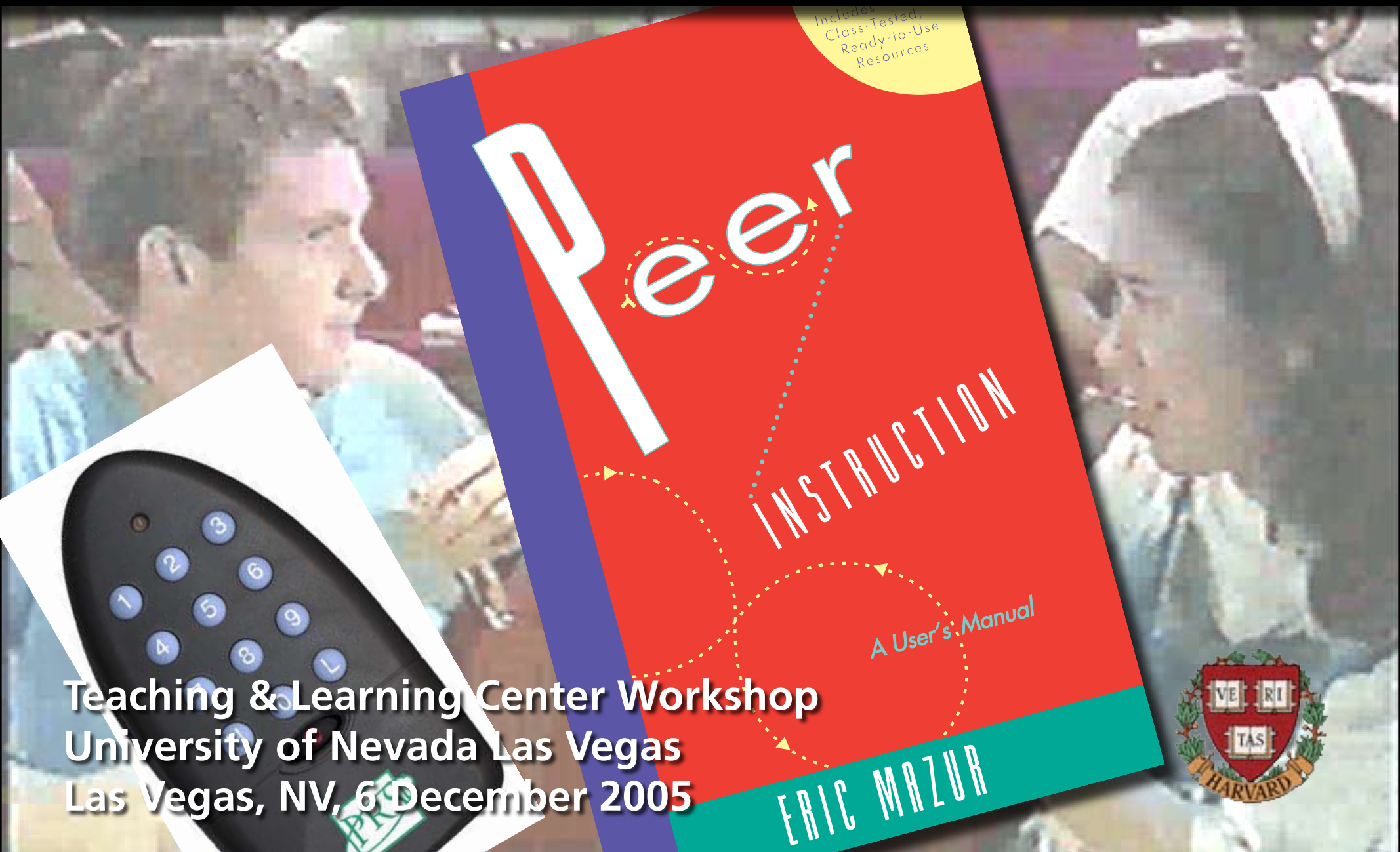
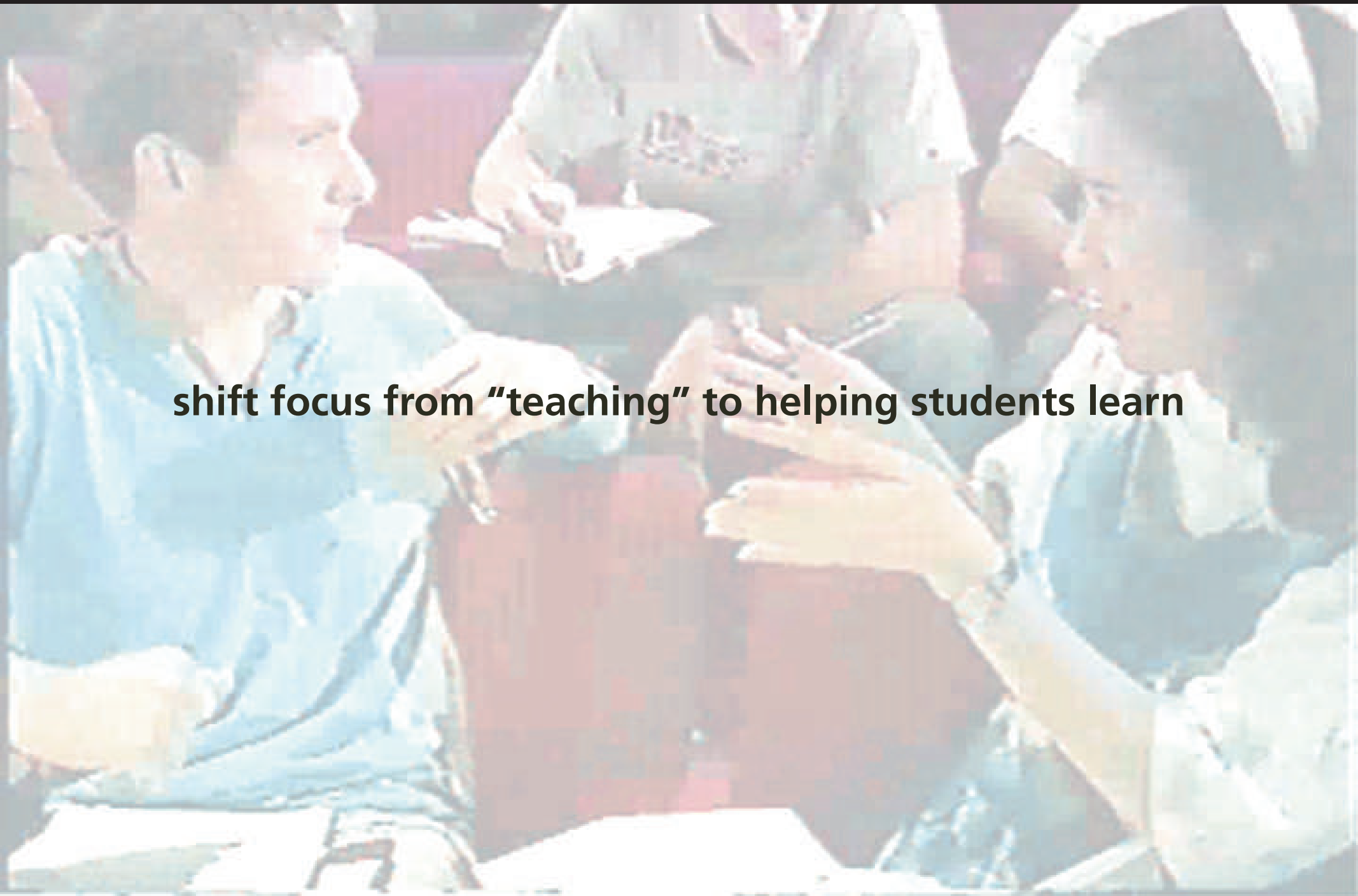
Active learning and interactive lectures



Teaching & Learning Center Workshop
University of Nevada Las Vegas
Las Vegas, NV, 6 December 2005

My message



shift focus from “teaching” to helping students learn

Outline

- Education

Outline

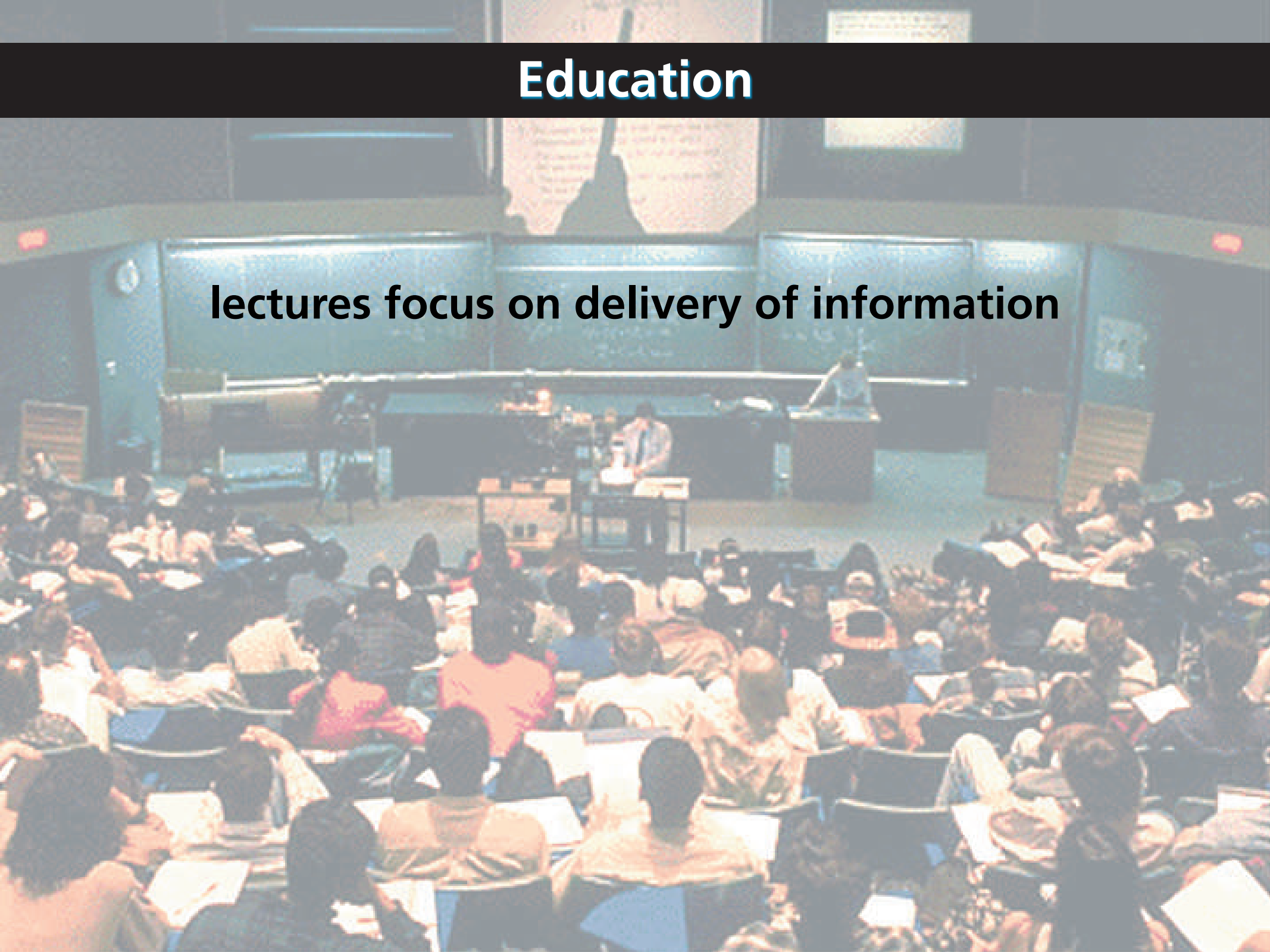
- Education
- Peer Instruction

Outline

- Education
- Peer Instruction
- Results

Education

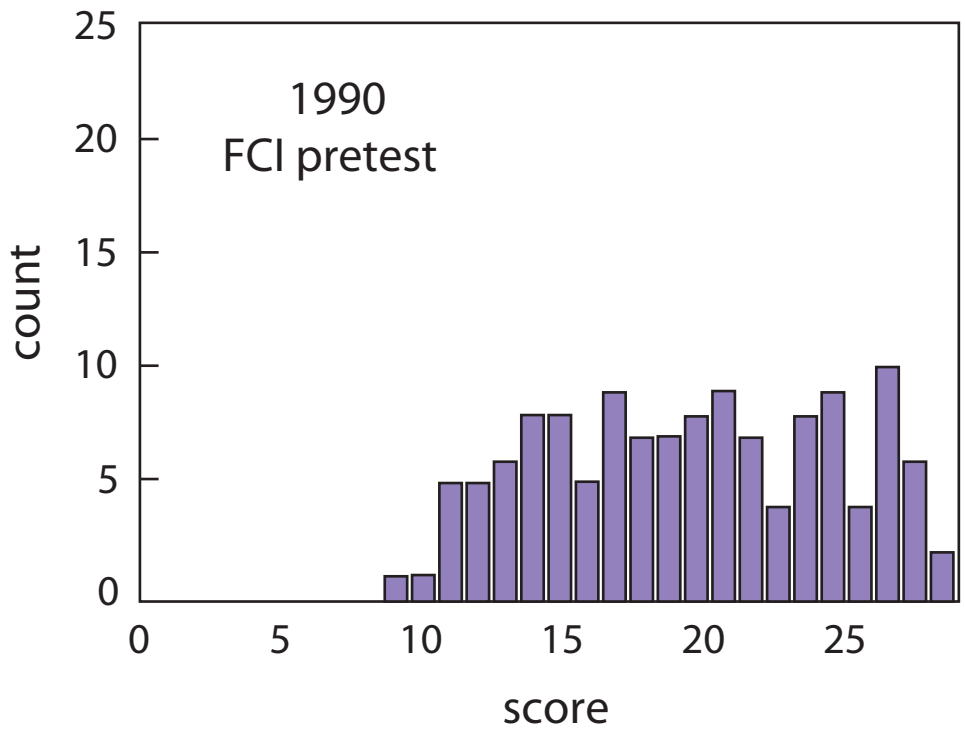
Education



lectures focus on delivery of information

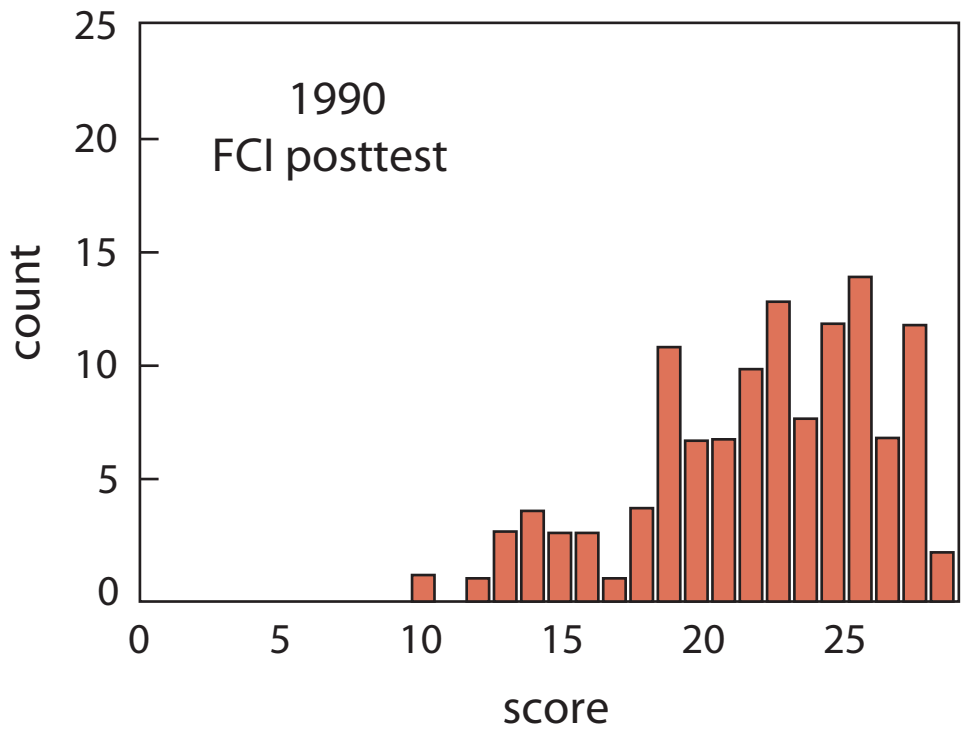
Education

education is not just information transfer



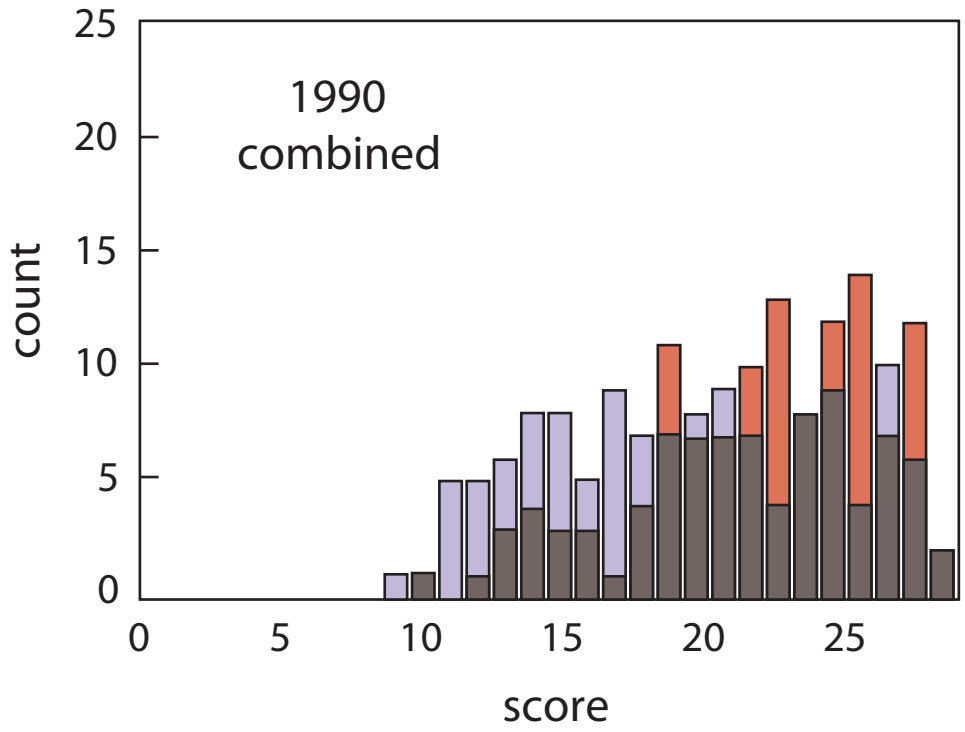
Education

education is not just information transfer

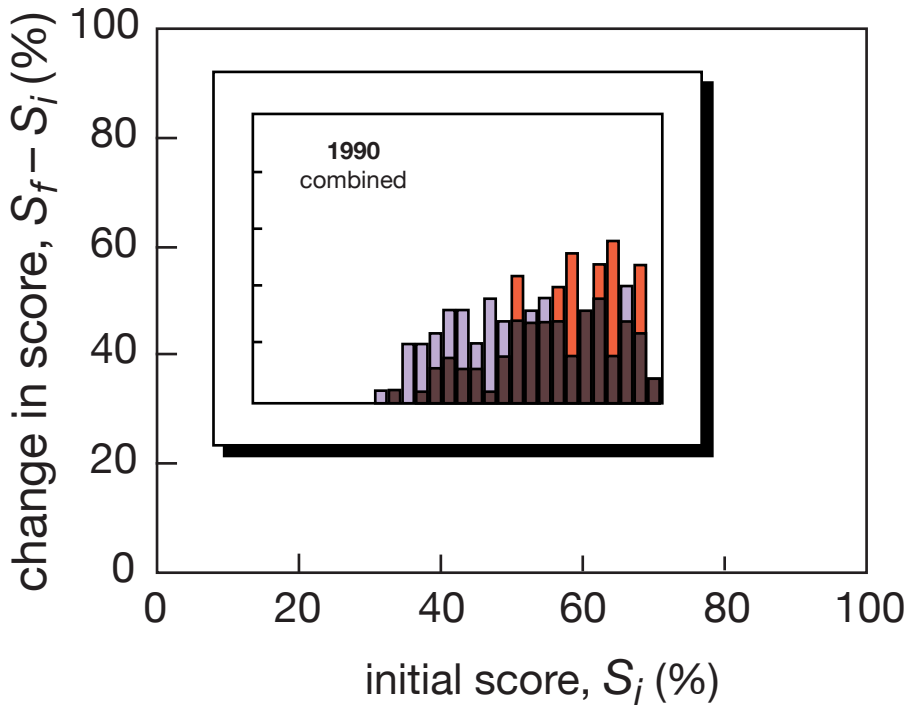


Education

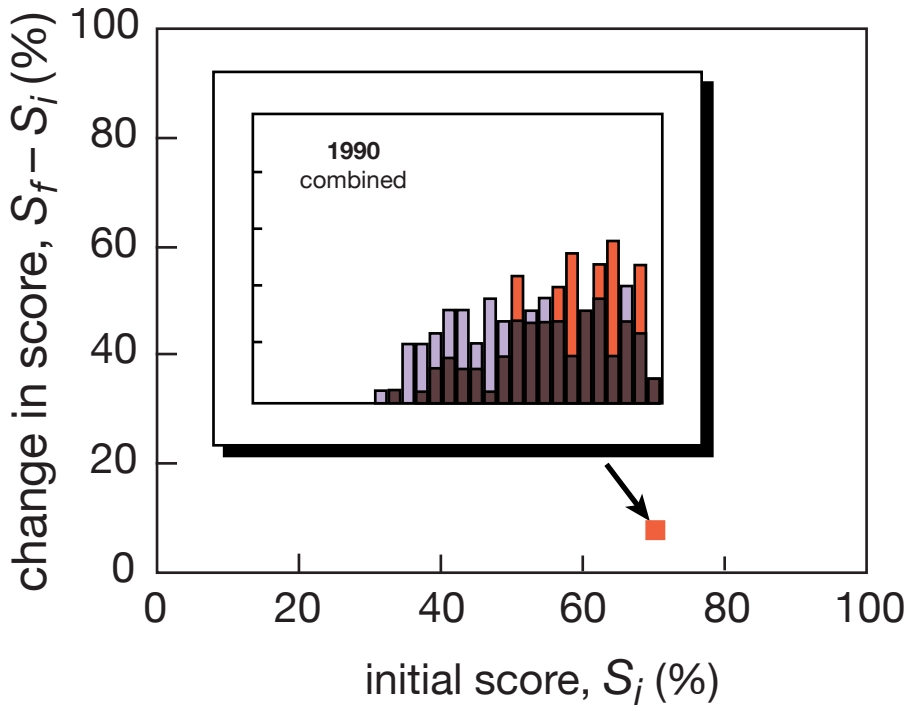
education is not just information transfer



Education


1990
combined
change in score, $S_f - S_i$ (%)
initial score, S_i (%)
0
20
40
60
80
100

