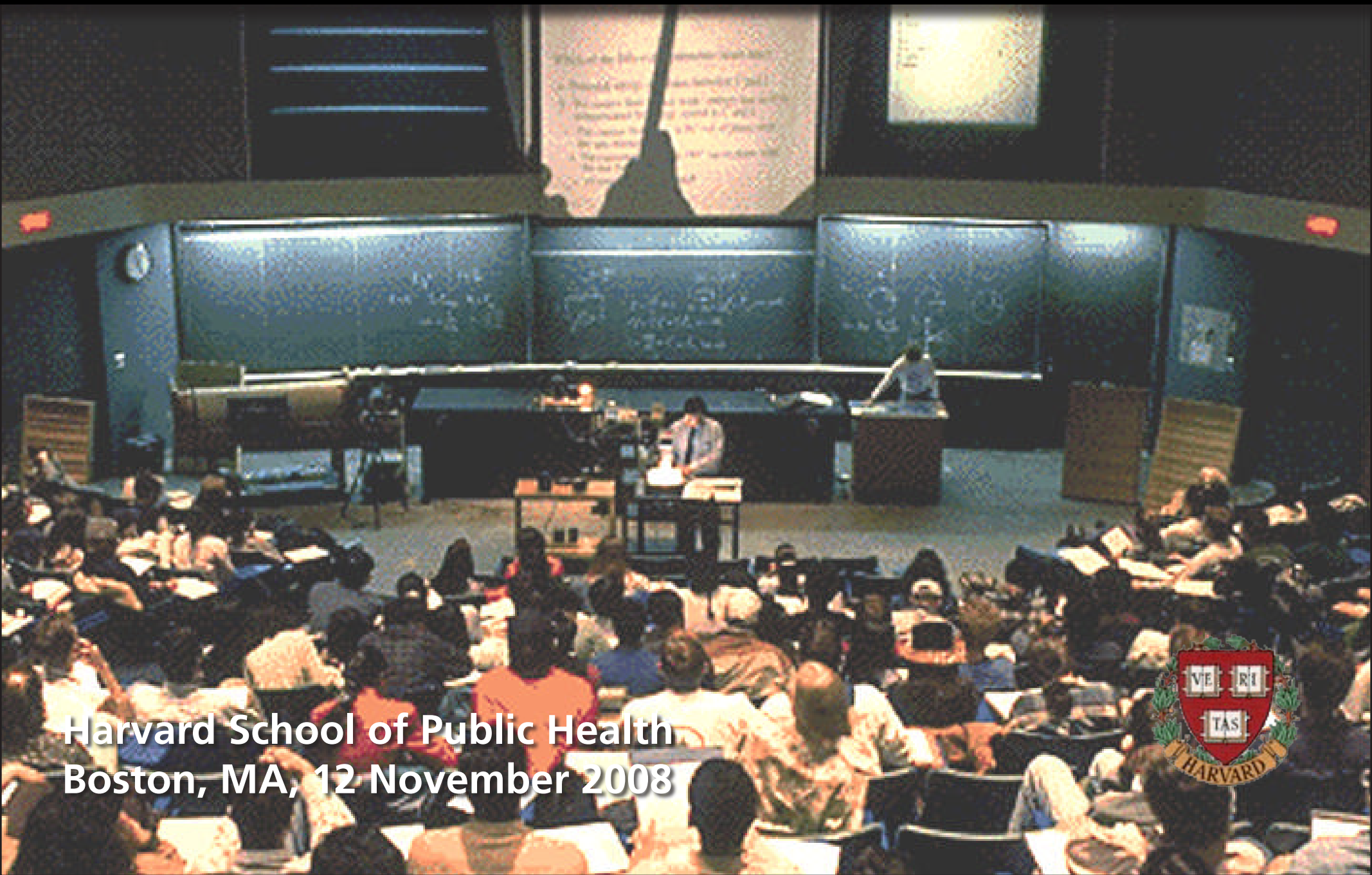
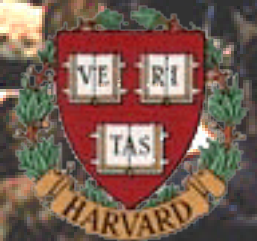


# Active learning in YOUR classroom

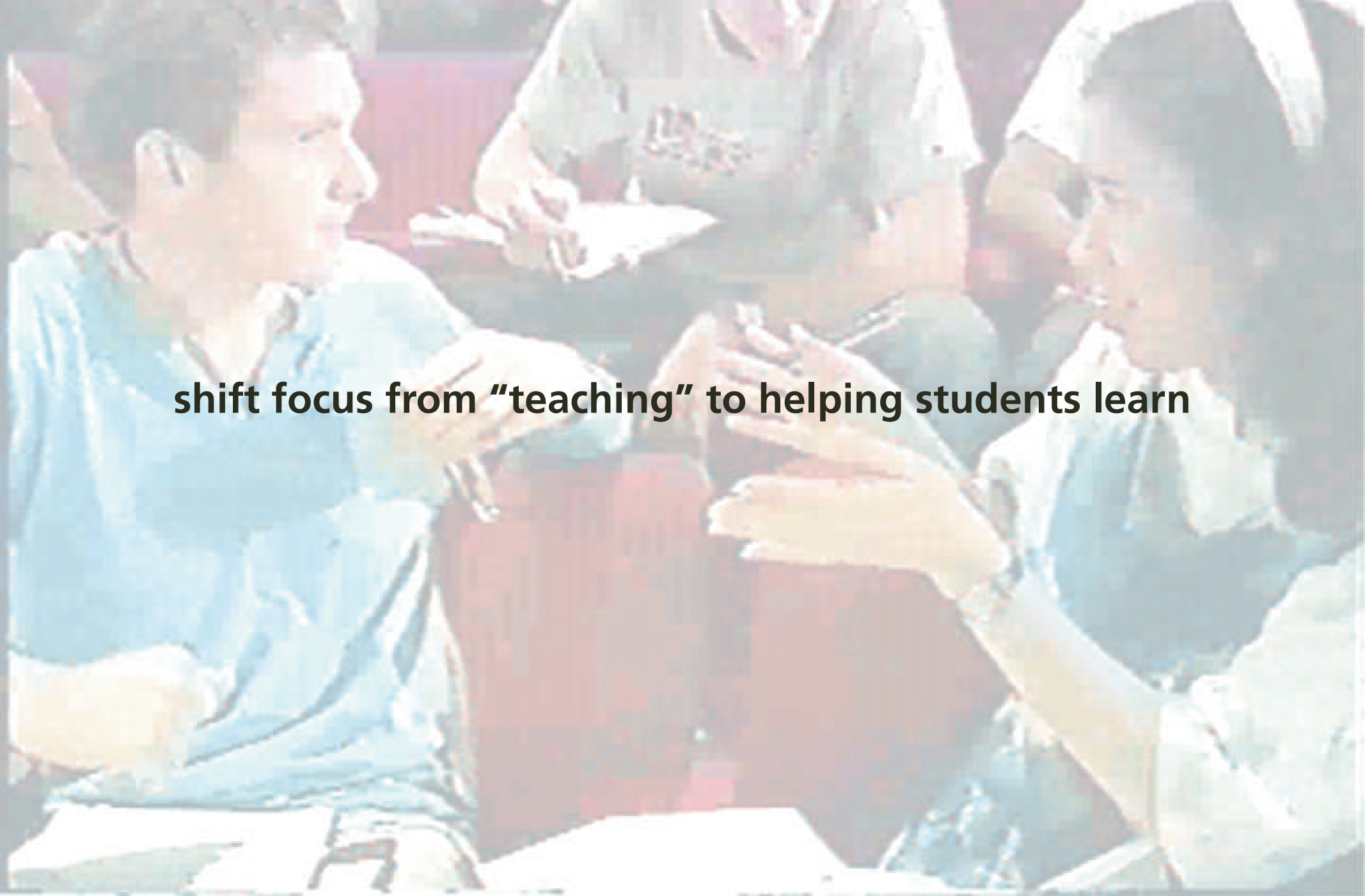


Harvard School of Public Health  
Boston, MA, 12 November 2008



# My message

**shift focus from “teaching” to helping students learn**



# Outline

- Education



# Outline

- Education
- Peer Instruction



# Outline

- Education
- Peer Instruction
- Results

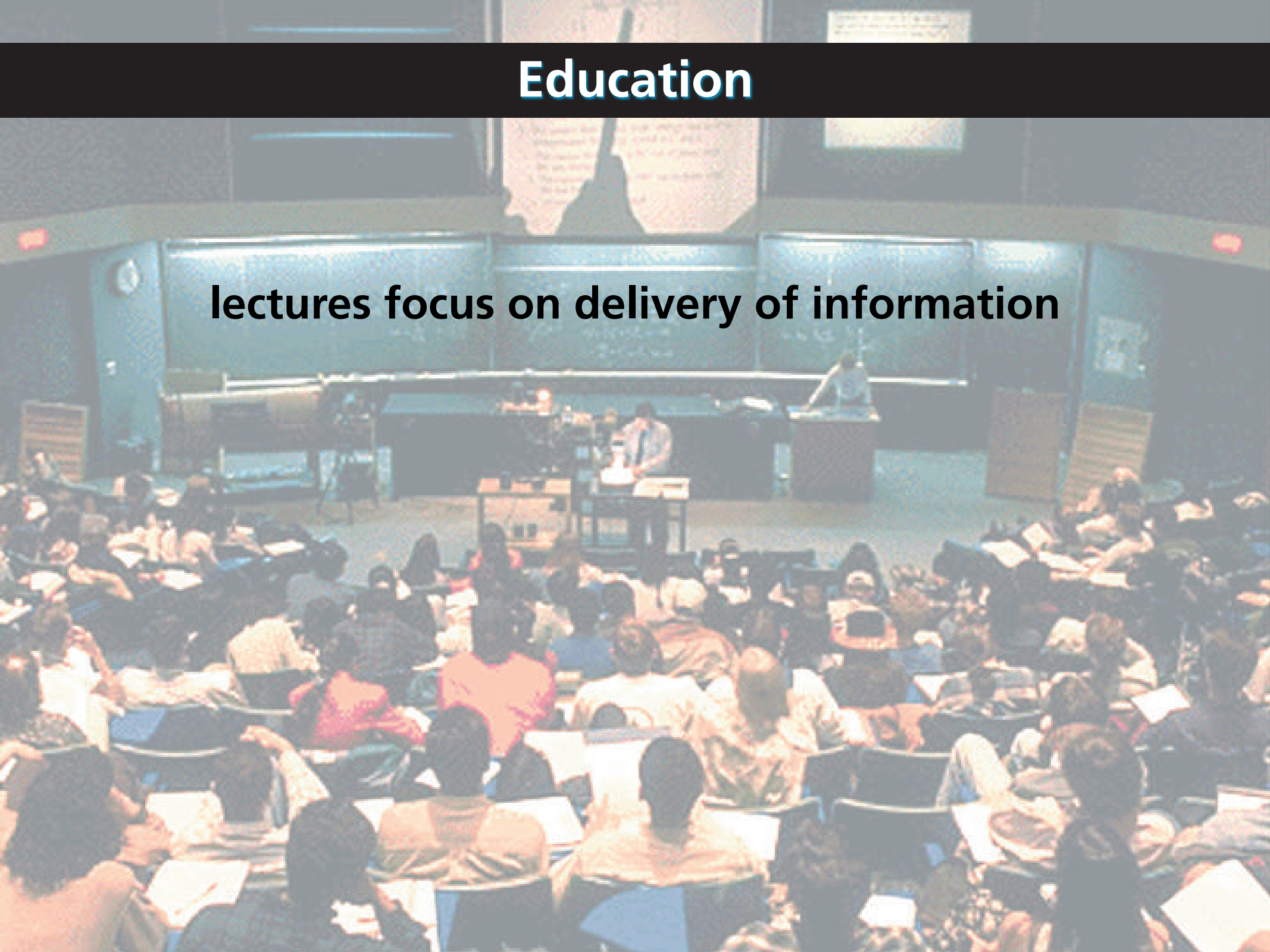


# Education



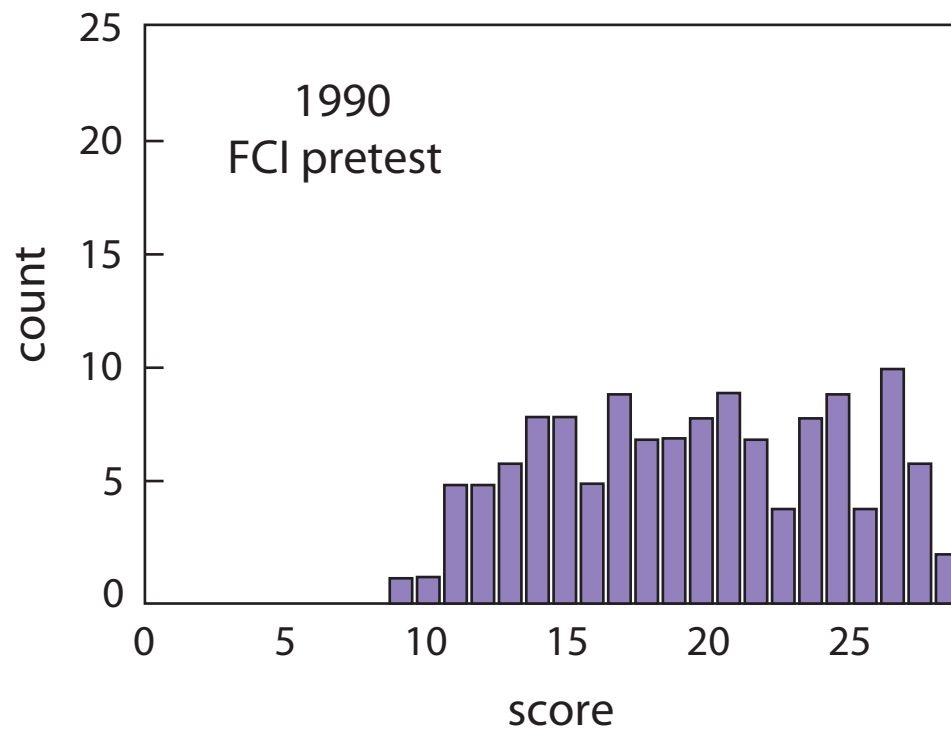
# Education

lectures focus on delivery of information



# Education

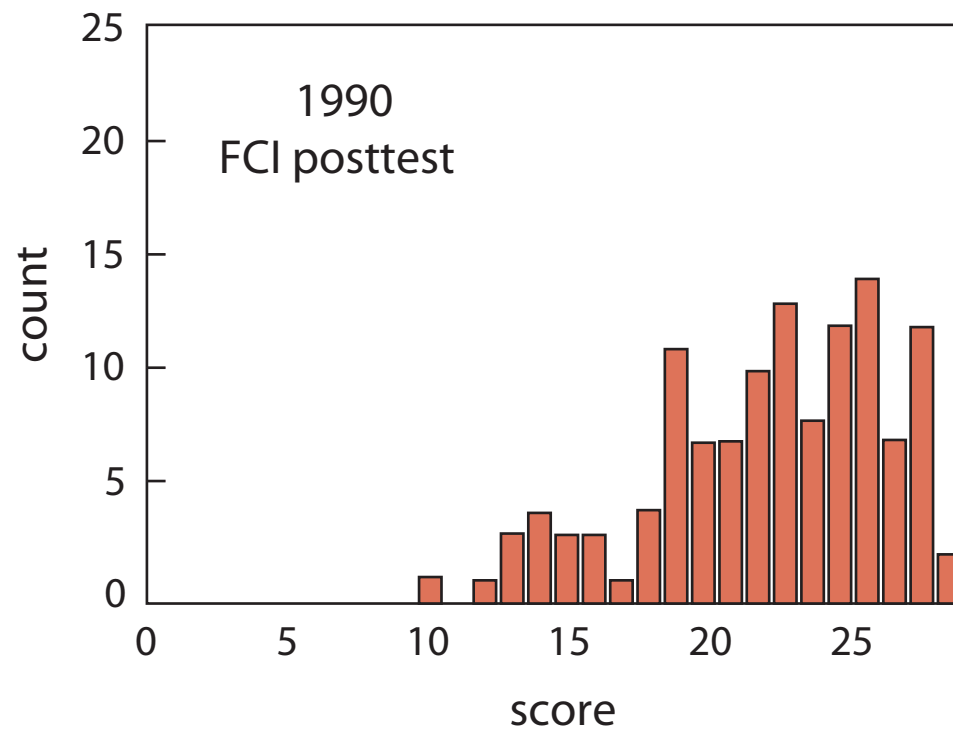
education is not just information transfer





