Peer Instruction:
A 'brains-on' workshop with clickers

Academic Transformation Speaker Series
University of Texas
Austin, TX, 12 November 2010

Get your clickers ready!

- no ON/OFF button
- only last "click" counts
- display shows recorded answer

www.TurningTechnologies.com

Get your clickers ready!

unique ID on back of clicker

www.TurningTechnologies.com

Quick survey…

I teach…

1. Engineering/Computer Science
2. Humanities
3. Life sciences/Medicine
4. Mathematics
5. Natural sciences
6. Social sciences
7. Visual and performing arts
8. Business or law
9. Other

Quick survey…

Peer Instruction…

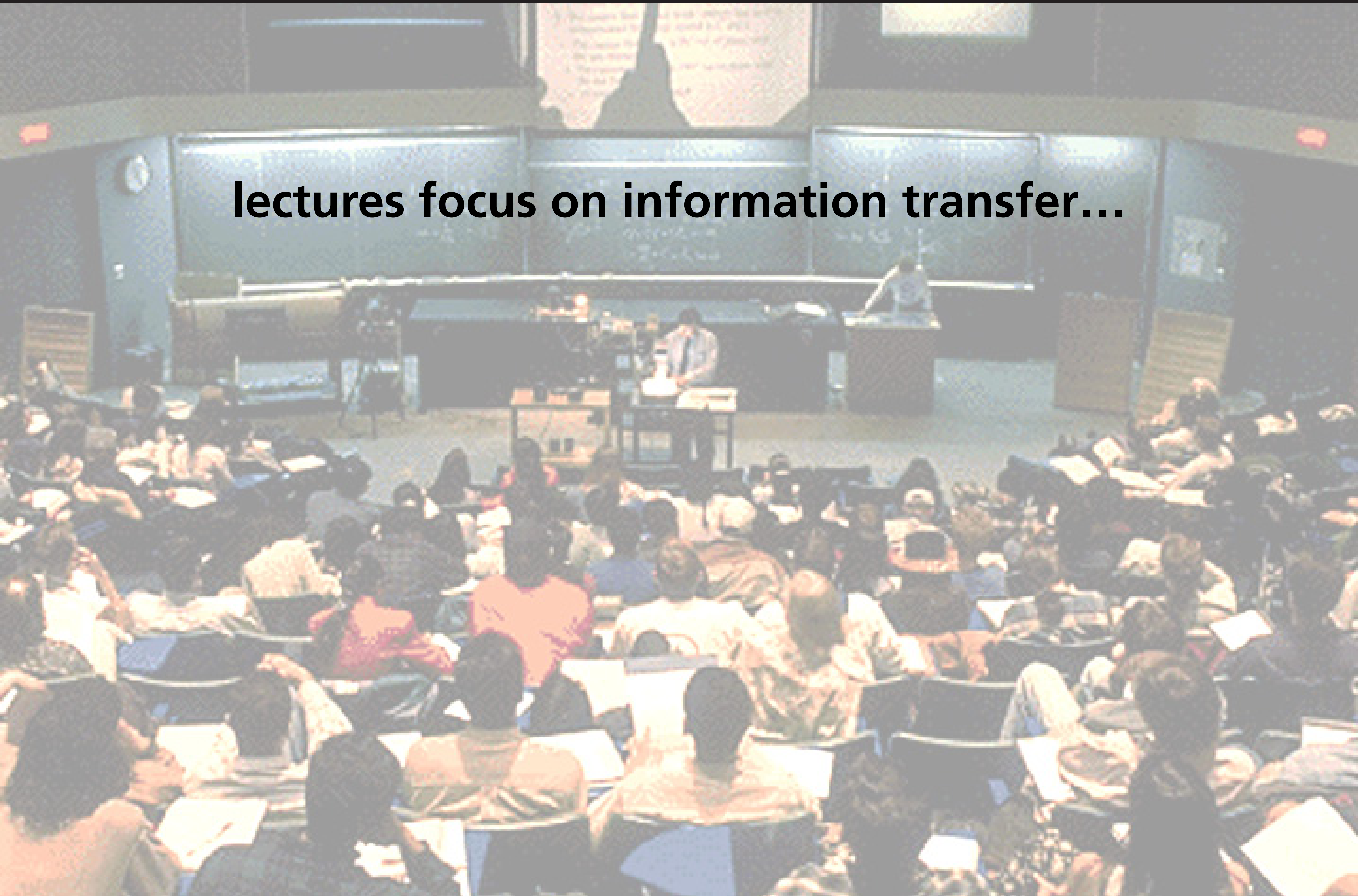
1. Never heard of it.
2. Heard of it, but don't really know what it is.
3. Quite familiar with it.
4. I heard you speak about it so often, I could give your talk!

Quick survey…

Peer Instruction…

1. Never heard of it.
2. Don't use it in my classes, but I'm open to it.
3. Considering using it in my classes.
4. I have used it in my classes a few times only.
5. I use it regularly in my classes.

Peer Instruction: a primer

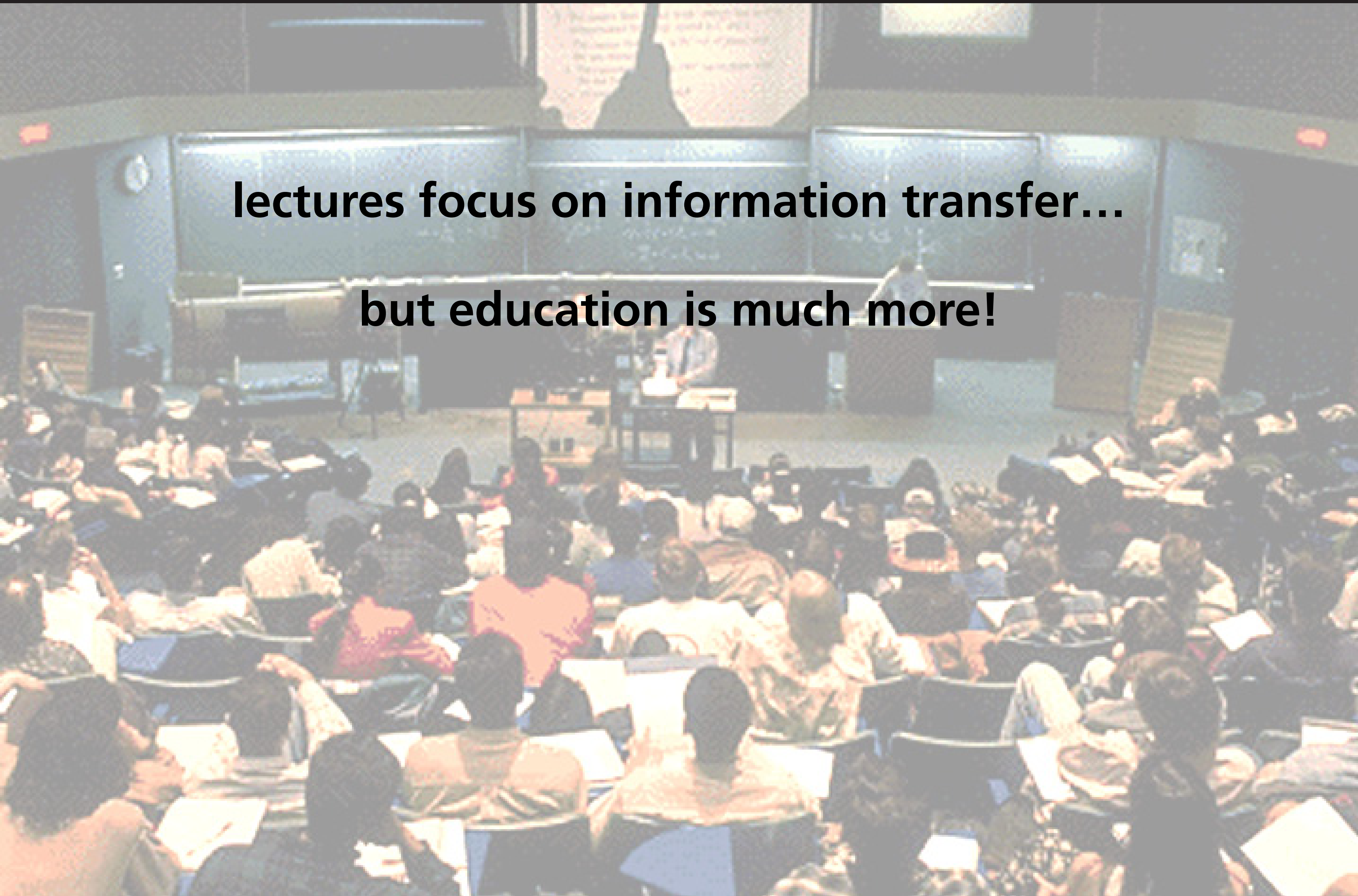


lectures focus on information transfer…

Peer Instruction: a primer

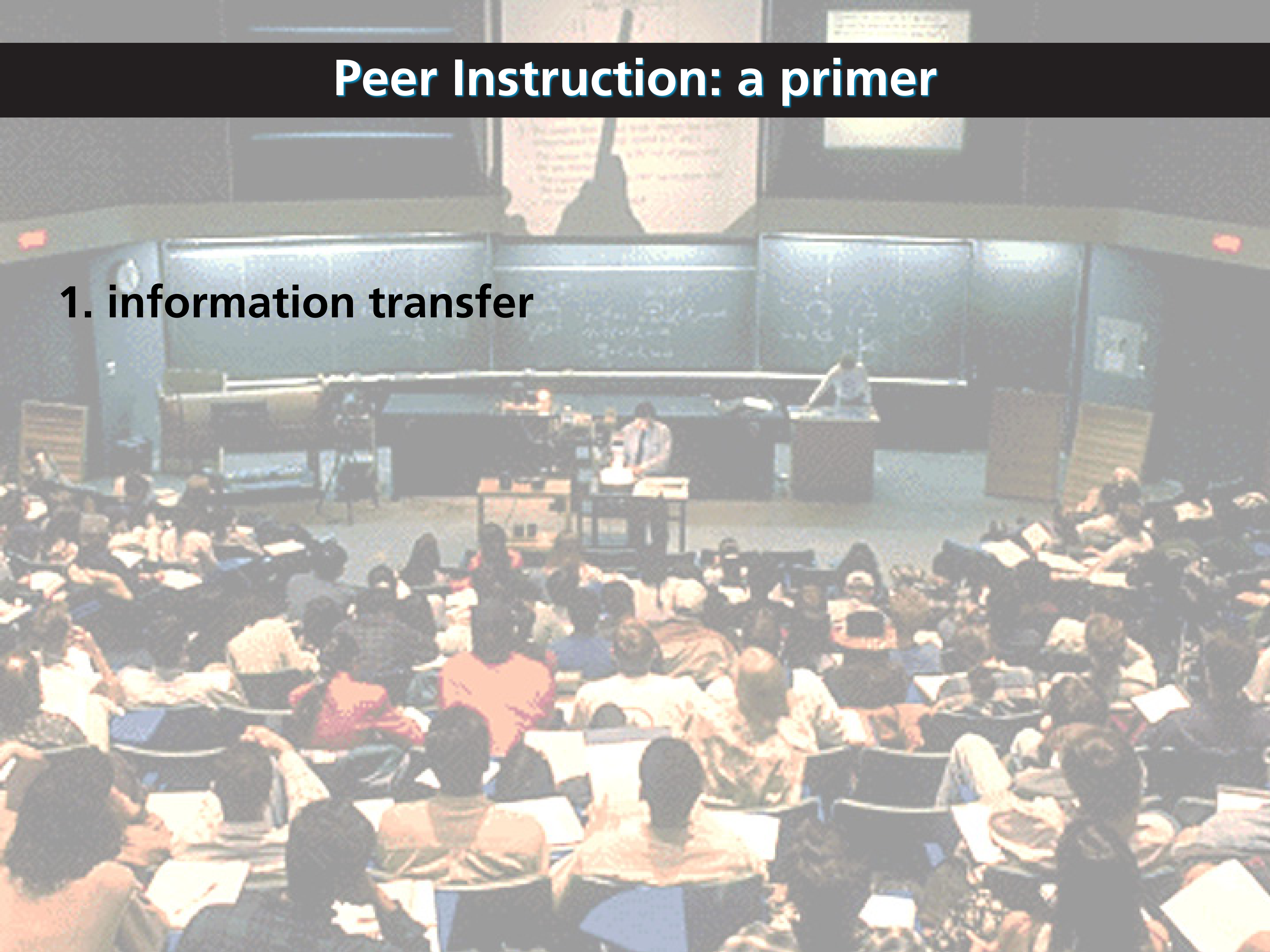
lectures focus on information transfer…

but education is much more!