Education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0
20
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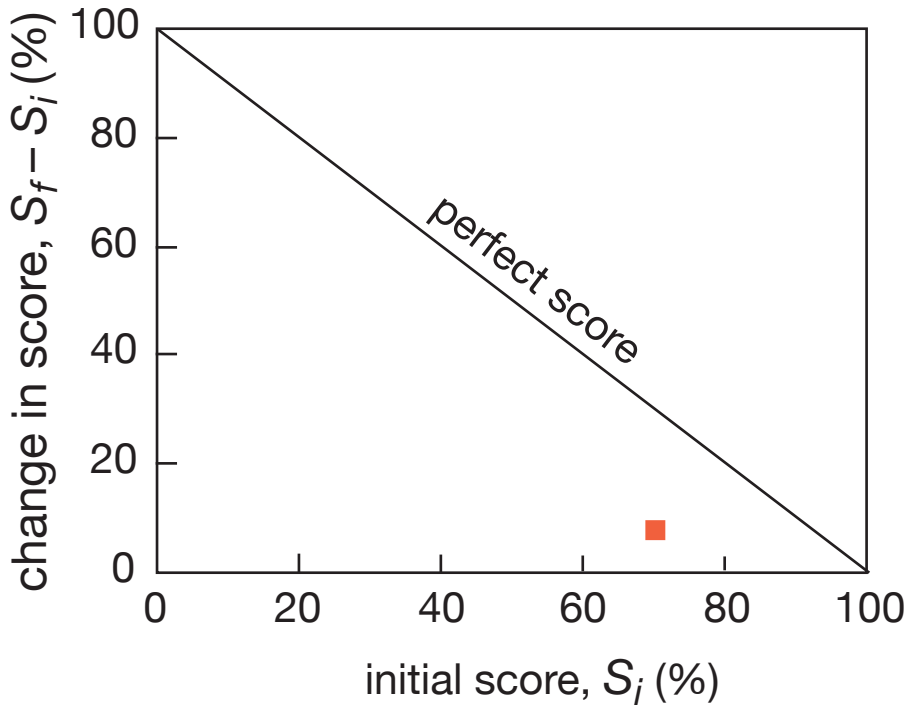
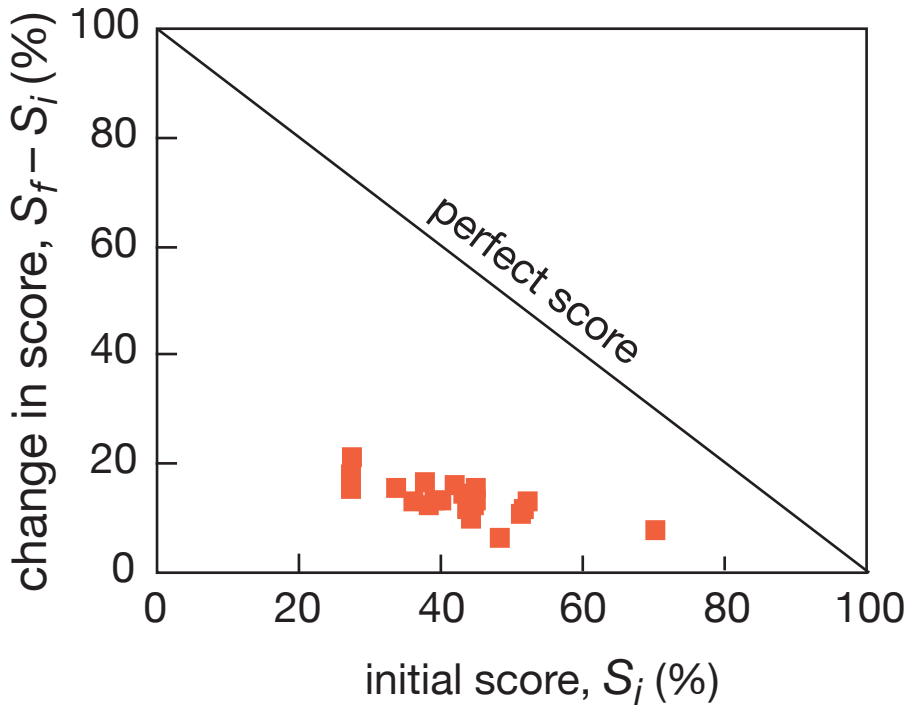
Education


100
80
60
40
20
0
0
20
40
60
80
100
perfect score
change in score, $S_f - S_i$ (%)
initial score, S_i (%)

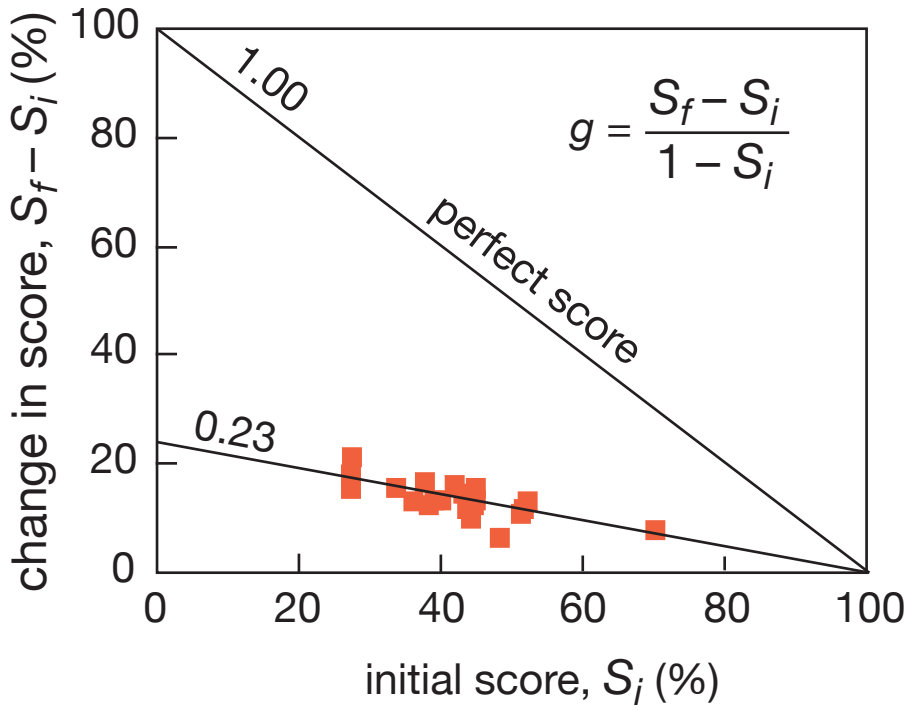
Education



R.R. Hake, *Am. J. Phys.* 66, 64 (1998)

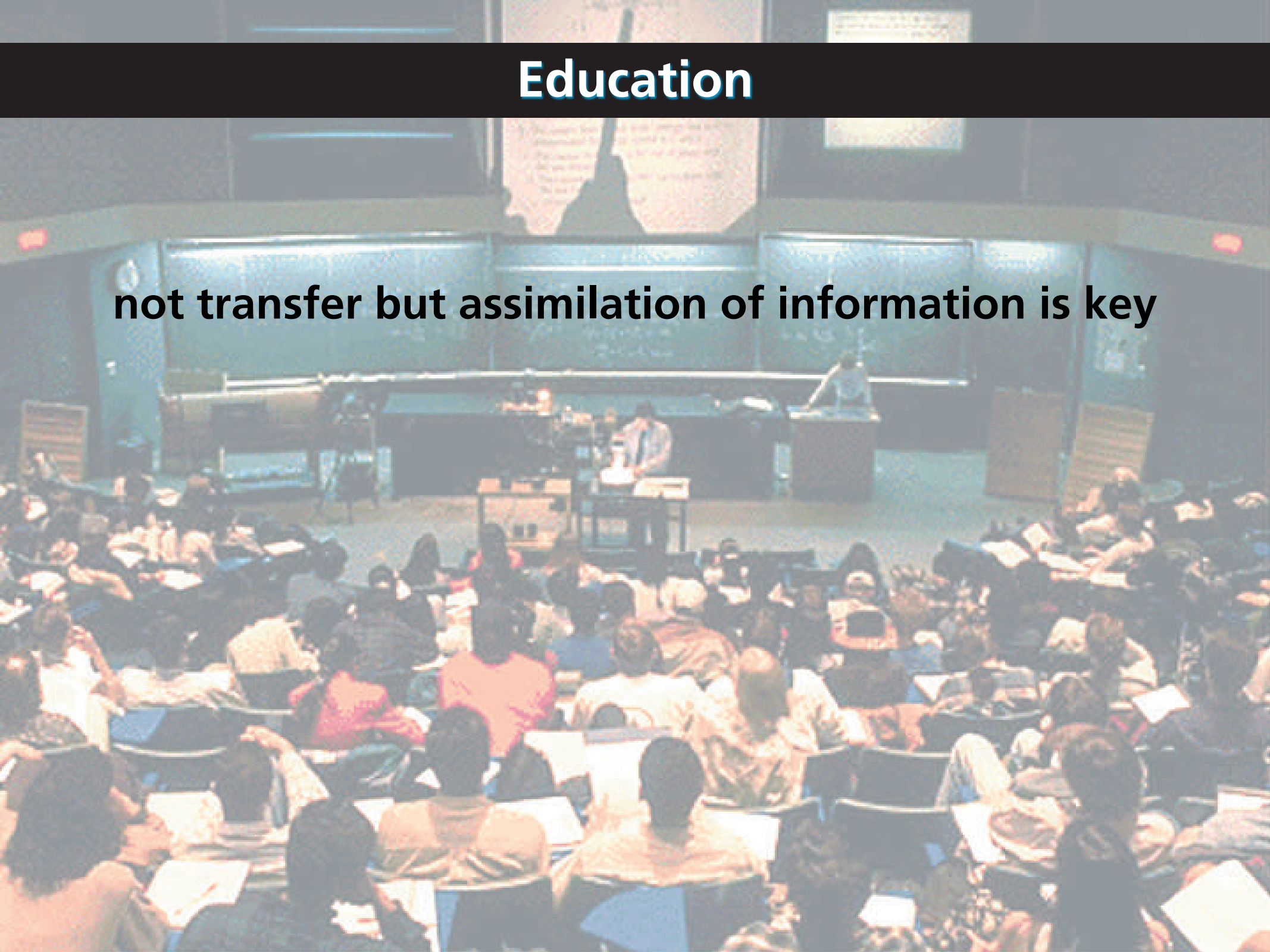
Education

only one quarter of maximum gain realized



R.R. Hake, *Am. J. Phys.* 66, 64 (1998)

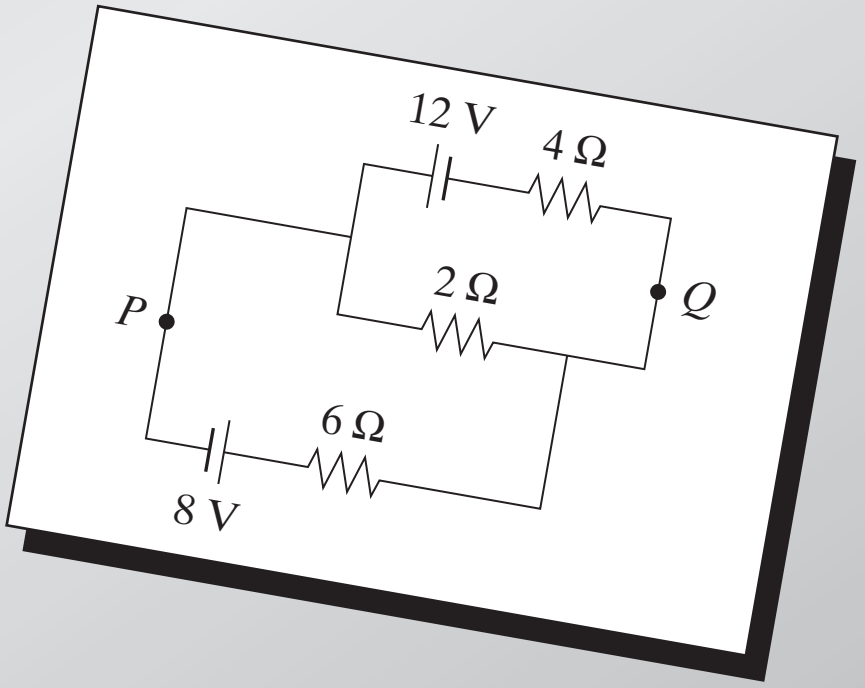
Education



not transfer but assimilation of information is key

Education

conventional problems misleading



Education

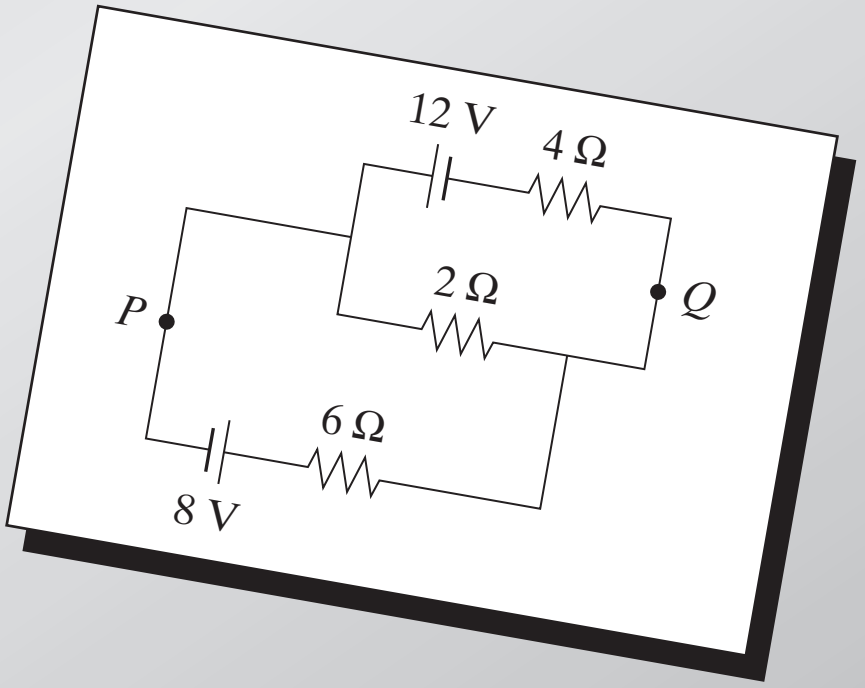
conventional problems misleading

Calculate:

(*a*) current in 2-W resistor

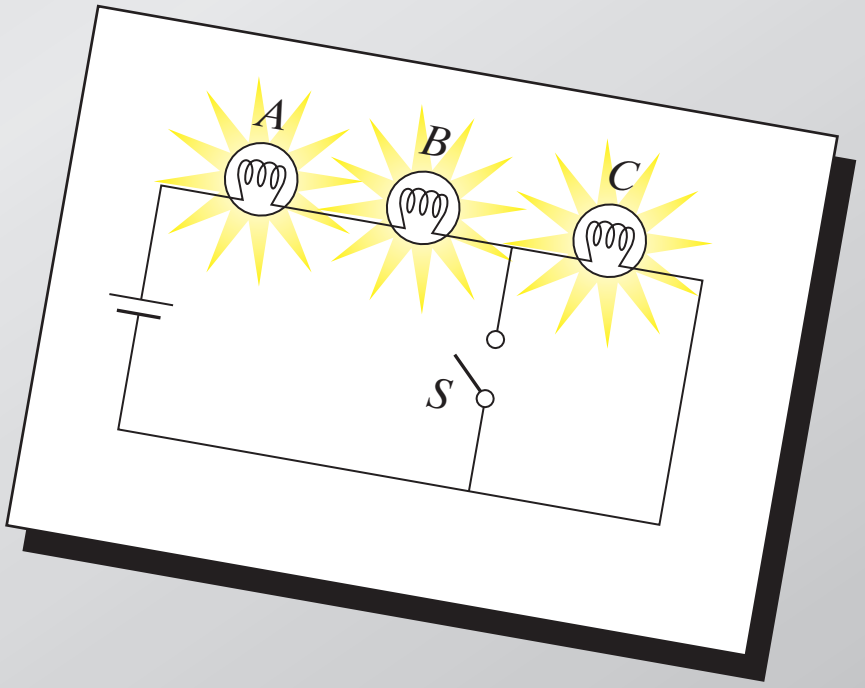
(*b*) potential difference

between *P* and *Q*



Education

are the basic principles understood?



Education

are the basic principles understood?

When *S* is closed, what happens to:

(*a*) intensities of A and B?

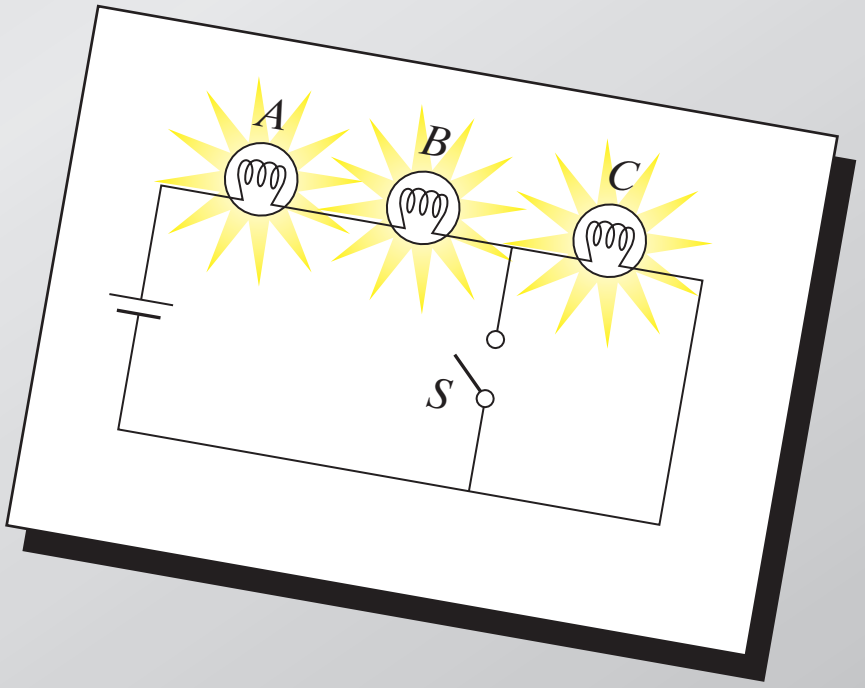
(*b*) intensity of C?

(*c*) current through battery?

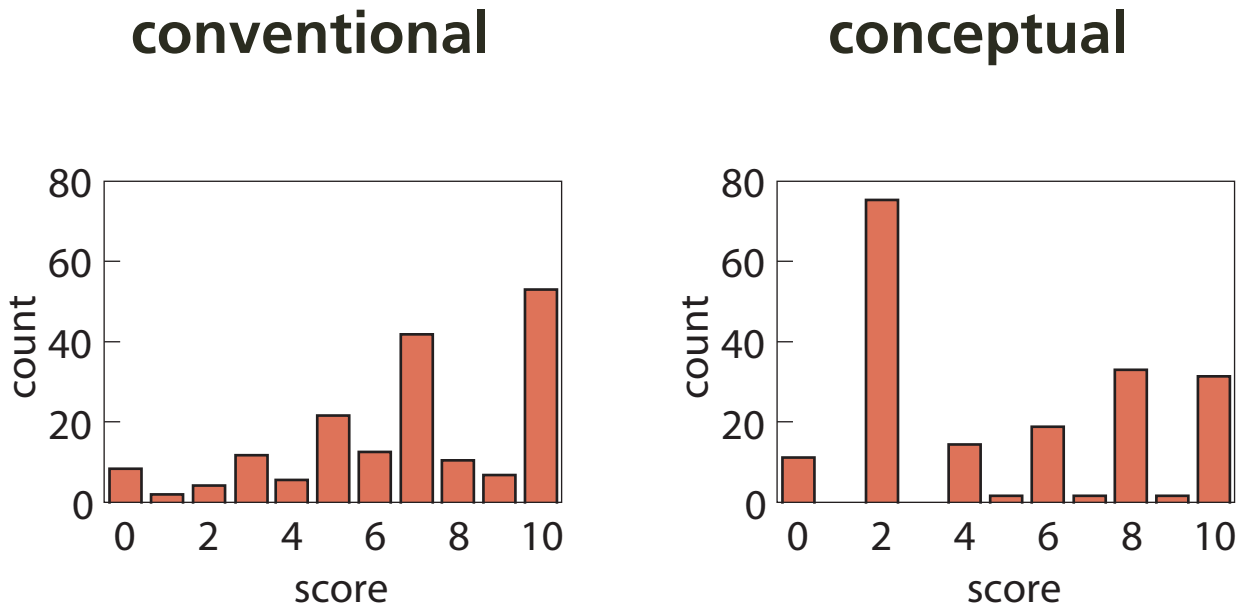
(*d*) potential difference across

A, *B*, and *C*?

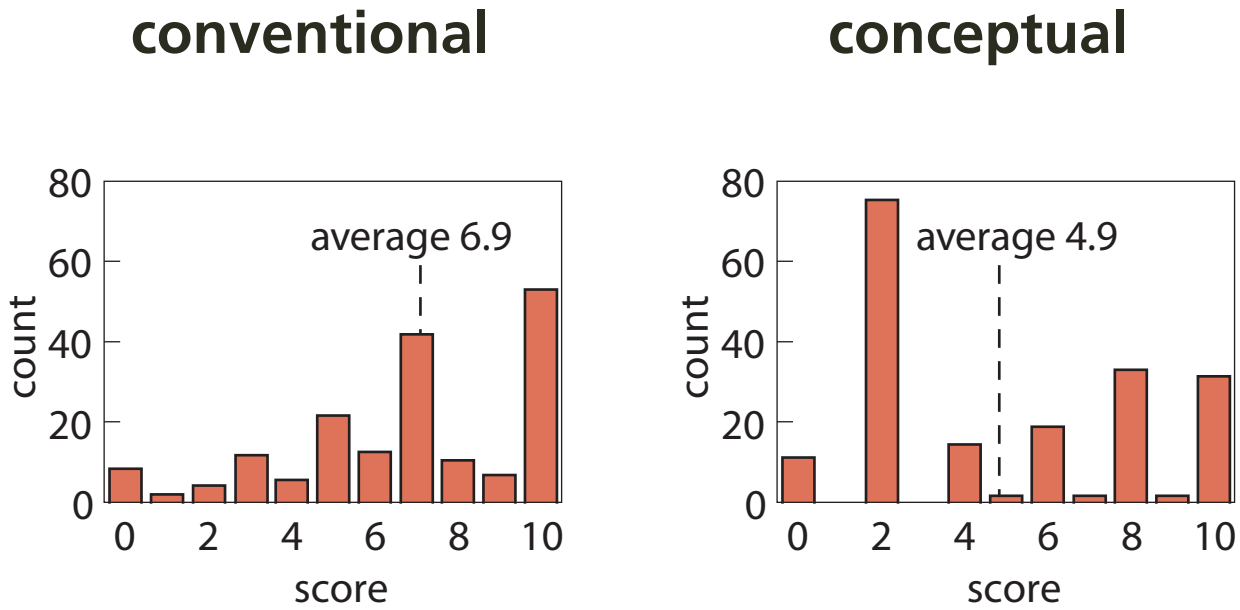
(*e*) the total power dissipated?