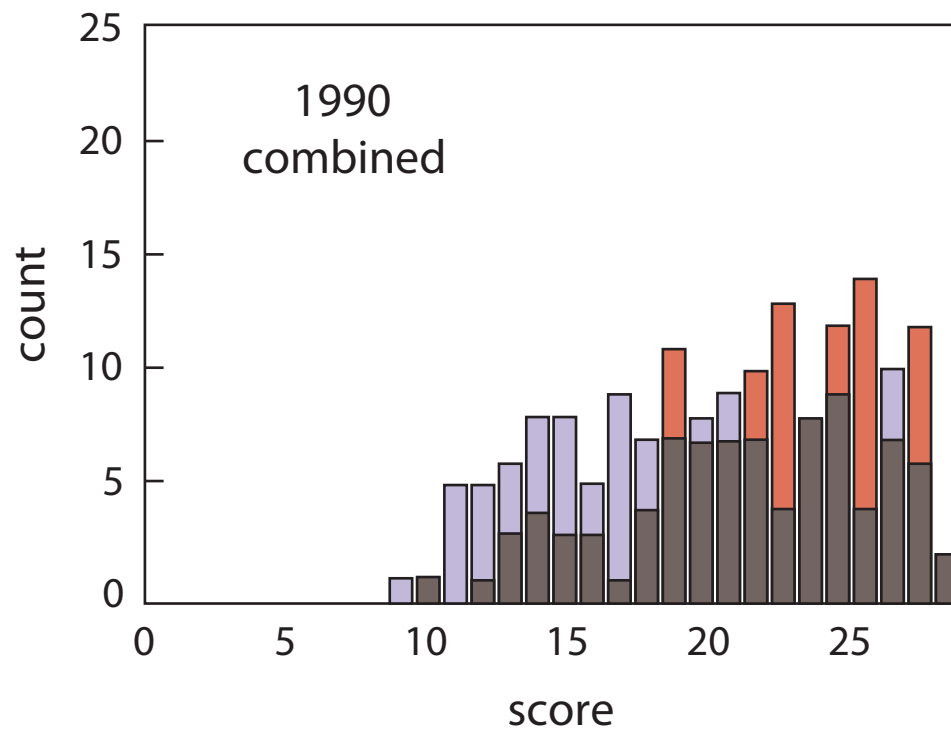
# Education

education is not just information transfer

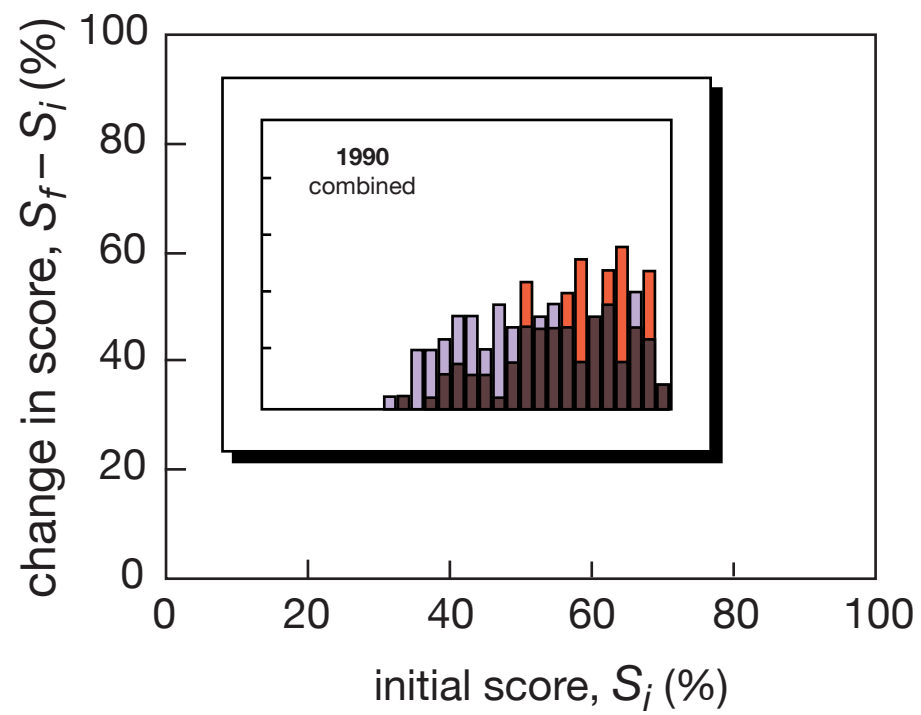


# Education

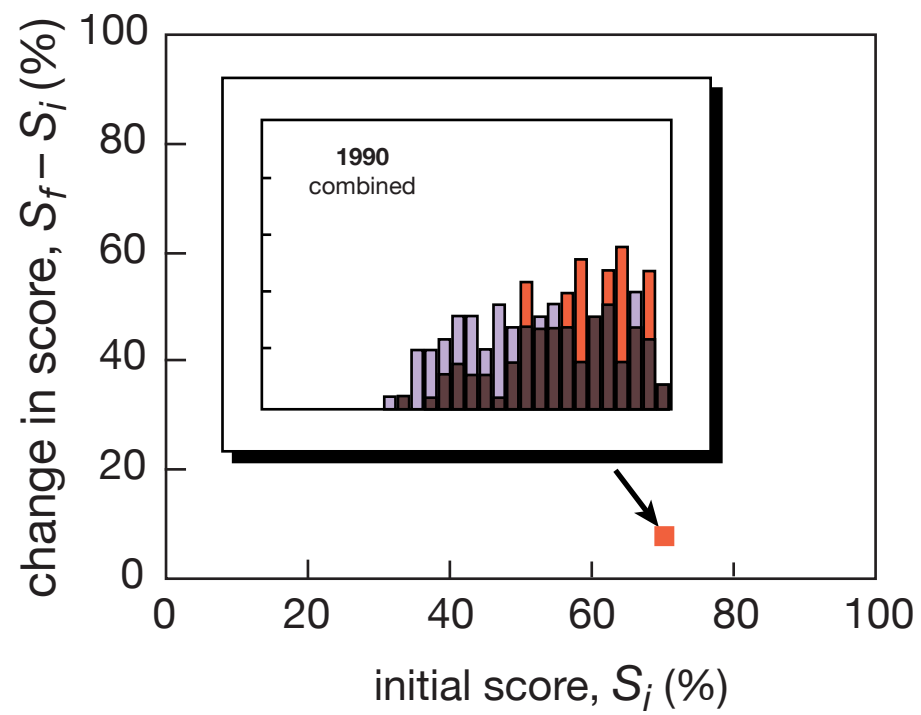
education is not just information transfer



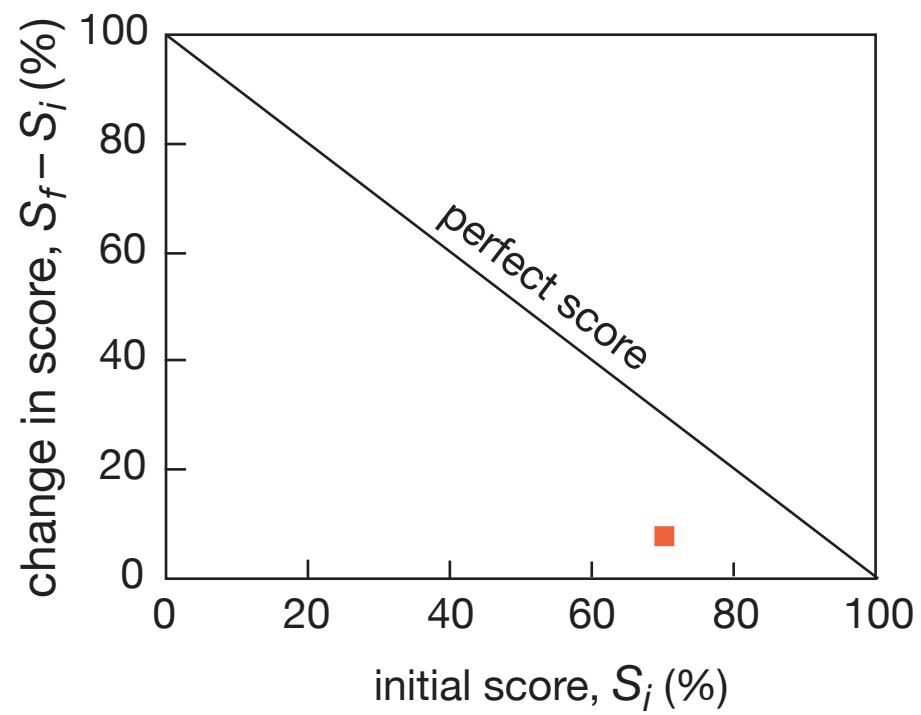
# Education



# Education

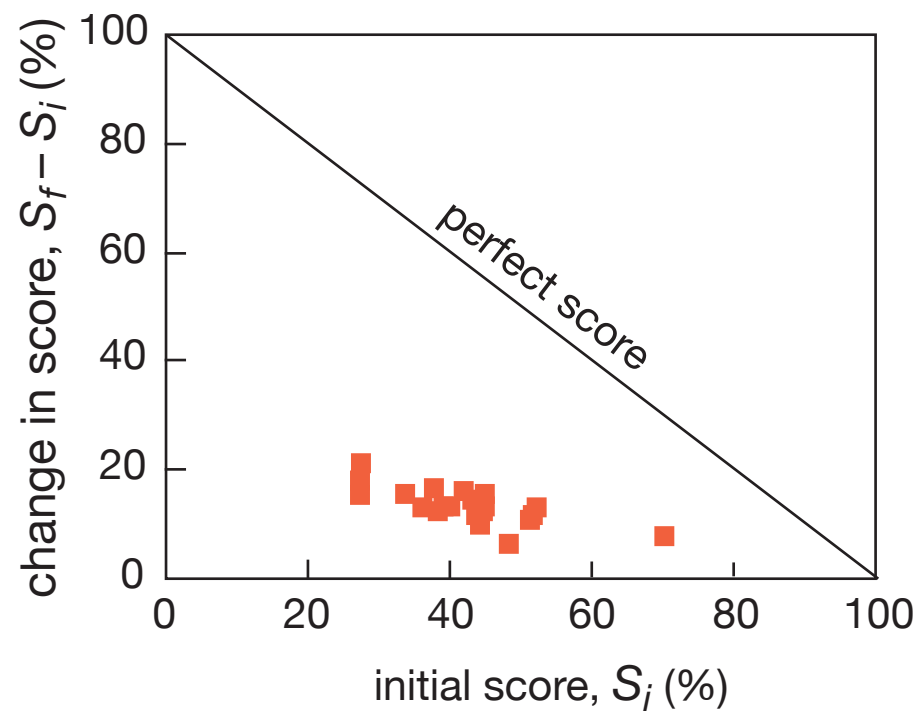


# Education



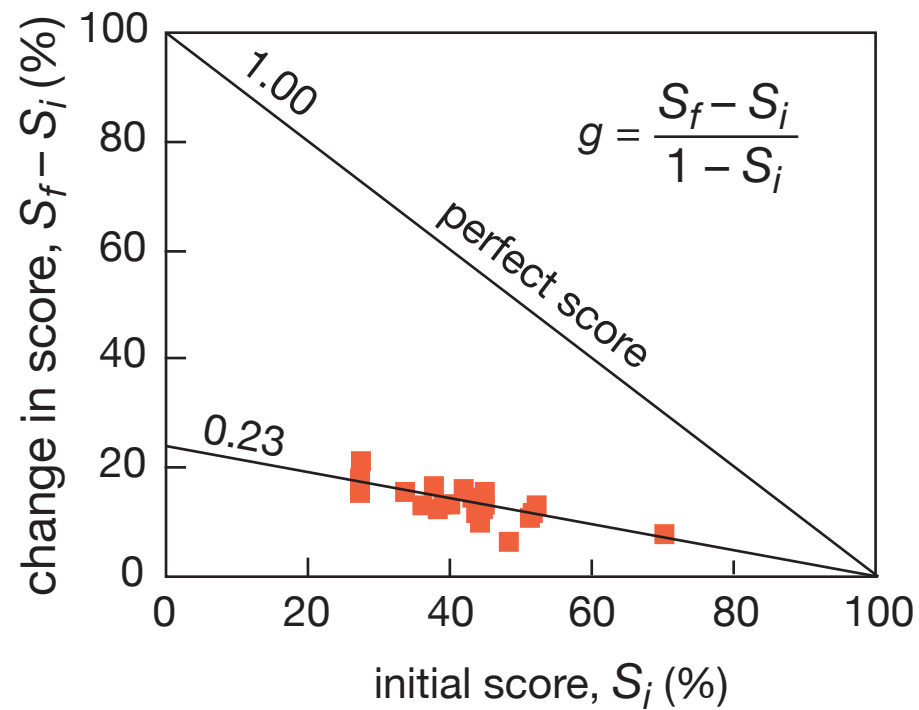


# Education



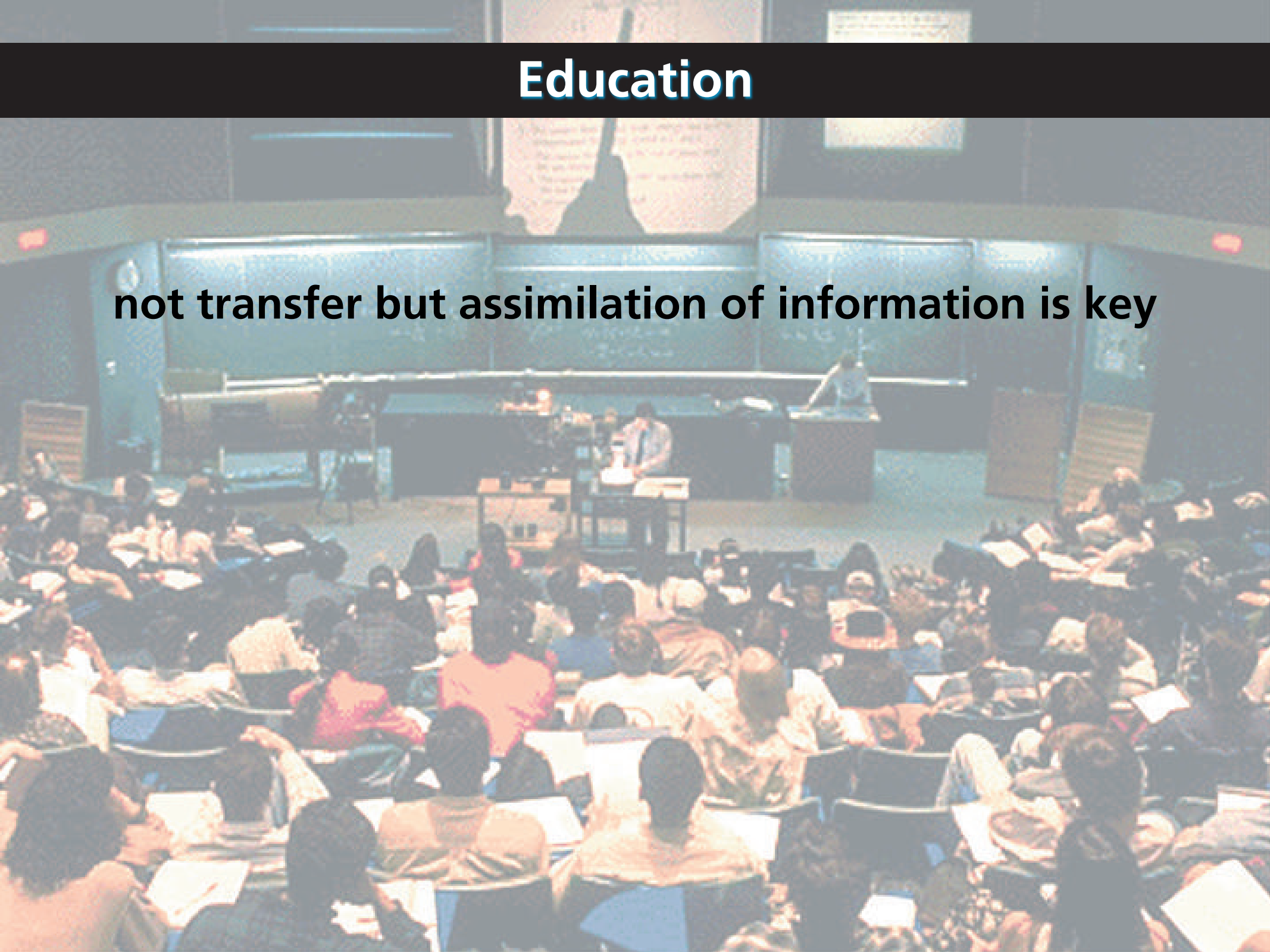
# Education

only one quarter of maximum gain realized



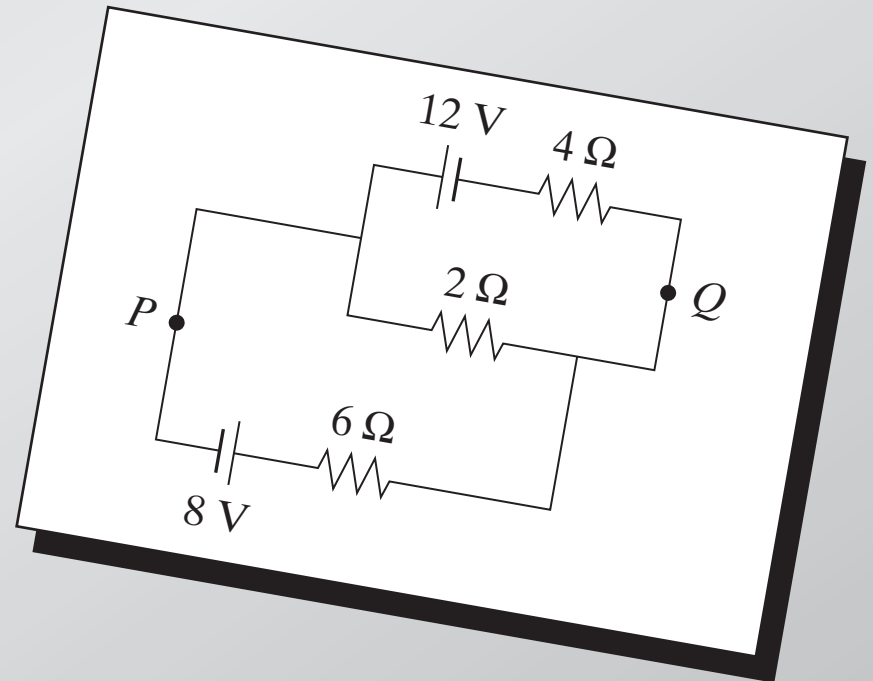
# Education

**not transfer but assimilation of information is key**



# Education

conventional problems misleading



# Education

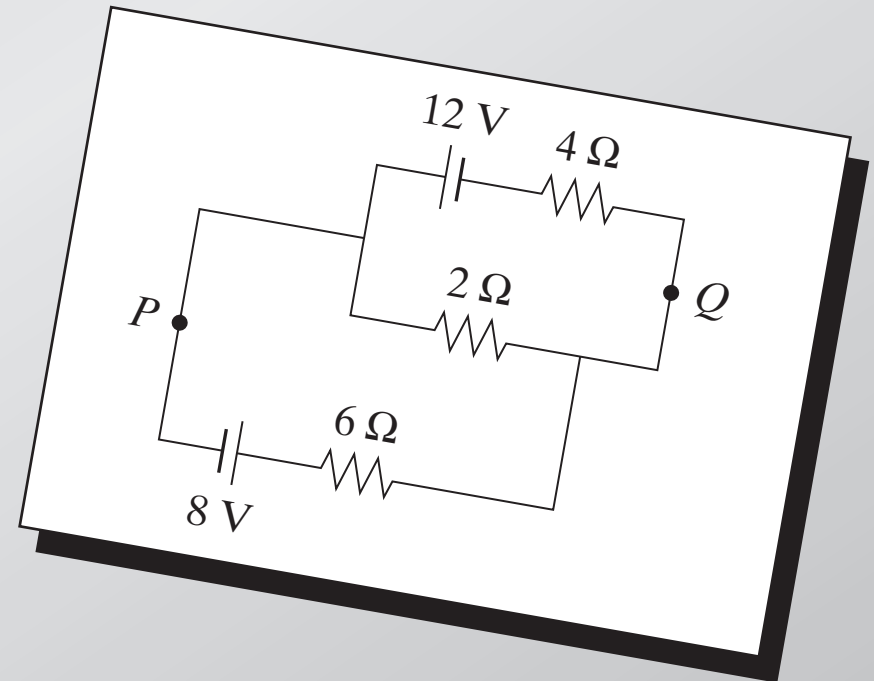
conventional problems misleading

Calculate:

(a) current in 2- $\Omega$  resistor

(b) potential difference

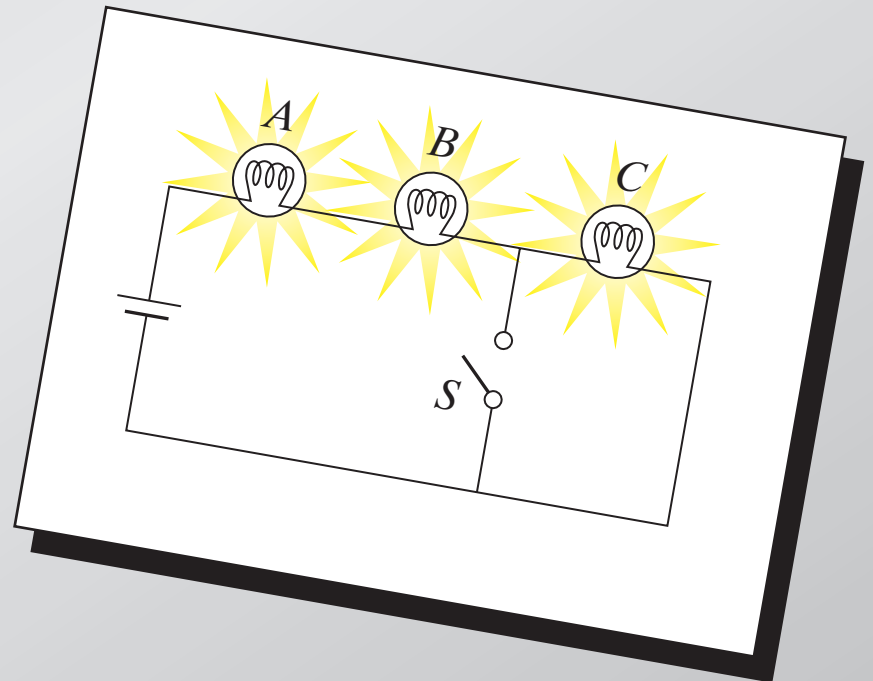
between  $P$  and  $Q$





# Education

are the basic principles understood?

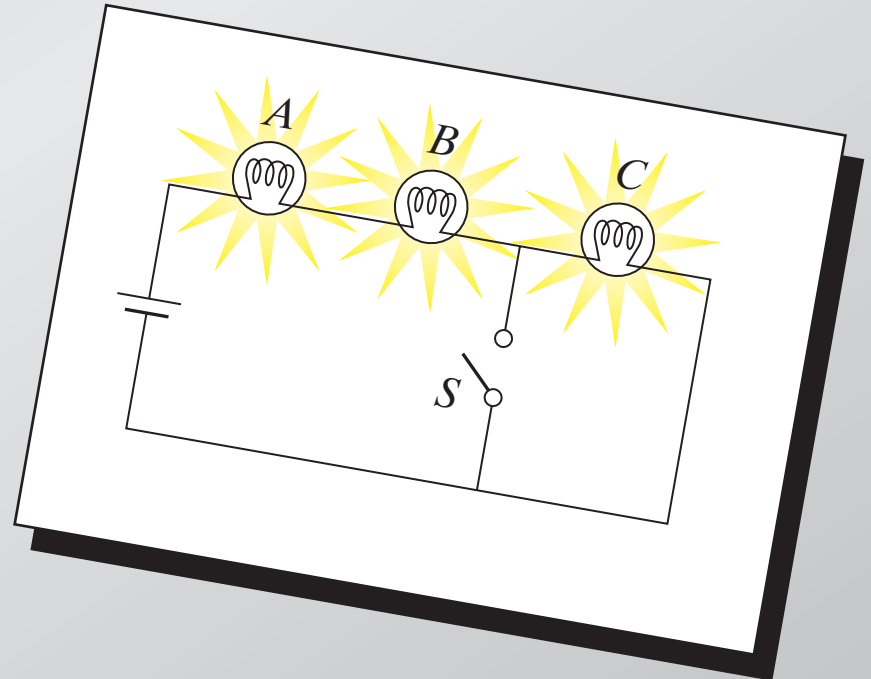


# Education

are the basic principles understood?

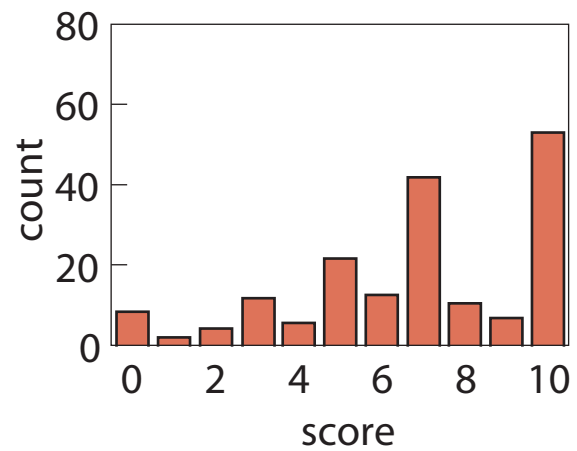
When  $S$  is closed, what happens to:

- (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?

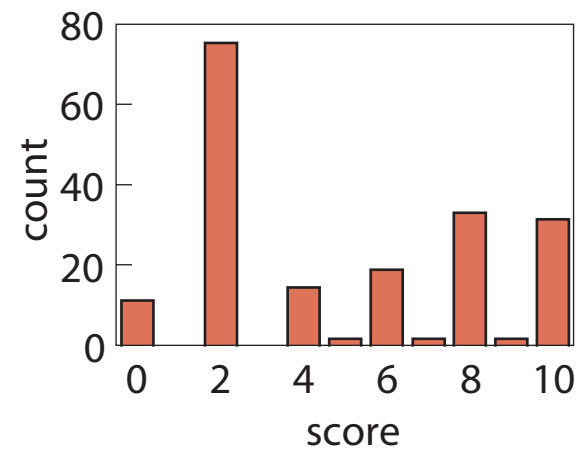


# Education

**conventional**

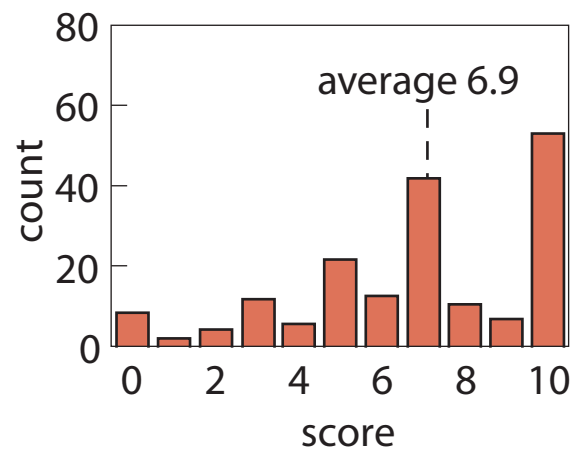


**conceptual**

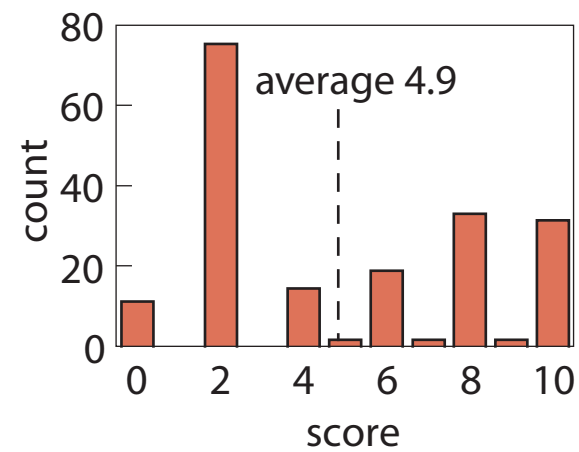


# Education

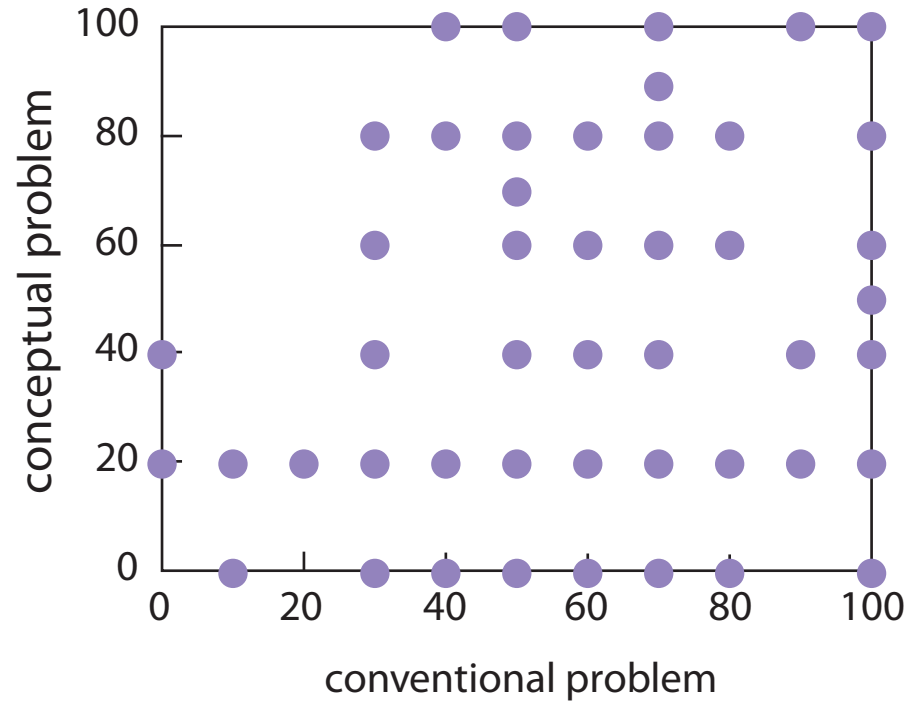
**conventional**



**conceptual**

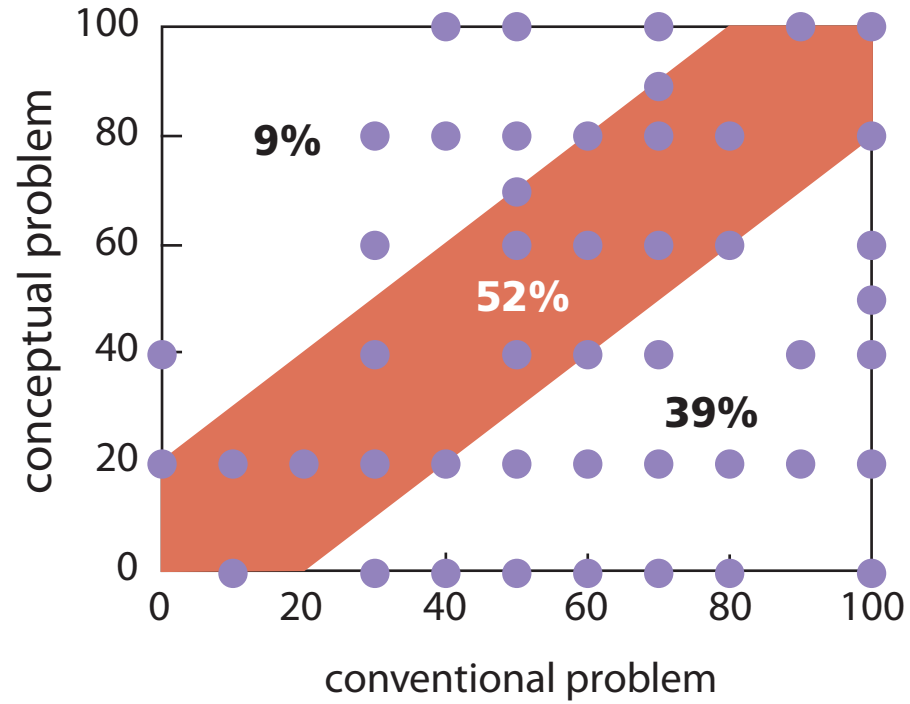


# Education





# Education



A wide-angle photograph of a large lecture hall. Students are seated in rows of desks, facing a stage. A lecturer is standing at a podium on the stage, facing the audience. A large screen is visible on the stage, displaying text. The text on the screen is partially legible and includes the phrase "So what should we do?".

So what should we do?

# Peer Instruction

**Give students more responsibility for gathering information...**

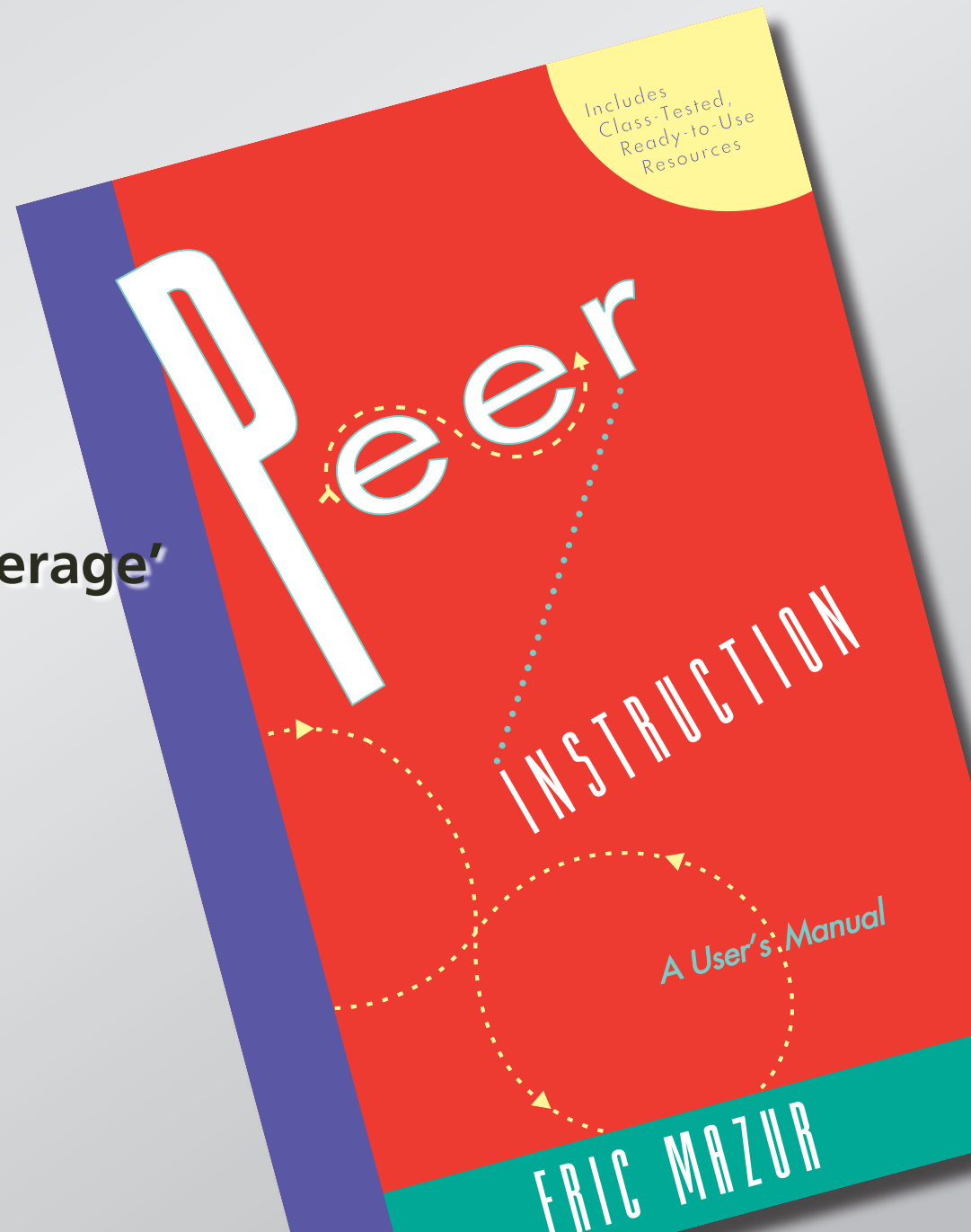
# Peer Instruction

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

# Peer Instruction

## 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**

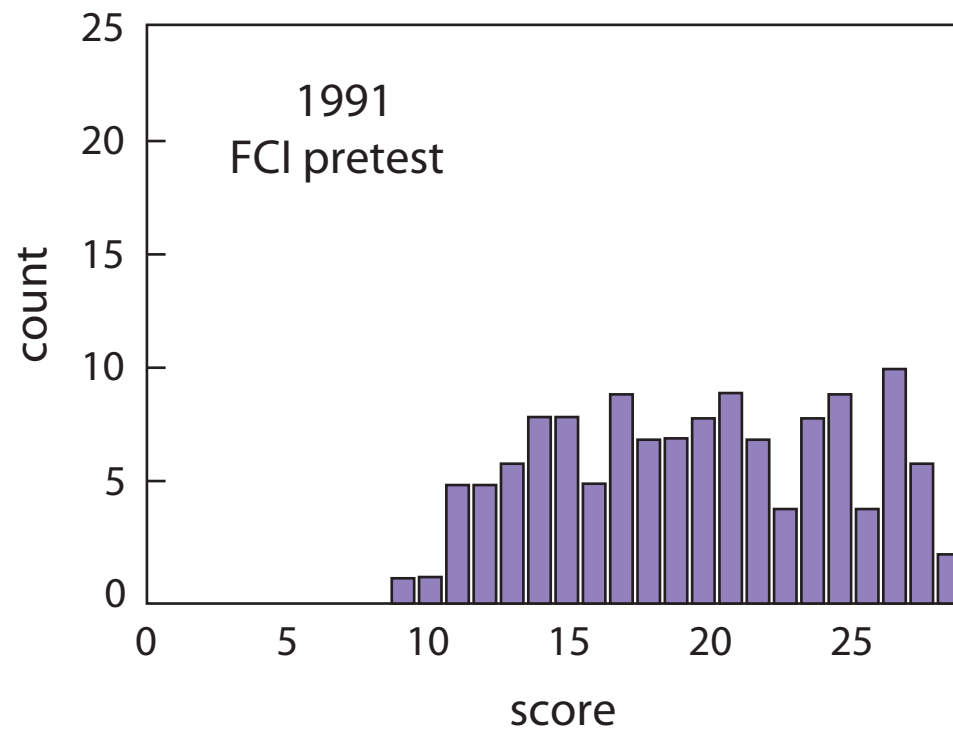


# Results

is it any good?