Peer Instruction: a primer

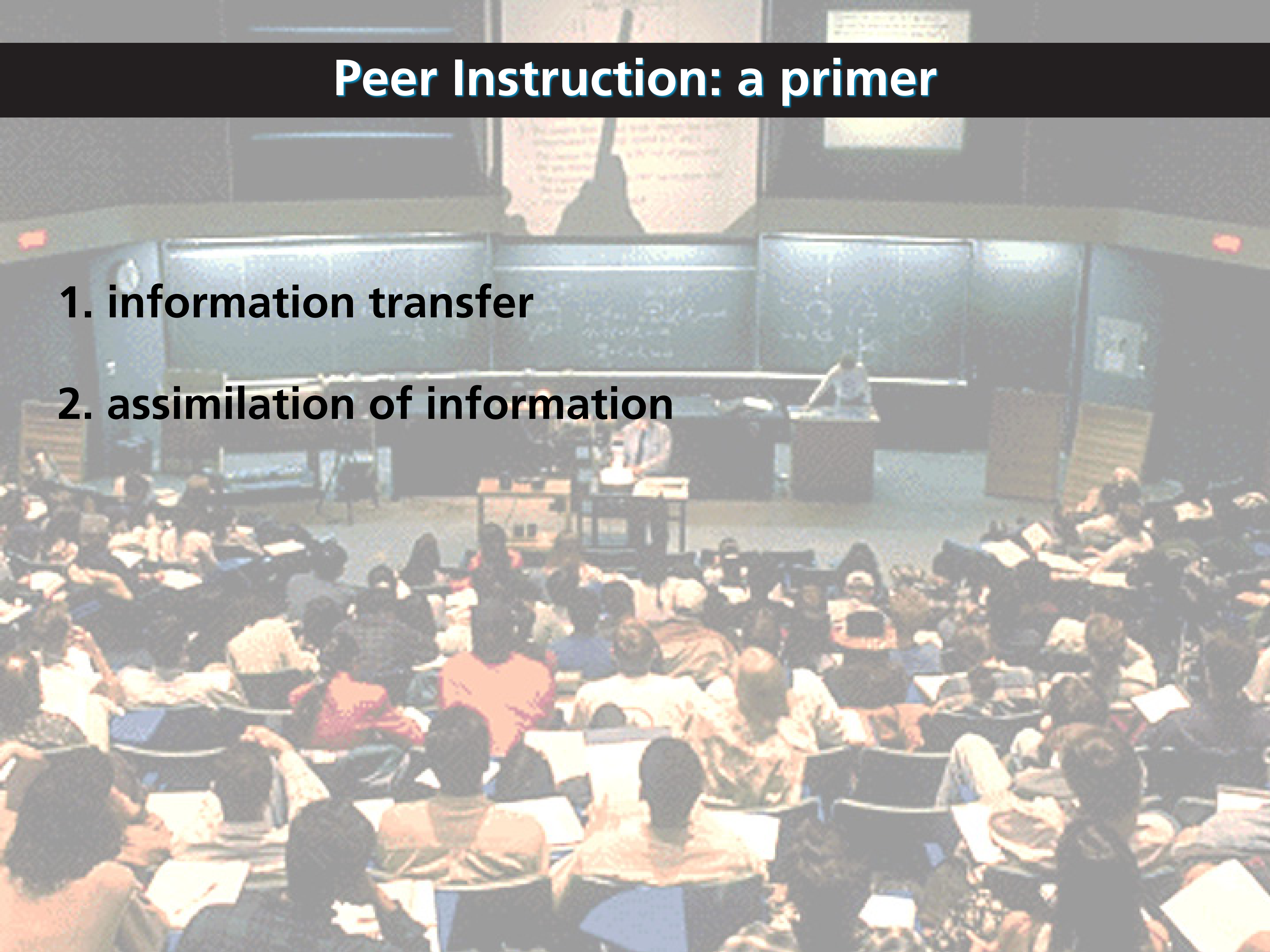
1. information transfer



Peer Instruction: a primer

1. information transfer

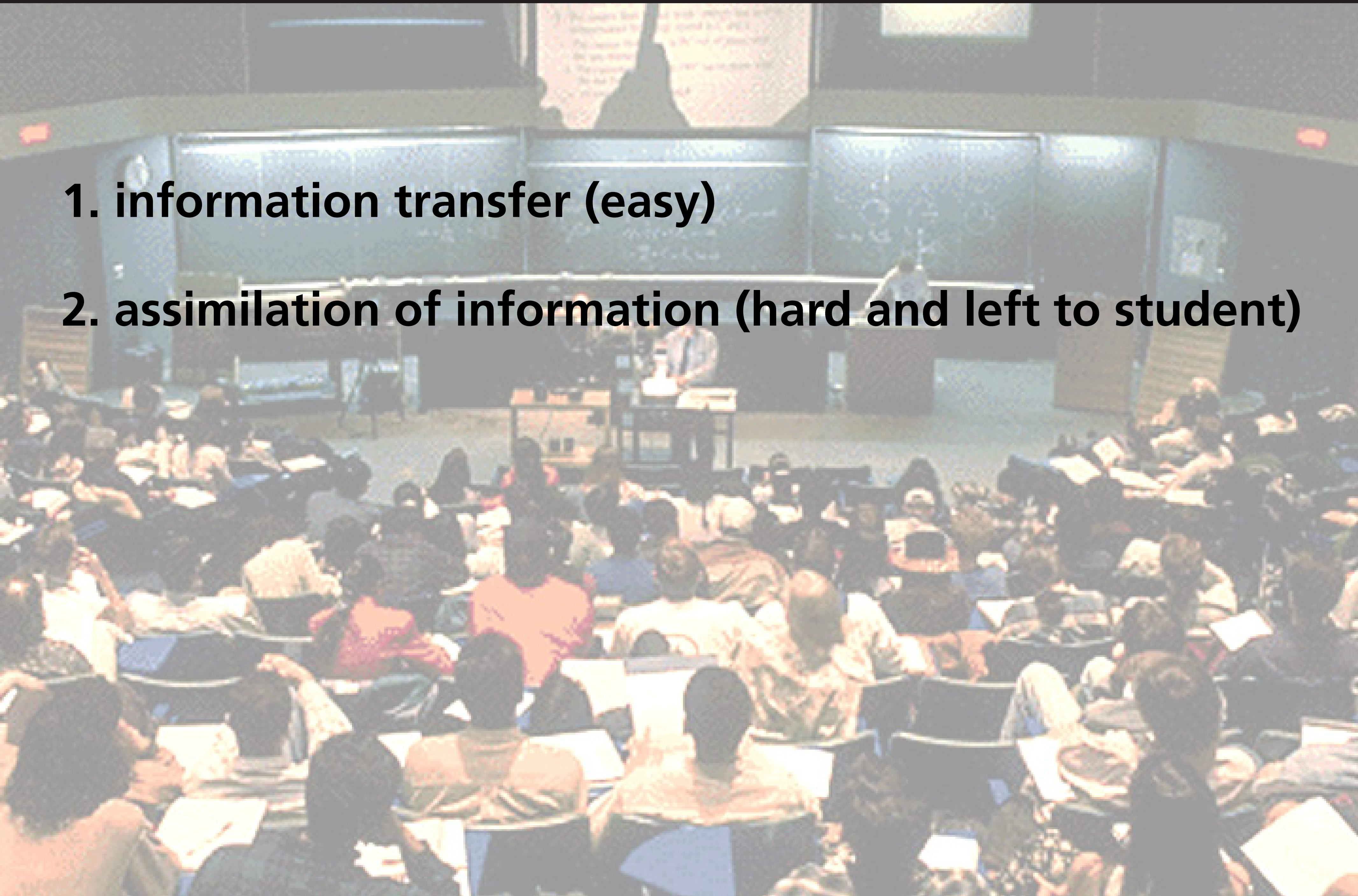
2. assimilation of information



Peer Instruction: a primer

1. information transfer (easy)

2. assimilation of information (hard and left to student)



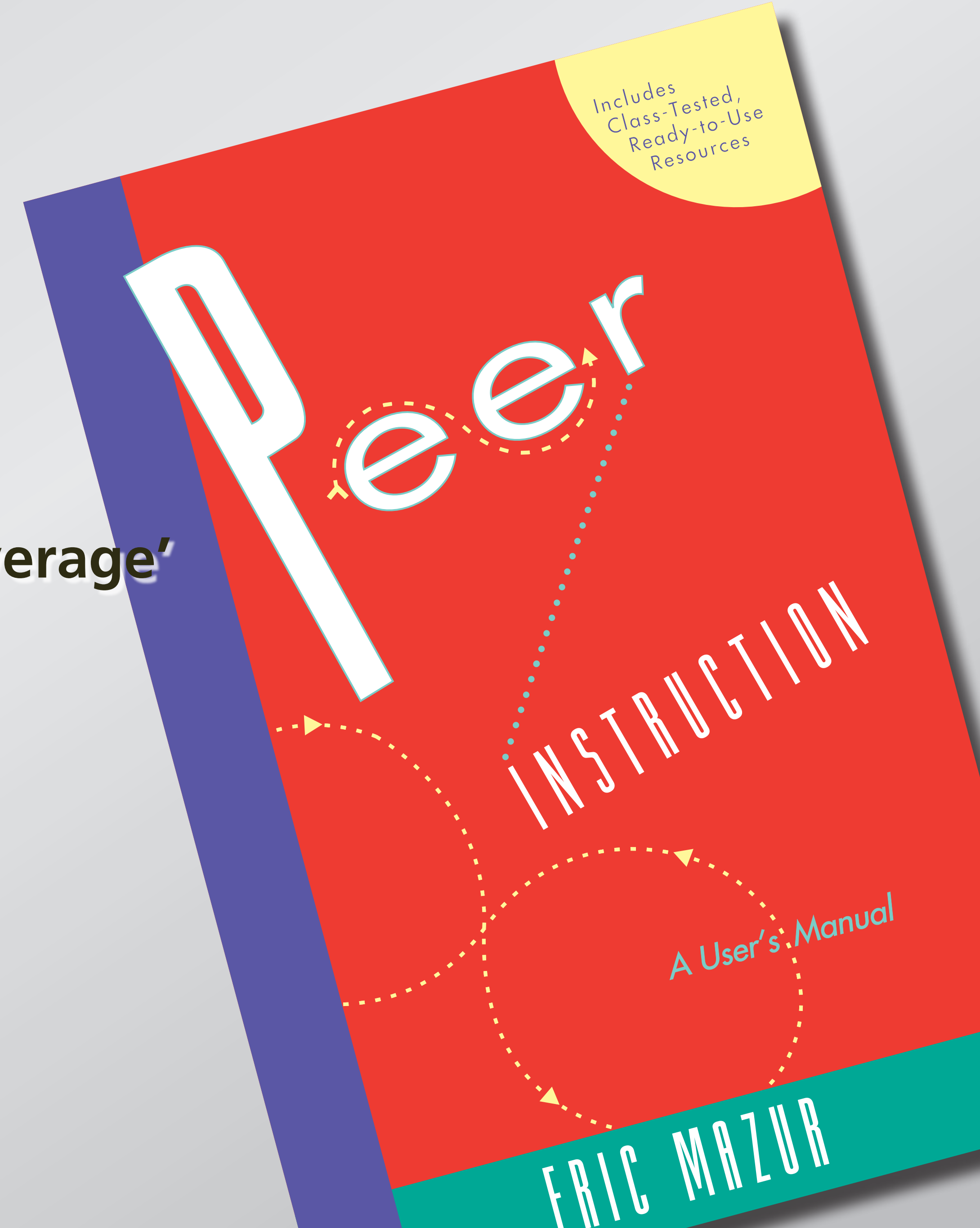
Peer Instruction: a primer

Solution: move information transfer out of classroom!

Peer Instruction: a primer

Main features:

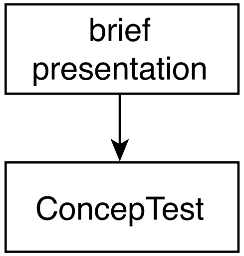
- pre-class reading
- in-class: depth, not 'coverage'
- ConcepTests



Peer Instruction: a primer

brief presentation

Peer Instruction: a primer



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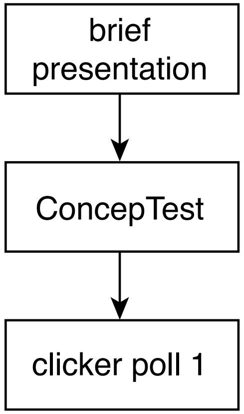

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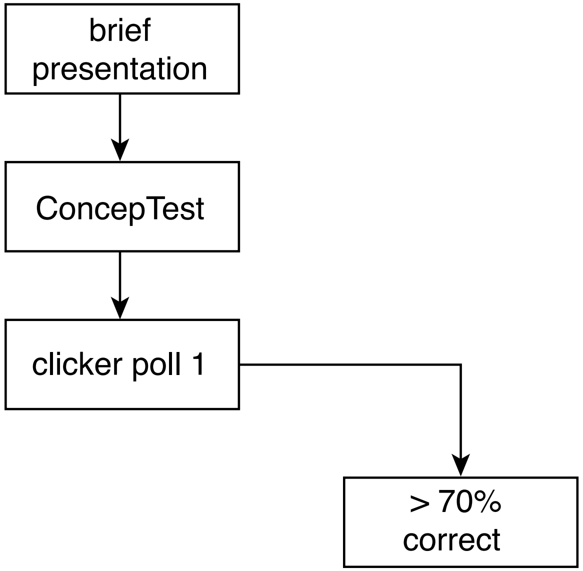

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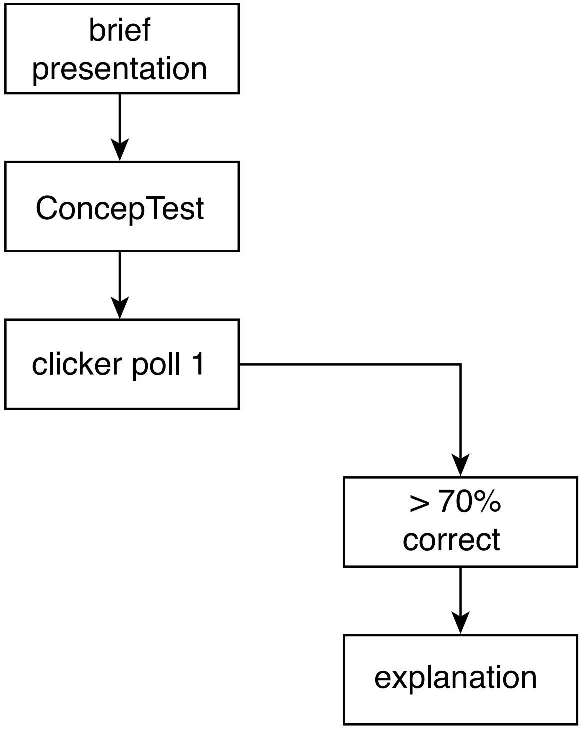

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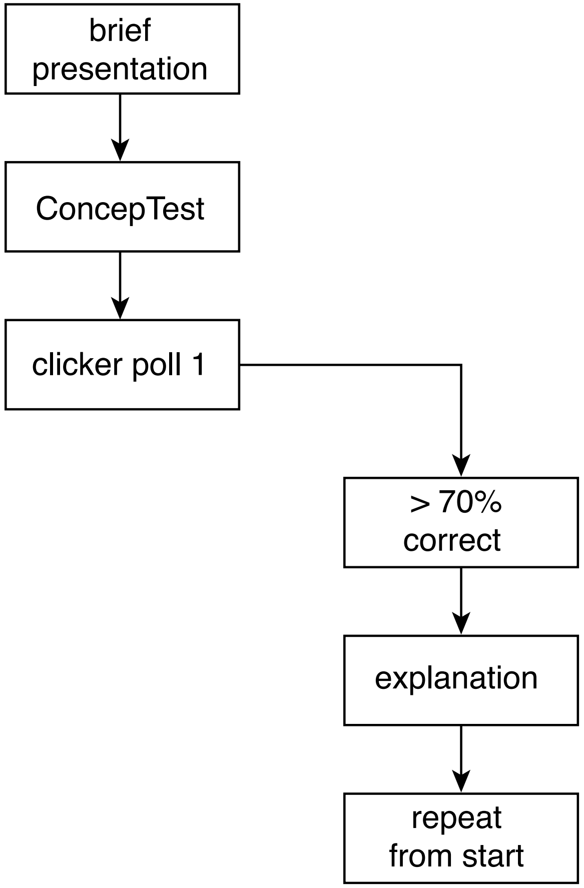