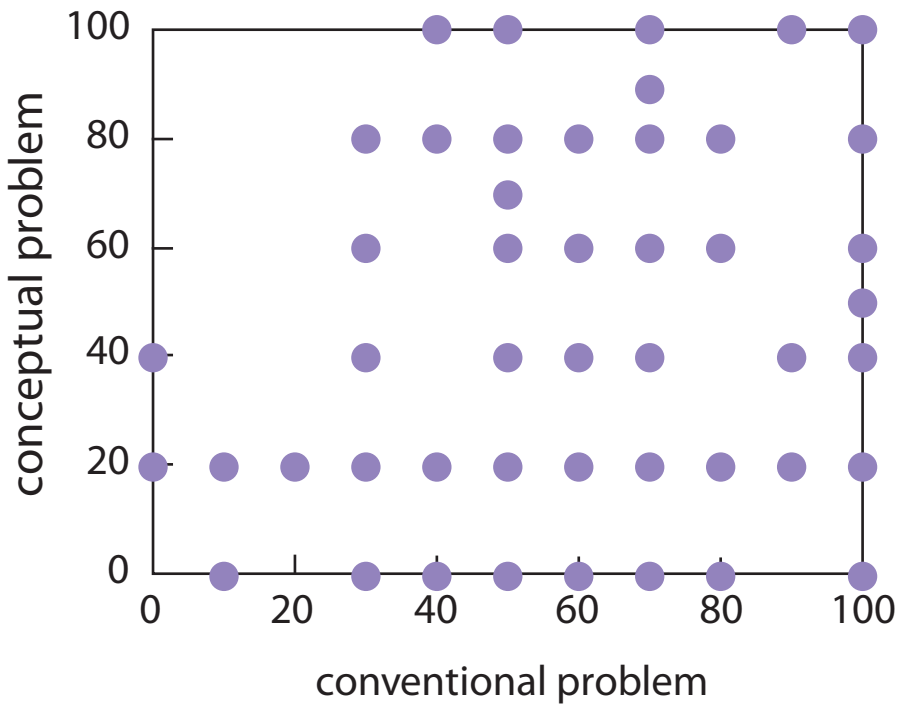
Education



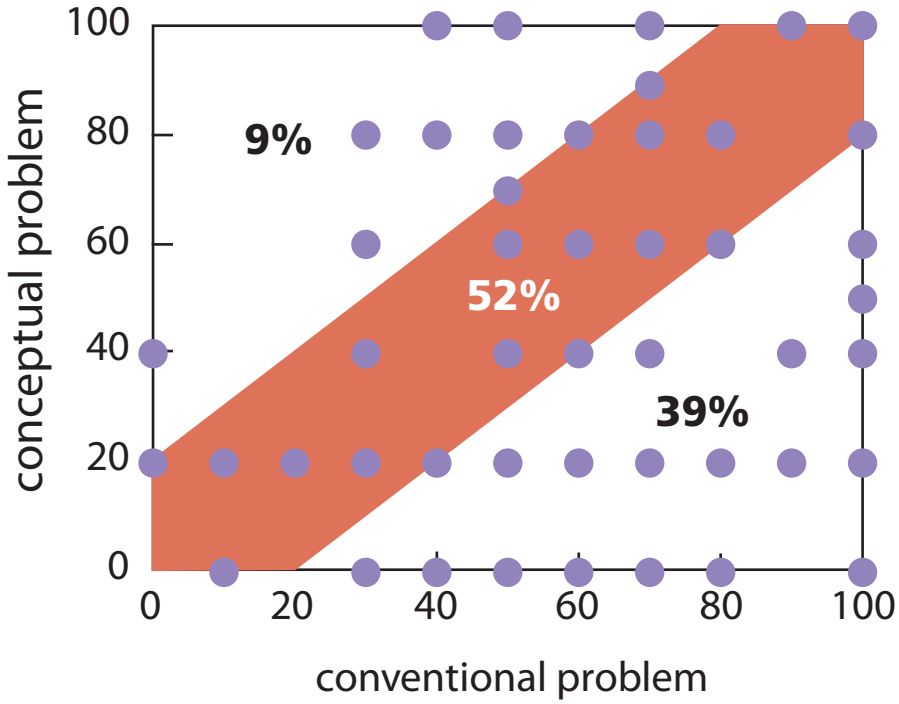
Education


conventional
conceptual
average 6.9
average 4.9
count
score
0
20
40
60
80
0
2
4
6
8
10

Education


100
80
60
40
20
0
conceptual problem
0
20
40
60
80
100
conventional problem

Education


100
80
60
40
20
0
conceptual problem
9%
52%
39%
0
20
40
60
80
100
conventional problem


So what should we do?

Peer Instruction

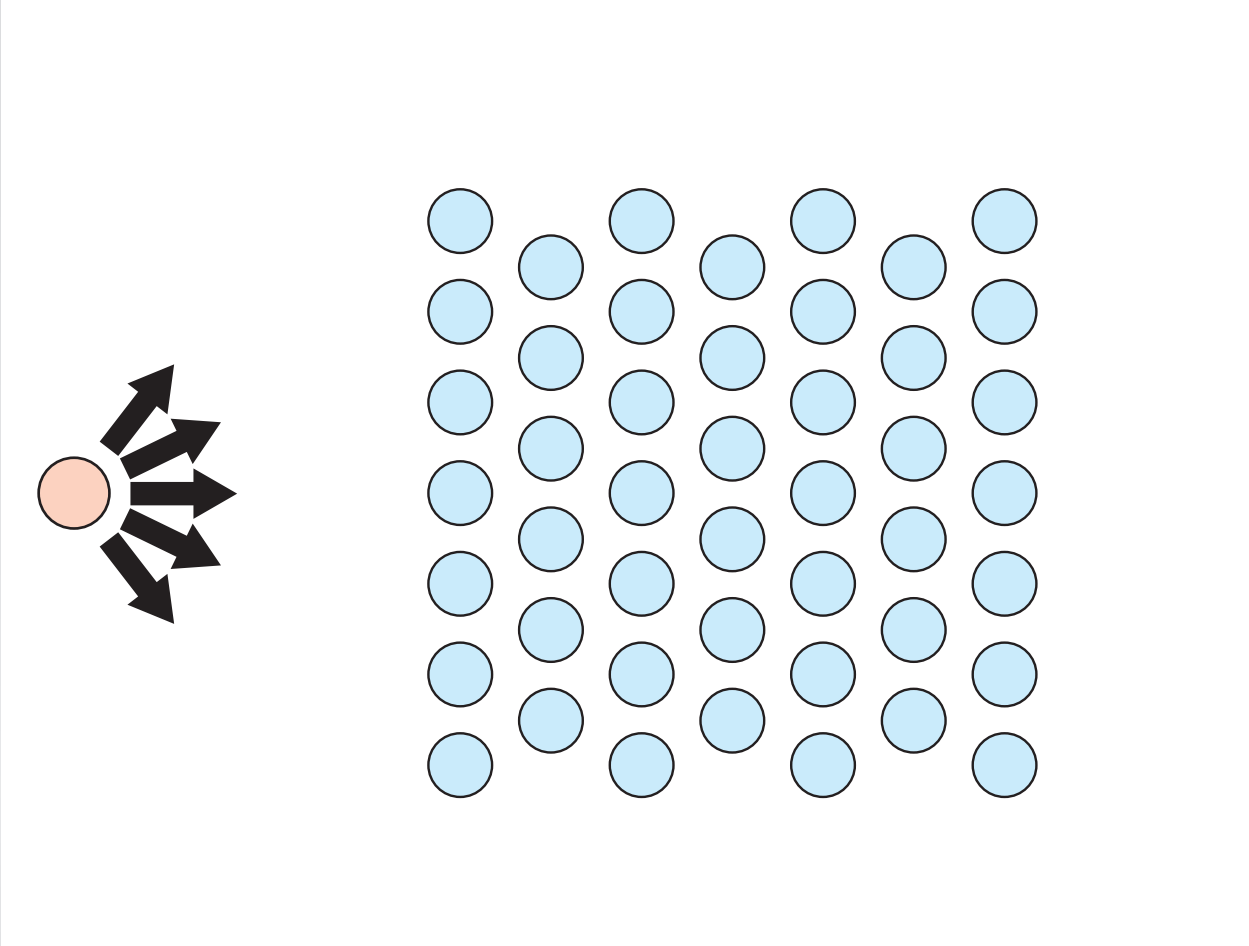
Give students more responsibility for gathering information…

Peer Instruction

Give students more responsibility for gathering information…
so we can better help them assimilate it.

Peer Instruction

1. Recognize the inefficacy of the lecture method



Peer Instruction

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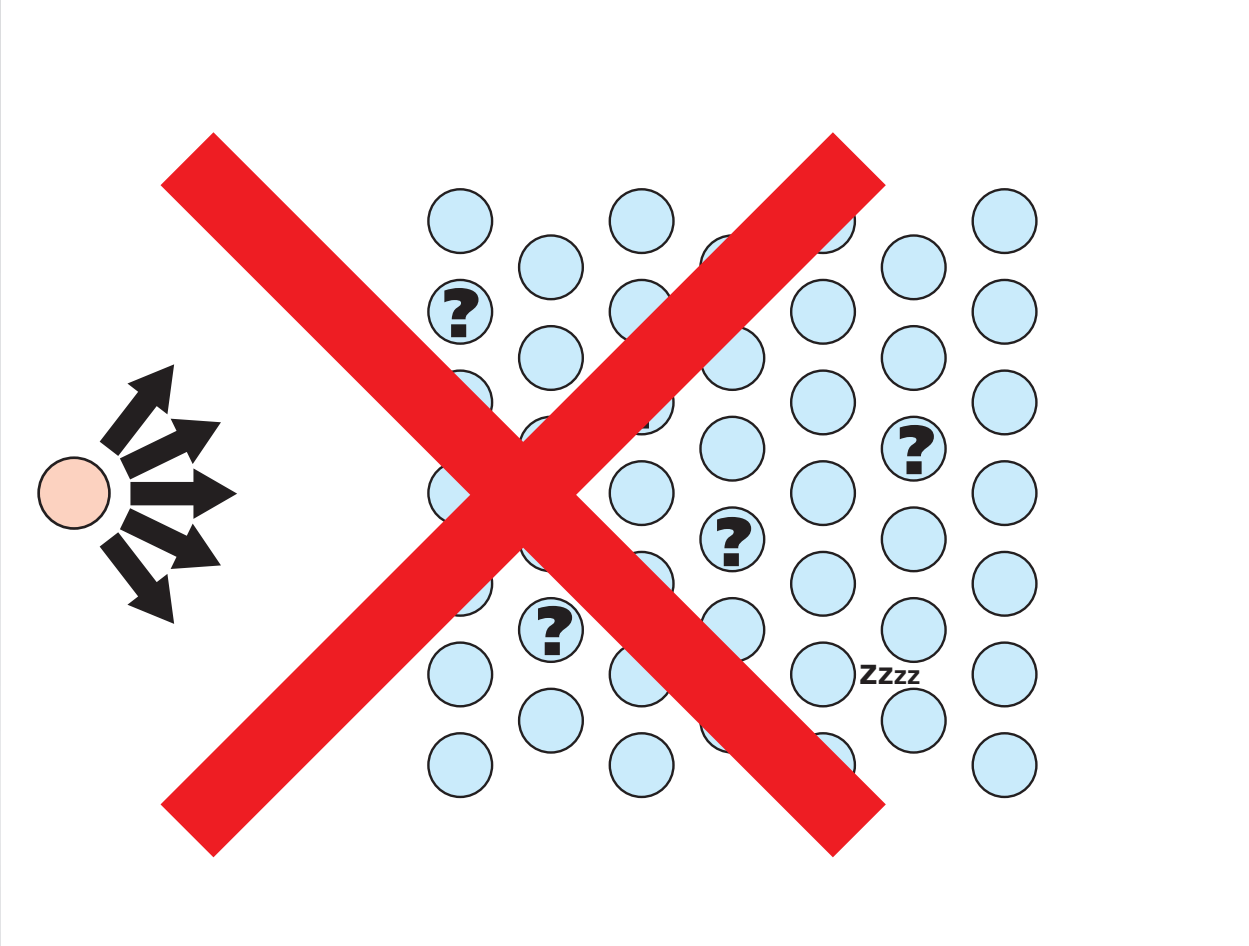
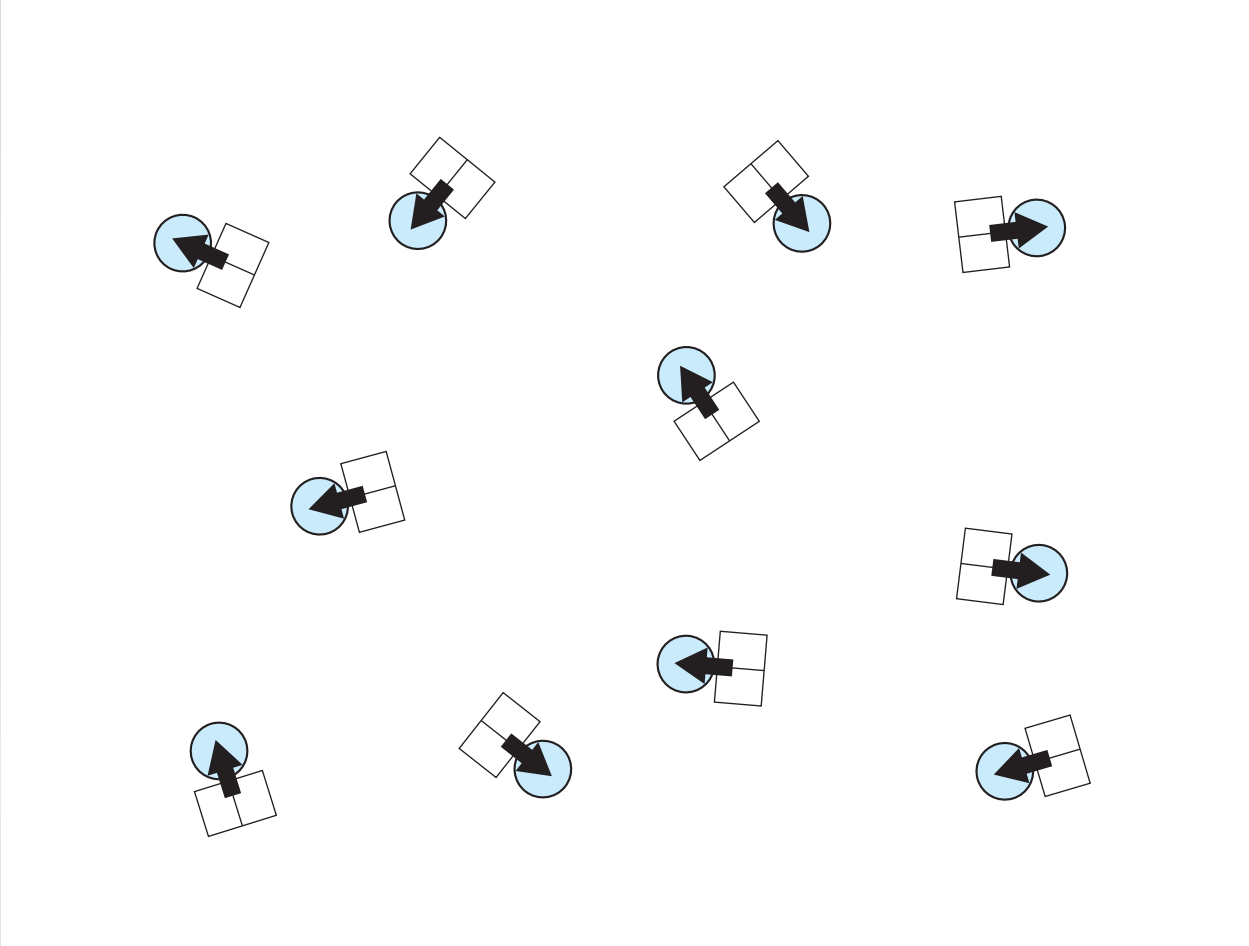


Peer Instruction

2. Move first exposure to material out of classroom



Peer Instruction

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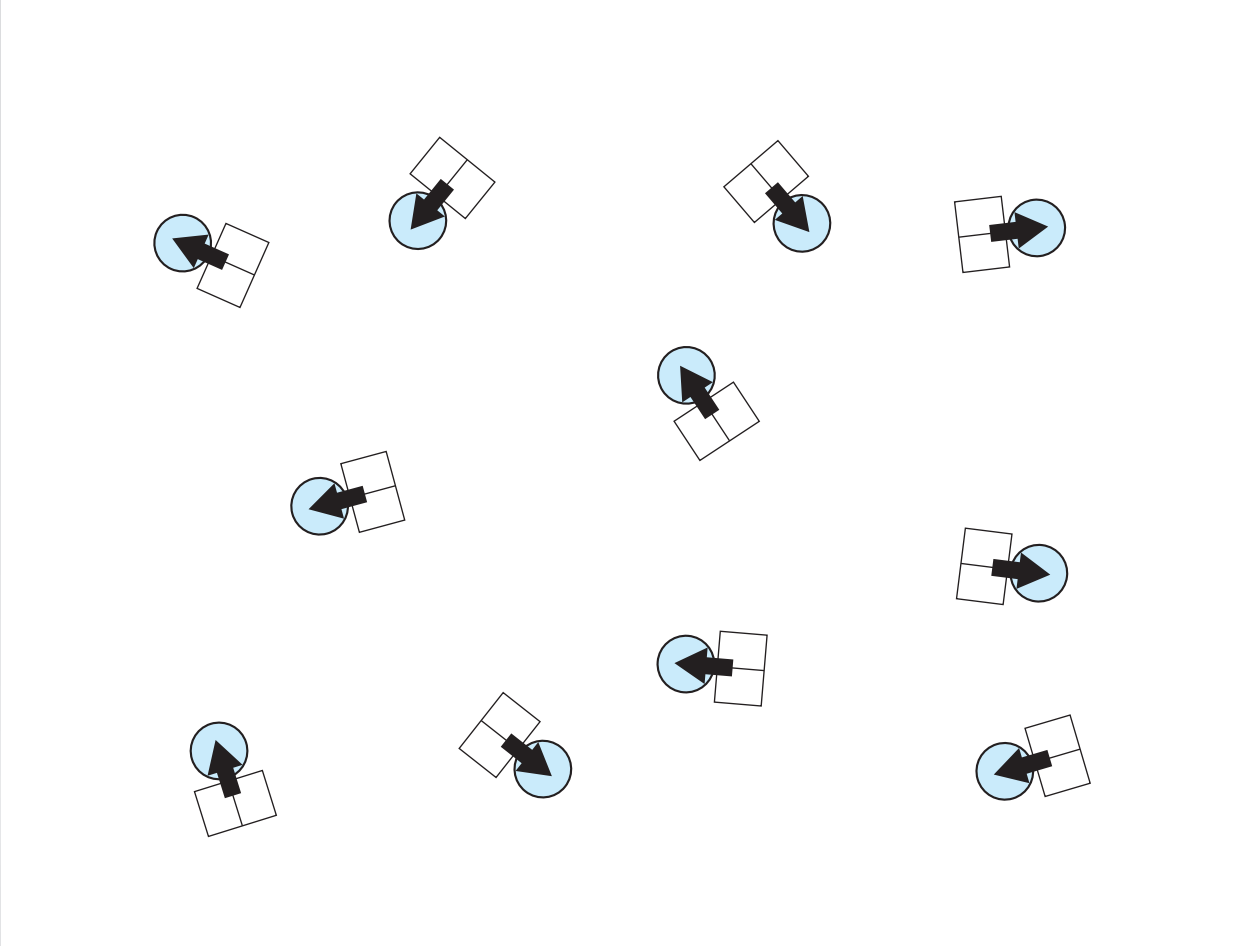


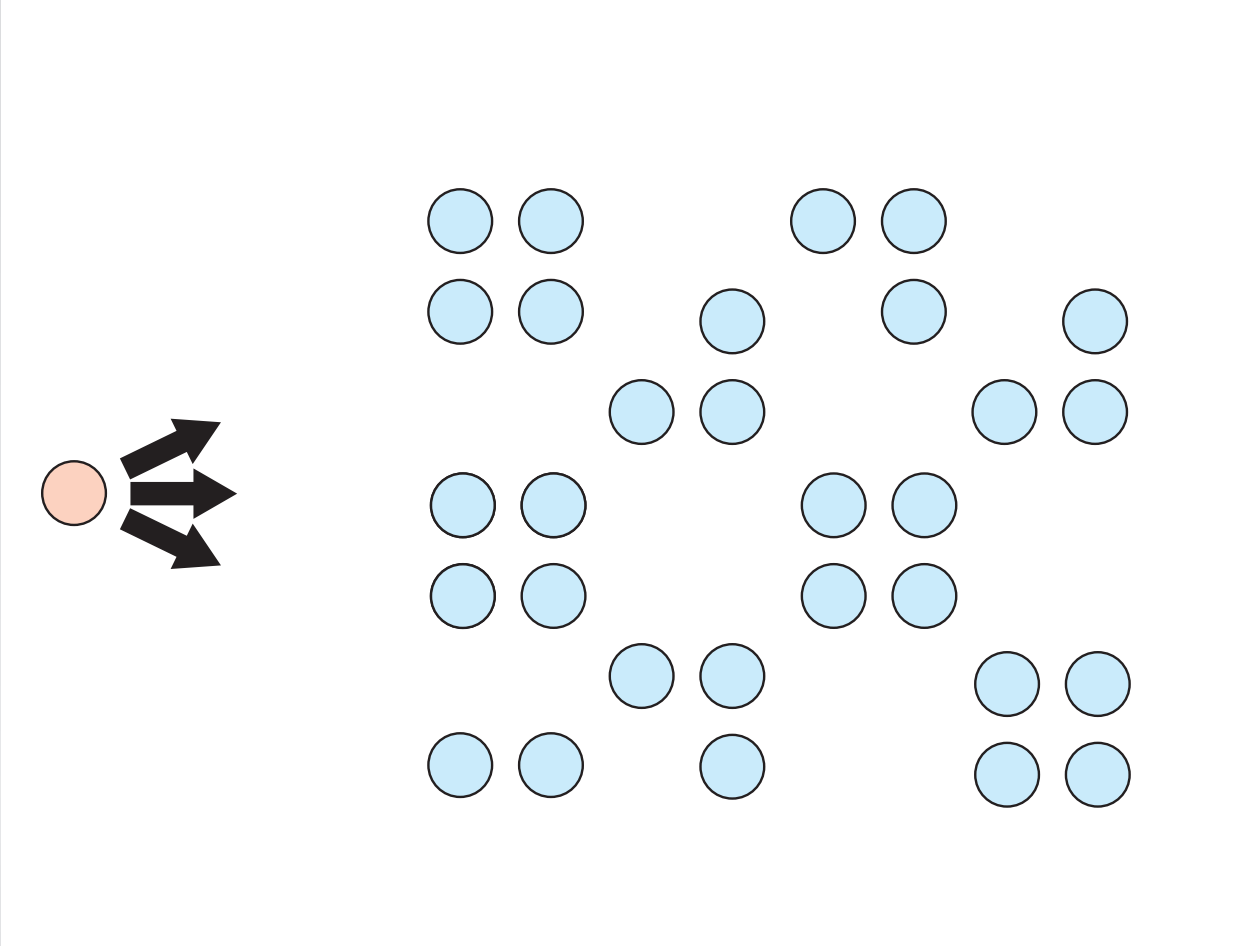
…assign reading!