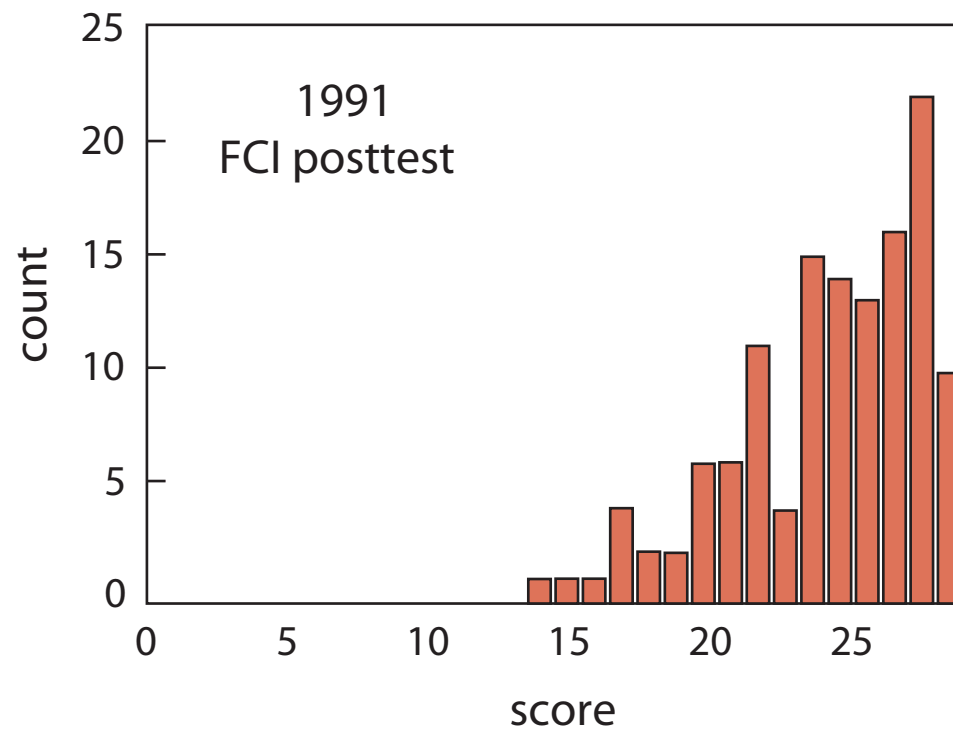
# Results

first year of implementing PI



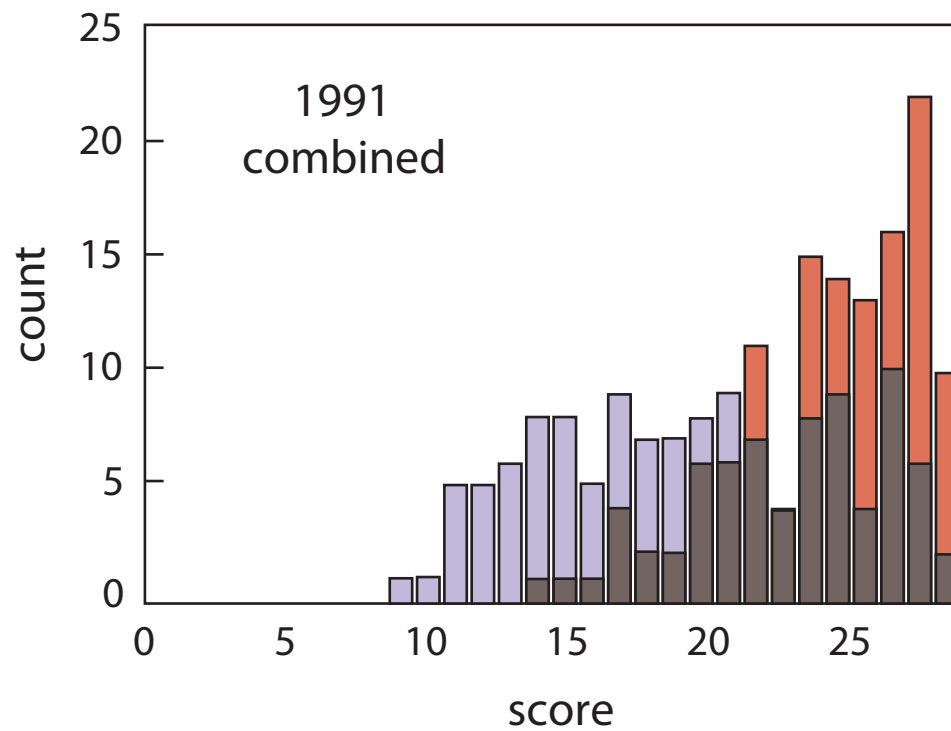
# Results

first year of implementing PI

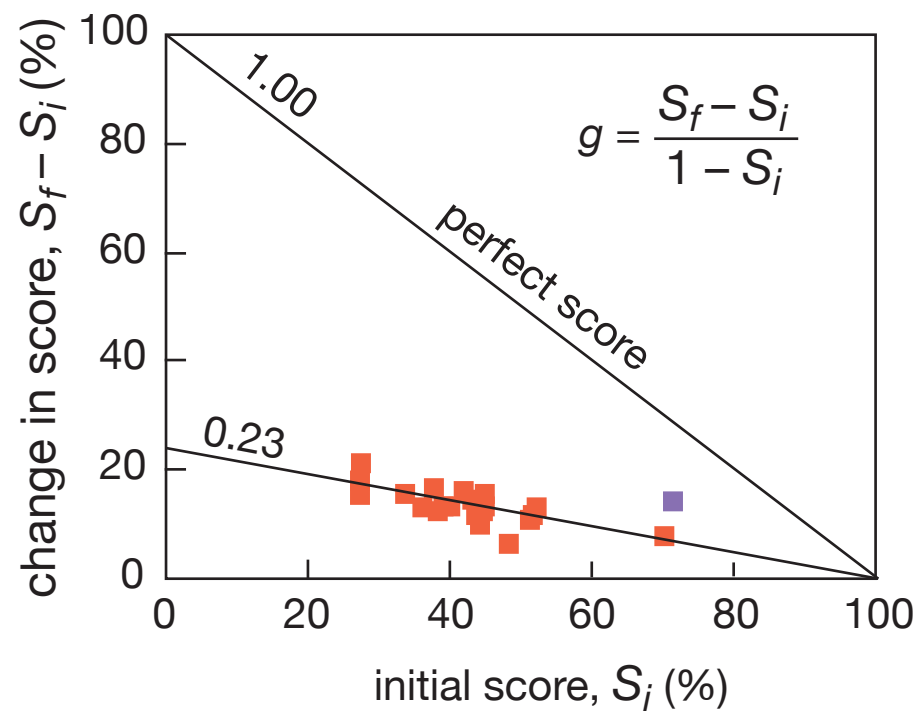


# Results

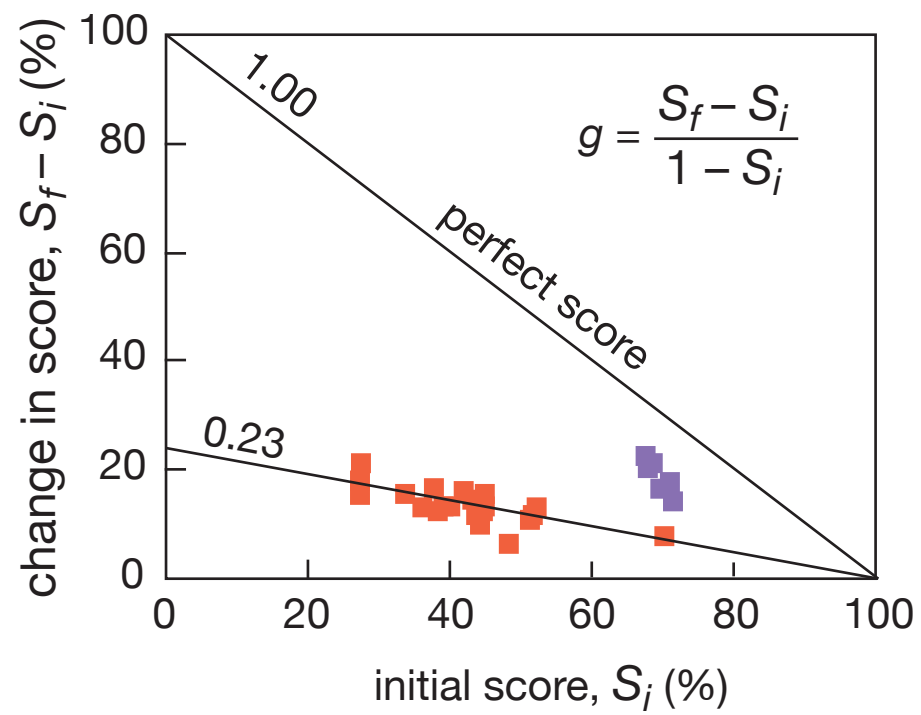
first year of implementing PI



# Results

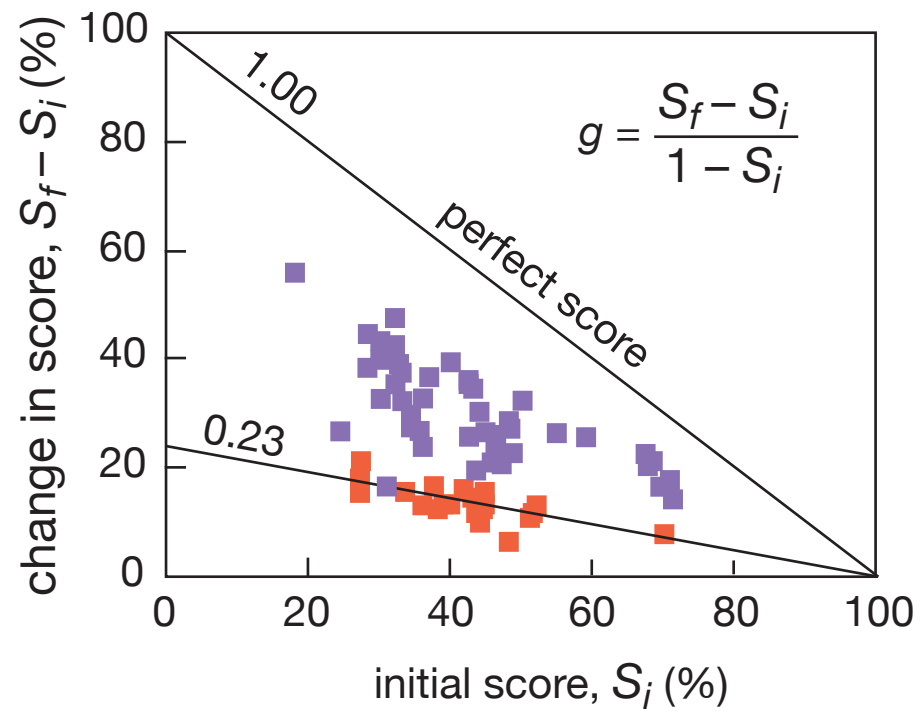


# Results

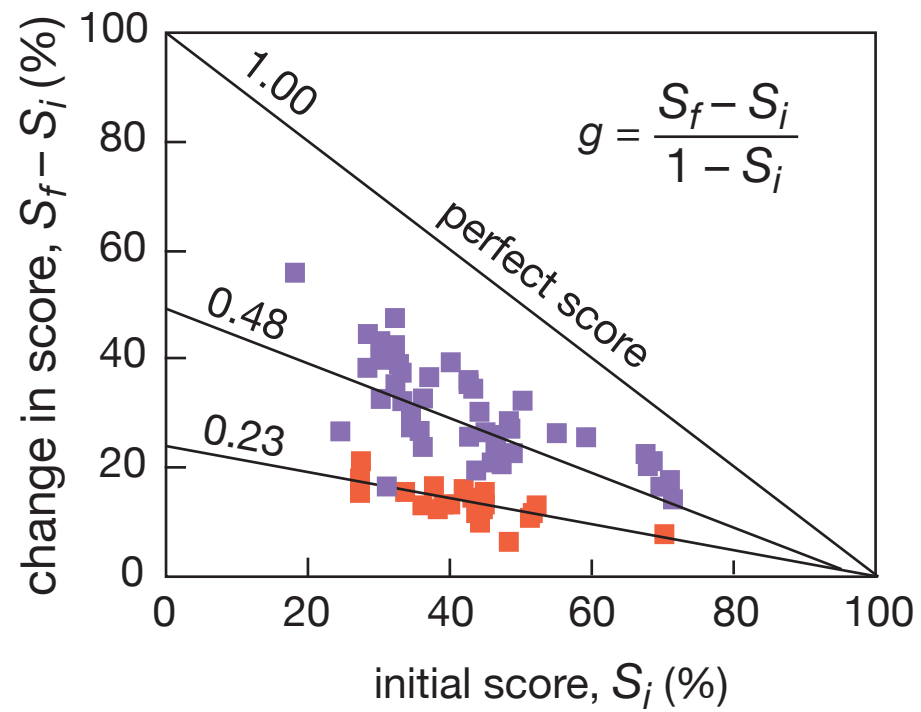




# Results



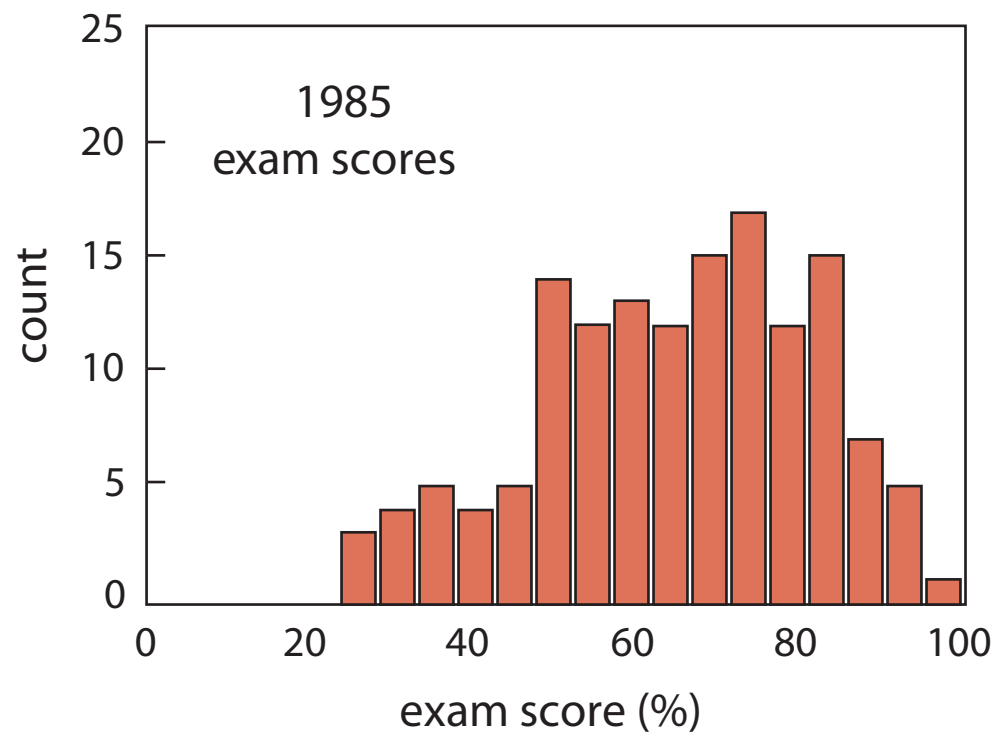
# Results



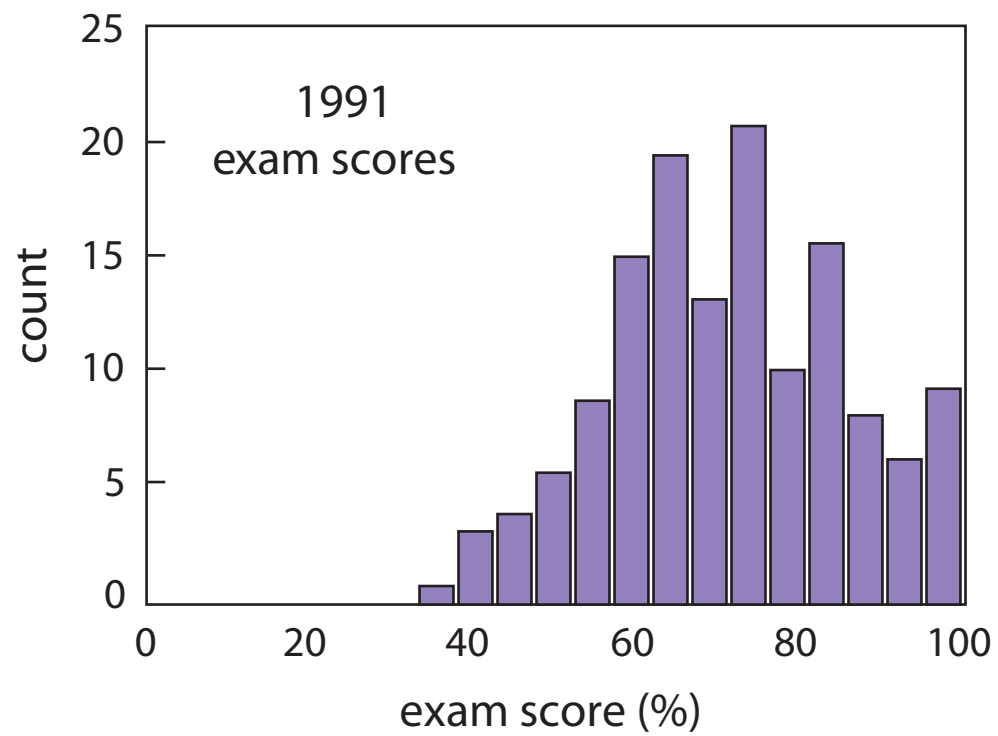
# Results

**what about problem solving?**

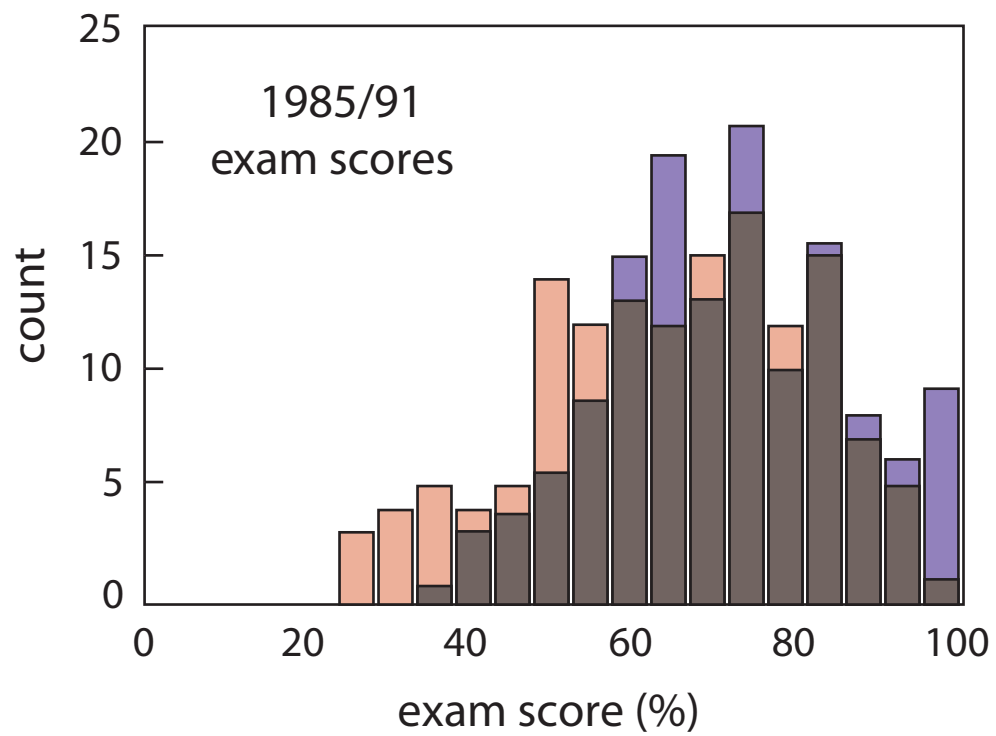
# Results



# Results



# Results



# 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!)**





**Funding:**

**National Science Foundation**

**for a copy of this presentation:**

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

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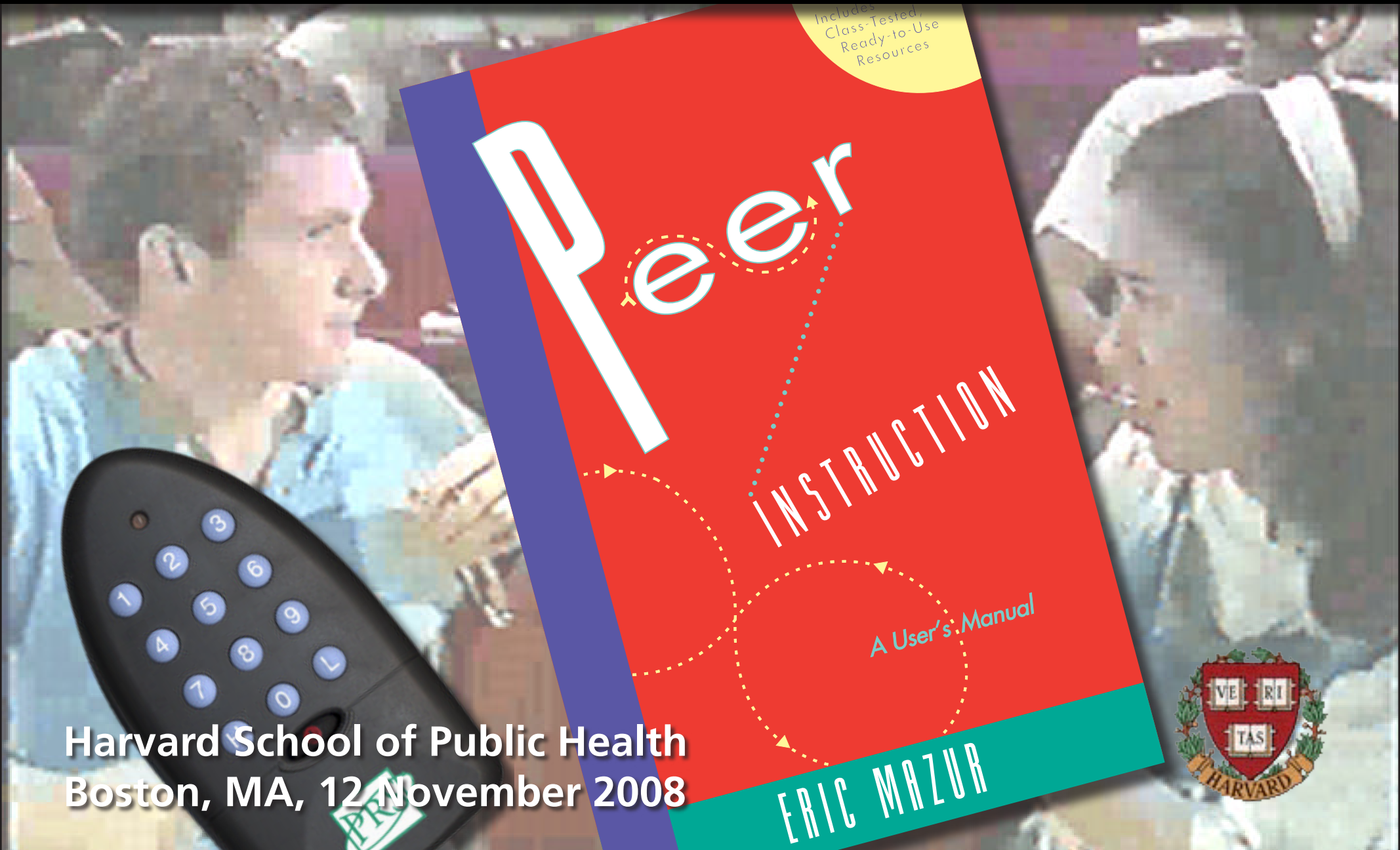
**Funding:**

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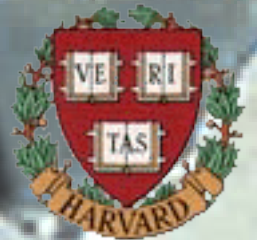
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# Peer Instruction Workshop



Harvard School of Public Health  
Boston, MA, 12 November 2008





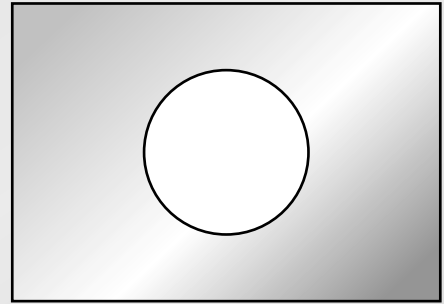
# Outline

**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.

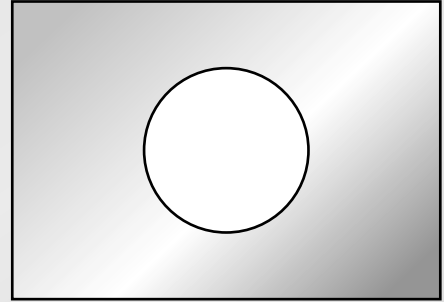


# Let's try it!

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.

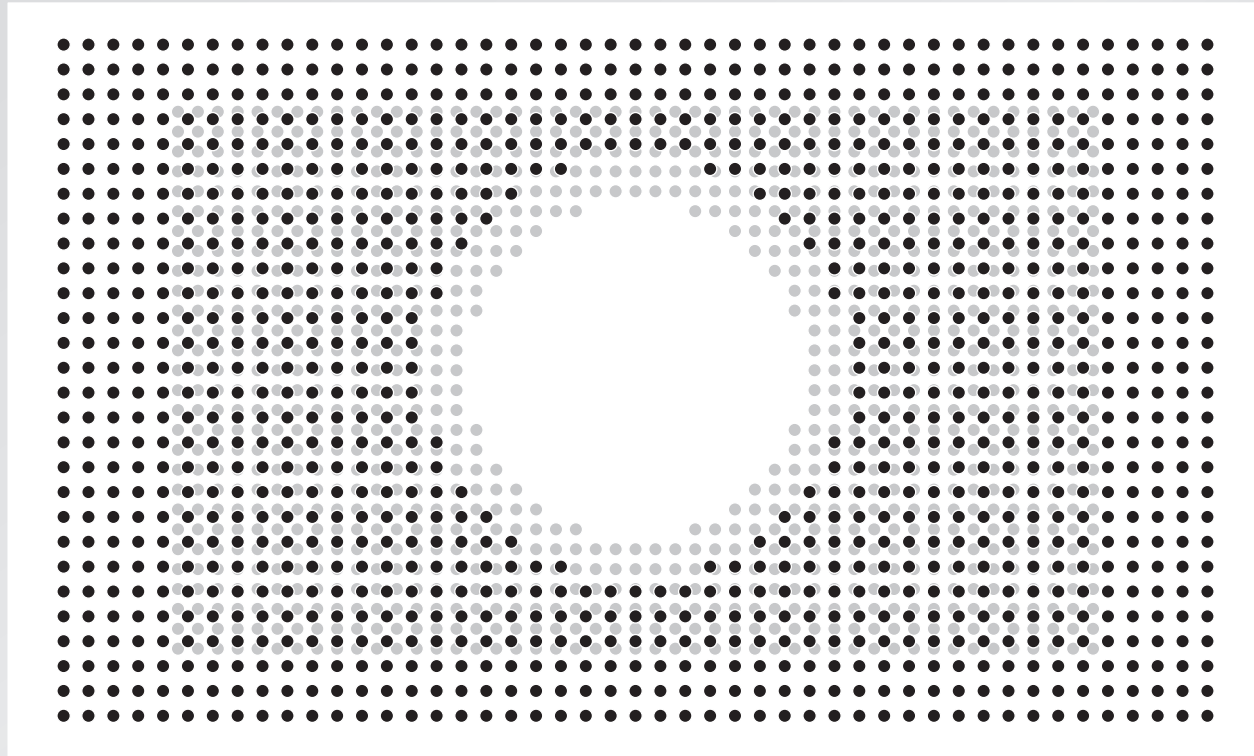


# Let's try it!

*It's easy to fire up the audience!*

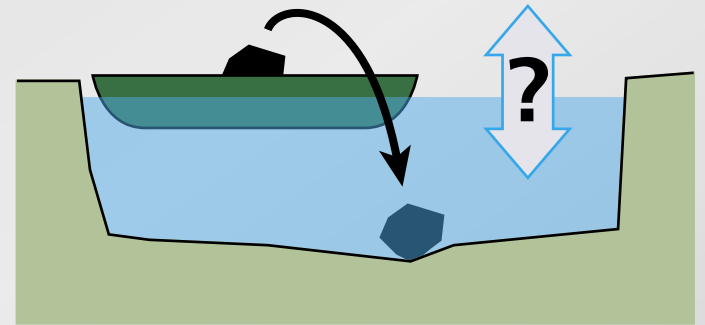
# Let's try it!

The distance between the atoms increases uniformly



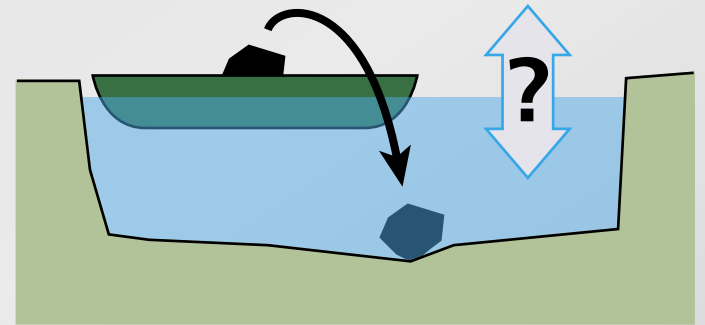