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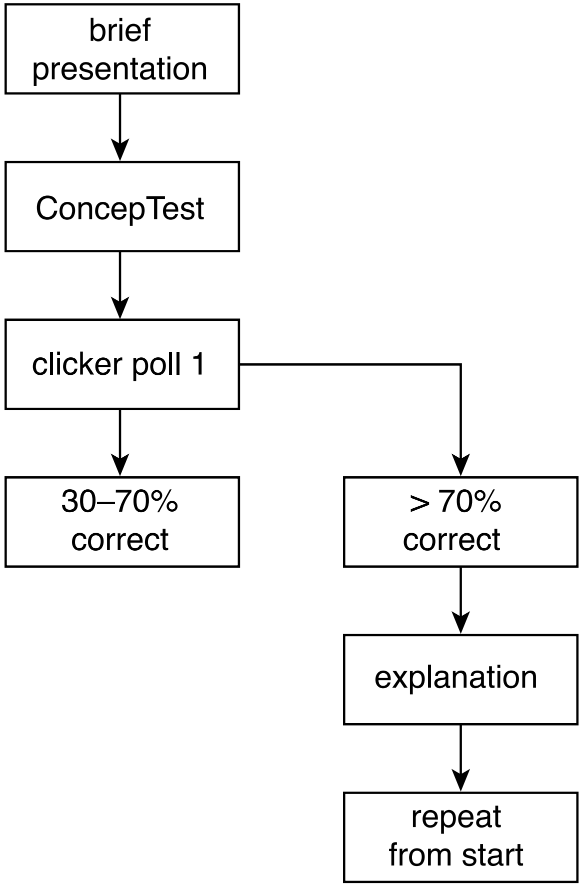

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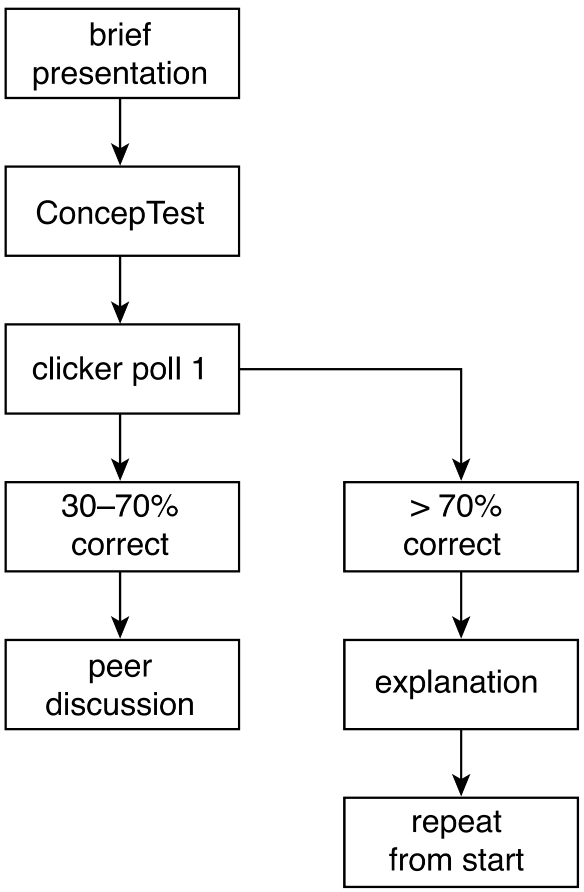

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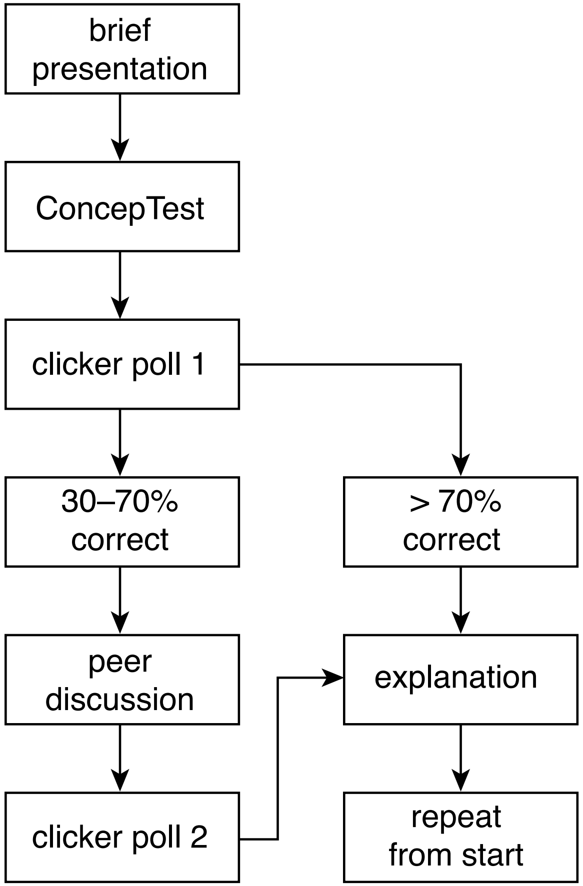

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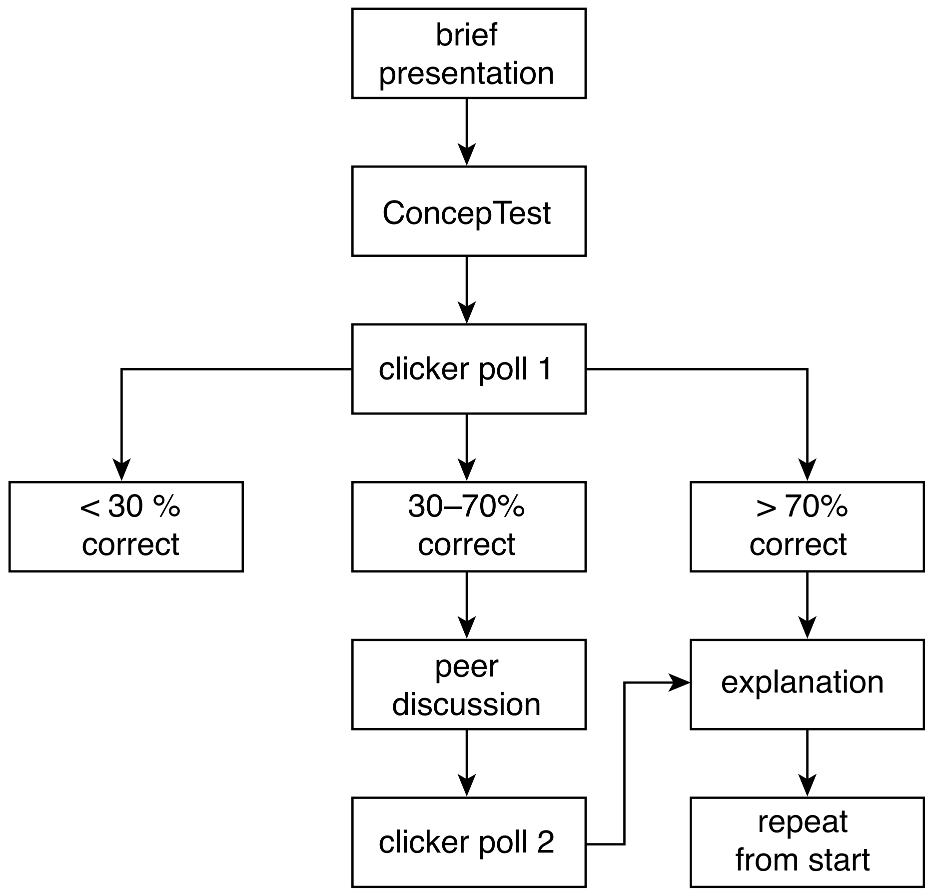

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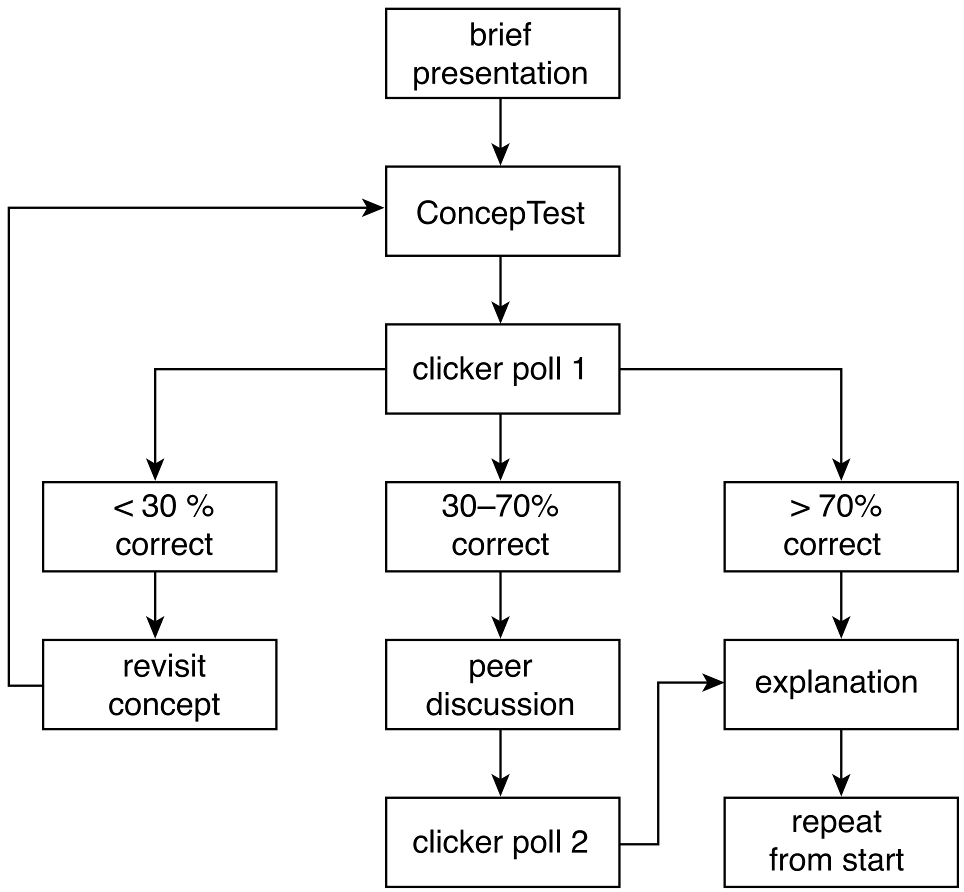

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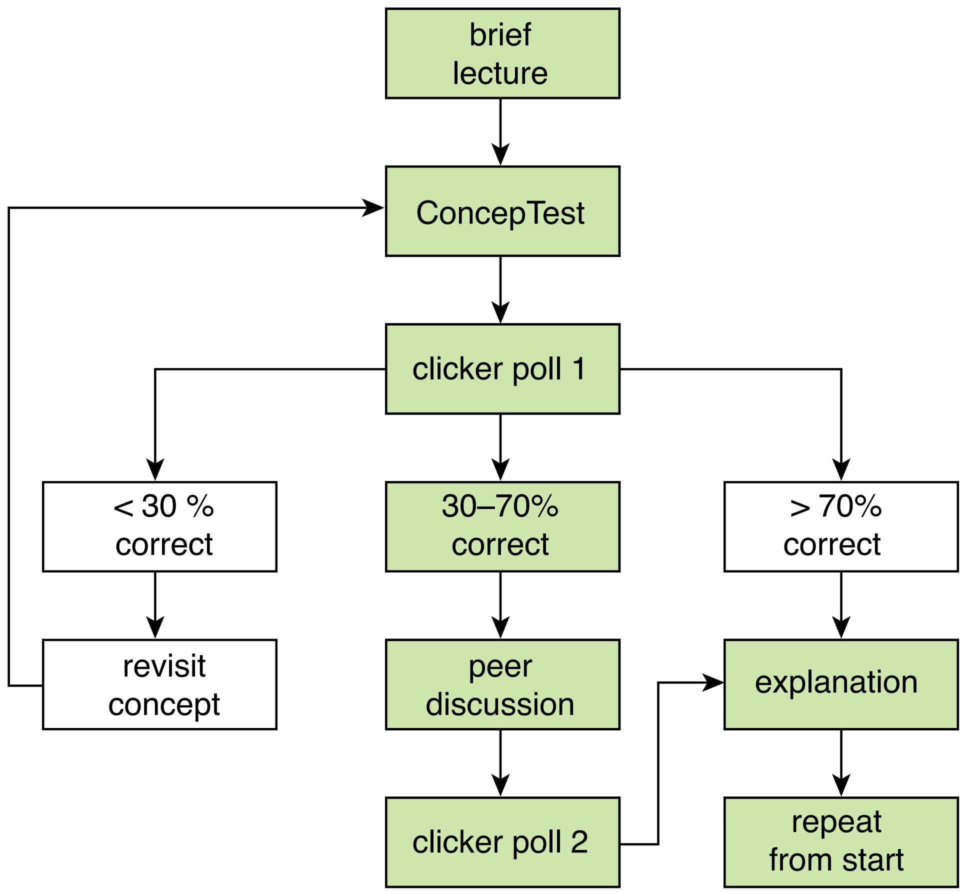
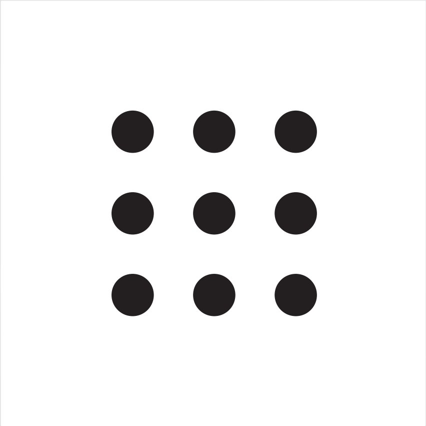


Let’s try it!

thermal expansion

Let's try it!

When metals heat up, they expand because all atoms get farther away from each other.



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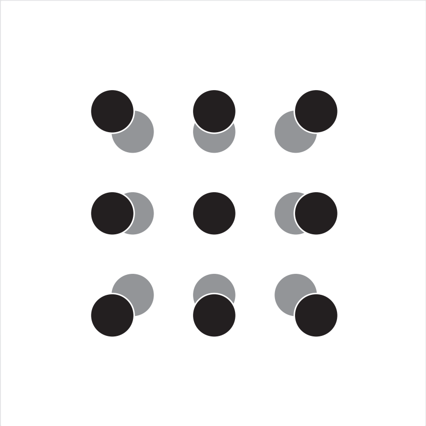
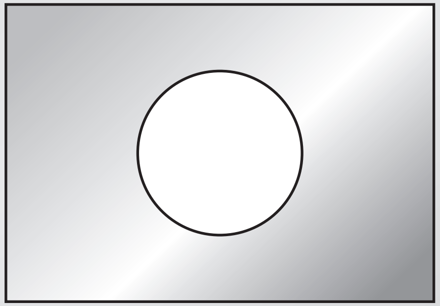


Let's try it!