Peer Instruction

3. Use class period to deepen and broaden understanding

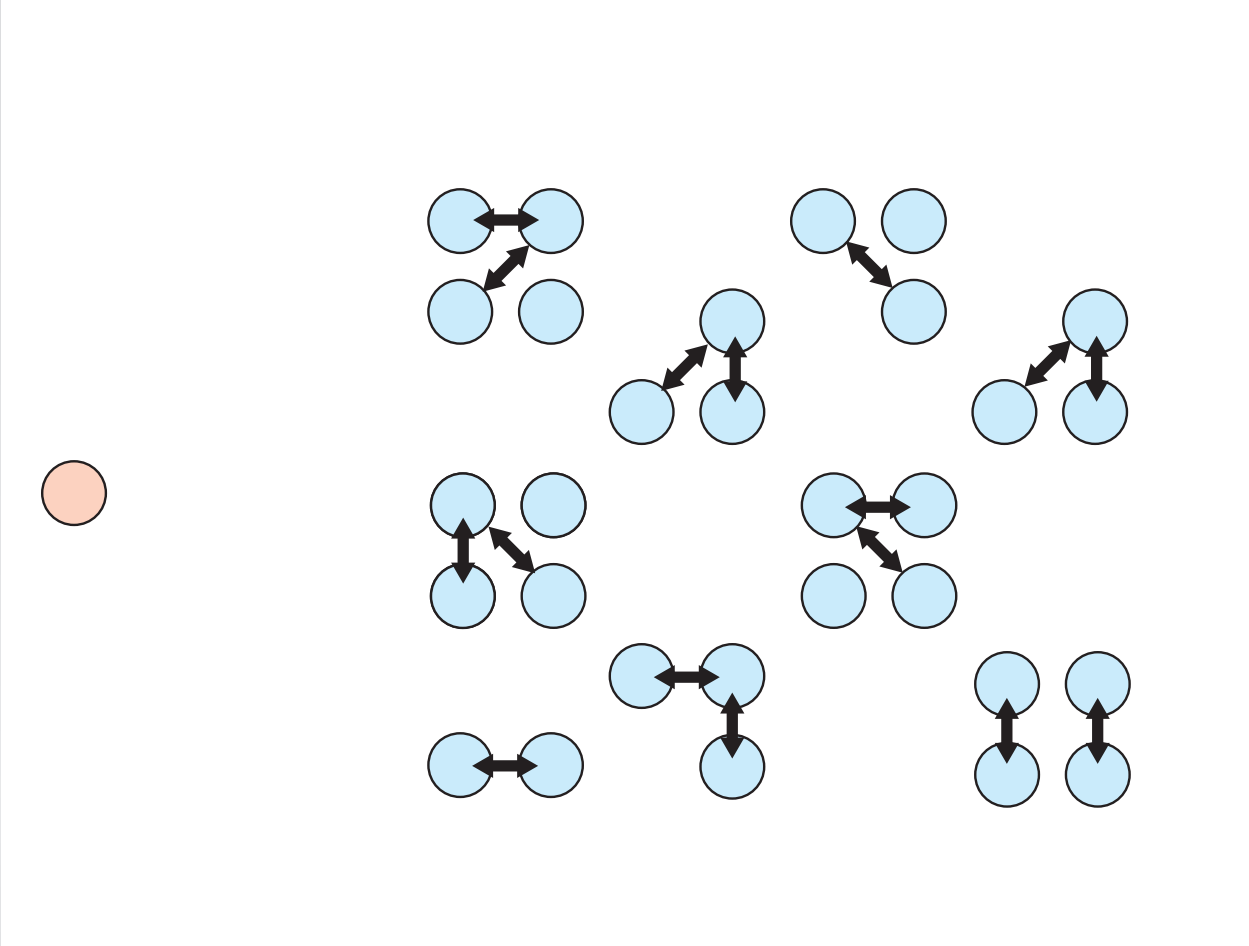
Peer Instruction

…by painting the big picture…



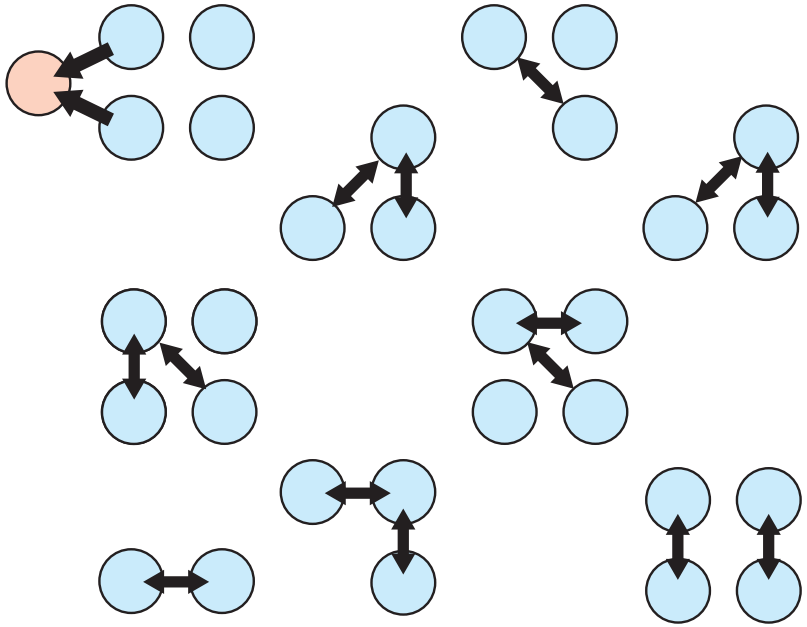
Peer Instruction

…and giving your students time to think and discuss



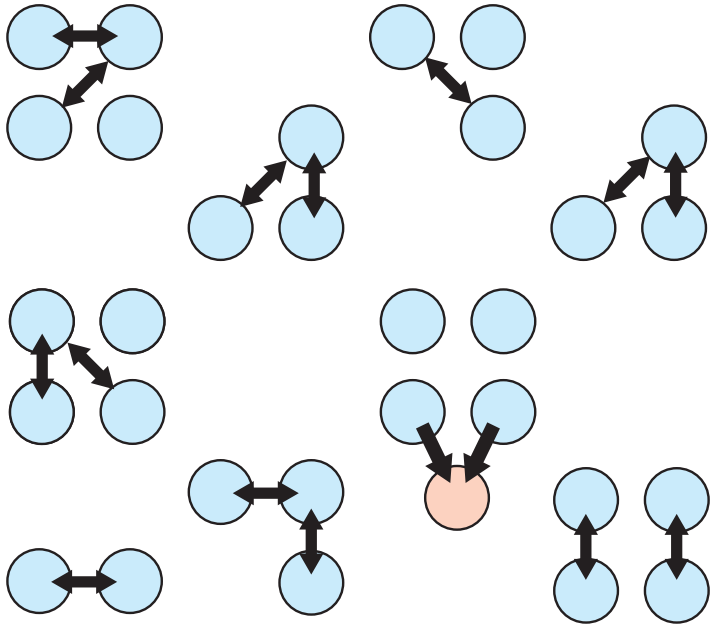
Peer Instruction

Better yet: Learn from your students…



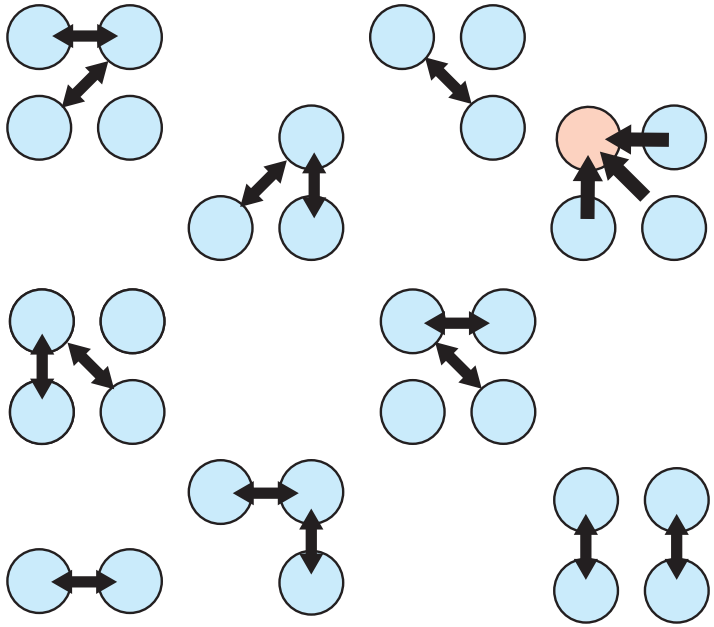
Peer Instruction

Better yet: Learn from your students…



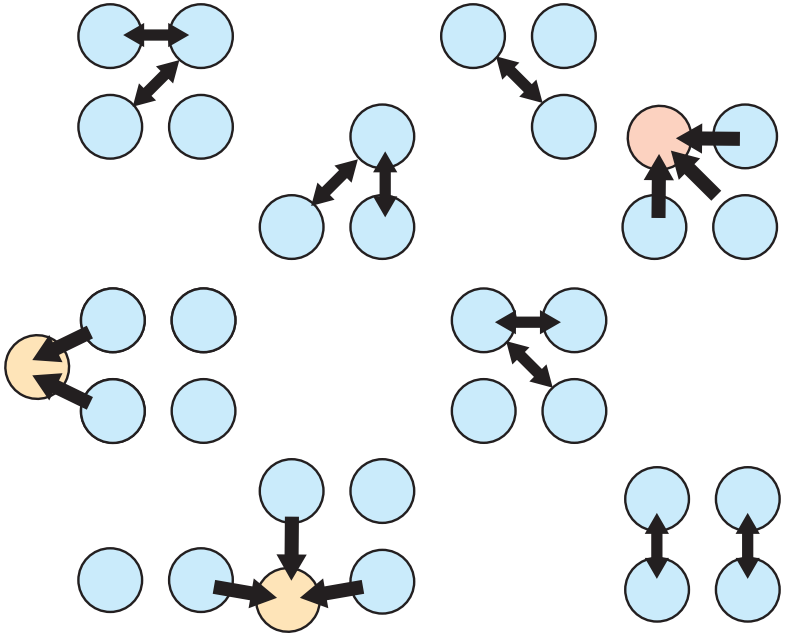
Peer Instruction

Better yet: Learn from your students…



Peer Instruction

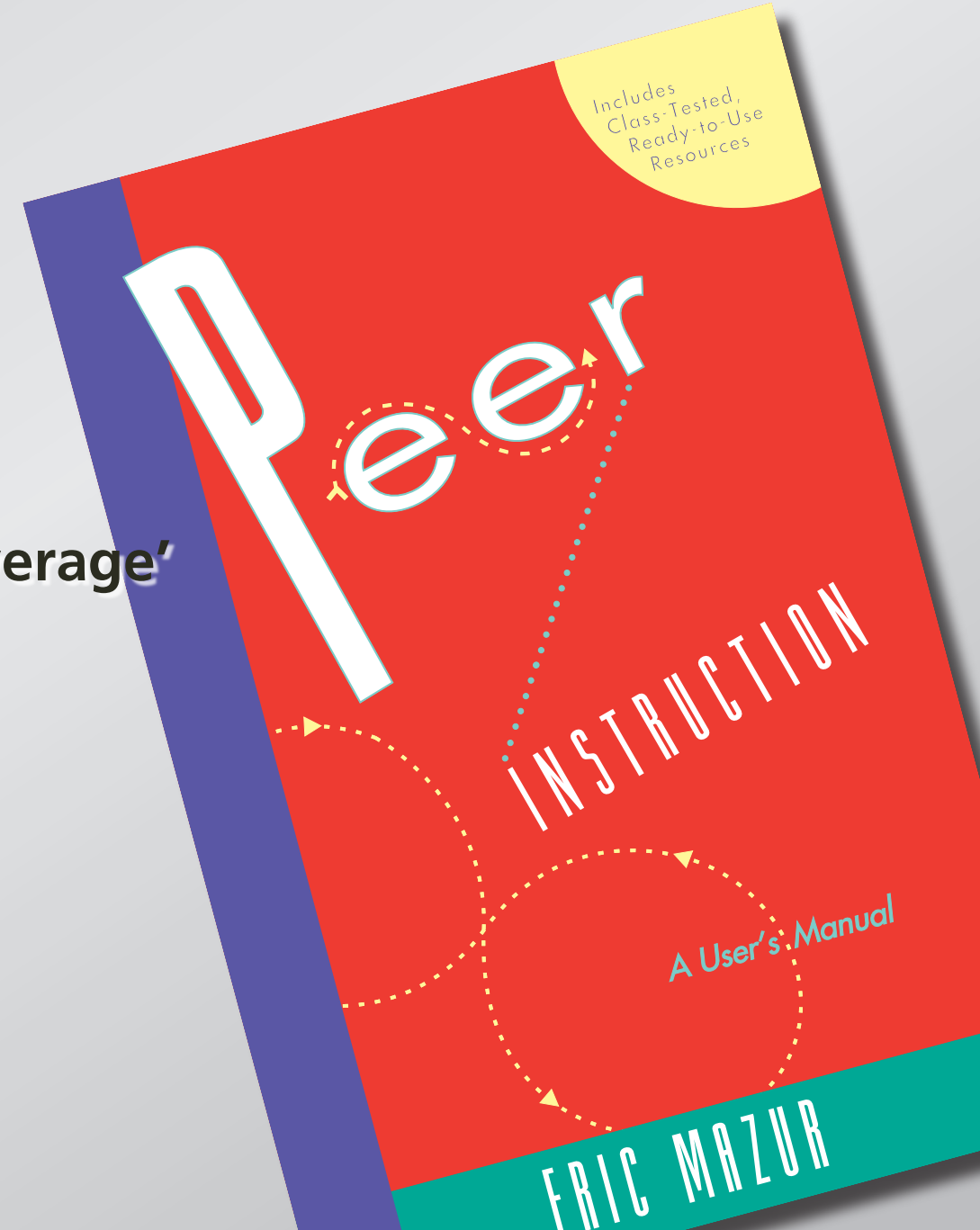
…bring in your Teaching Assistants too!



Peer Instruction

Main features:

- pre-class reading
- in-class: depth, not ‘coverage’
- ConcepTests



Peer Instruction

ConcepTest:

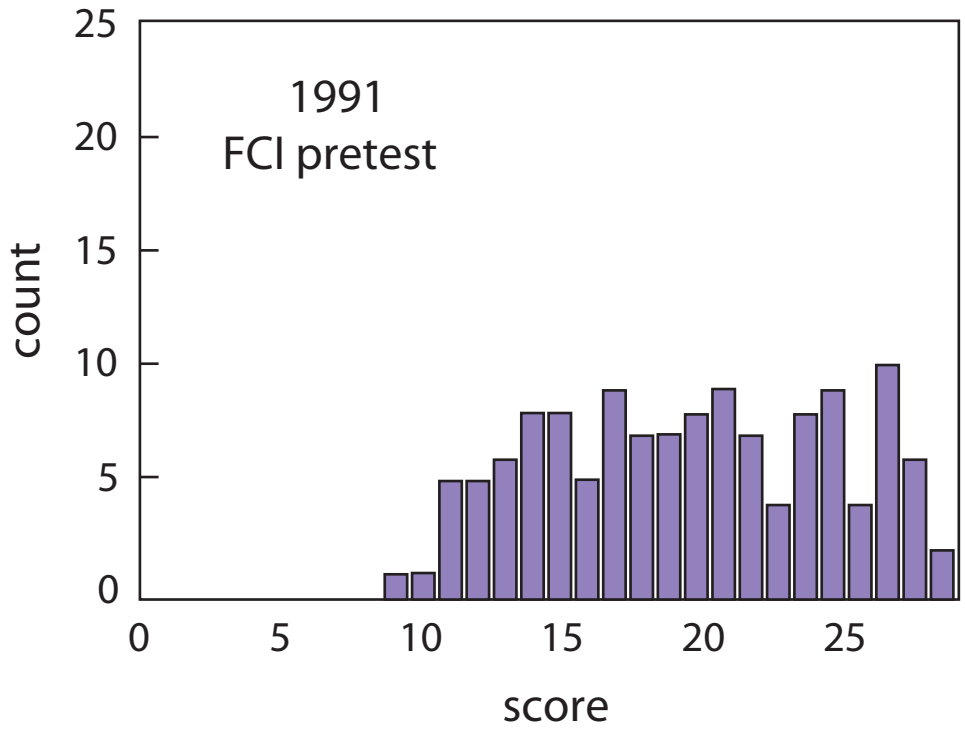
1. Question
2. Thinking
3. Individual answer
4. Peer discussion
5. Revised/Group answer
6. Explanation

Results

is it any good?

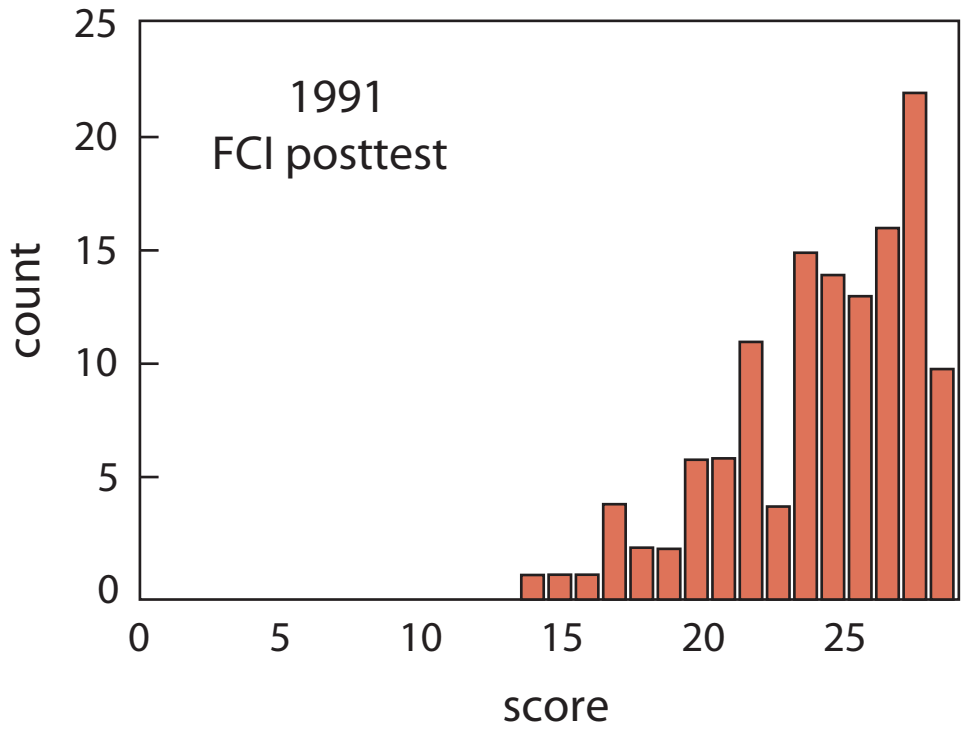
Results

first year of implementing PI



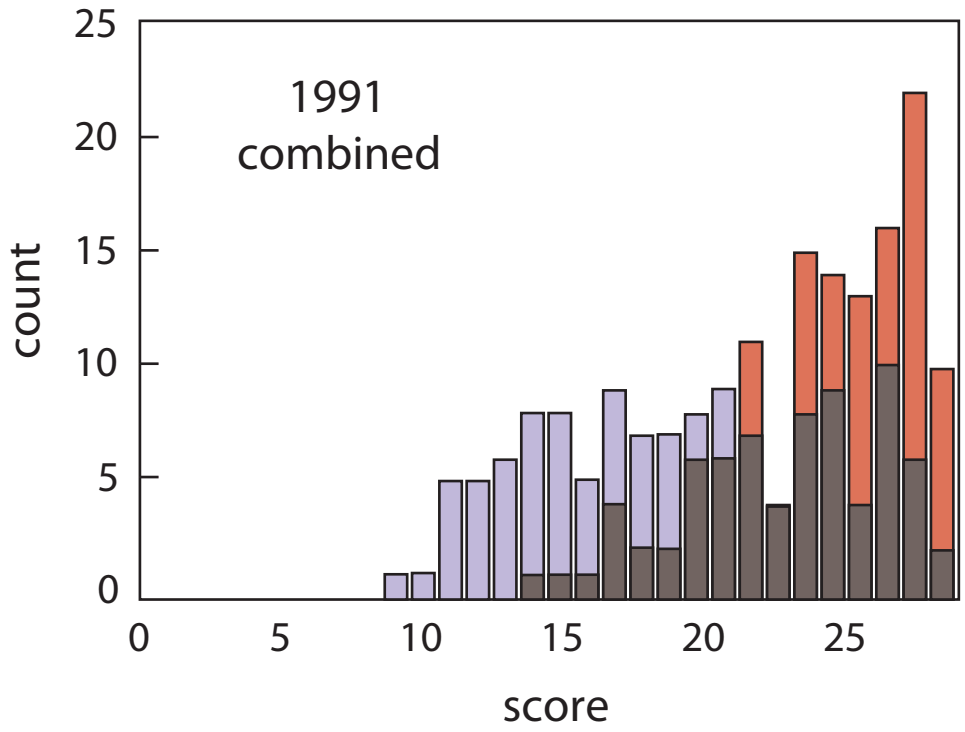
Results

first year of implementing PI

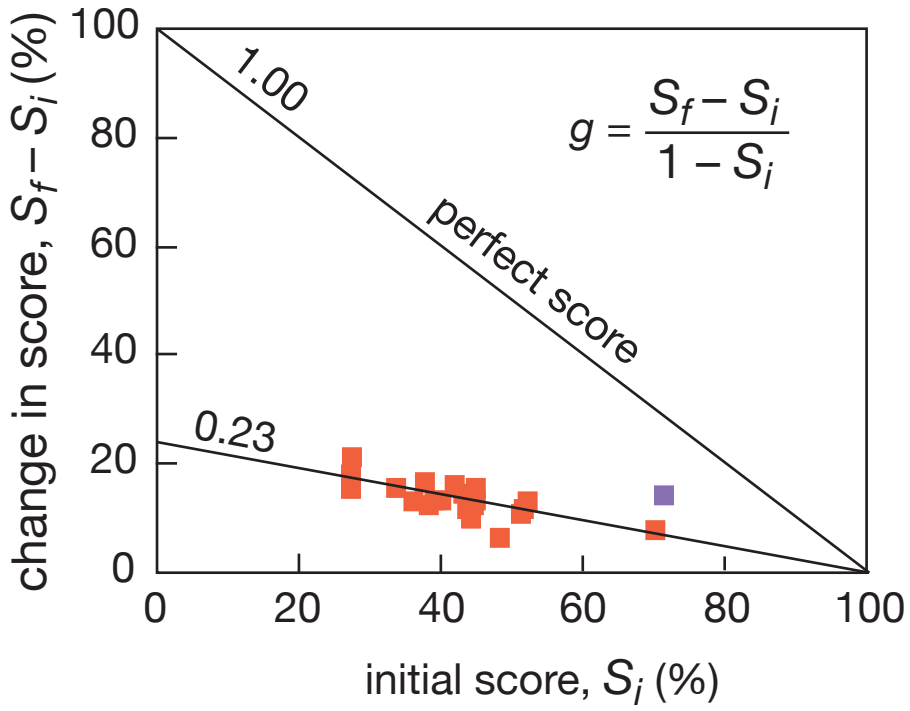


Results

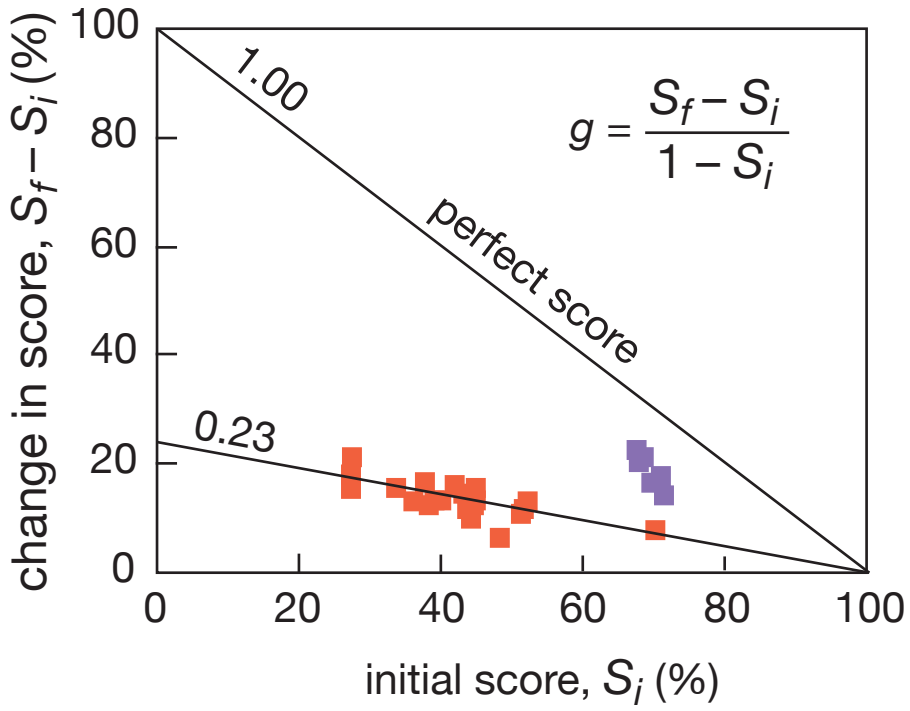
first year of implementing PI



Results


100
80
60
40
20
0
0
20
40
60
80
100
1.00
perfect score
0.23
$g = \frac{S_f - S_i}{1 - S_i}$
change in score, $S_f - S_i$ (%)
initial score, S_i (%)