# Let's try it!

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!**

***We all make mistakes!***



# 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:

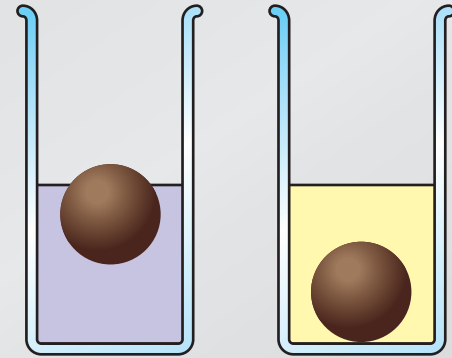
1. the mirror is oriented vertically.
2. we have two eyes in the horizontal plane.
3. the Earth's gravitation is directed downward.
4. a habit we have when looking at images in a mirror.
5. It only *appears* to run from left to right.

# Let's try it!

*It's "simple" only if you know the answer*

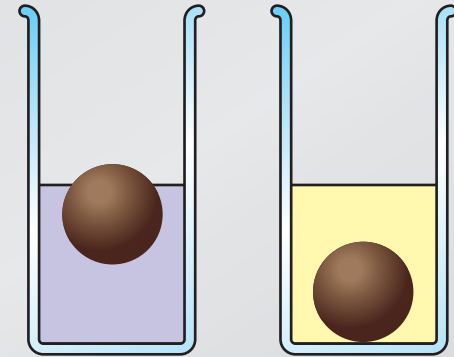
# Let's try it!

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



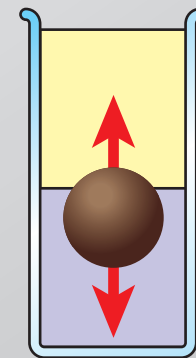
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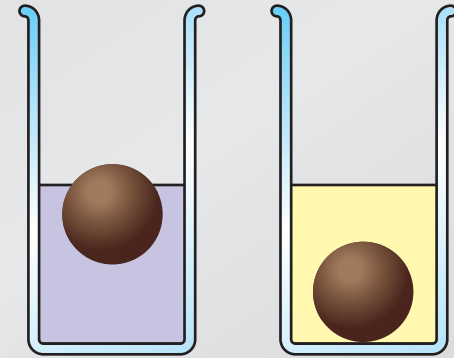
If we slowly pour the oil on top of the water so it completely covers the object, the object

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



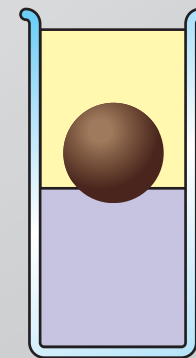
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If we slowly pour the oil on top of the water so it completely covers the object, the object

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



# Let's try it!

*It's easy to make simple demonstrations fascinating!*

# Developing ConceptTests

## Good ConceptTests:

- are based on student difficulties
- focus on single concept
- cannot be solved by “plug and chug”
- are clear and concise
- are of manageable difficulty



# Developing ConceptTests

**Try writing a ConceptTests on the following topic:**

**The acceleration due to gravity is constant**

# Developing ConceptTests

A ball is thrown downward (not dropped) from the top of a tower.