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



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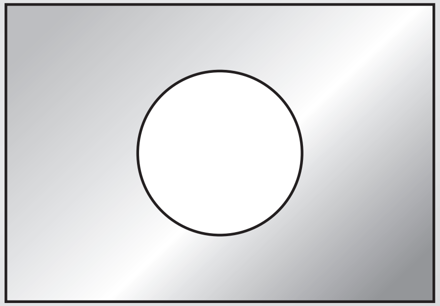


When the plate is uniformly heated, the diameter of the hole

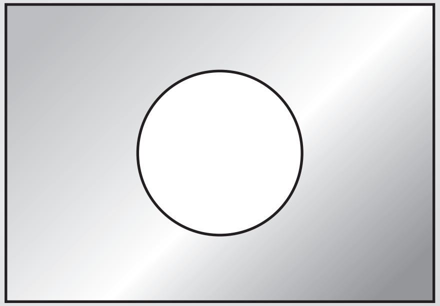
1. increases.
2. stays the same.
3. decreases.

Let’s try it!

It’s easy to fire up the audience!

Let's try it!

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



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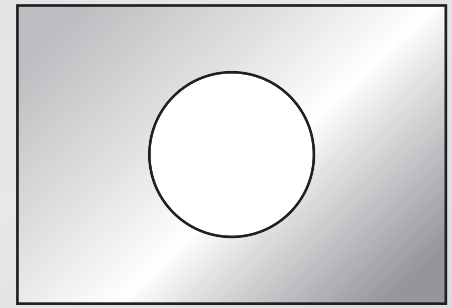

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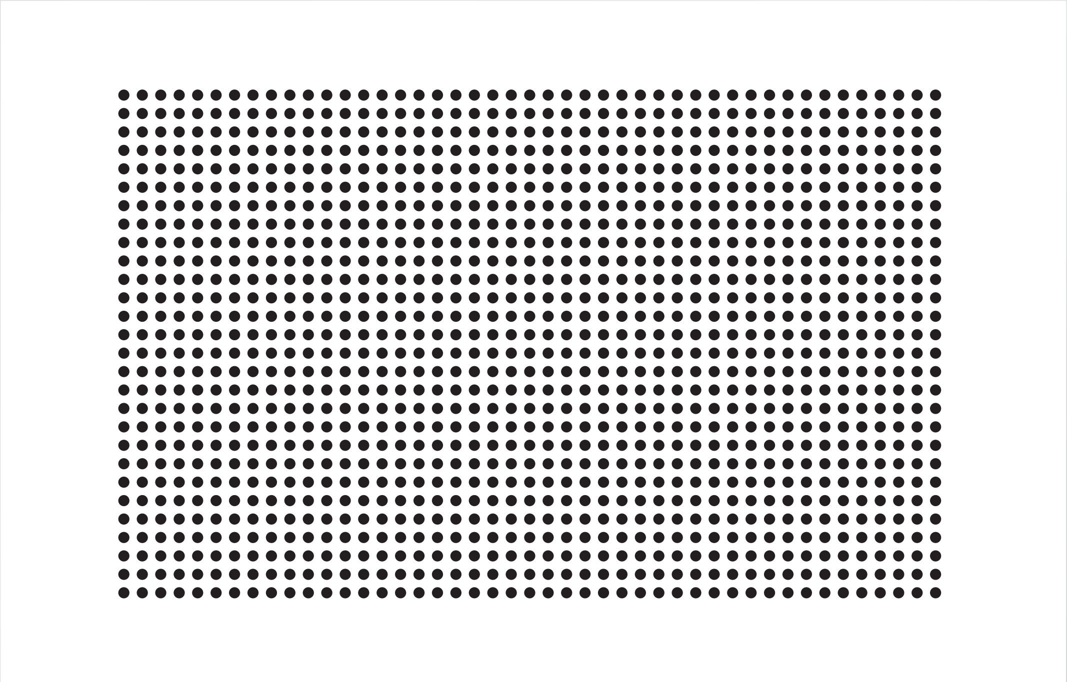
Let's try it!

remember: all atoms must get farther away from each other!



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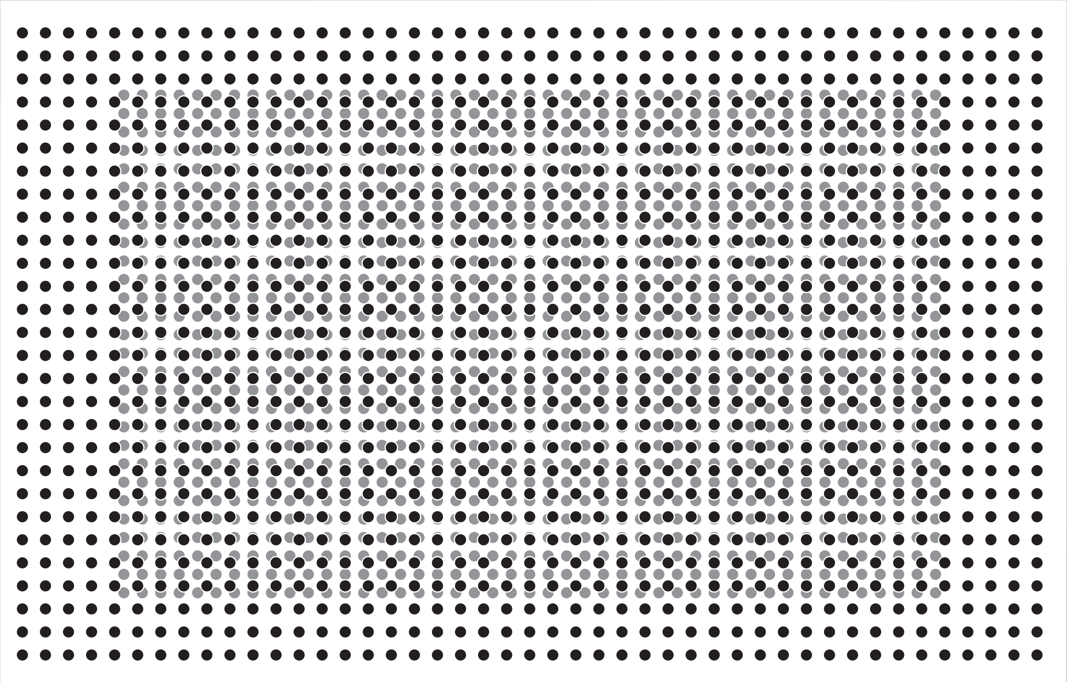
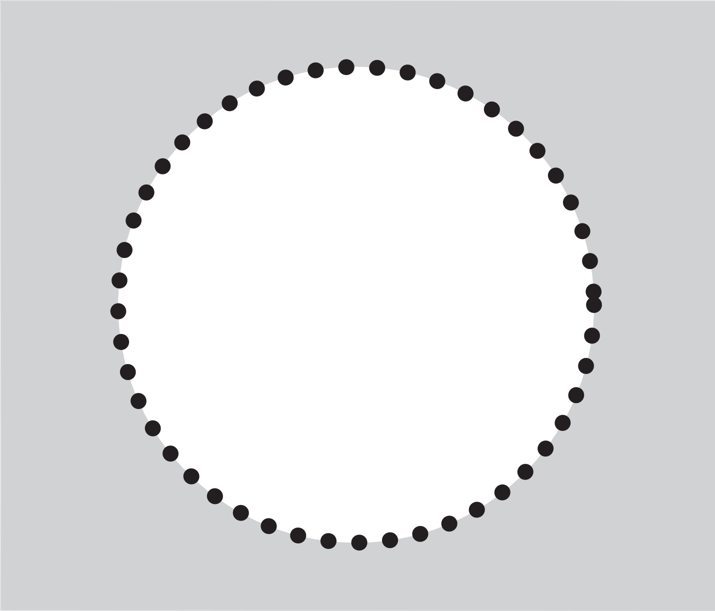


Let's try it!

consider the atoms at the rim of the hole



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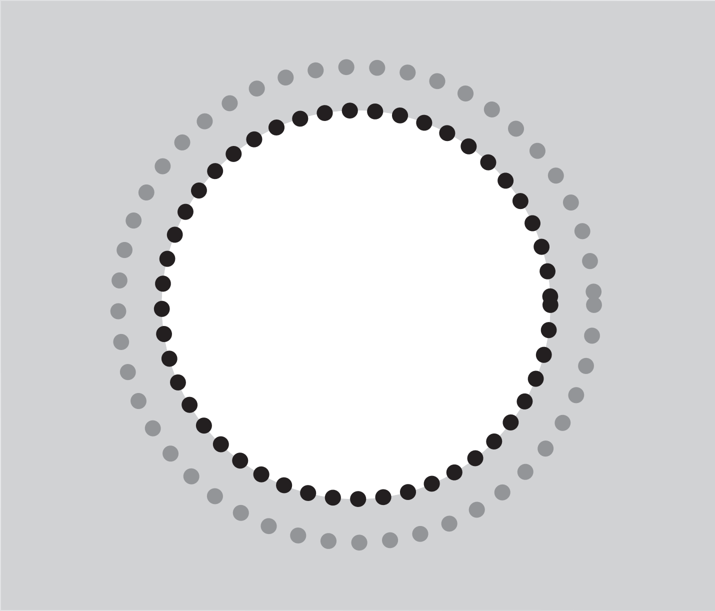

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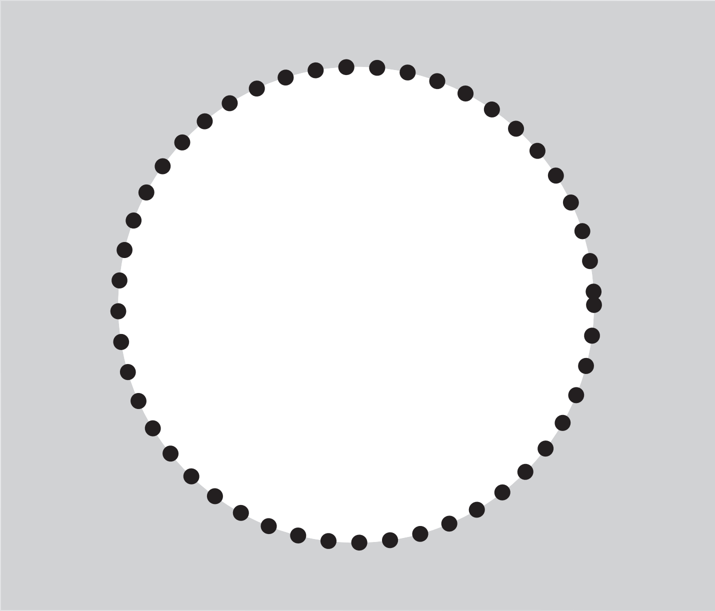

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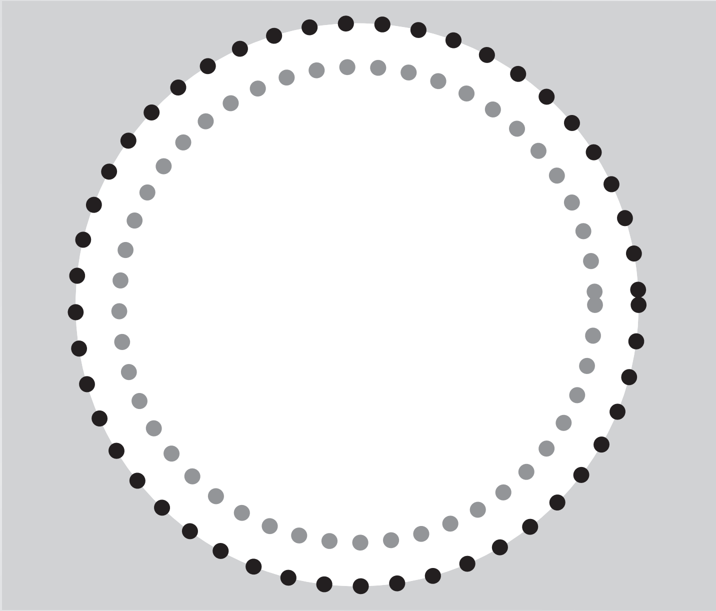

Consider this

Professors A and B teach the same mechanics class at the same college during different semesters. Professor A uses the traditional approach to teaching and lectures. Professor B uses Peer Instruction and students respond to the questions using clickers. Each class is evaluated using the traditional end-of-semester questionnaire and using the FCI to measure students' comprehension of mechanics. Both professors are middle-aged and male. The results are as follows.

A: student evaluation: 1.5/5.0; <g> = 0.42
B: student evaluation: 3.7/5.0; <g> = 0.57

Consider this

Professor	A	B
pedagogy	traditional	PI with clickers
student evaluation	1.5/5.0	3.7/5.0
FCI <g>	0.42	0.57

What might account for the large difference in evaluation?

I. professor personality
II. technology
III. pedagogy

1. I only
2. II only
3. III only
4. II and III
5. I, II, and III
6. other combination

Consider this

a couple of points worth noting:

Consider this

a couple of points worth noting:

1. you got engaged

Consider this

a couple of points worth noting:

1. you got engaged
2. no “correct” answer

Consider this

a couple of points worth noting:

1. you got engaged
2. no “correct” answer
3. you got engaged

Consider this

a couple of points worth noting:

1. you got engaged
2. no “correct” answer
3. you got engaged
4. you don’t need a correct answer!

Outline

Outline

- Setting the stage
- Making it happen
- Overcoming barriers

Setting the stage

To set stage for successful implementation, I need to…

Setting the stage

To set stage for successful implementation, I need to…

(actions to take *before* course begins)

Setting the stage

- convince yourself (and your colleagues)
- set learning goals
- select approaches
- identify resources

Setting the stage

Pre/post-testing important for:

- justifying approach
- improving implementation

Setting the stage

Evaluate assessment by comparing

student performance on various kinds of problems

Setting the stage

What constitutes a good problem?

Setting the stage

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.

Setting the stage

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.

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

Setting the stage

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.

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

Requires:

Assumptions
Developing a model
Applying that model

Setting the stage

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. On average people shop for 2 hours.

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

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

Setting the stage

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. On average people shop for 2 hours.