Results


100
80
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40
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0
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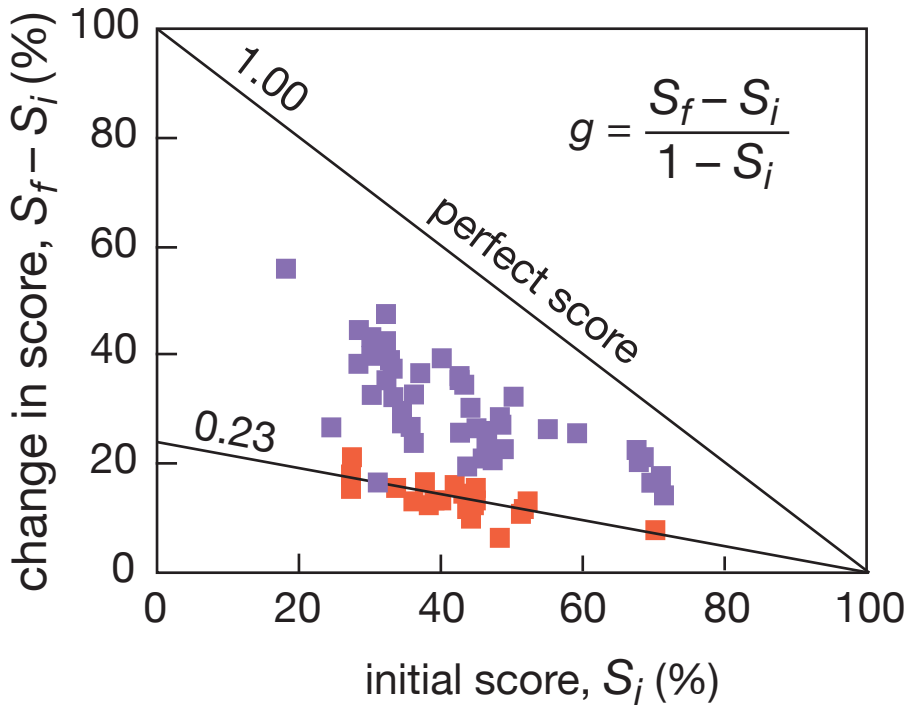
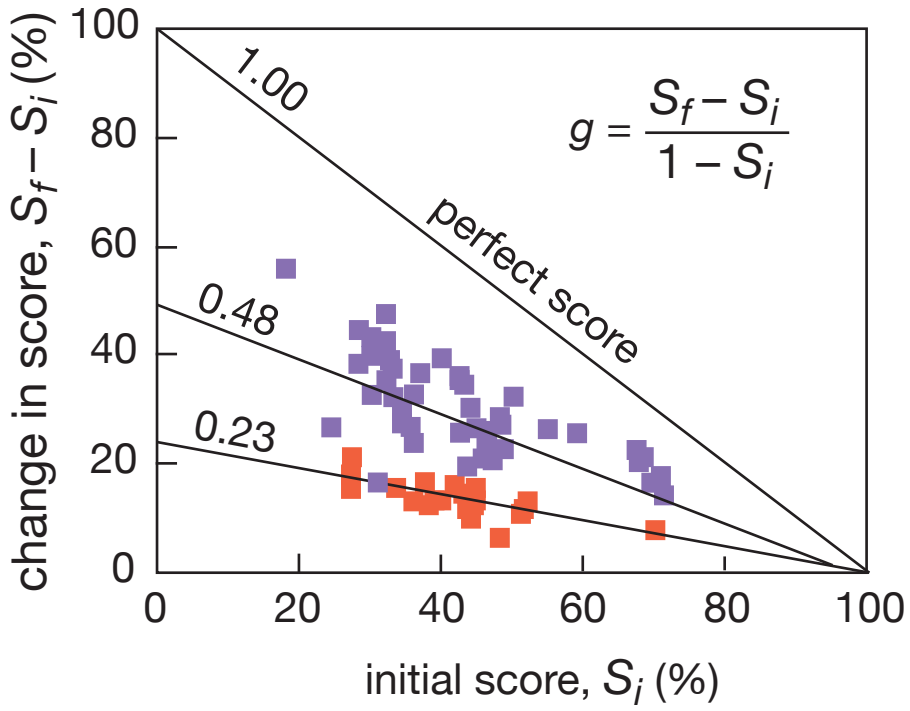
20
40
60
80
100
1.00
perfect score
0.23
$g = \frac{S_f - S_i}{1 - S_i}$
change in score, $S_f - S_i$ (%)
initial score, S_i (%)

Results



R.R. Hake, *Am. J. Phys.* 66, 64 (1998)

Results

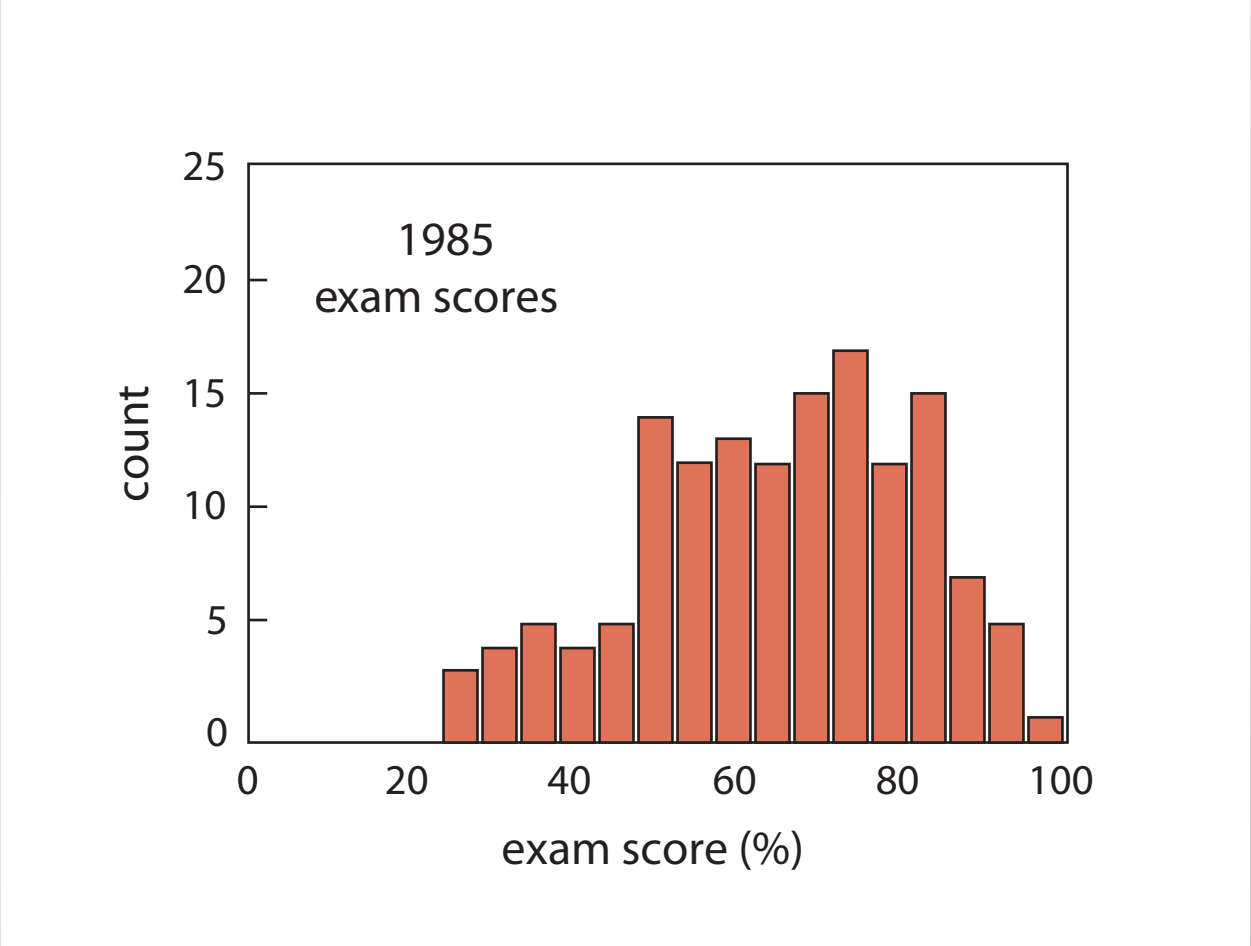


R.R. Hake, *Am. J. Phys.* 66, 64 (1998)

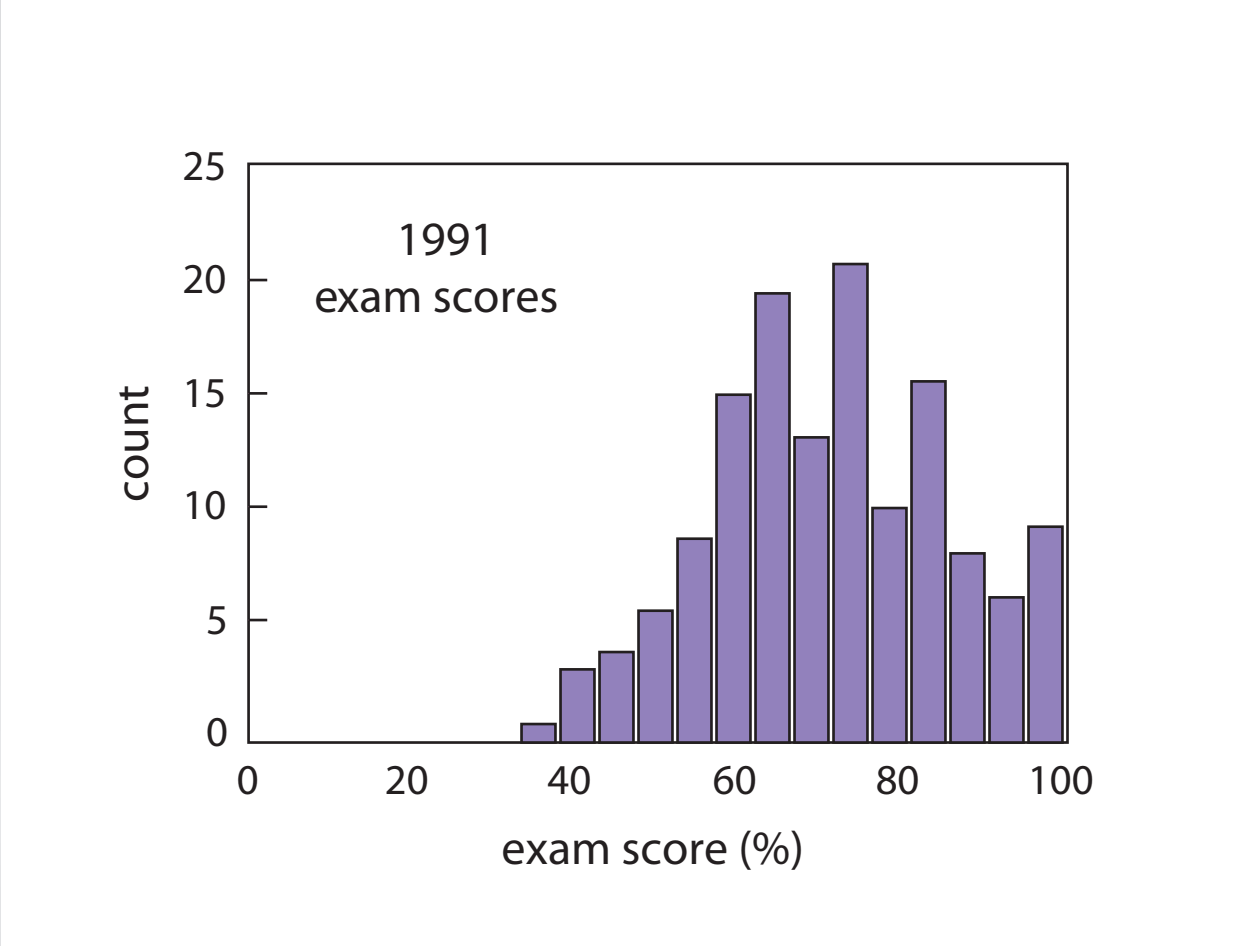
Results

what about problem solving?

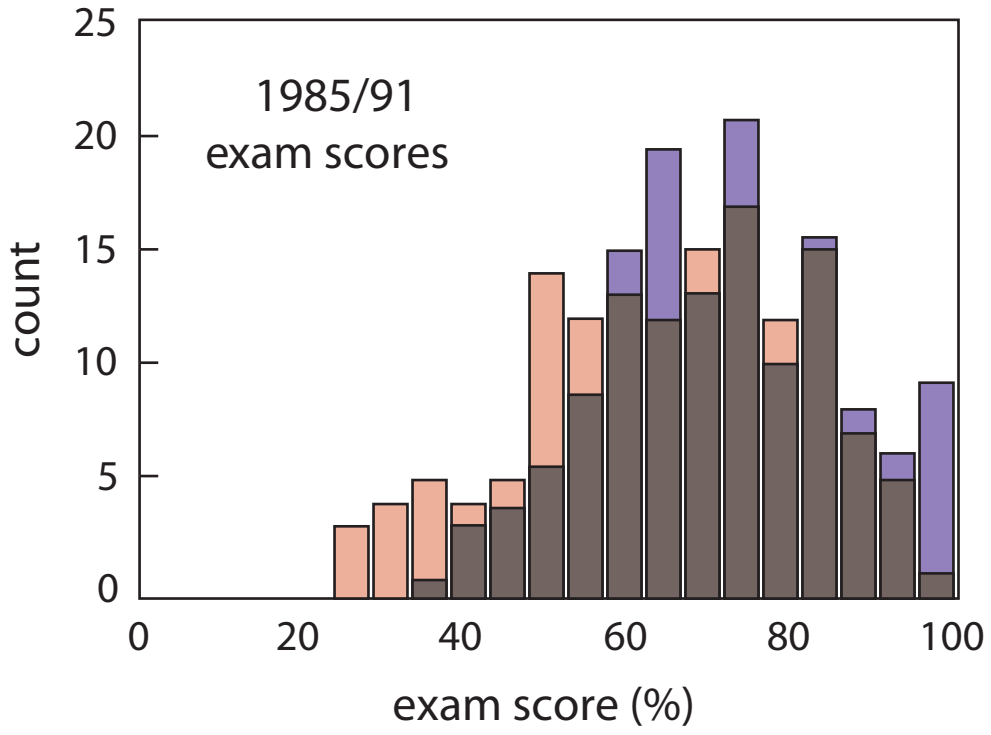
Results


1985
exam scores
count
25
20
15
10
5
0
0
20
40
60
80
100
exam score (%)

Results


1991
exam scores
count
25
20
15
10
5
0
0
20
40
60
80
100
exam score (%)

Results


1985/91
exam scores
count
25
20
15
10
5
0
0
20
40
60
80
100
exam score (%)

Summary

So better understanding leads to better problem solving!

Summary

So better understanding leads to better problem solving!

(but “good” problem solving doesn’t always indicate understanding!)

Why does it work?

Students:

- promotes thinking
- helps uncover and address misunderstanding
- boosts confidence

Why does it work?

Students:

- promotes thinking
- helps uncover and address misunderstanding
- boosts confidence

Faculty:

- change of format, not content
- with existing questions, little effort
- adaptable

Conclusion

A little reorganization goes a long way!

Funding:

National Science Foundation

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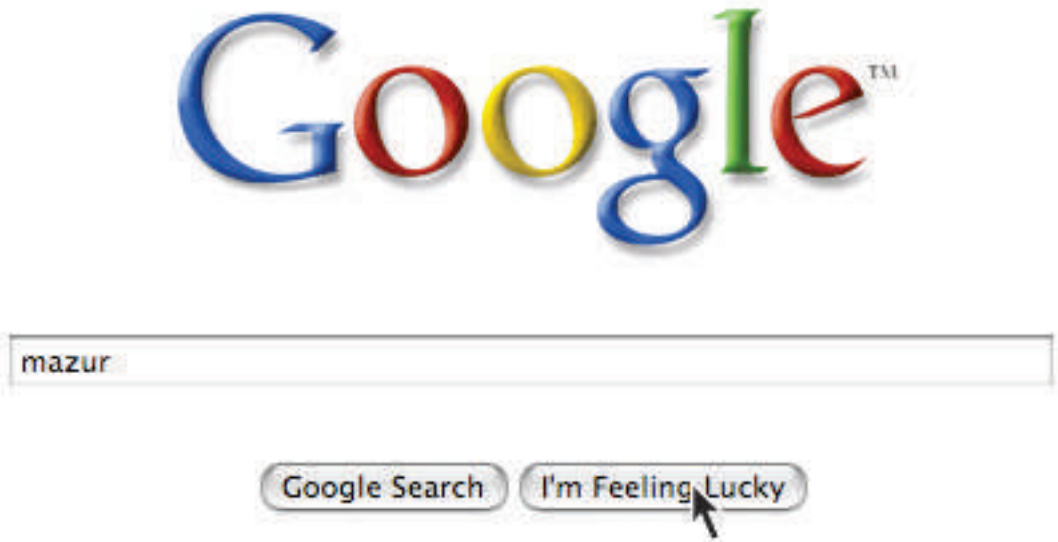
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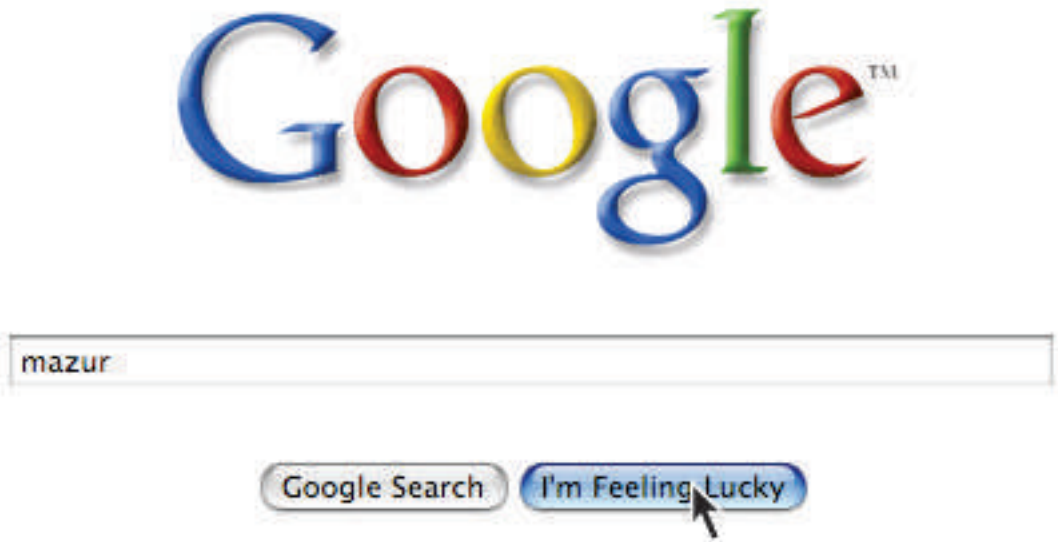
Google
mazur
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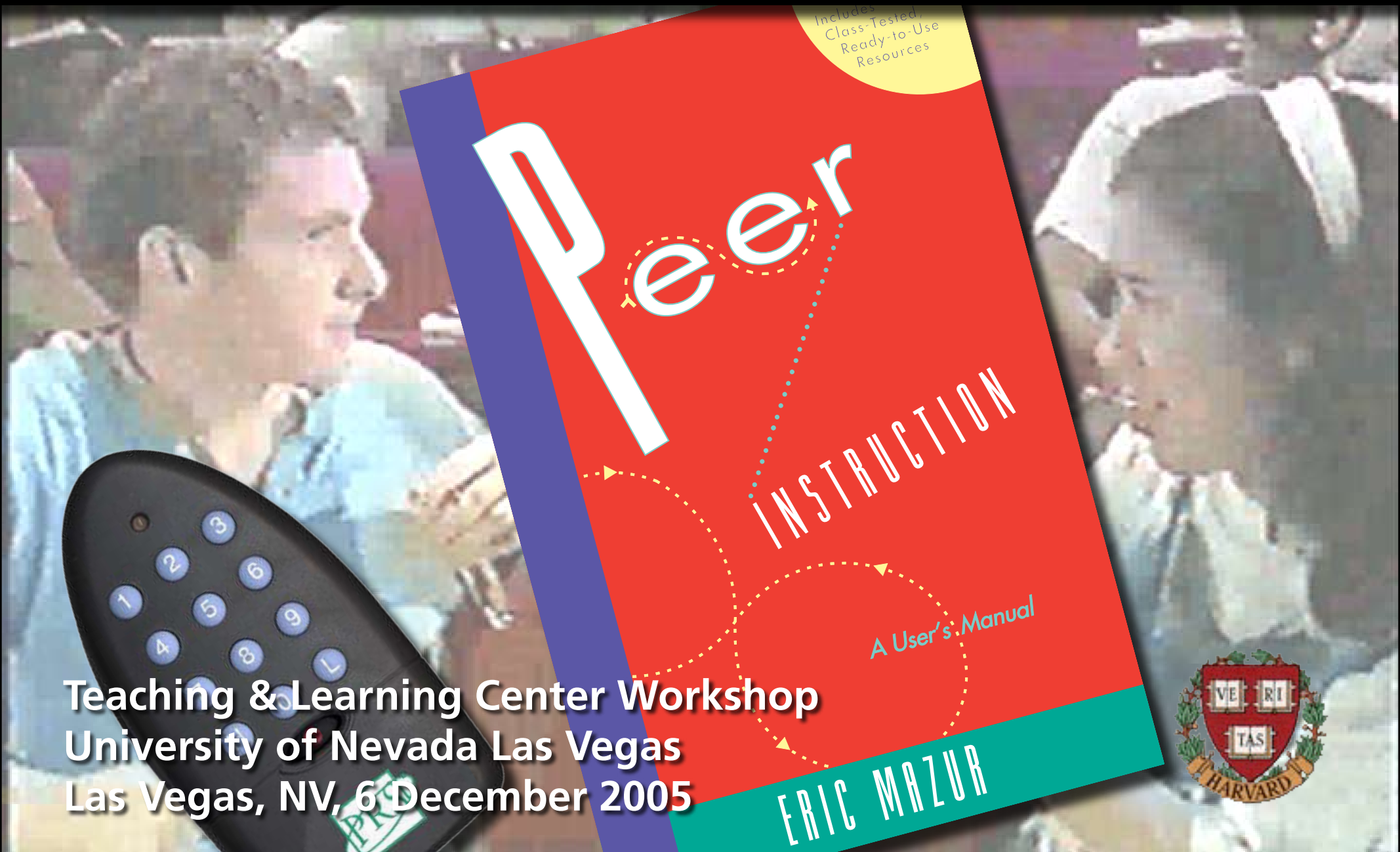
Peer Instruction: discussion and 'brains-on' demo