After being released, its downward acceleration is:

1. greater than  $g$
2. exactly  $g$
3. smaller than  $g$

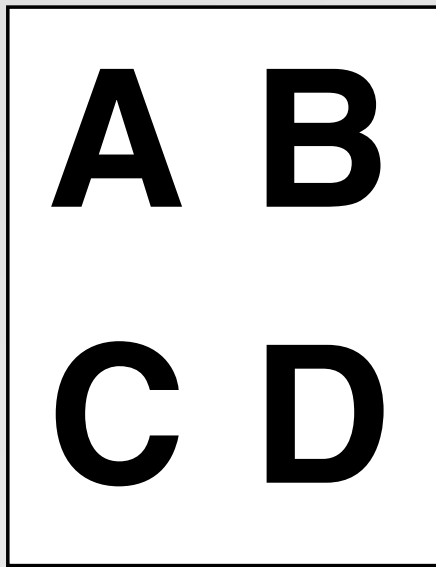
# Feedback methods

**Show of hands:**

**easy, but only moderately effective**

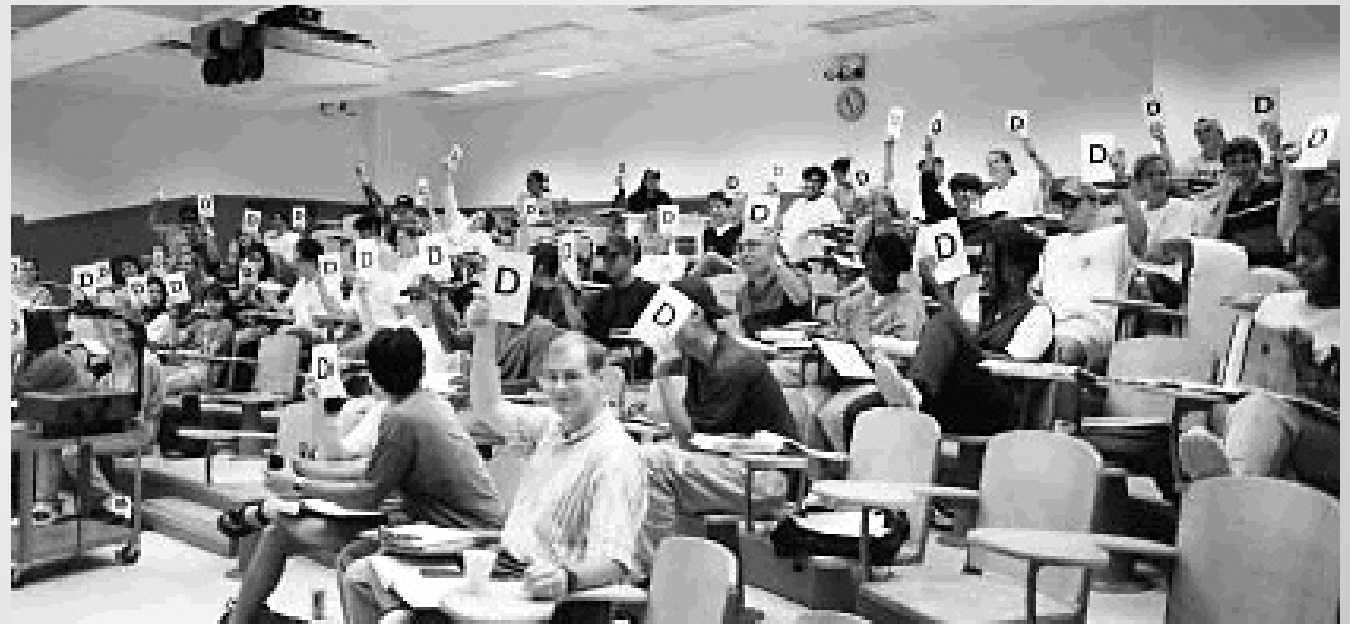
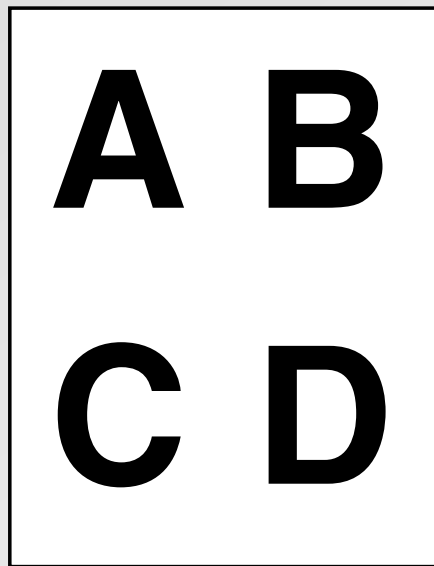
# Feedback methods

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



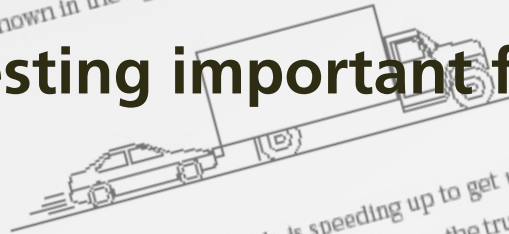


# Research: providing the basis for change

## Pre/post-testing important for:

- justifying approach
- improving implementation

Use the statement and figure below to answer the next two questions (15 and 16).  
A large truck breaks down on the road and receives a push back into town by a compact car as shown in the figure below.



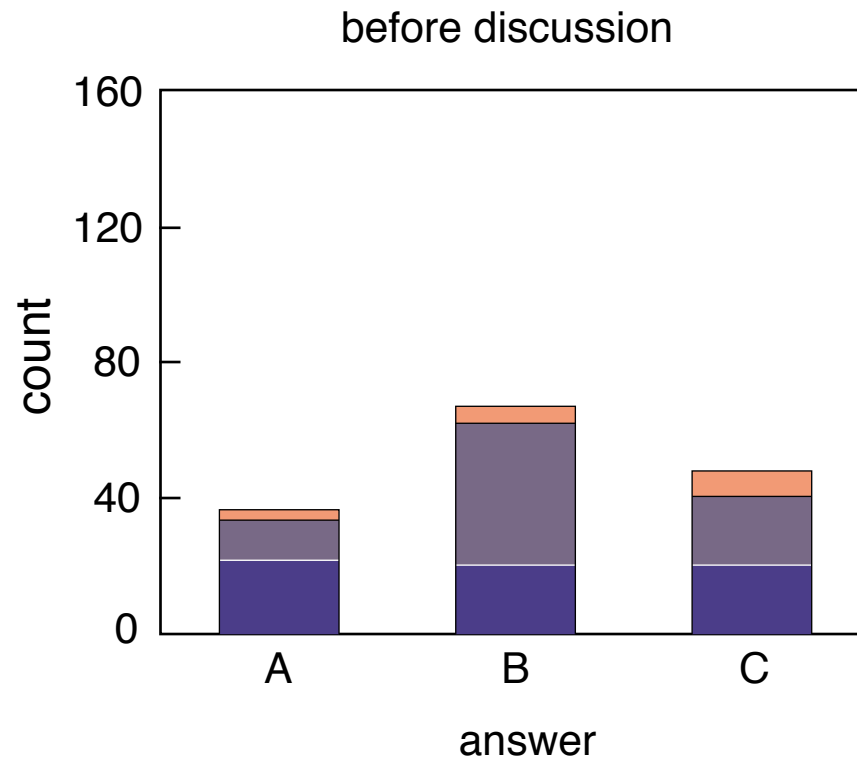
15. While the car, still pushing the truck, is speeding up to get up to cruising speed,
- \_\_\_ 1. the amount of force with which the car pushes on the truck is equal to that with which the truck pushes back on the car.
  - \_\_\_ 2. the amount of force with which the car pushes on the truck is smaller 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.
  - \_\_\_ 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.

# **Research: providing the basis for change**

**Evaluate assessment by comparing  
student performance on various kinds of problems**

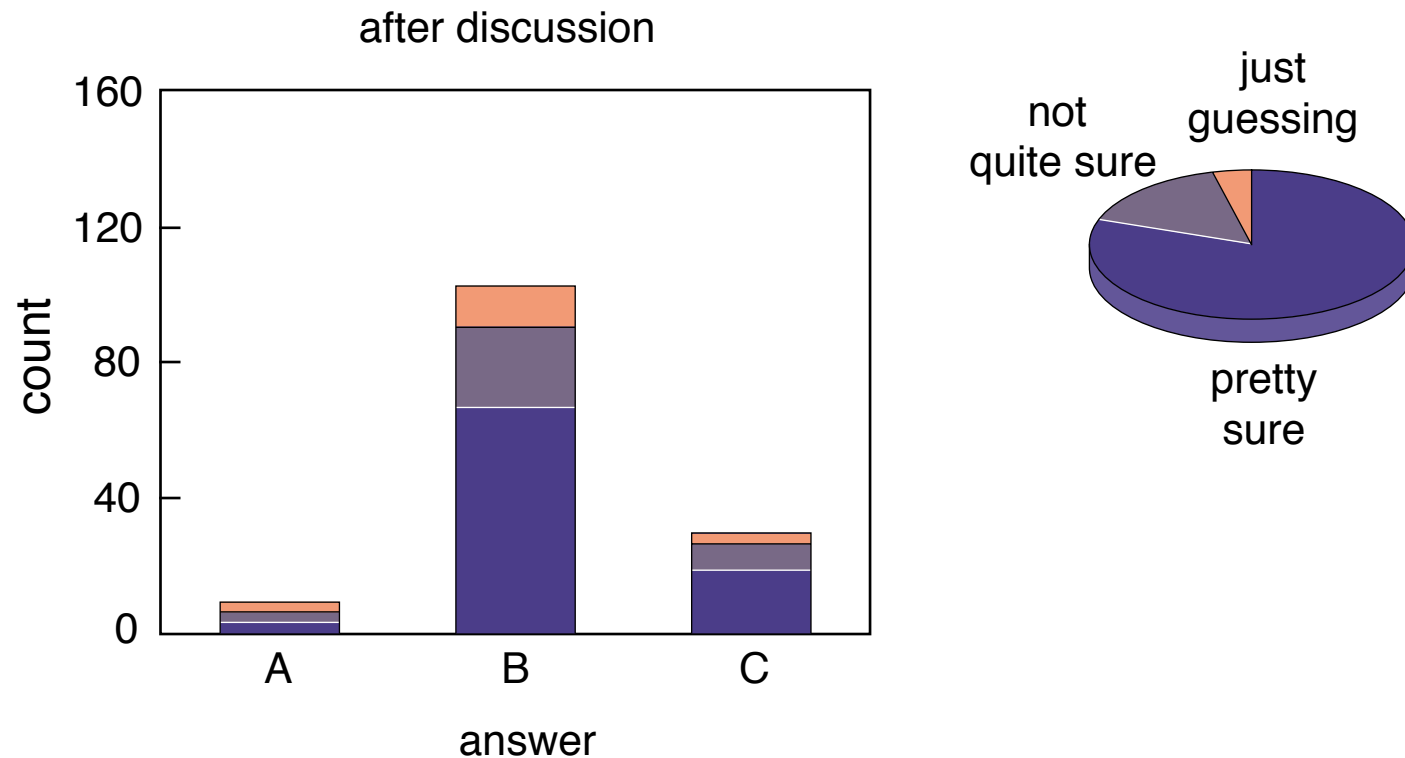
# Research: providing the basis for change

## ConcepTest data



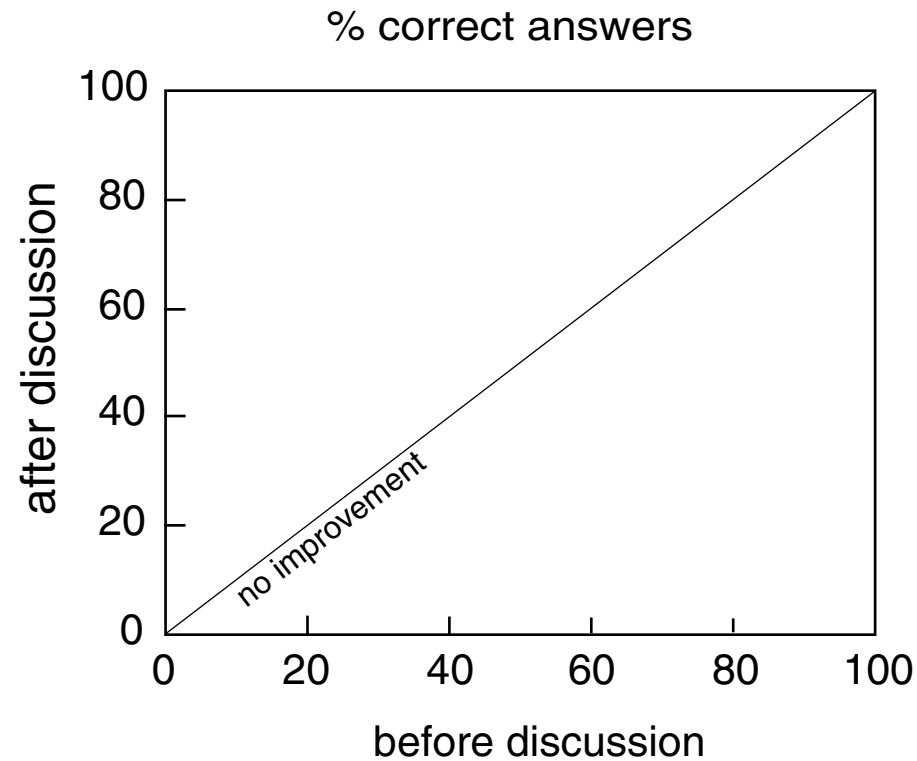
# Research: providing the basis for change

## ConceptTest data



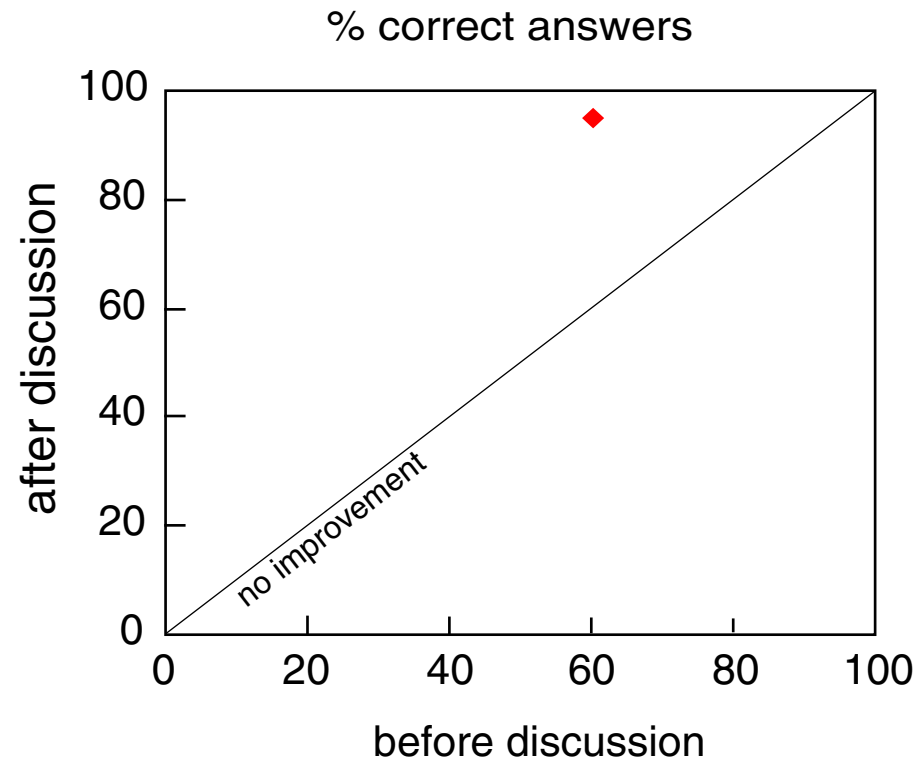
# Research: providing the basis for change

## ConceptTest data



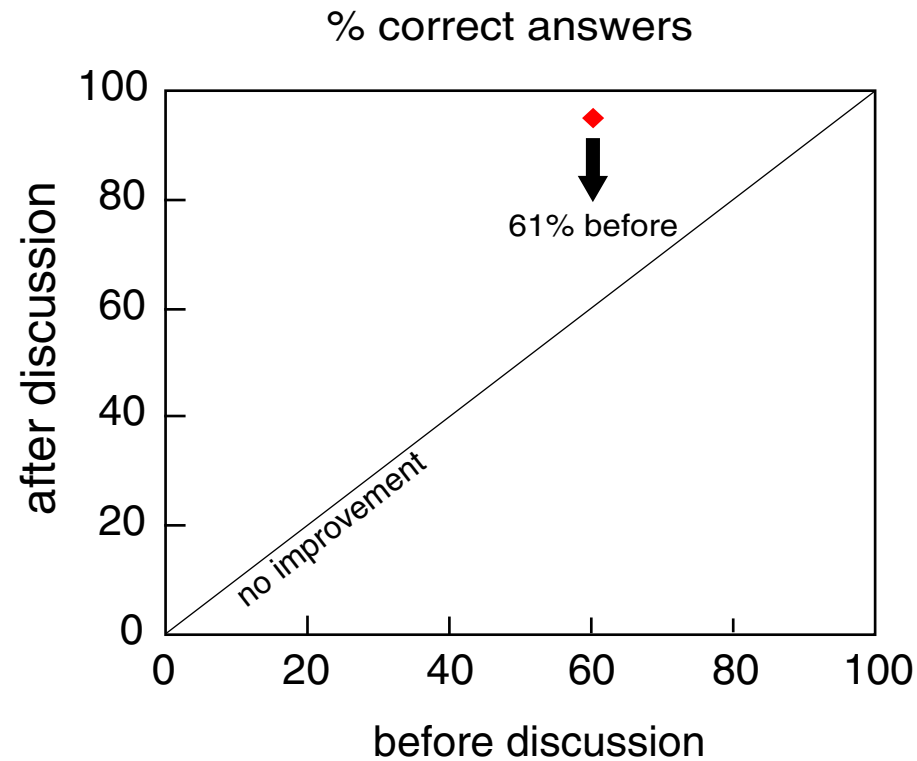
# Research: providing the basis for change