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

Setting the stage

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

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

Setting the stage

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

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

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

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

Requires:

Using a calculator

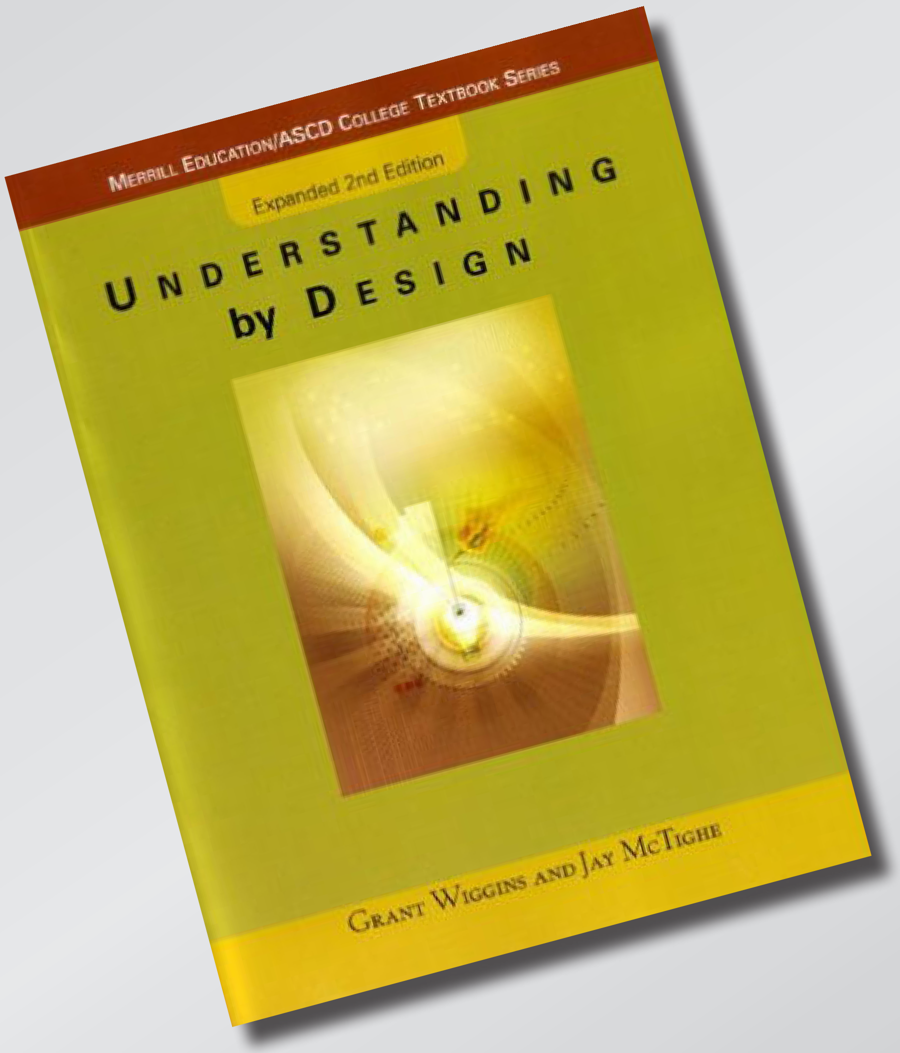
$$t_{wait} = \frac{T_{shop}}{N_{spaces}}$$

Setting the stage

Need to test meaningful skills!