Teaching & Learning Center Workshop
University of Nevada Las Vegas
Las Vegas, NV, 6 December 2005

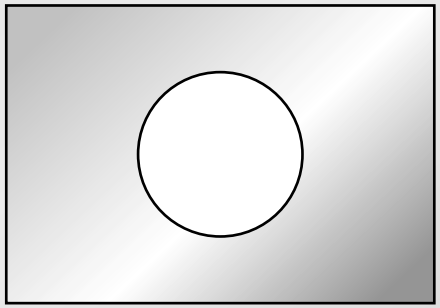
Outline

Some options:

- Let's try it!
- Feedback methods
- Research: providing the basis for change
- Problems with problems
- Resources
- Barriers to reform

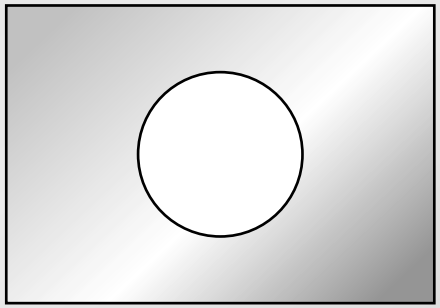
Let's try it!

Consider a rectangular metal plate with a circular hole in it.



Let's try it!

Consider a rectangular metal plate with a circular hole in it.

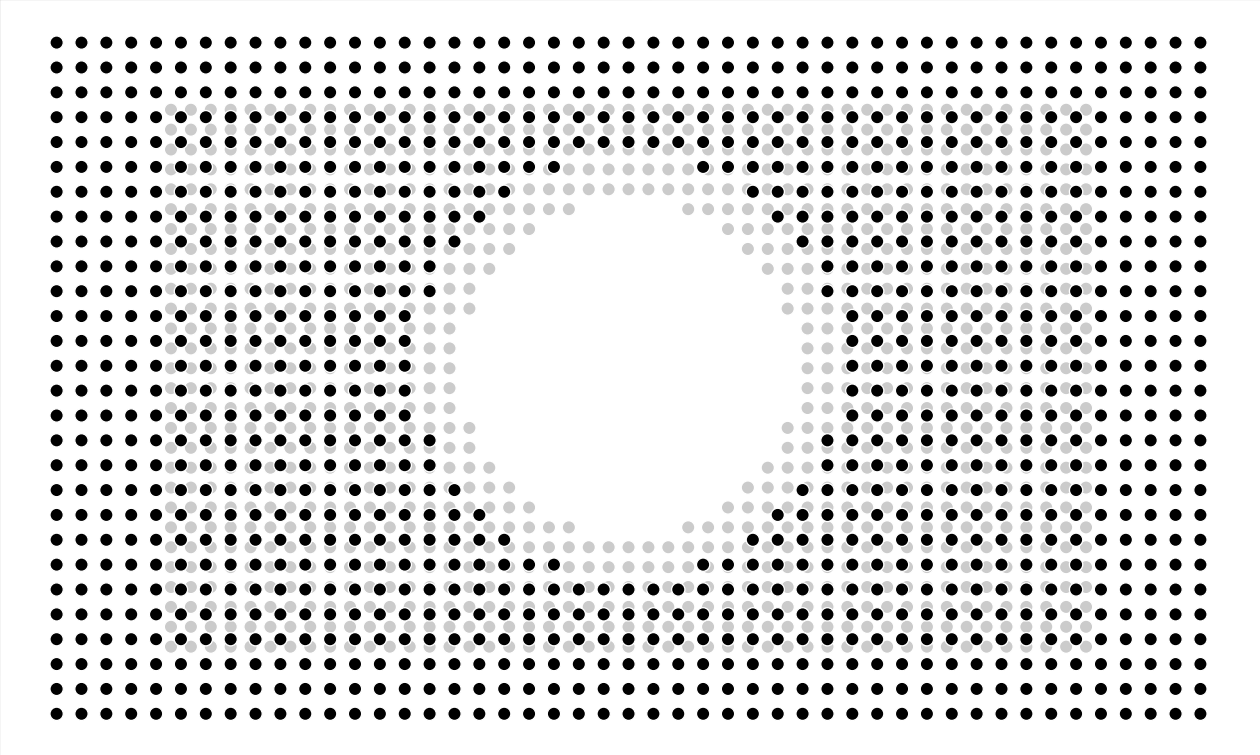


When the plate is uniformly heated, the diameter of the hole

1. increases.
2. stays the same.
3. decreases.

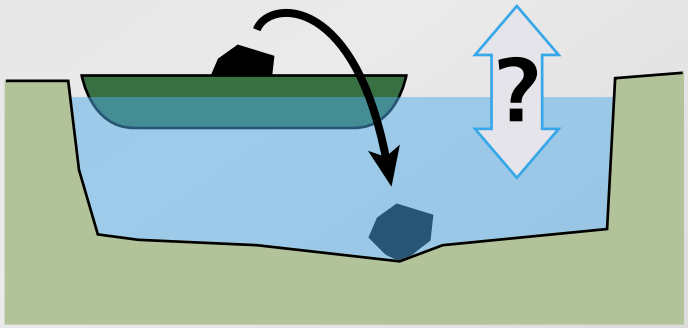
Let’s try it!

The distance between the atoms increases uniformly



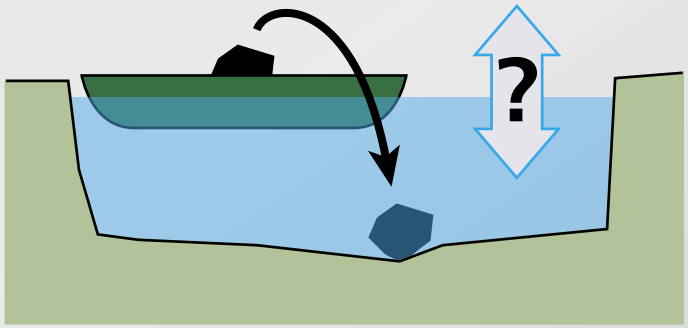
Let's try it!

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.



Let's try it!

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.



After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than

it was when the boulder was in the boat.

Let's try it!

When we hold a page of printed text in front of a mirror, the text on the image in the mirror runs from right to left:

The New York Times

Let's try it!

When we hold a page of printed text in front of a mirror, the text on the image in the mirror runs from right to left:

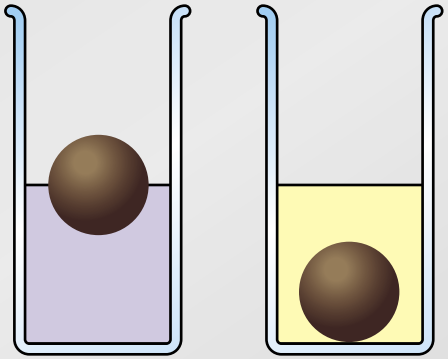
The New York Times

Why is it that right and left are interchanged and not top and bottom? Because:

1. the mirror is oriented vertically.
2. we have two eyes in the horizontal plane.
3. the Earth's gravitation is directed downward.
4. a habit we have when looking at images in a mirror.
5. It only *appears* to run from left to right.

Let's try it!

Consider an object that floats in water, but sinks in oil. When the object floats in water, half of it is submerged.



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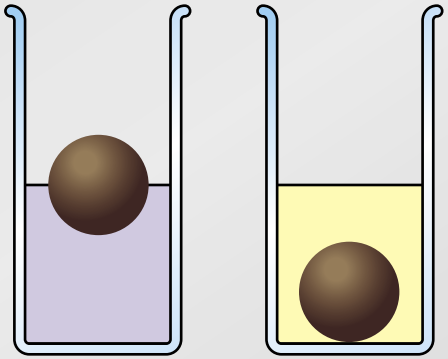
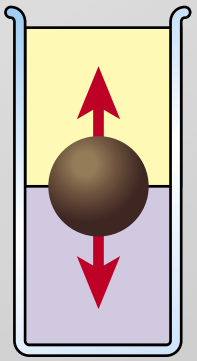


If we slowly pour the oil on top of the water so it completely covers the object, the object

1. moves up.
2. stays in the same place.
3. moves down.



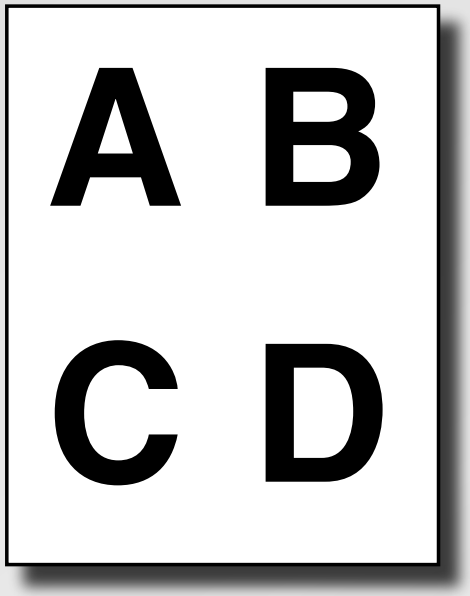
Feedback methods

Show of hands:

easy, but only moderately effective

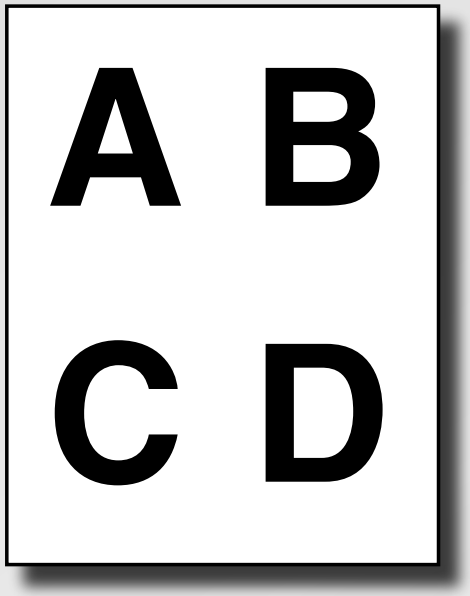
Feedback methods

Flashcards: simple and effective



Feedback methods

Flashcards: simple and effective



Meltzer and Mannivanan, South Eastern Louisiana University

Feedback methods

Infrared transmitters (PRS): easy collection of data

Feedback methods

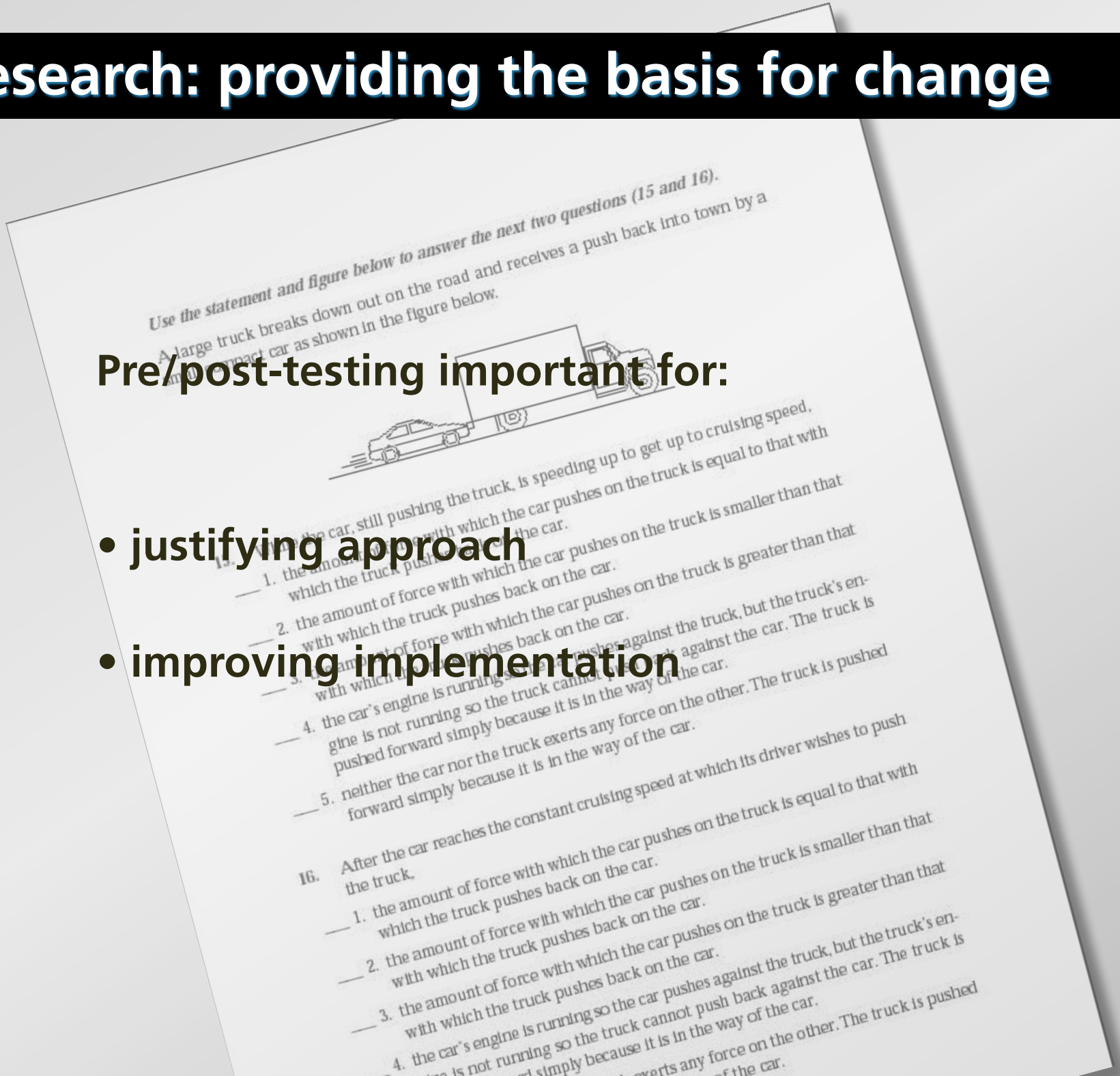
Infrared transmitters (PRS): easy collection of data

Kristy Beauvais, Concord Carlisle High School

Feedback methods

near future: wireless classroom

Research: providing the basis for change


Use the statement and figure below to answer the next two questions (15 and 16).

A large truck breaks down out on the road and receives a push back into town by a small compact car as shown in the figure below.

15. When the car, still pushing the truck, is speeding up to get up to cruising speed,
___ 1. the amount of force with which the car pushes on the truck is equal to that with which the truck pushes back on the car.
___ 2. the amount of force with which the car pushes on the truck is smaller than that with which the truck pushes back on the car.
___ 3. the amount of force with which the car pushes on the truck is greater than that with which the truck pushes back on the car.
___ 4. the car's engine is running so the car pushes against the truck, but the truck's engine is not running so the truck cannot push back against the car. The truck is pushed forward simply because it is in the way of the car.
___ 5. neither the car nor the truck exerts any force on the other. The truck is pushed forward simply because it is in the way of the car.

16. After the car reaches the constant cruising speed at which its driver wishes to push the truck,
___ 1. the amount of force with which the car pushes on the truck is equal to that with which the truck pushes back on the car.
___ 2. the amount of force with which the car pushes on the truck is smaller than that with which the truck pushes back on the car.
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Pre/post-testing important for:

- **justifying approach**
- **improving implementation**

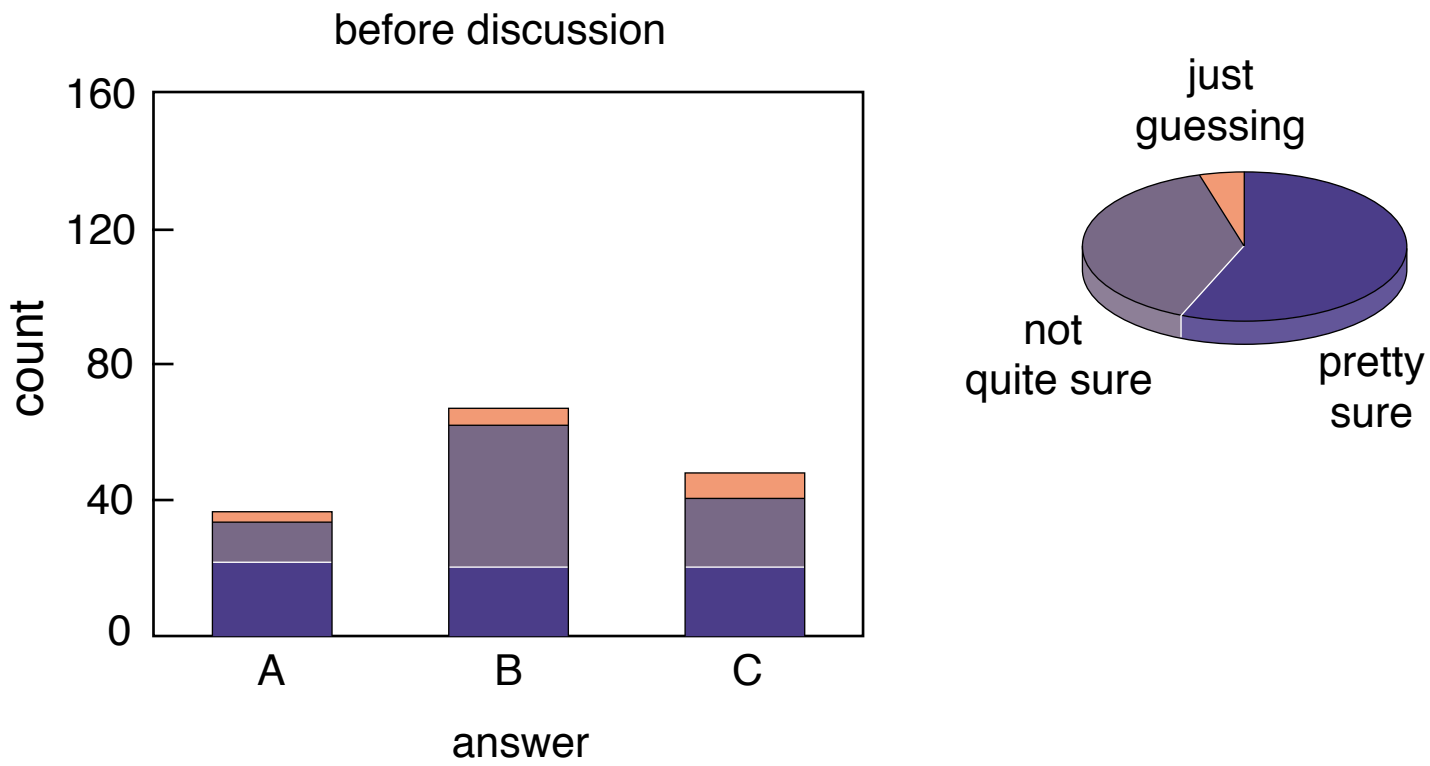
Research: providing the basis for change

Evaluate assessment by comparing

student performance on various kinds of problems

Research: providing the basis for change

ConcepTest data



Research: providing the basis for change

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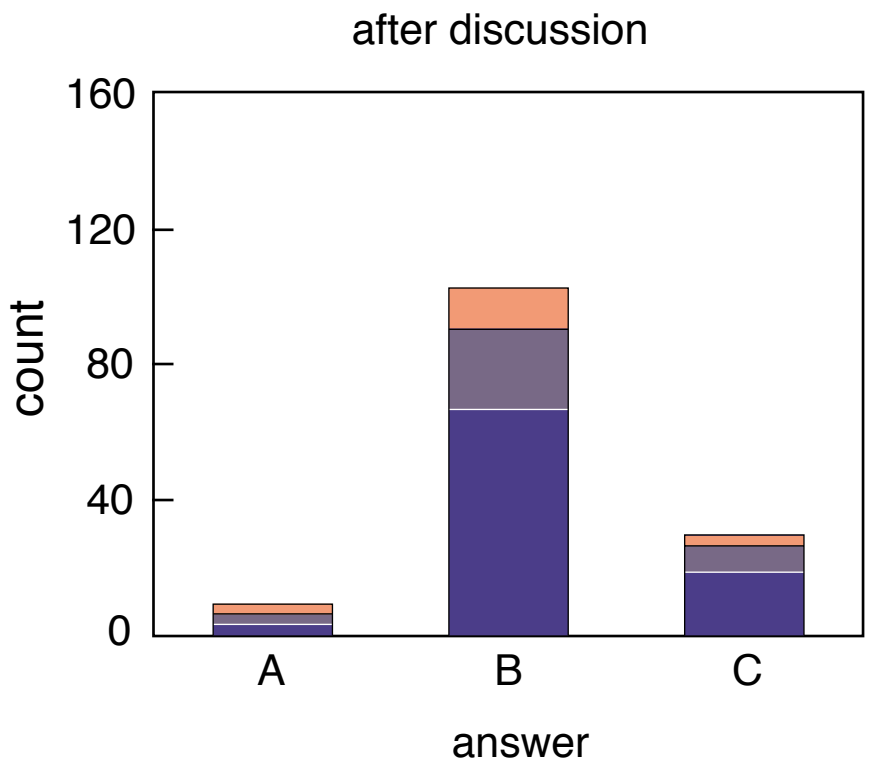