## ConceptTest data



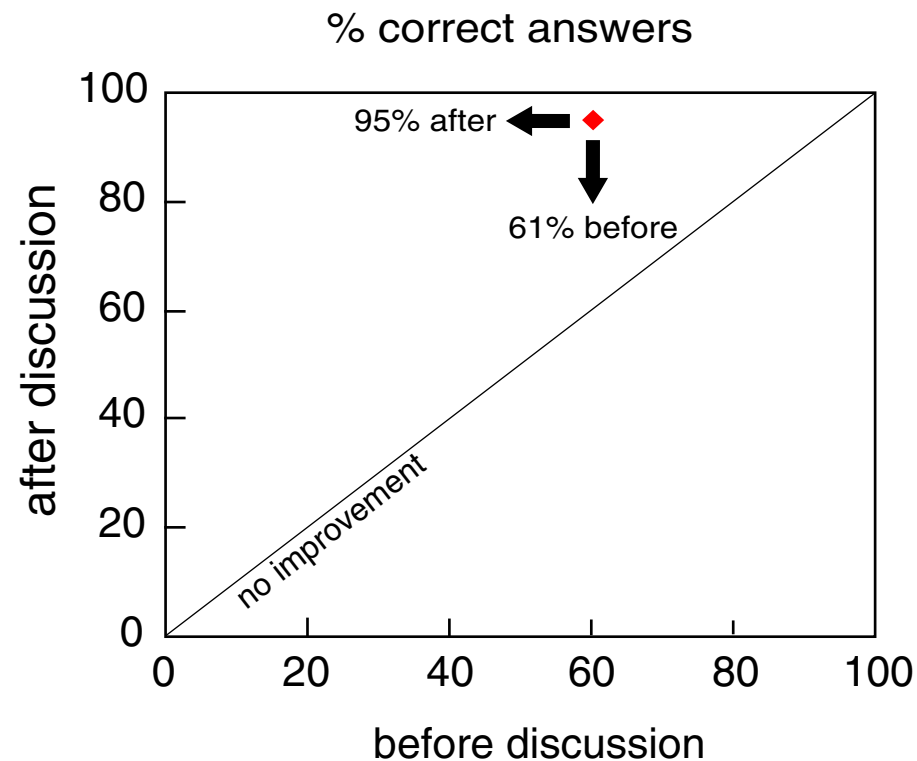
# Research: providing the basis for change

## ConceptTest data



# Research: providing the basis for change

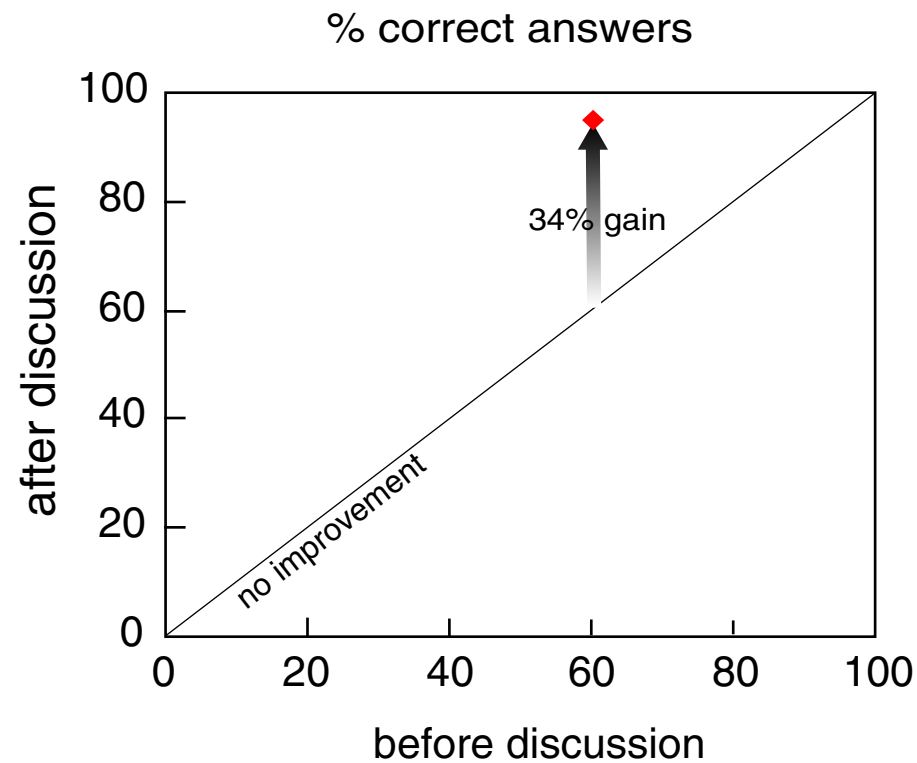
## ConceptTest data





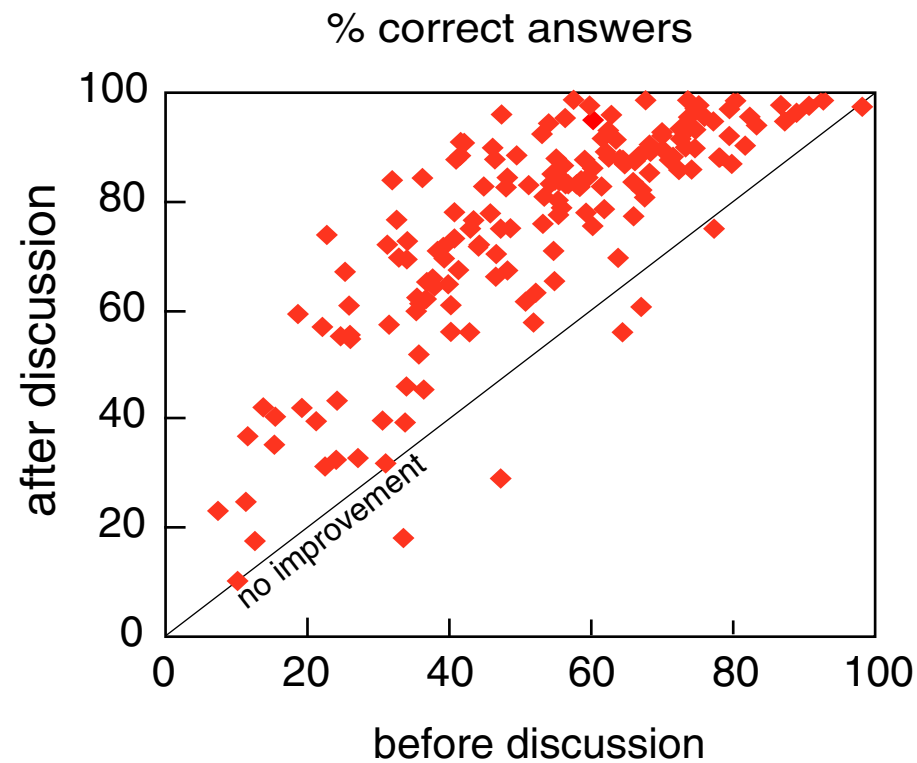
# Research: providing the basis for change

## ConcepTest data



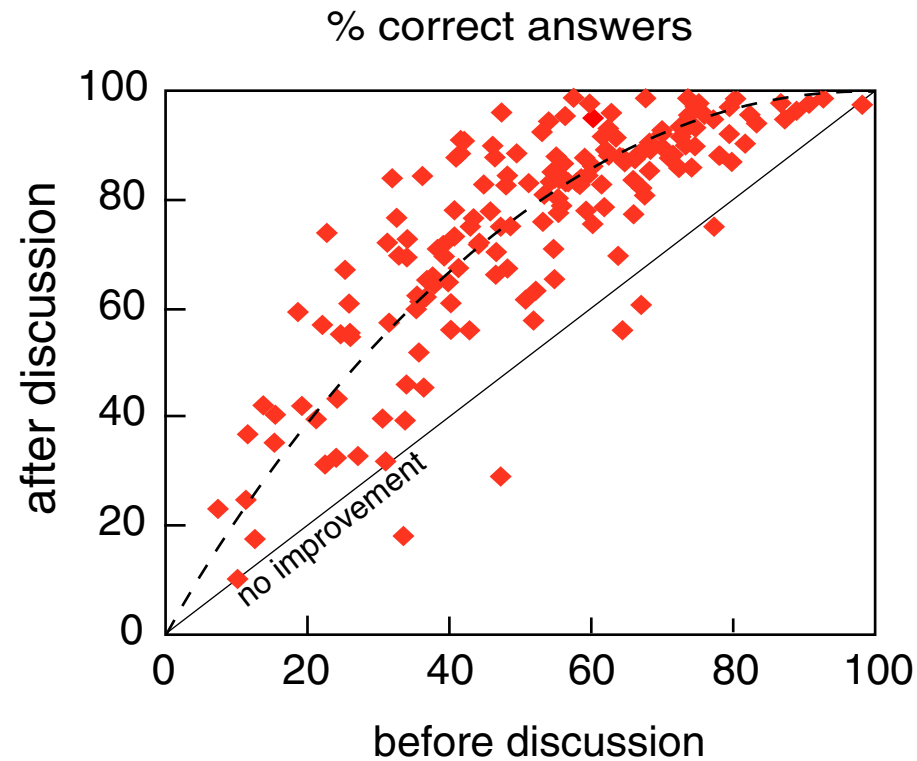
# Research: providing the basis for change

## ConcepTest data



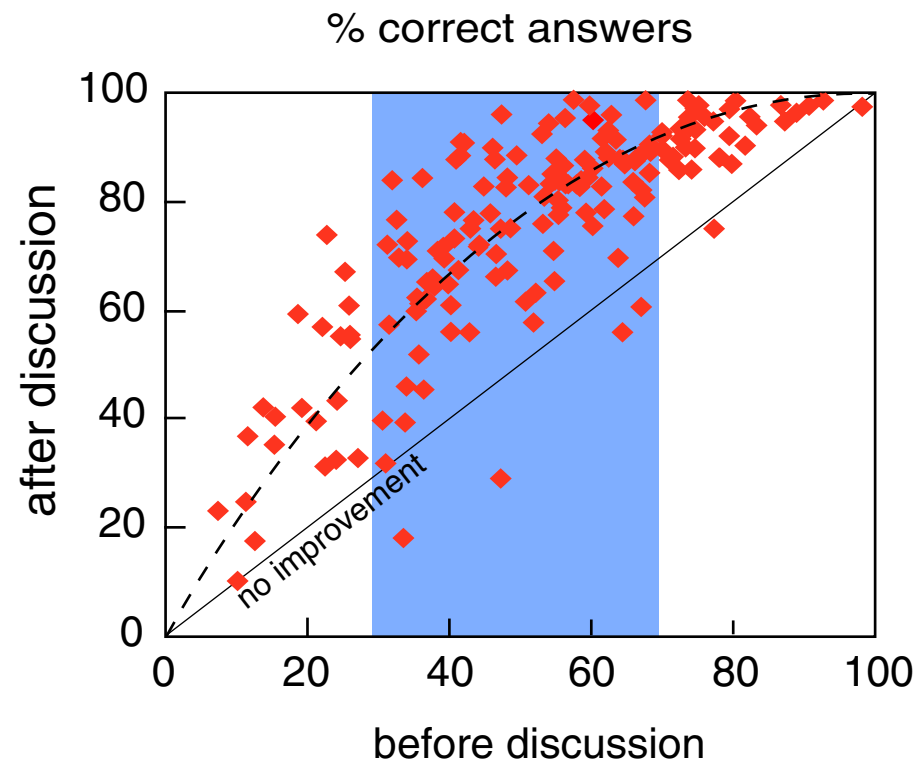
# Research: providing the basis for change

## ConcepTest data



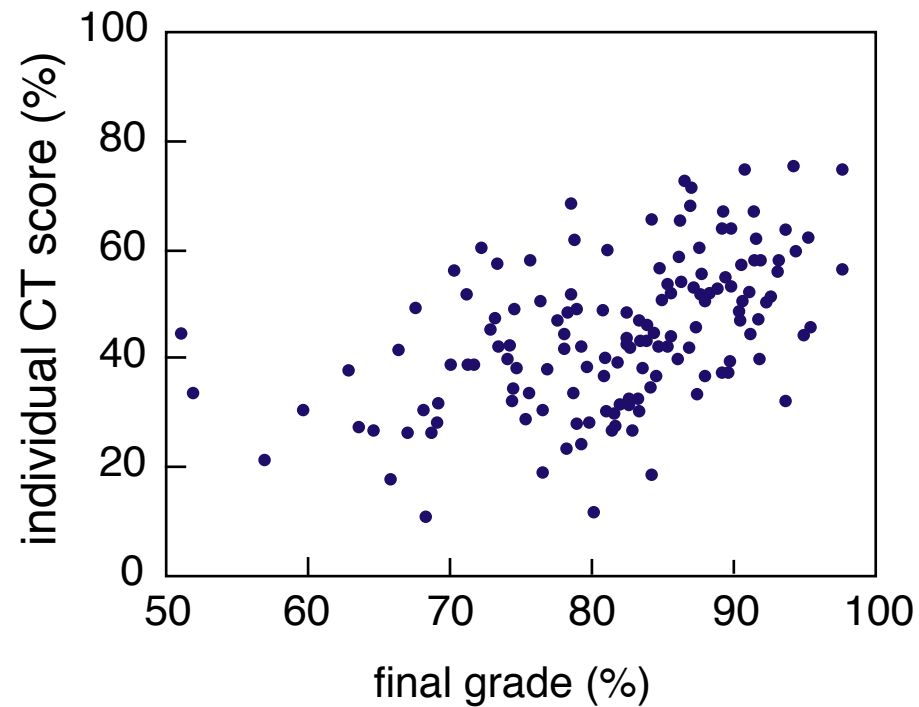
# Research: providing the basis for change

## ConcepTest data



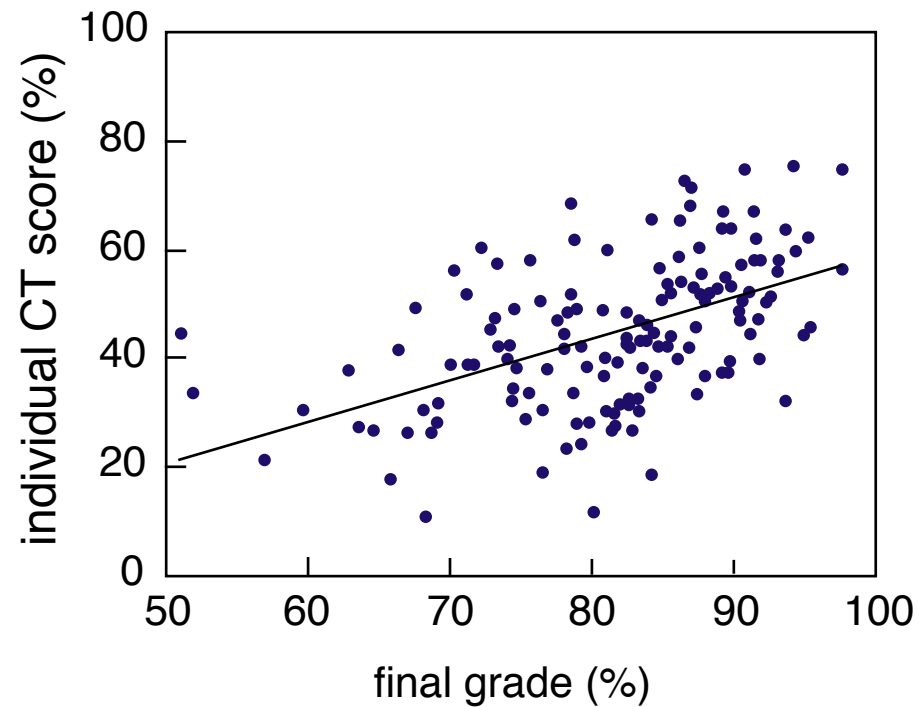
# Research: providing the basis for change

who benefits from the ConcepTests?



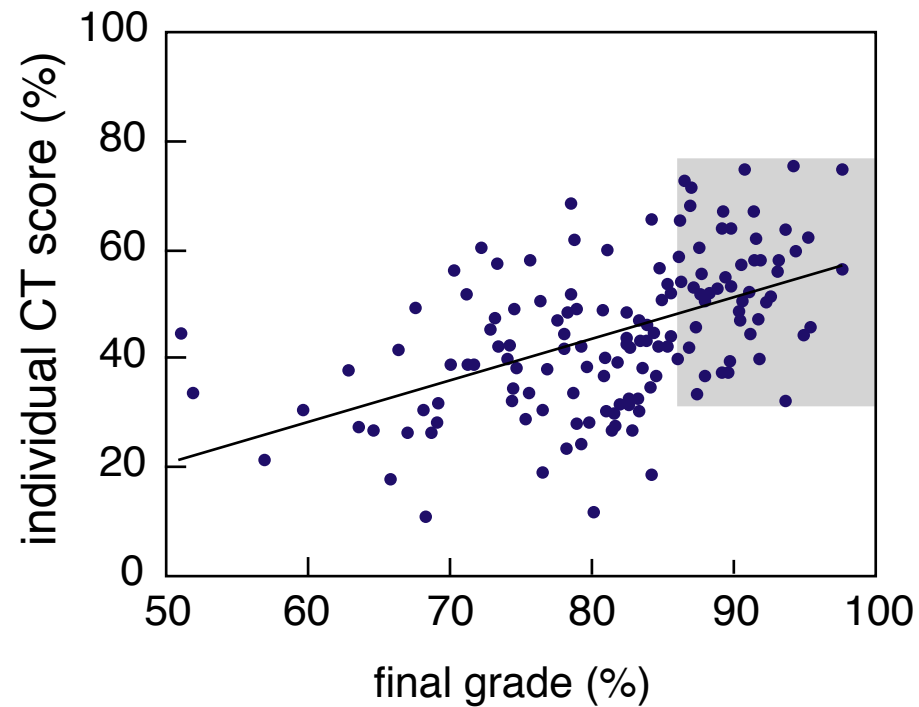
# Research: providing the basis for change

who benefits from the ConcepTests?