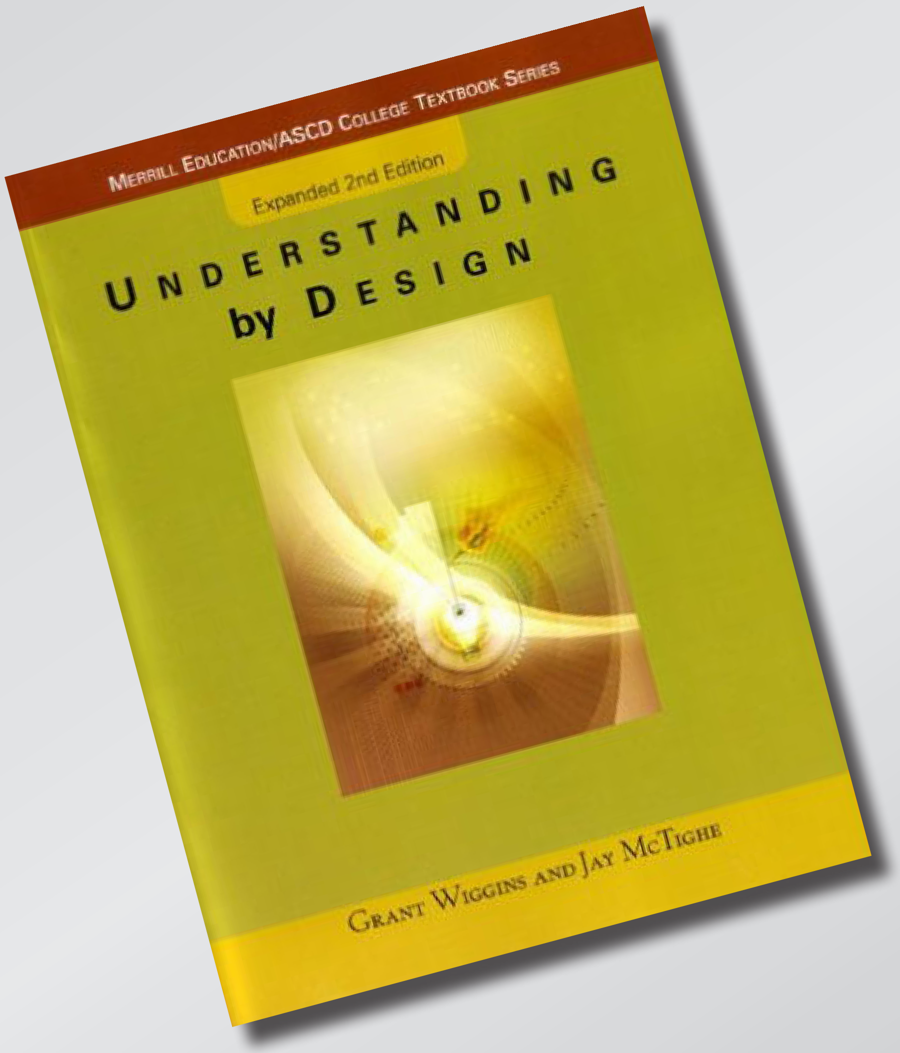
Setting the stage

Setting learning goals



Setting the stage

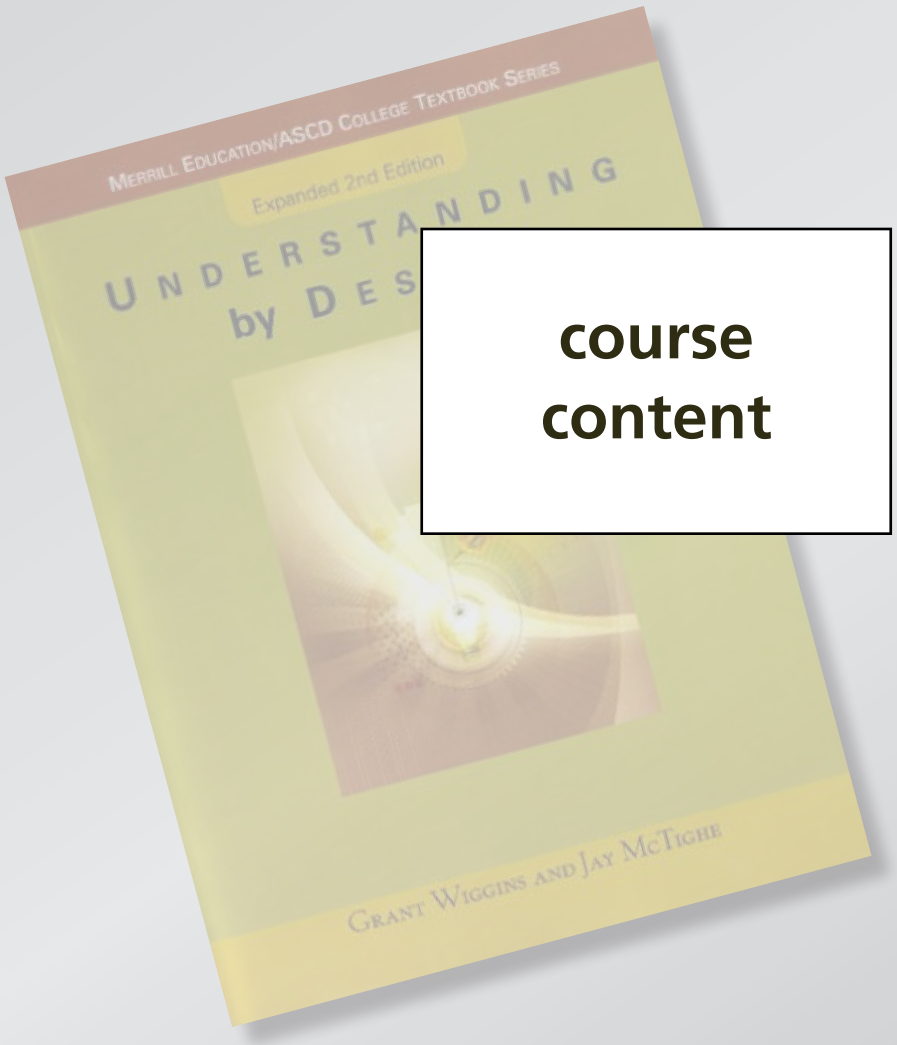
Setting learning goals



- approach, not content
- focus on understanding
- backward design

Setting the stage

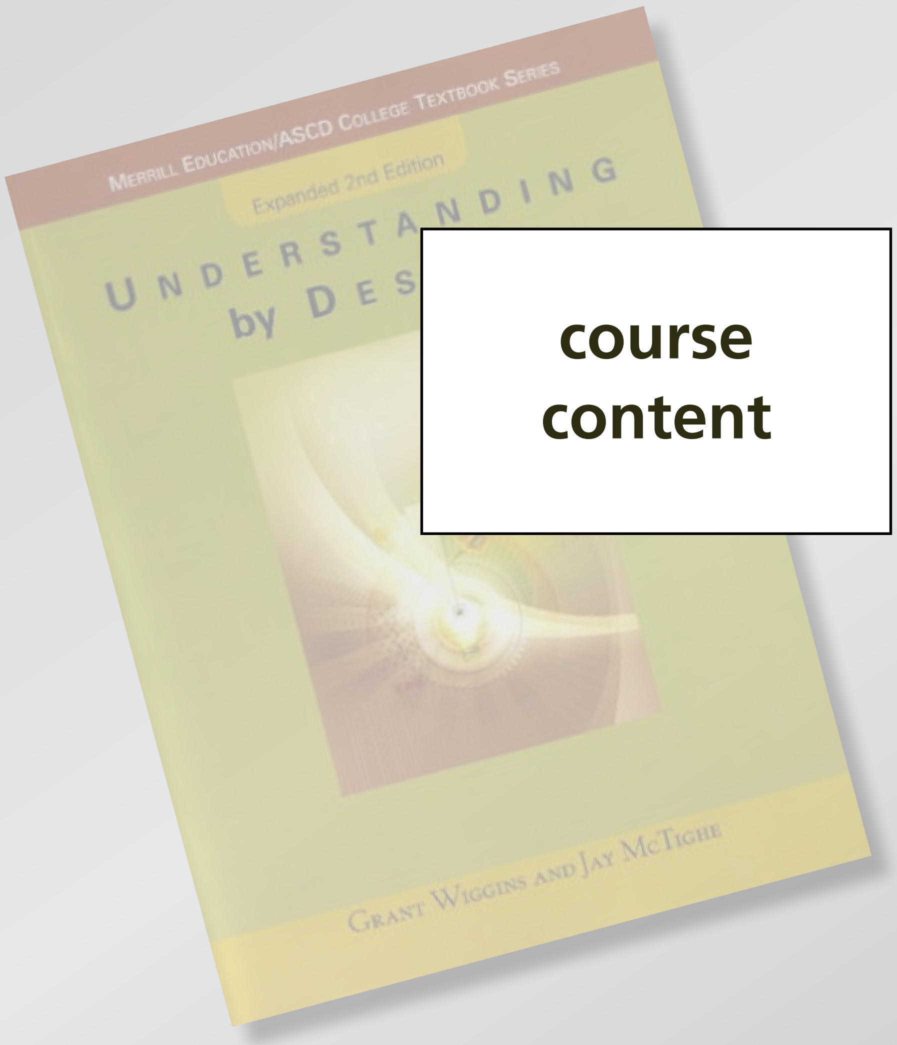
Traditional approach to course planning



course content

Setting the stage

Traditional approach to course planning



course content ▶ assessment

Setting the stage

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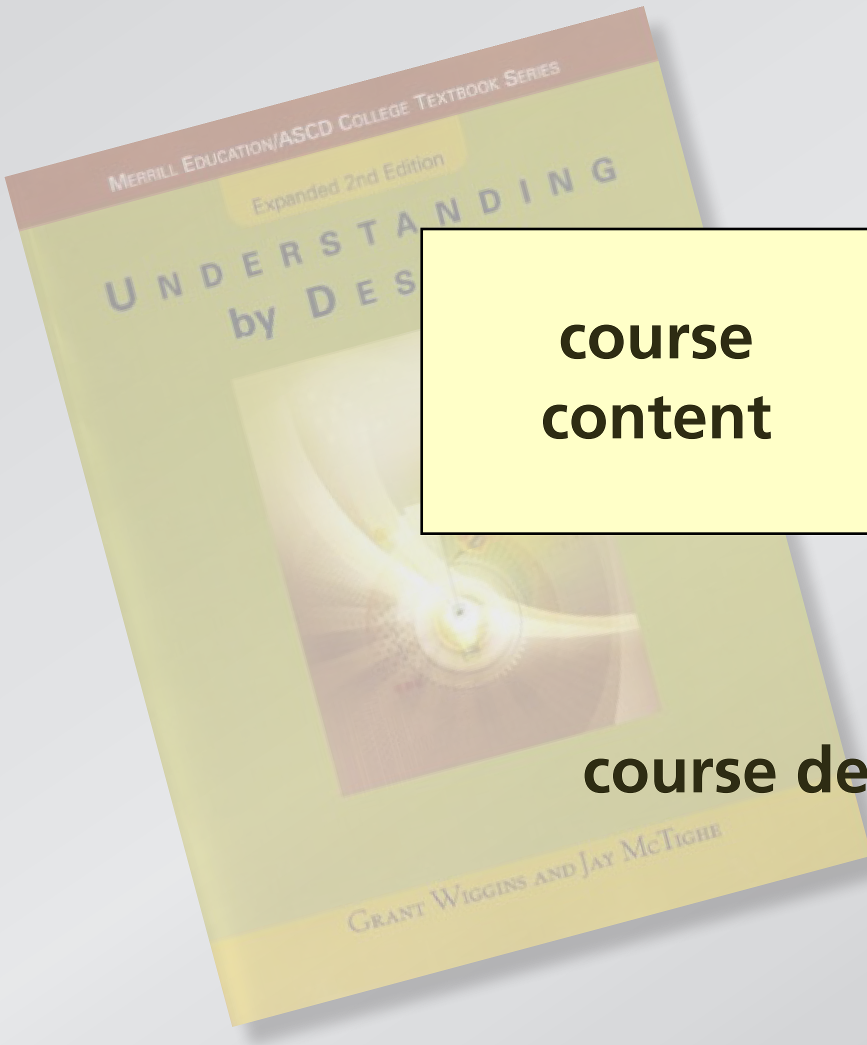
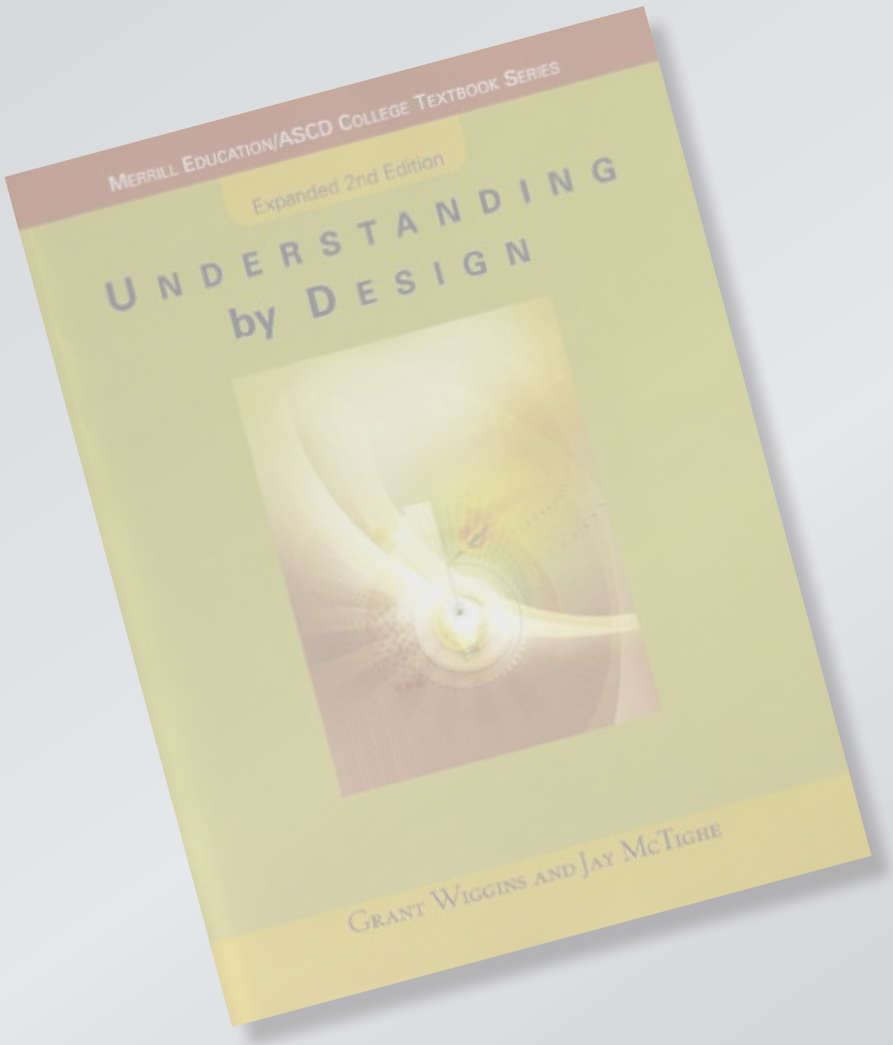


course content ► assessment

course defined by content

Setting the stage

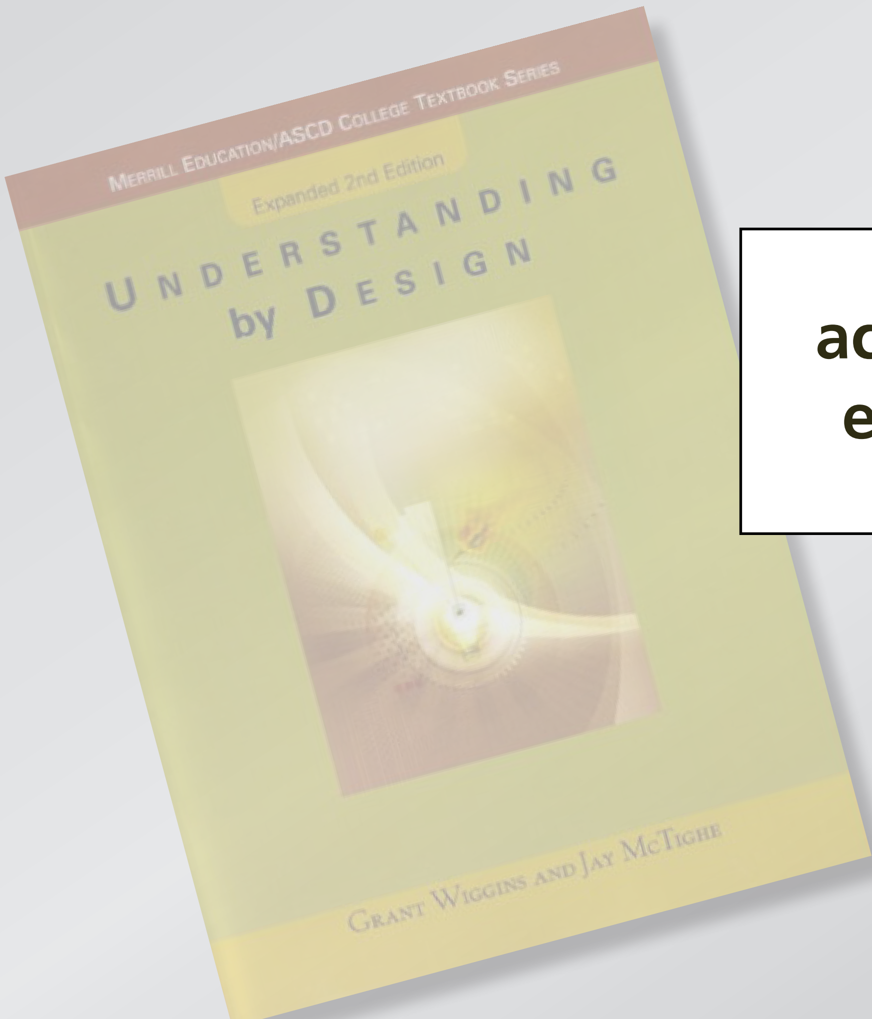
Backward design



desired outcomes

Setting the stage

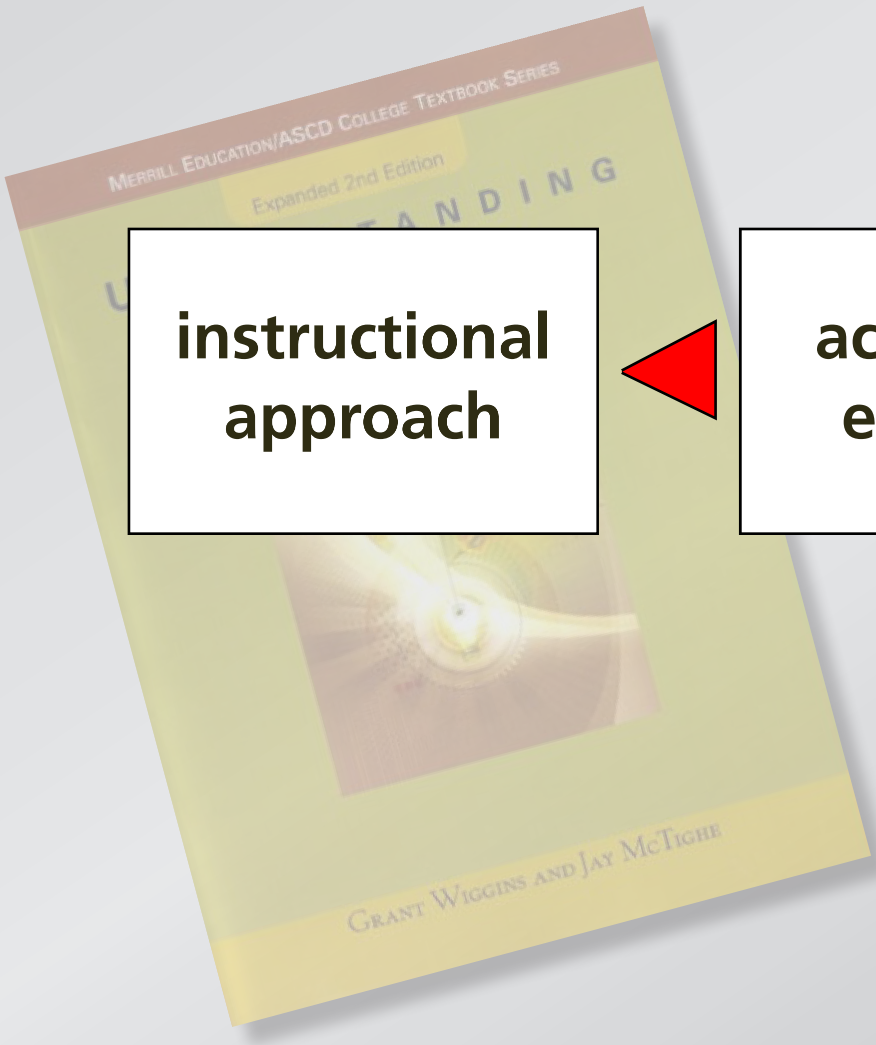
Backward design



acceptable evidence ◀ desired outcomes

Setting the stage

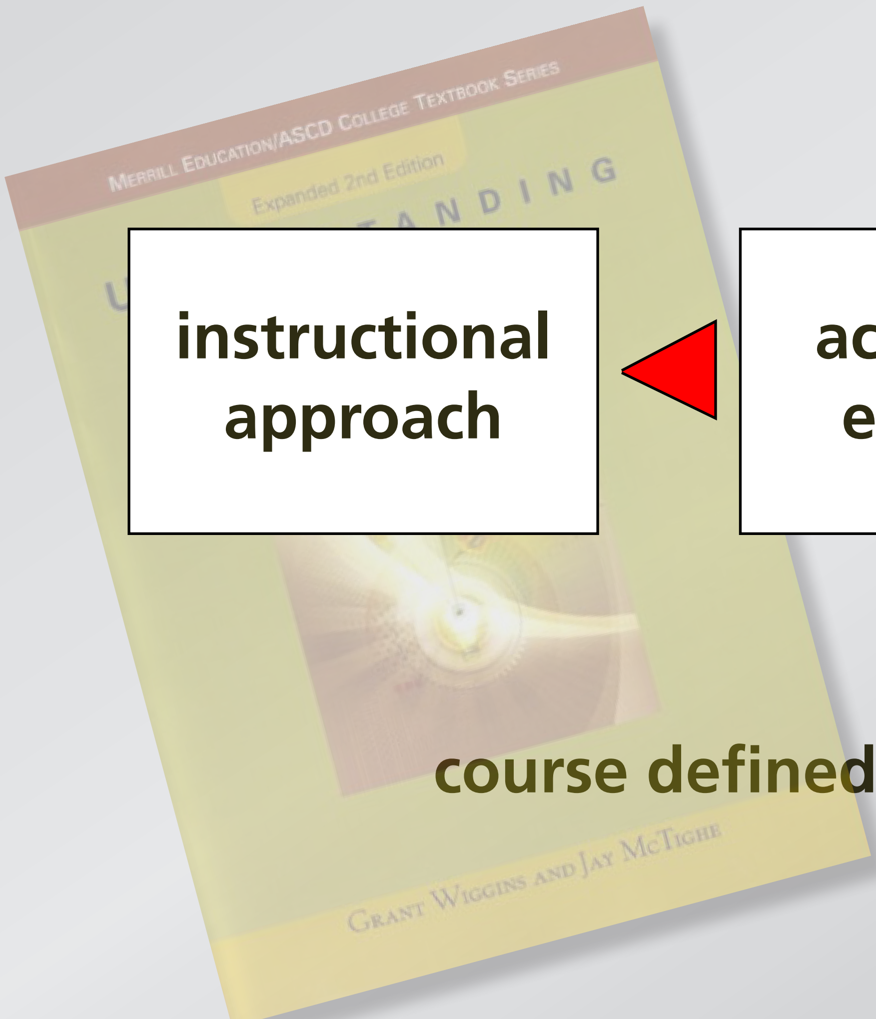
Backward design



instructional approach ◀ **acceptable evidence** ◀ **desired outcomes**

Setting the stage

Backward design



instructional approach ◀ acceptable evidence ◀ desired outcomes

course defined by desired outcomes

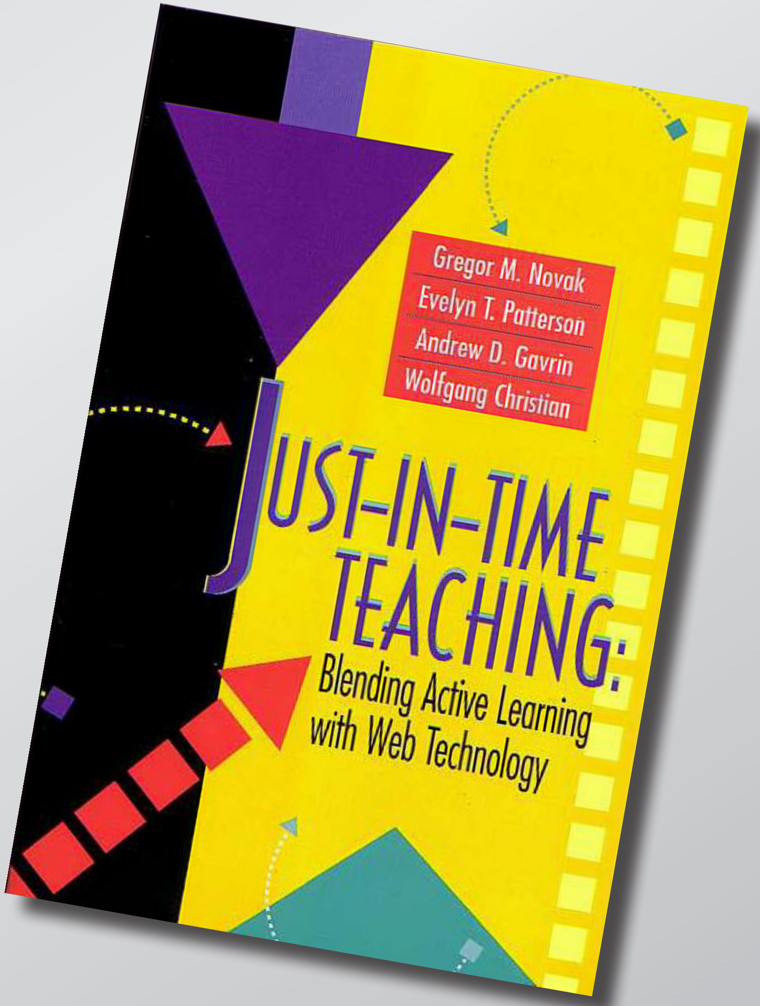
Setting the stage

How to move information transfer out of classroom?