Research: providing the basis for change

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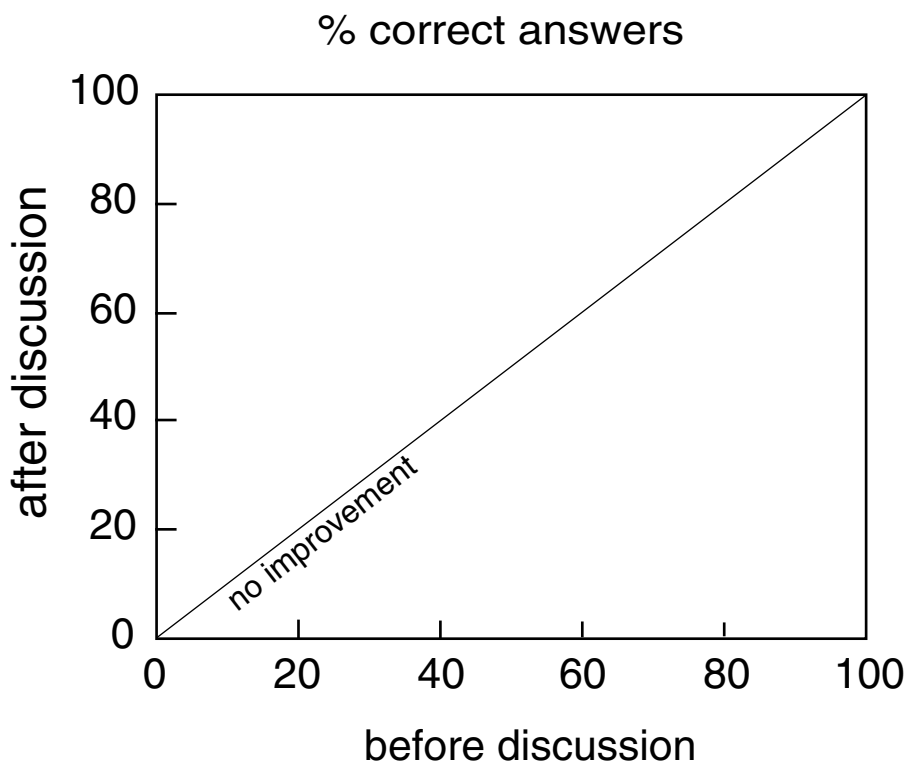

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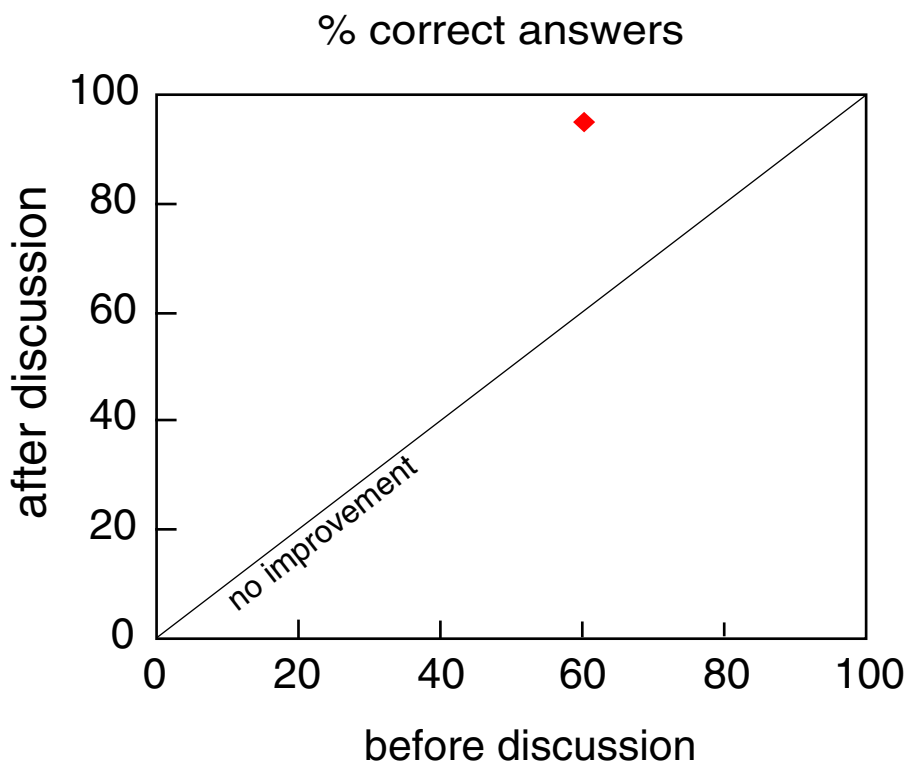

Research: providing the basis for change

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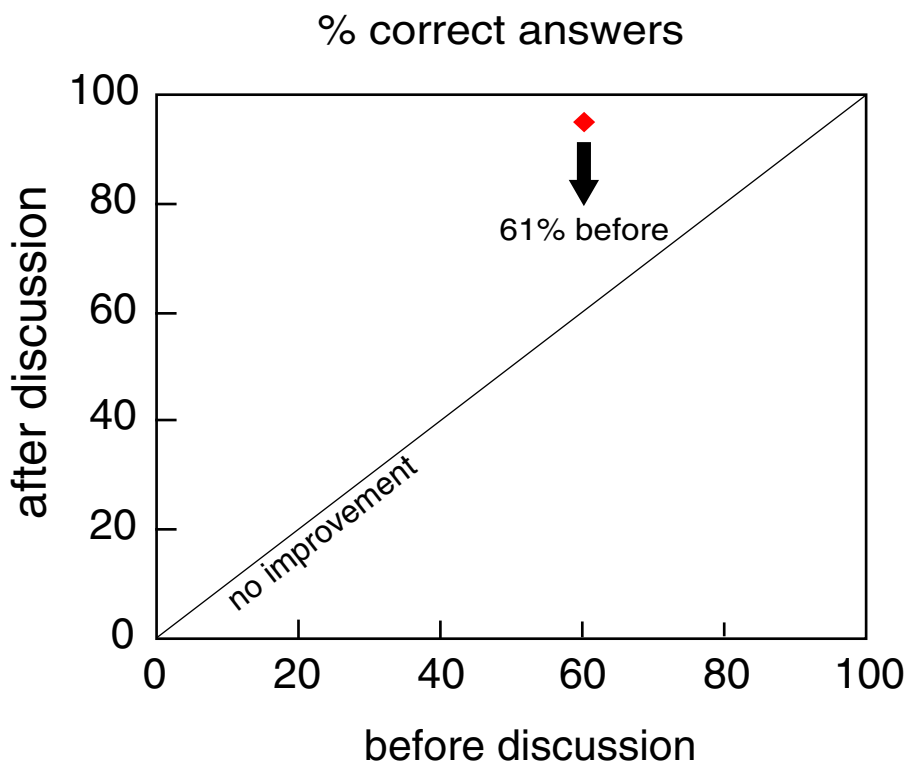

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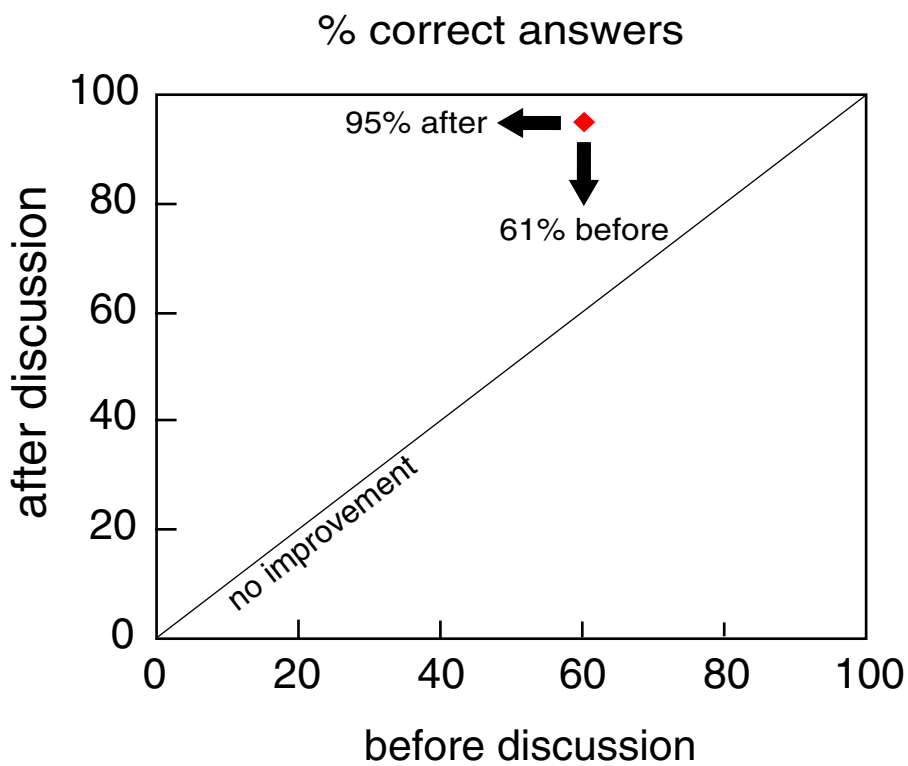

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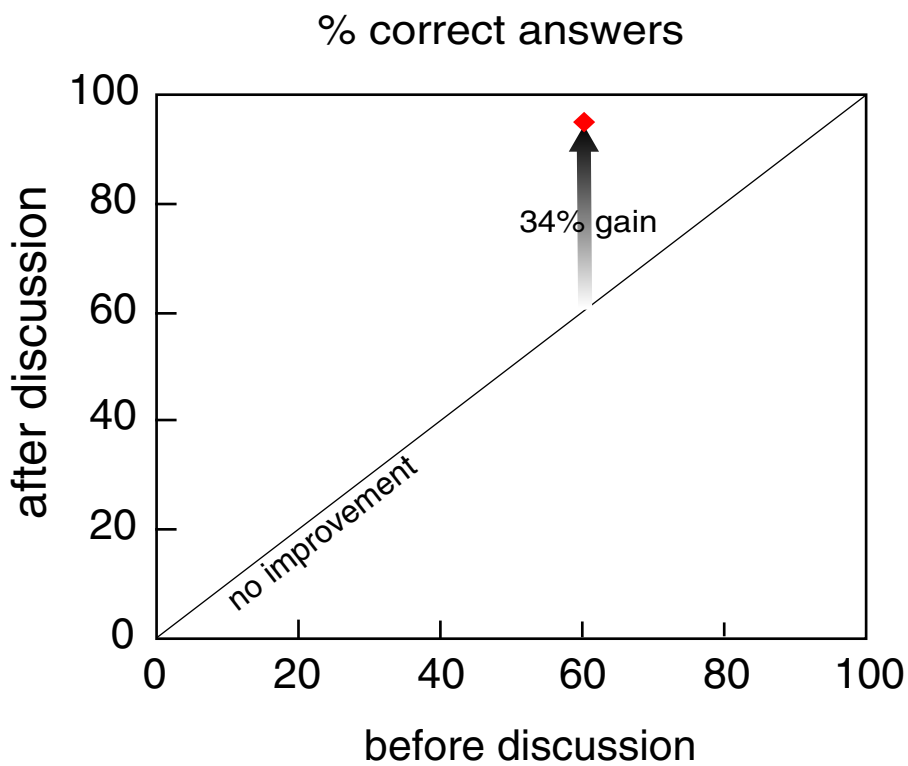

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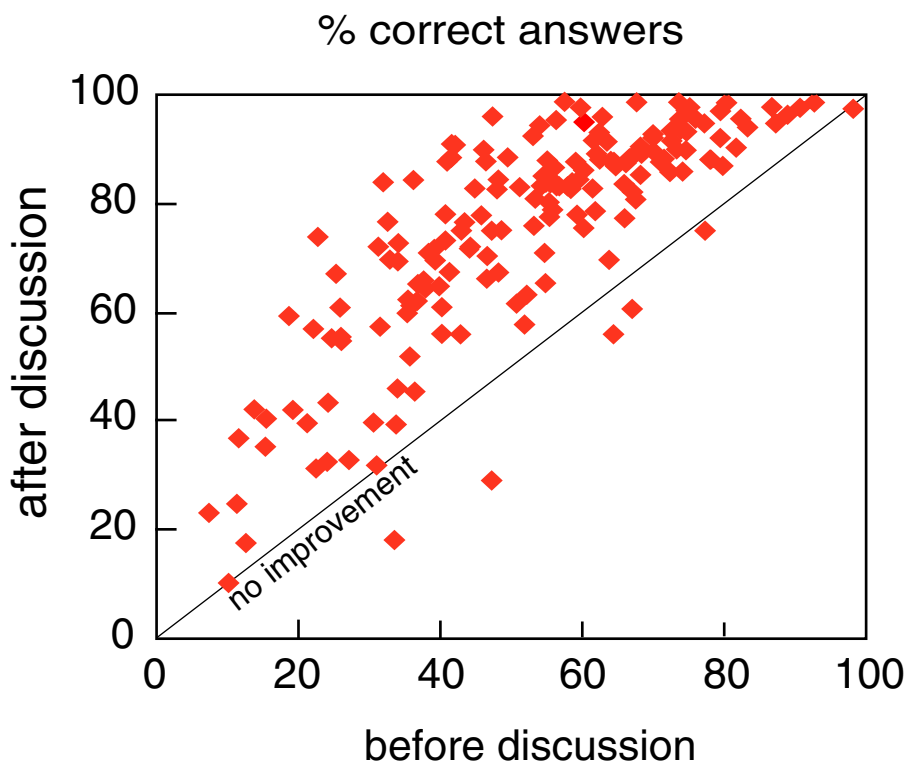

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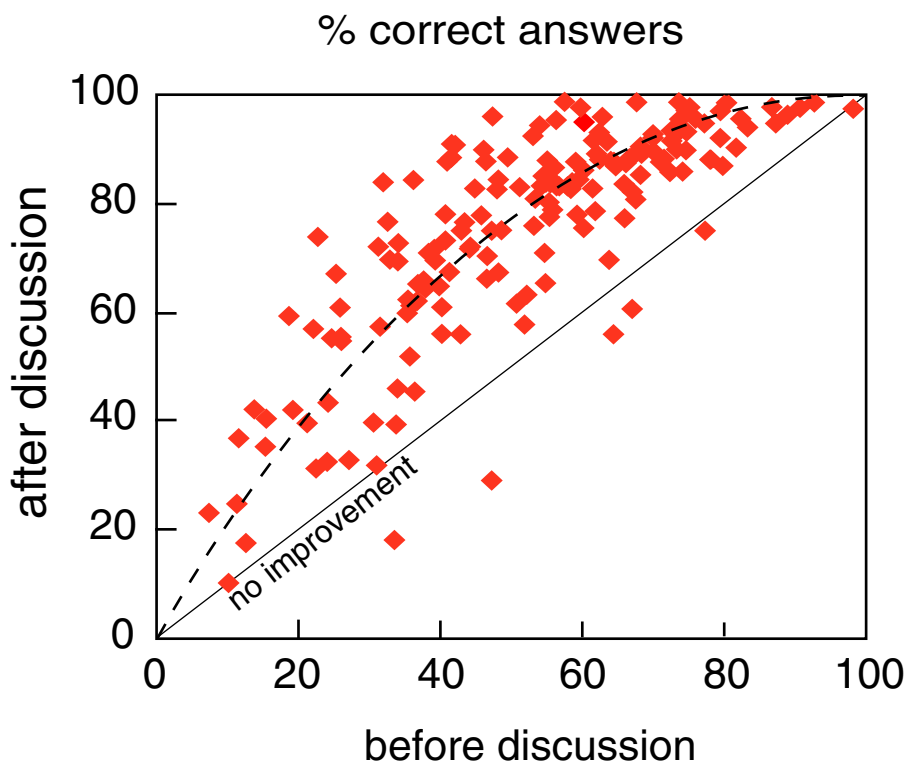

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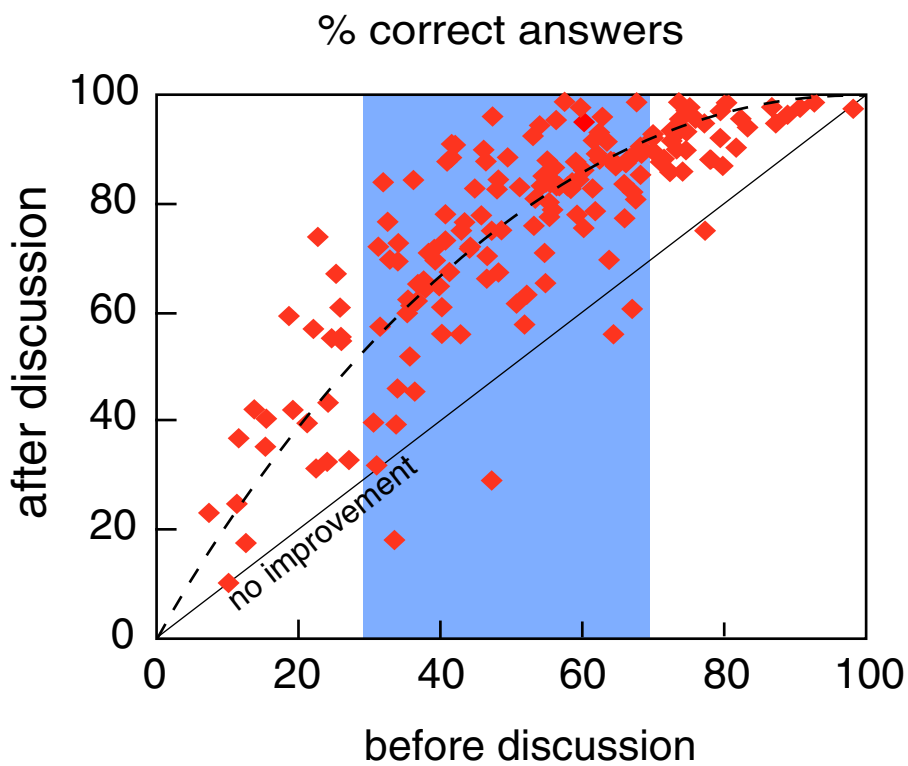
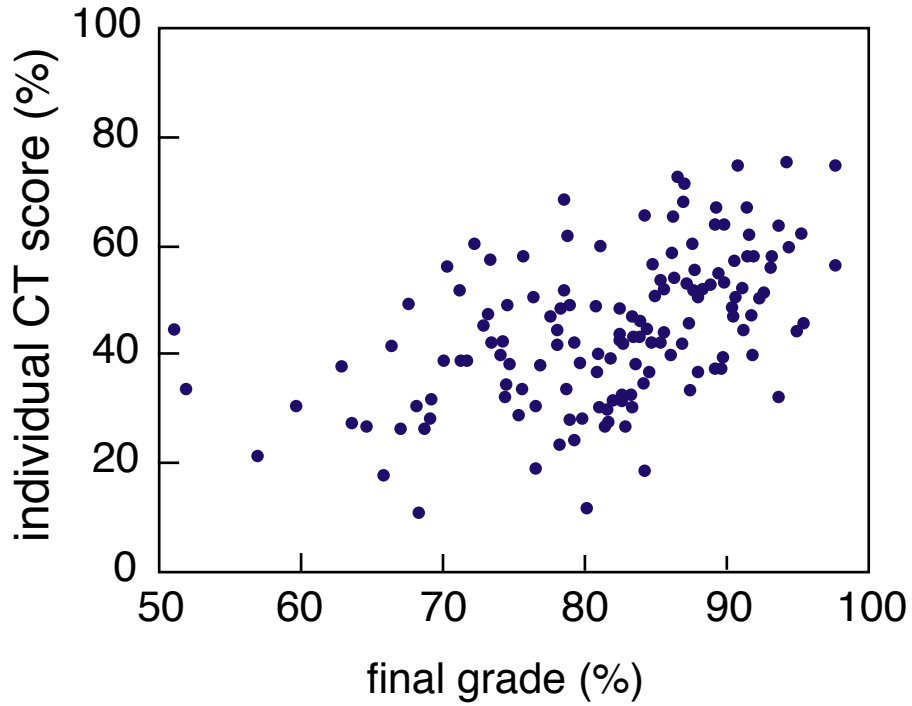


Research: providing the basis for change

who benefits from the ConcepTests?