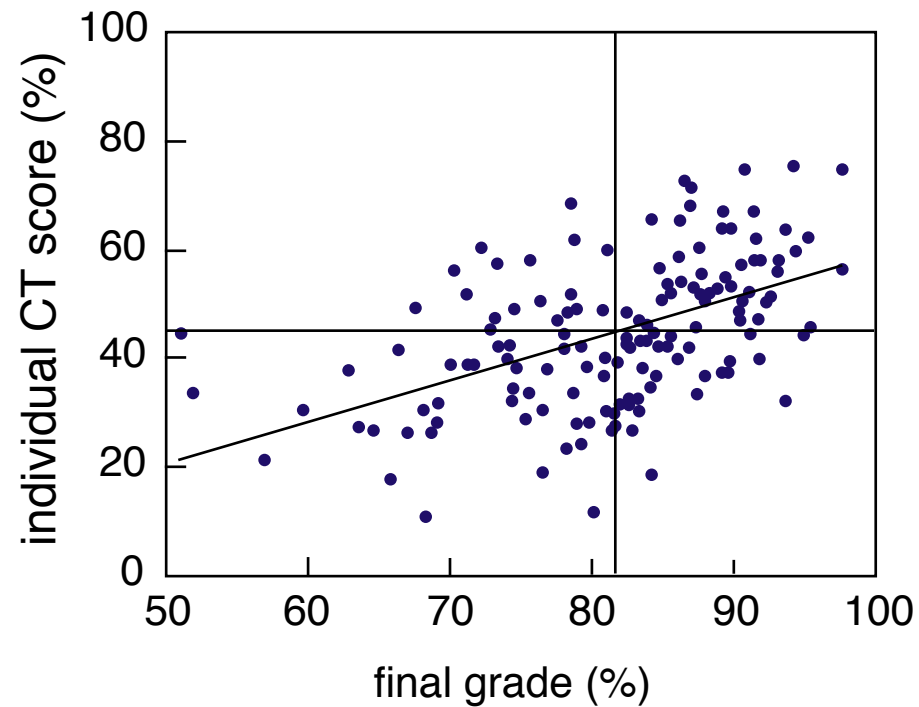
# Research: providing the basis for change

even the best students are challenged



# Research: providing the basis for change

even the best students are challenged





# Problems with problems

On a Saturday afternoon, you pull into a parking lot with unmeasured 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.

# Problems with problems

On a Saturday afternoon, you pull into a parking lot with unmeasured 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.

How long do you have to wait before someone frees up a space?

# Problems with problems

On a Saturday afternoon, you pull into a parking lot with unmeasured 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.

How long do you have to wait before someone frees up a space?

Requires:

Assumptions

Developing a model

Applying that model

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**Assuming people leave at regularly-spaced intervals,** how long do you have to wait before someone frees up a space?

Requires:

Applying a (new) model

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On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area, where people are known 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:

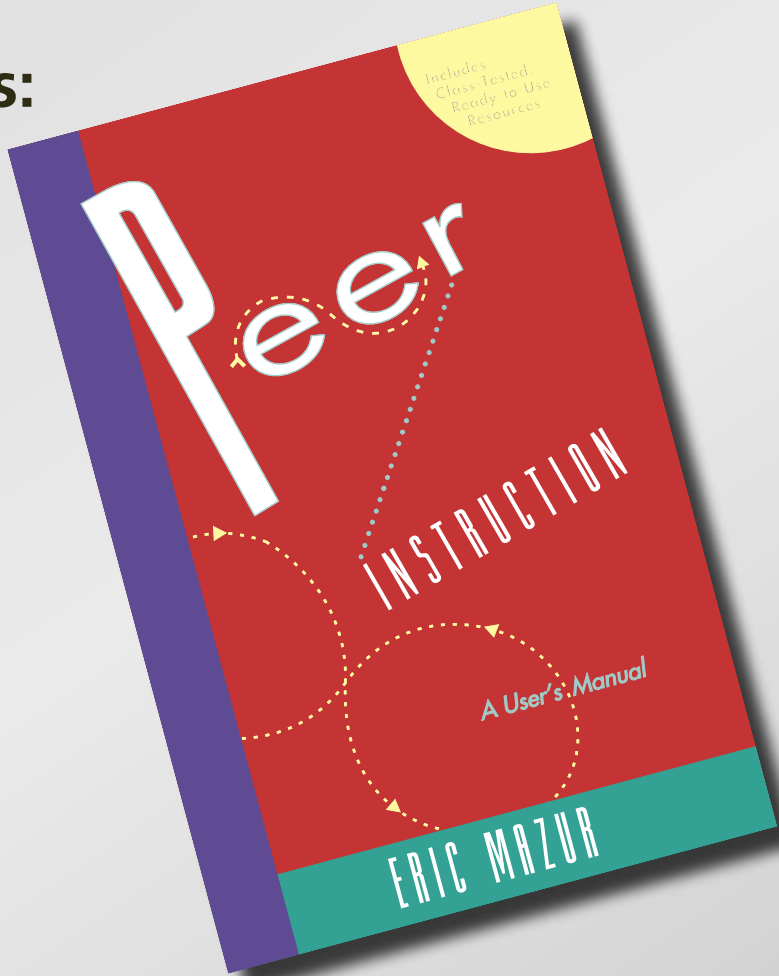
Using a calculator

$$t_{wait} = \frac{T_{shop}}{N_{spaces}}$$

# Resources

## Books with ConcepTests:

- Physics (Prentice Hall)



# Resources

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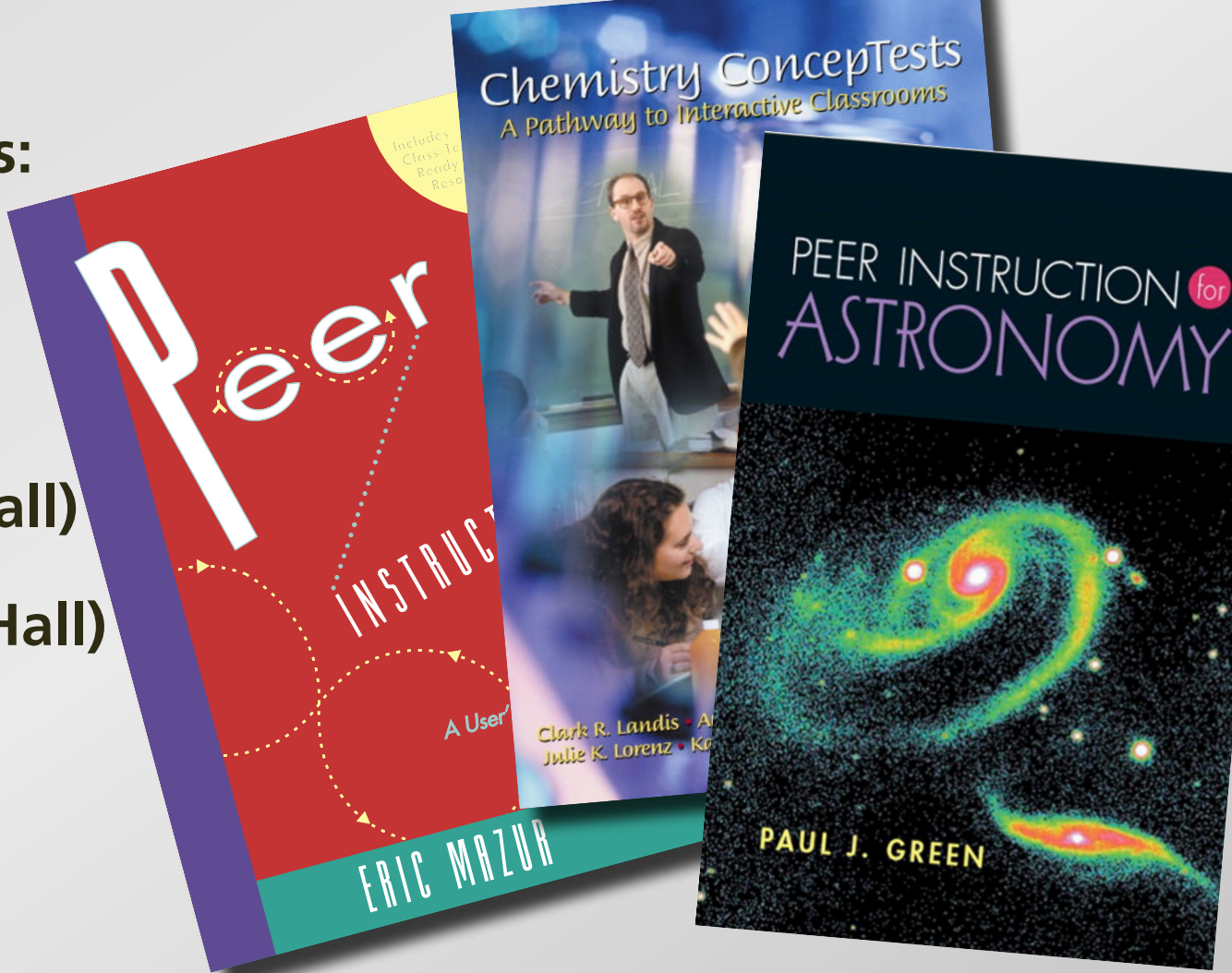
- Physics (Prentice Hall)
- Chemistry (Prentice Hall)



# Resources

## Books with ConcepTests:

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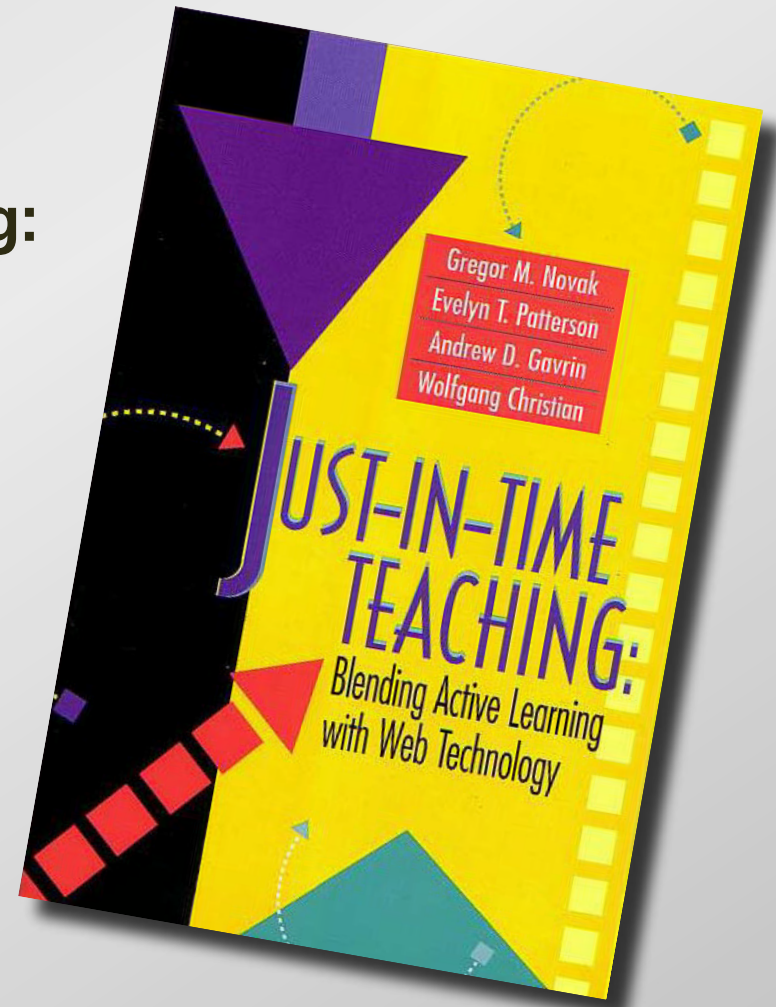
- Physics (Prentice Hall)
- Chemistry (Prentice Hall)
- Astronomy (Prentice Hall)
- Calculus (Wiley)



# Resources

## Information on Just-in-Time-Teaching:

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

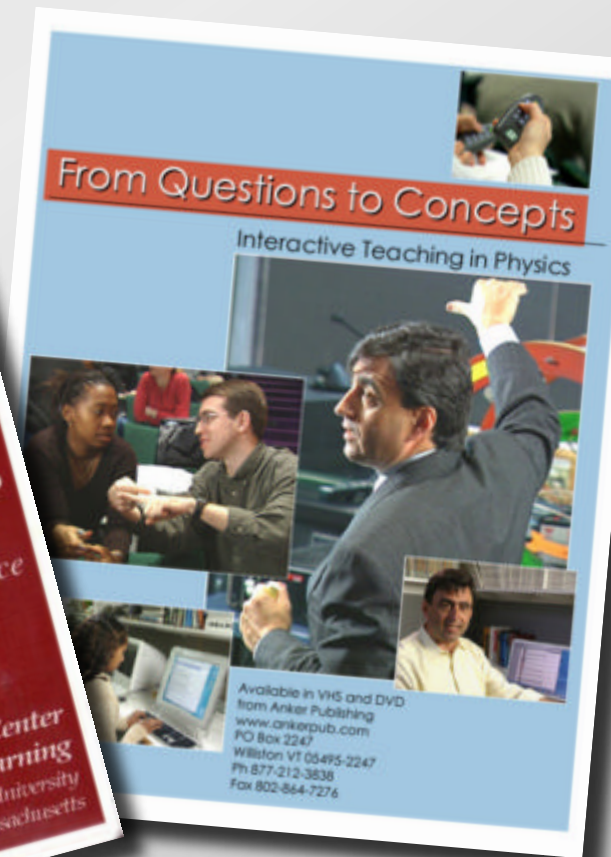


# Resources

## Videos:

- Thinking together
- From questions to concepts

<http://www.ankerpub.com>





# Resources

Course management:

<http://deas.harvard.edu/ilt>

ILT: Manage

http://www.conceptest.org

ILT: Login local ILT: Lecture ILT: Reading

Physics 1b

HOME READING LECTURES ASSIGNMENTS FORUMS NEWS HANDOUTS

Logged in as Eric Mazur Sign out

Courses > Physics 1b > Lectures > Changing magnetic fields II 4/8 > |

Physics > Introductory Electromagnetism > Magnetism > CT: 3691  
October 25, 2001 00:55:08 am

1. A permanent magnet is dropped through a long aluminum tube, as shown. As the magnet drops, electric currents are induced around the tube. Compared to a freely-falling magnet, the magnet through the tube drops



1. more slowly.  
2. exactly the same way.  
3. faster.  
4. Need more information.

Hint: consider the effects of induced currents through strips ahead of and behind the dropped magnet.

Answer: 1. In a loop of the aluminum tube just below the magnet, the flux is increasing as the magnet gets nearer. This induces a counterclockwise current producing an opposing magnetic field which repels the magnet. In a loop above the magnet, the flux is decreasing, so a clockwise current is induced, producing a magnetic field in the same direction as the magnet's field, thus attracting the magnet upward. So the net effect is to slow the magnet down.

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Physics > Introductory Electromagnetism > Magnetism > CT: 3756  
October 12, 2001 05:55:06 pm

2. Consider the arrangement shown below. Conducting rod AB is lying on a U-shaped conductor, making good electrical contact. The arrangement is placed in a magnetic field (into page).



# Barriers to reform

## Challenges:

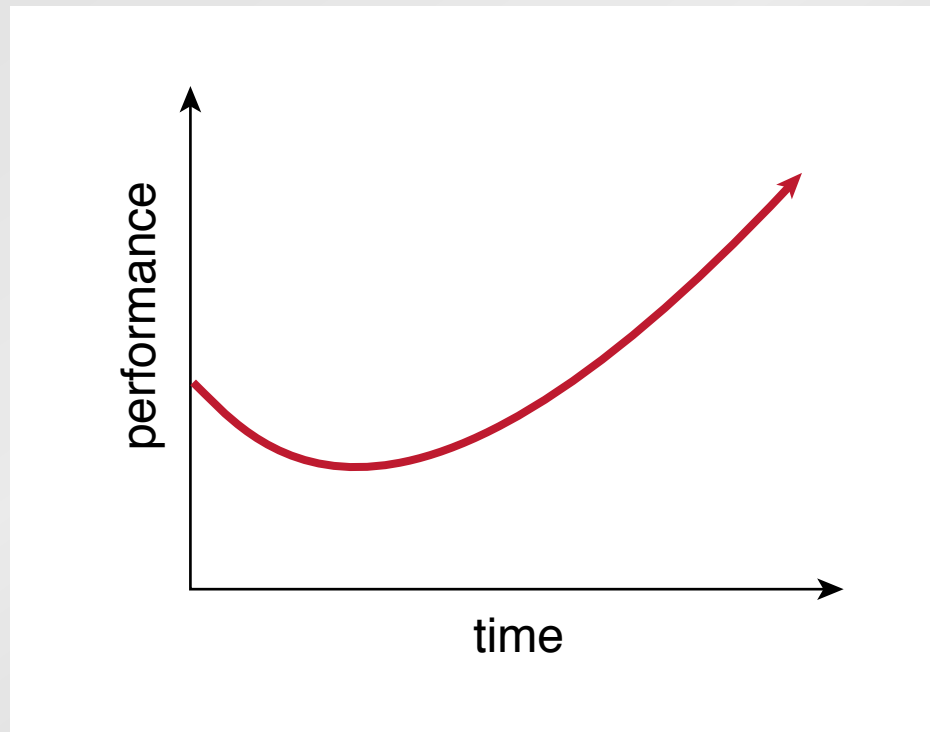
- skepticism
- growing pains
- limited circle of influence

# 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**

# Barriers to reform

	<b>"lectures"</b>	<b>PI</b>
<b>coverage</b>	<b>complete</b>	<b>partial</b>
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<b>retention</b>	<b>little</b>	<b>better</b>	<b>not part of grade</b>

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**for a copy of this presentation:**

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