Setting the stage

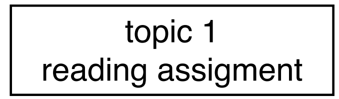
Just-in-time-Teaching (JiTT)

www.jitt.org



Setting the stage

JiTT workflow



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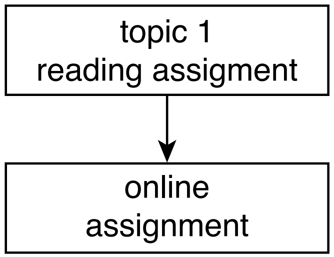

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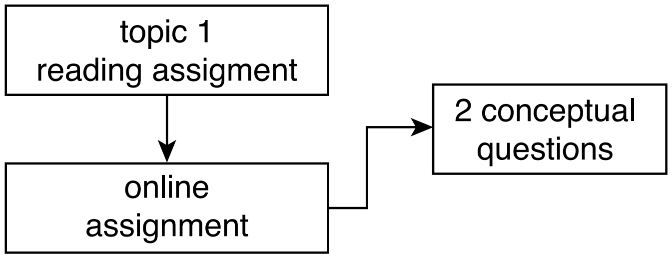

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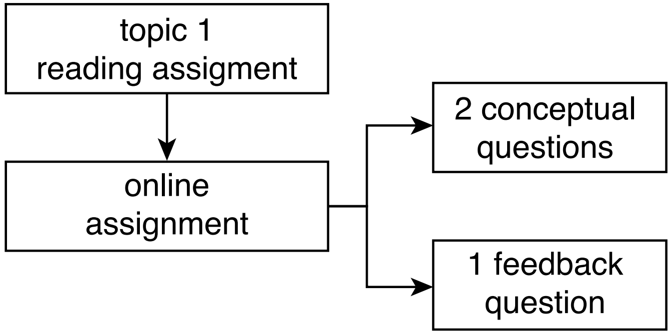

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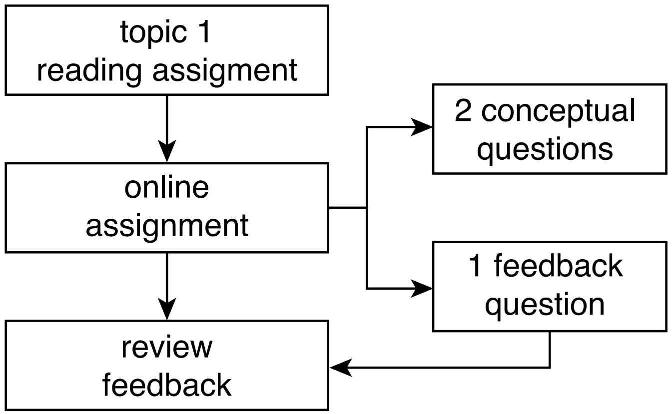

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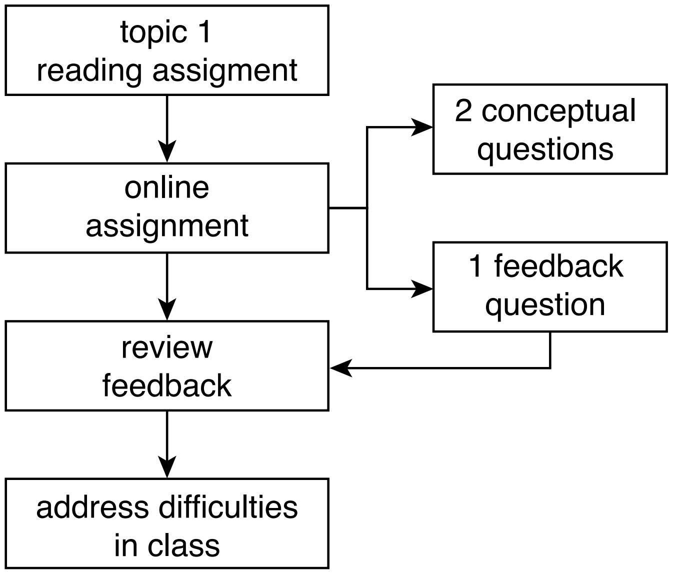

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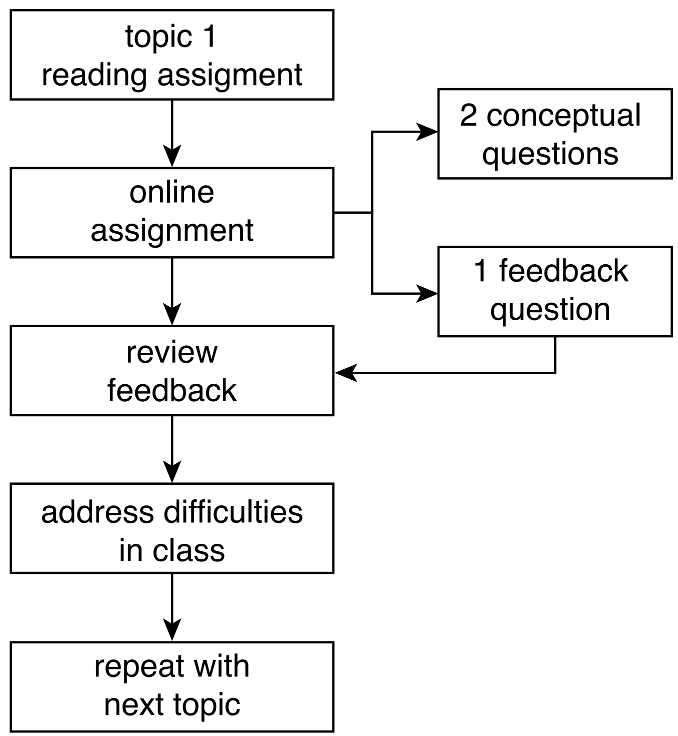


Setting the stage

JiTT:

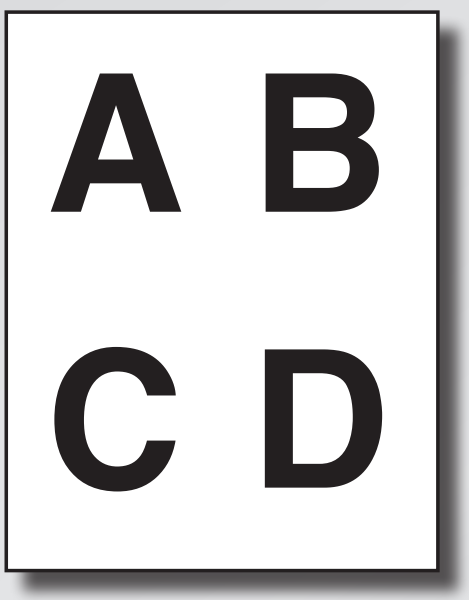
- prepares you for class
- prepares students for class
- helps you address student difficulties

Setting the stage

Are clickers a required resource?

Setting the stage

Flashcards: simple and effective



Setting the stage

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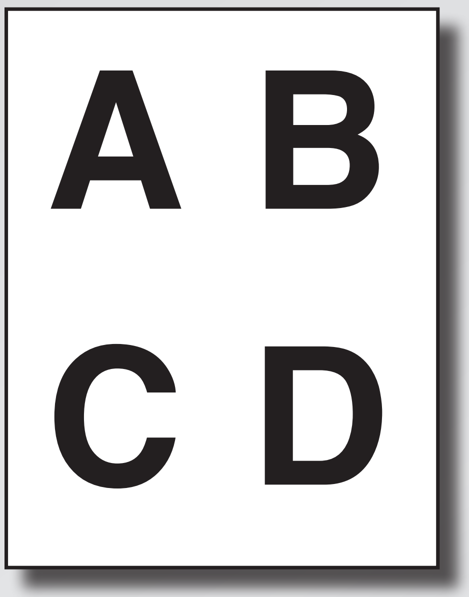

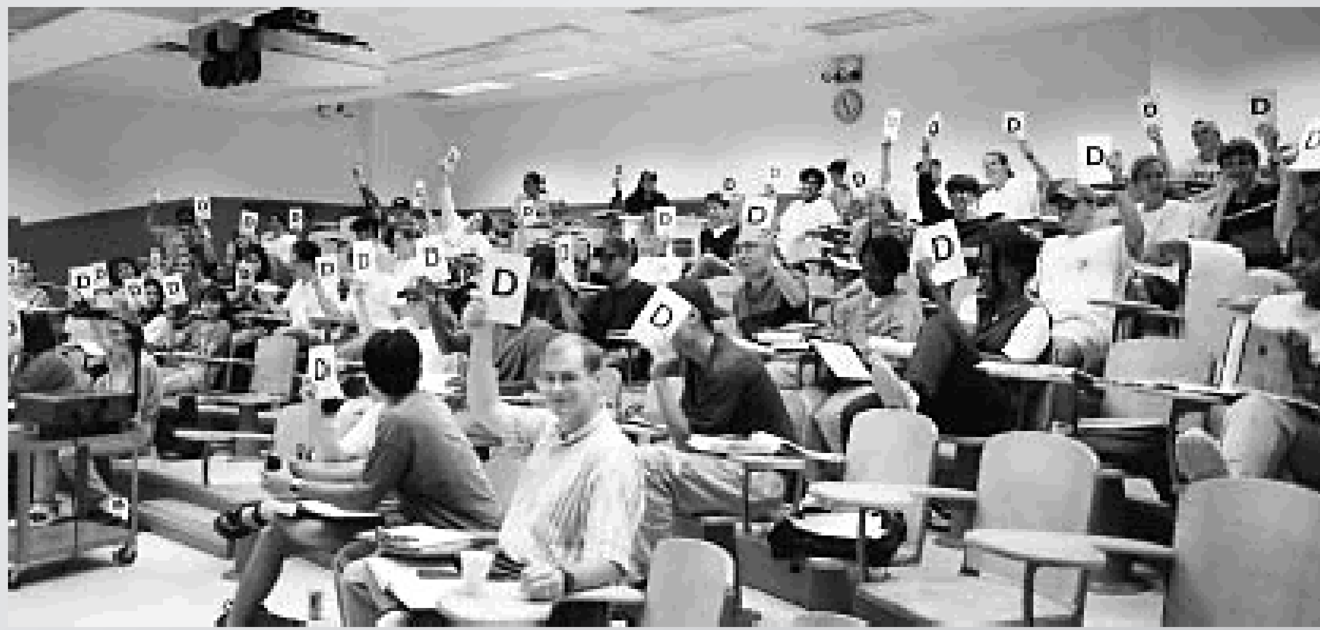

Meltzer and Mannivanan, South Eastern Louisiana University

Setting the stage

Imagine a rope that fits snugly along the equator.

Setting the stage

Imagine a rope that fits snugly along the equator.

Suppose the rope is cut and 1 m of rope is inserted between the cut ends. If the rope were to maintain a circular shape, how far off the surface of the Earth would it float?

1. the width of a few atoms
2. the width of a few hairs
3. the height of a curb
4. exactly 1 m
5. more than 1 m

Setting the stage

Imagine a rope that fits snugly along the equator.

Suppose the rope is cut and 1 m of rope is inserted between the cut ends. If the rope were to maintain a circular shape, how far off the surface of the Earth would it float?

1. the width of a few atoms
2. the width of a few hairs
3. **the height of a curb ✔**
4. exactly 1 m
5. more than 1 m

Setting the stage

circumference at equator:

$$2\pi R_E$$

Setting the stage

circumference at equator:

$$2\pi R_{\mathrm{E}}$$

new circumference:

$$2\pi R_{\mathrm{E}} + 1\ \mathrm{m}$$

Setting the stage

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$$2\pi R_{\mathrm{E}}$$

new circumference:

$$2\pi R_{\mathrm{E}} + 1\ \mathrm{m}$$

radius of circle with new circumference:

$$2\pi R = 2\pi R_{\mathrm{E}} + 1\ \mathrm{m}, \quad \textbf{and so} \quad R = R_{\mathrm{E}} + \frac{1\ \mathrm{m}}{2\pi}.$$

Setting the stage

You all got fired up!

Setting the stage

You all got fired up!

(WITHOUT CLICKERS!)

Setting the stage

It’s not the technology, but the pedagogy!

Setting the stage

It’s not the technology, but the pedagogy!

