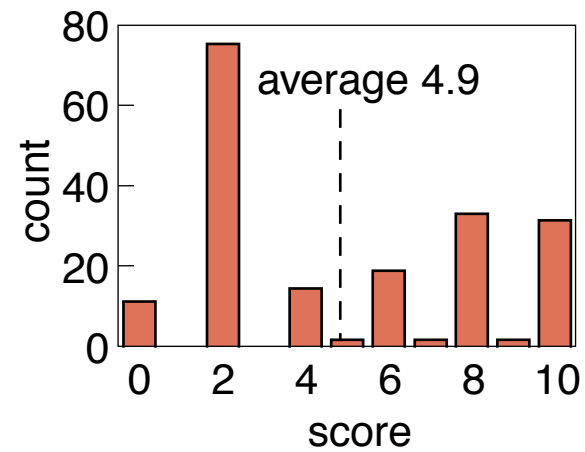


Research: the basis for change

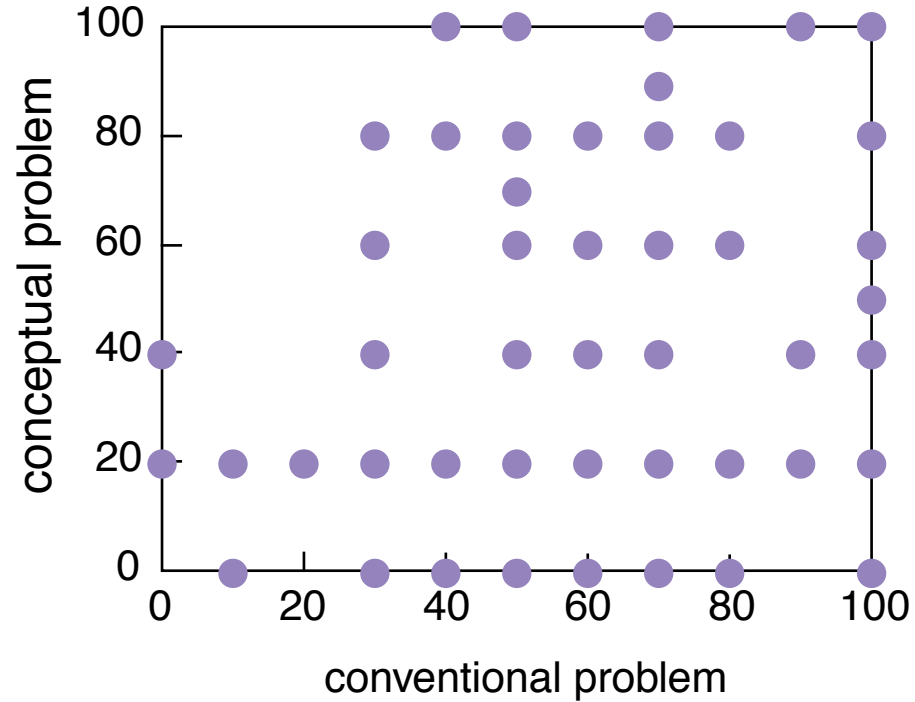
conventional



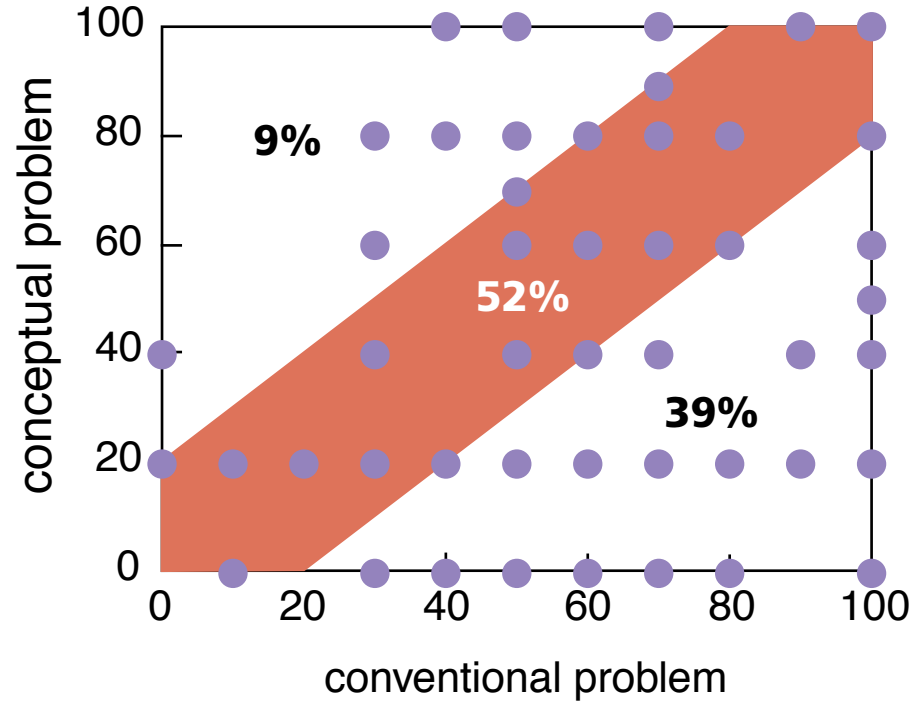
conceptual



Research: the basis for change



Research: the basis for change

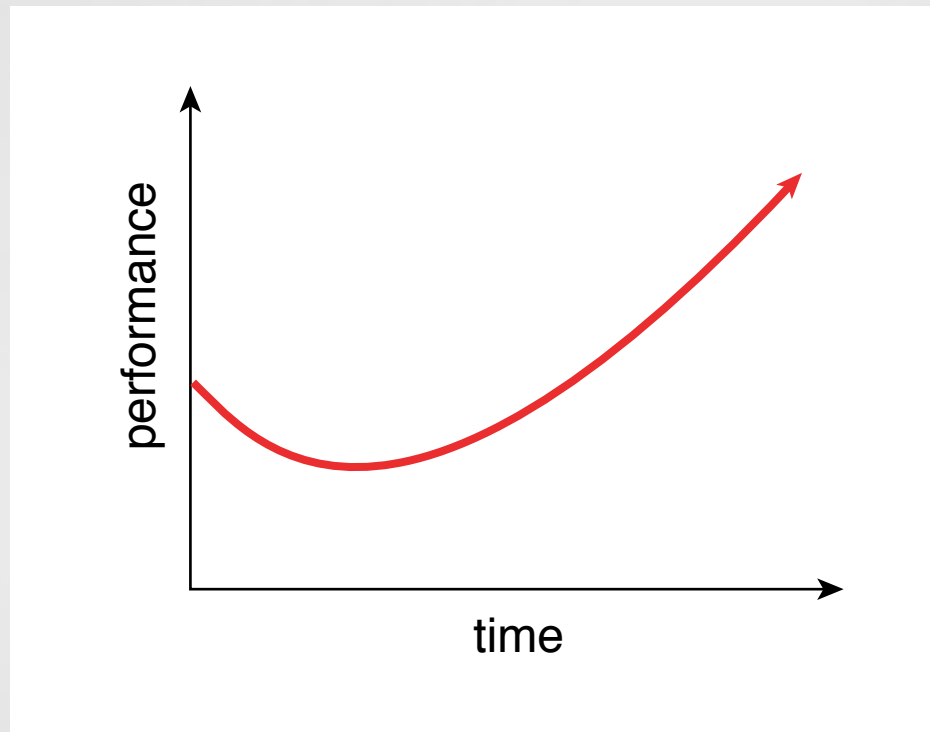


Barriers

Two things to watch out for

Barriers

After changing, things might get *worse* before they get better!



Barriers

Better understanding leads to *more* — not fewer — questions!

(must recognize confusion as step towards understanding)

Barriers

Things to do:

- **take data**
- **motivate students**
- **be prepared for initial adjustments**

Barriers

“There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success than to take the lead in the introduction of a new order of things, because the Innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new.”

Macchiavelli, *The Prince*

for a copy of these slides:

<http://mazur-www.harvard.edu>