Research: providing the basis for change

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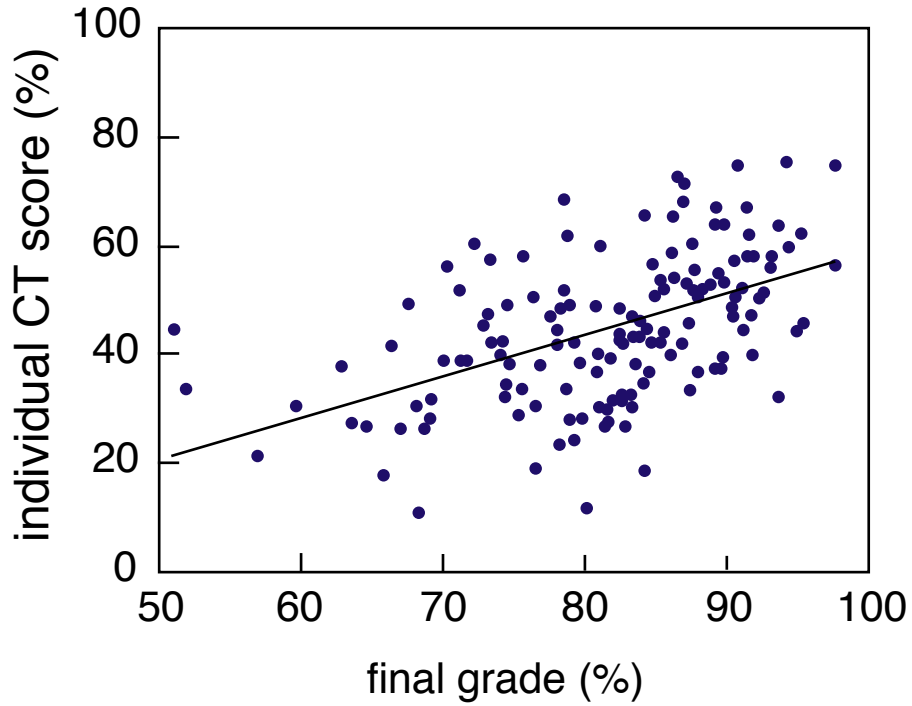
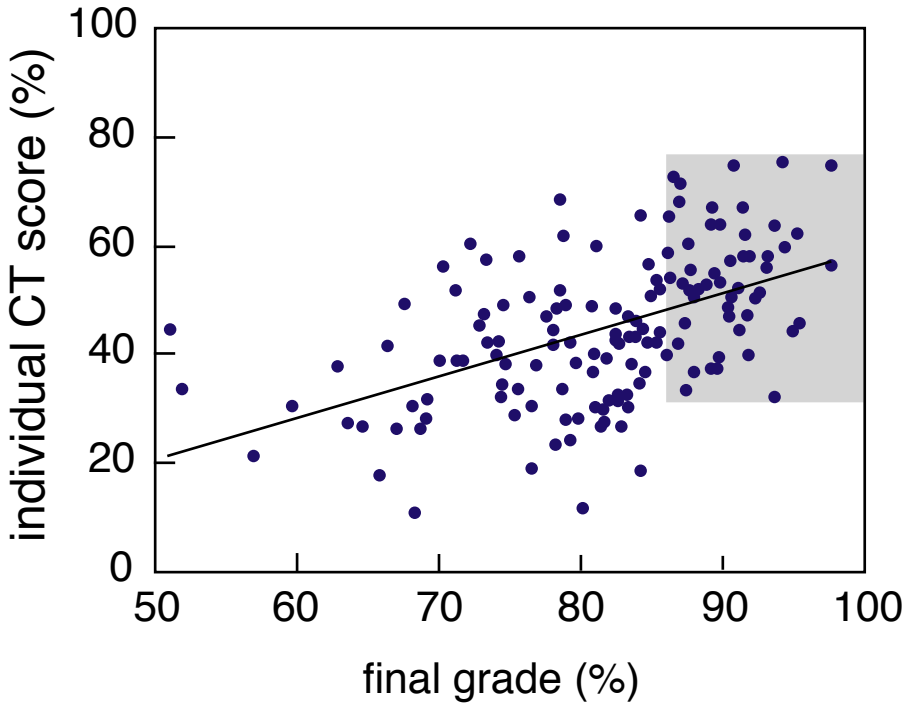


Research: providing the basis for change

even the best students are challenged



Research: providing the basis for change

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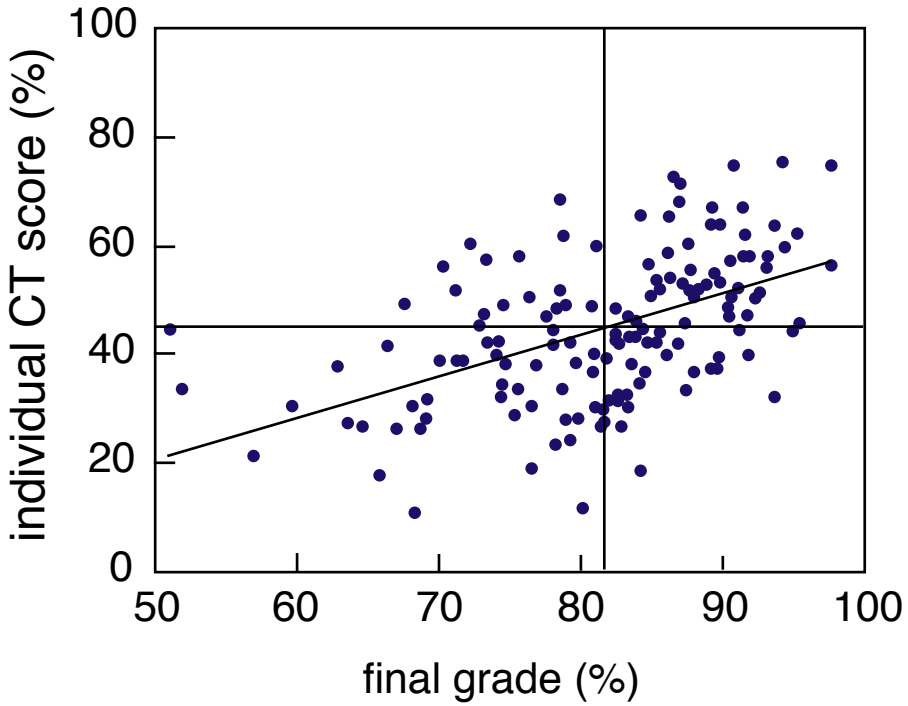

Problems with problems

On a Saturday afternoon, you pull into a parking lot with unmetered spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

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Requires:

Assumptions
Developing a model
Applying that model

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Requires:

Applying a (new) model

Problems with problems

On a Saturday afternoon, you pull into a parking lot with unmetered spaces near a shopping area, where people are know to shop, on average, for 2 hours. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

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Requires:

Using a calculator

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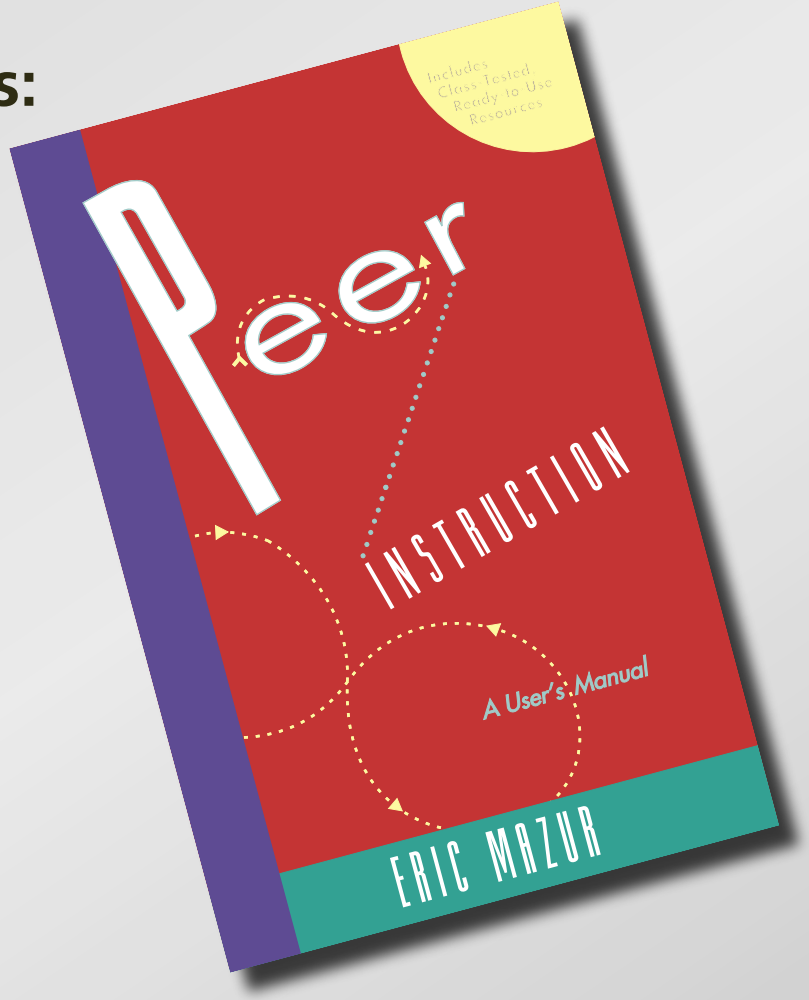
Resources

Books with ConcepTests:

- **Physics (Prentice Hall)**



Resources

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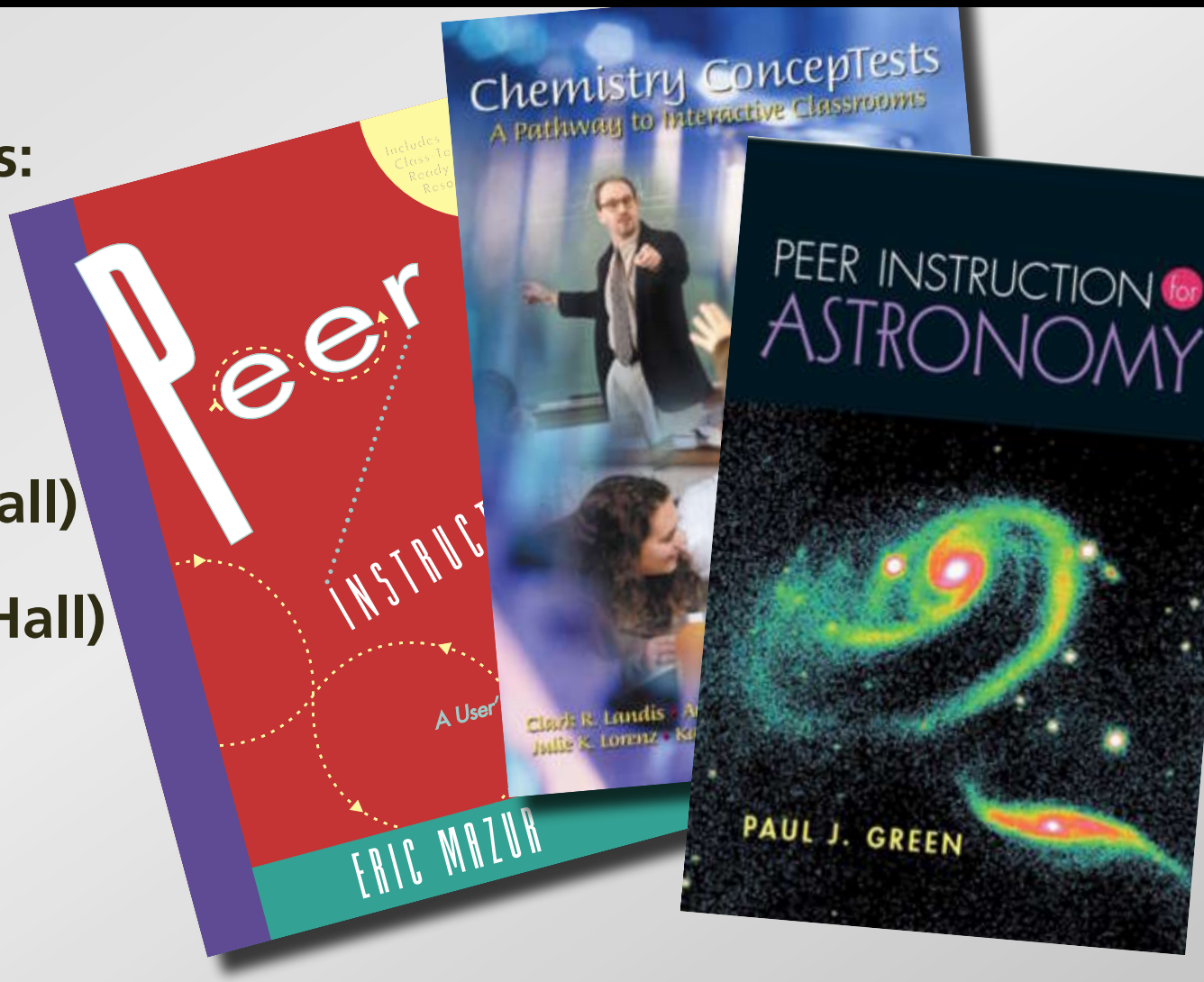
- **Chemistry (Prentice Hall)**
- **Astronomy (Prentice Hall)**



Resources

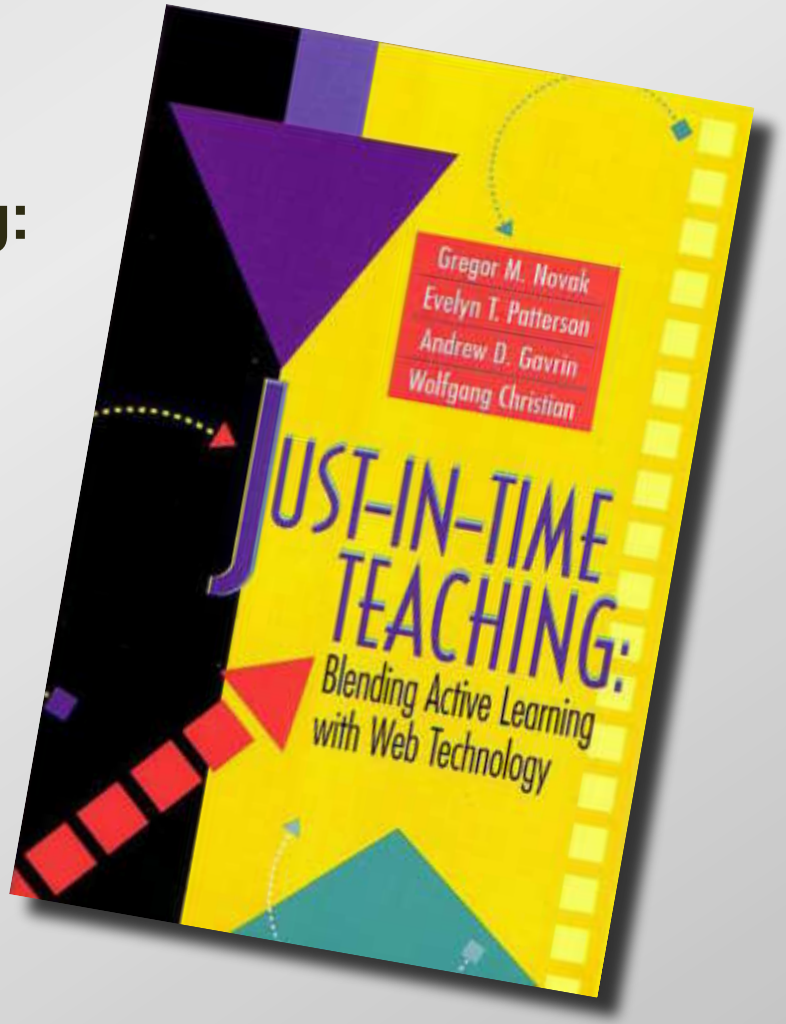
Books with ConcepTests:

- **Physics (Prentice Hall)**
- **Chemistry (Prentice Hall)**
- **Astronomy (Prentice Hall)**
- **Calculus (Wiley)**

Resources

Information on Just-in-Time-Teaching:

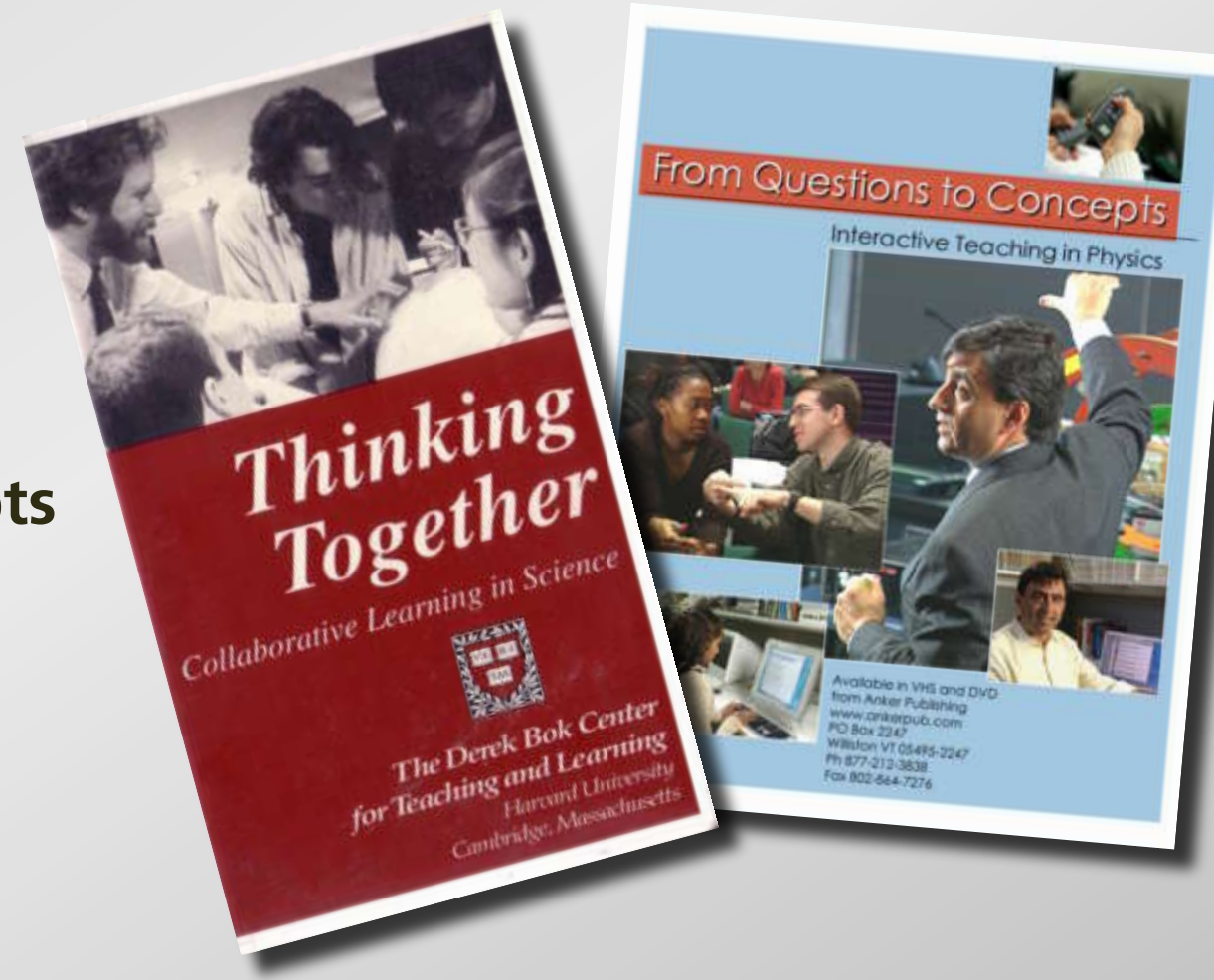
- Prentice Hall book
- http://www.jitt.org



Resources

Videos:

- **Thinking together**
- **From questions to concepts**

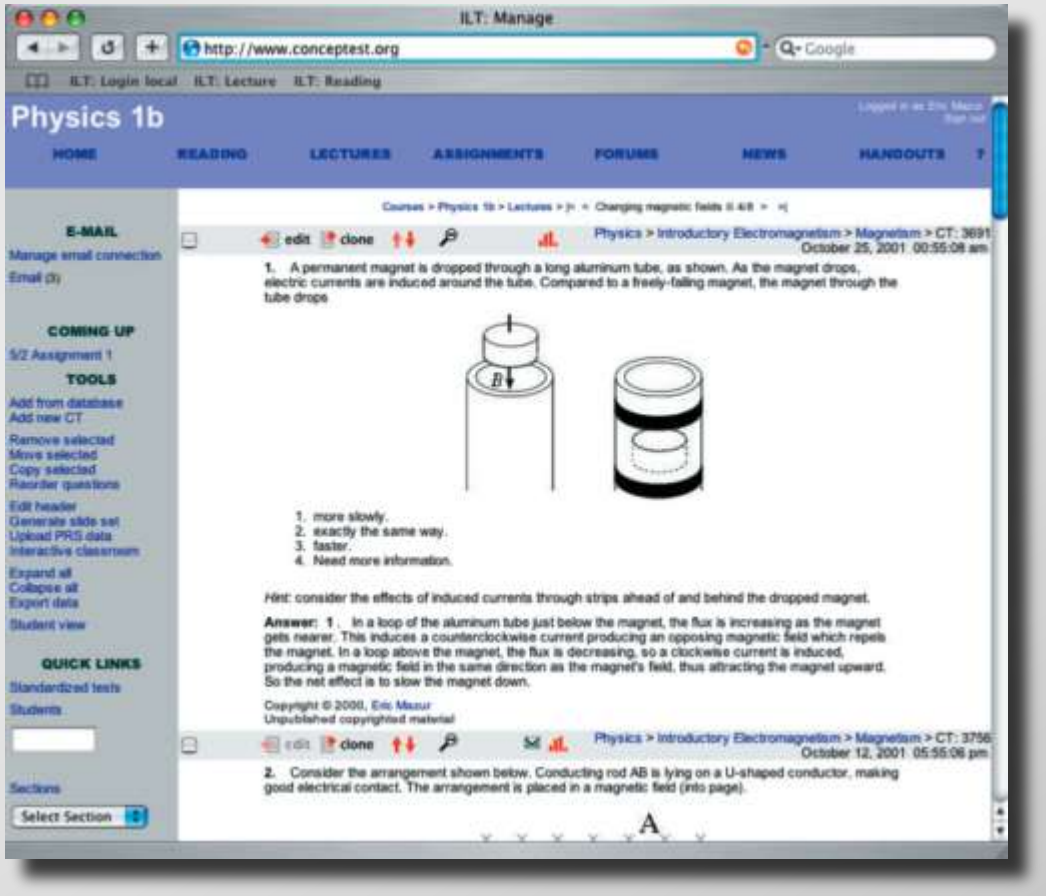


http://www.ankerpub.com

Resources

Course management:

http://deas.harvard.edu/ilt



Barriers to reform

Challenges:

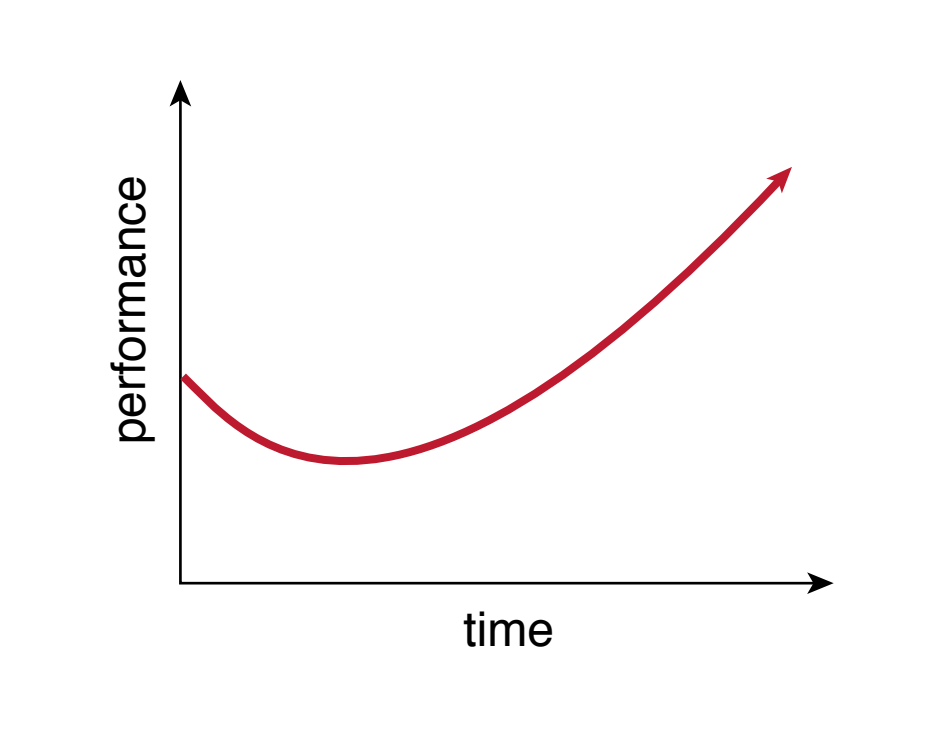
- skepticism
- growing pains
- limited circle of influence

Barriers to reform

Two things to watch out for

Barriers to reform

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



Barriers to reform

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

(must recognize confusion as step towards understanding)

Barriers to reform

Things to do:

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

Funding:

National Science Foundation

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