(but clickers do offer advantages)

Outline

- Setting the stage
- **Making it happen**
- Overcoming barriers

Making it happen

To make it happen, I need to…

Making it happen

To make it happen, I need to…

(actions to take during course)

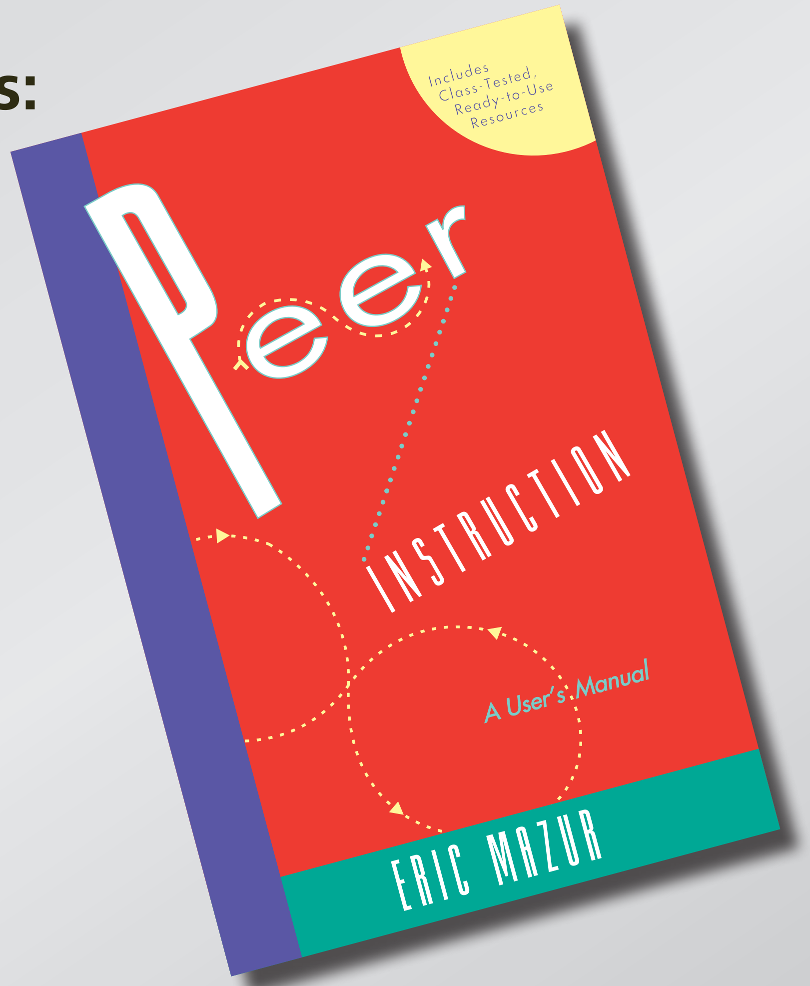
Making it happen

- find or develop good questions
- know how to manage time

Making it happen

Books with ConcepTests:

- **Physics (Prentice Hall)**



Making it happen

Books with ConcepTests:

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

Making it happen

Books with ConcepTests:

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

Making it happen

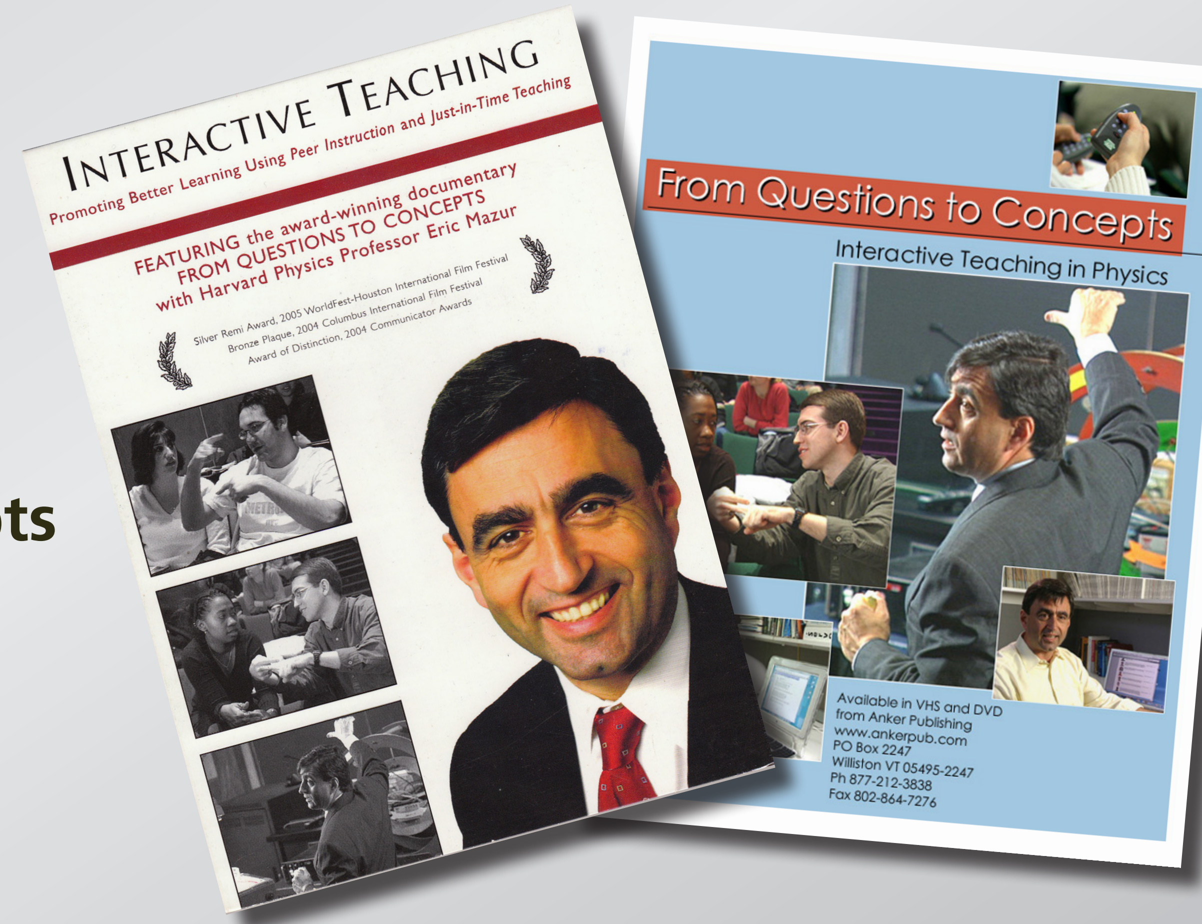
Books with ConcepTests:

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

Making it happen

Videos:

- Interactive Teaching DVD
- From questions to concepts



Making it happen

Types of questions

- survey
- discussion
- model testing
- select from list

Making it happen

Which of the following airlines tries to save fuel by suggesting that its passengers use the bathroom before boarding?

1. Delta Airlines
2. Lufthansa
3. All Nippon Airways
4. British Midland Airways
5. Air France
6. JAL
7. Aboriginal Air Services
8. Aeroflot
9. Are you kidding me? None of the above.

Making it happen

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Making it happen

hole in plate/circumference	model
Professor A/B	discussion
airline	fact

Making it happen

hole in plate/circumference	model
Professor A/B	discussion
airline	fact

fact-recall not engaging

Making it happen

Good conceptual questions (ConcepTests):

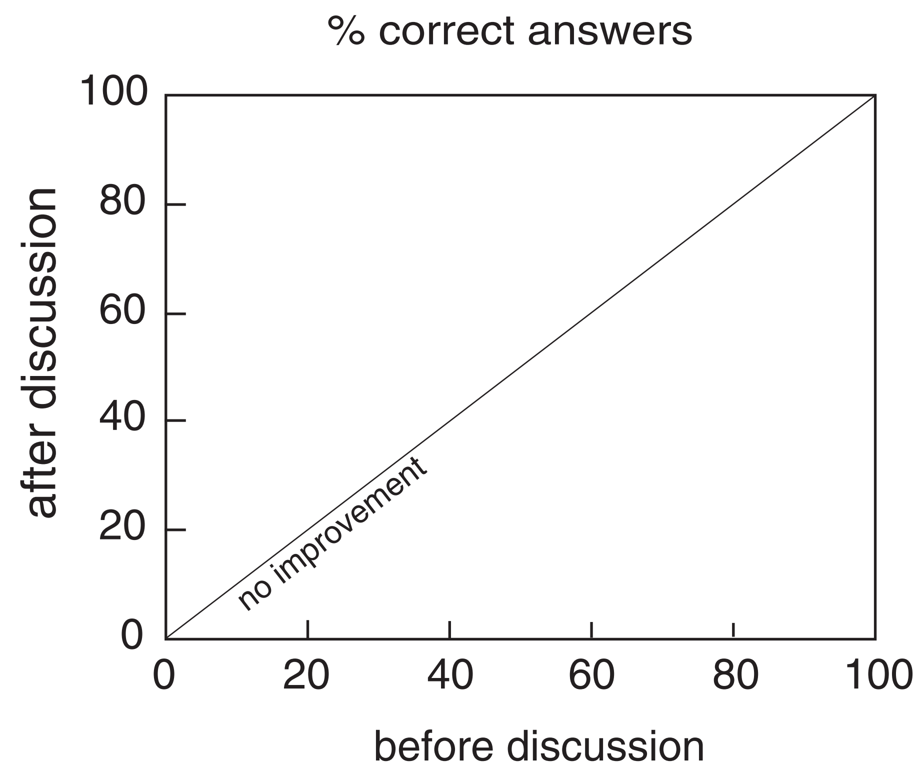
- are based on common student difficulties
- focus on single concept
- require more than “plug and chug”
- are clear and concise
- are of manageable difficulty

Making it happen

must adjust level to audience

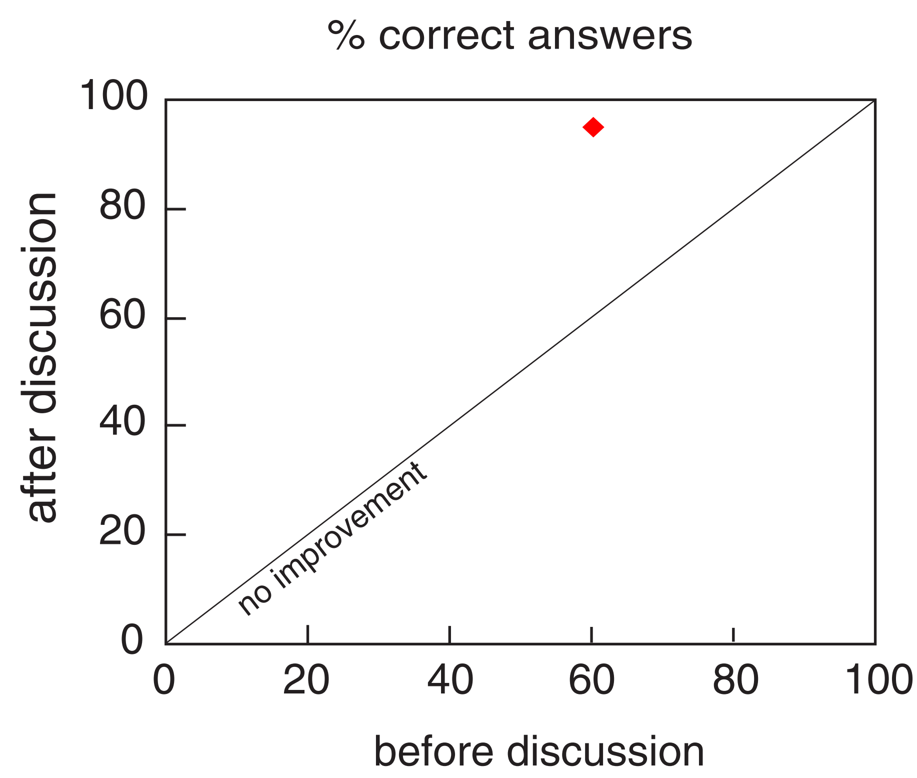
Making it happen

ConcepTest data



Making it happen

ConcepTest data



Making it happen

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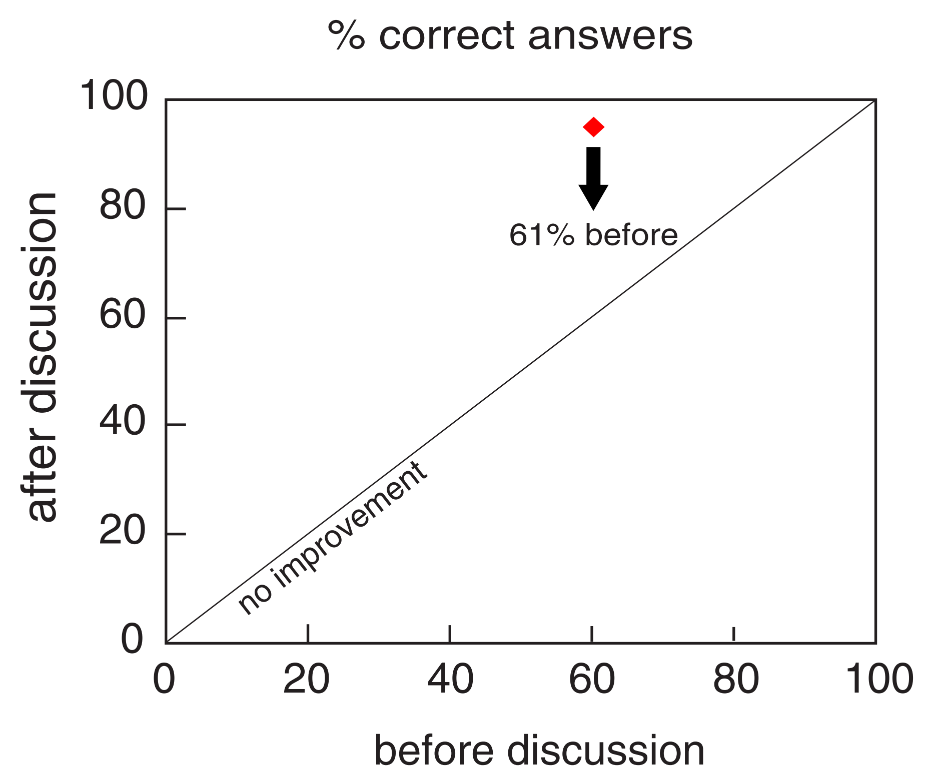

Making it happen

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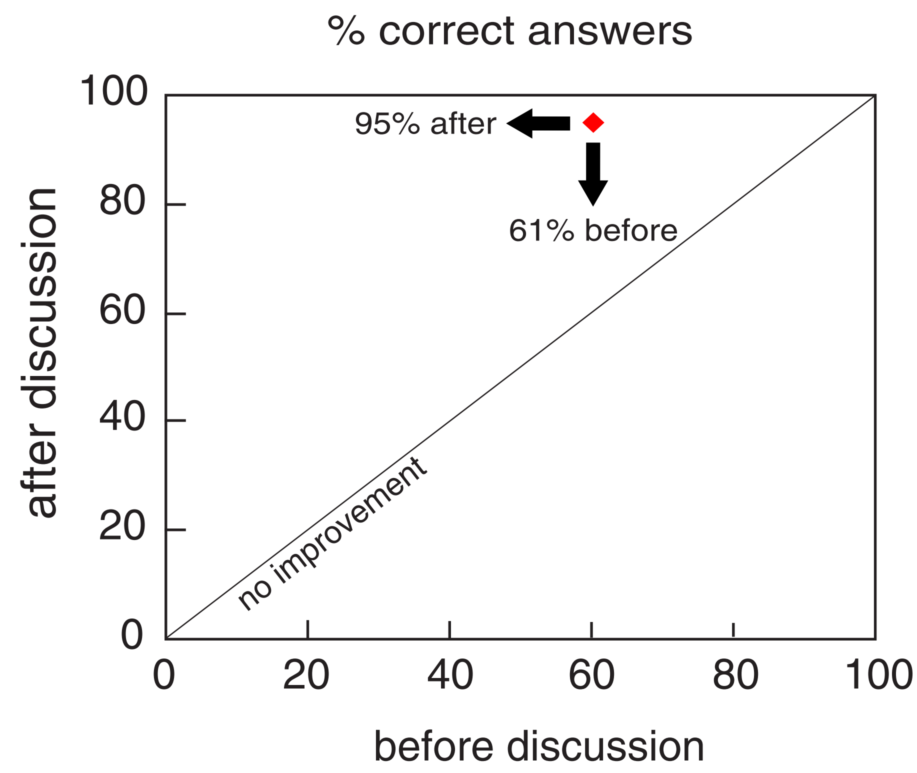

Making it happen

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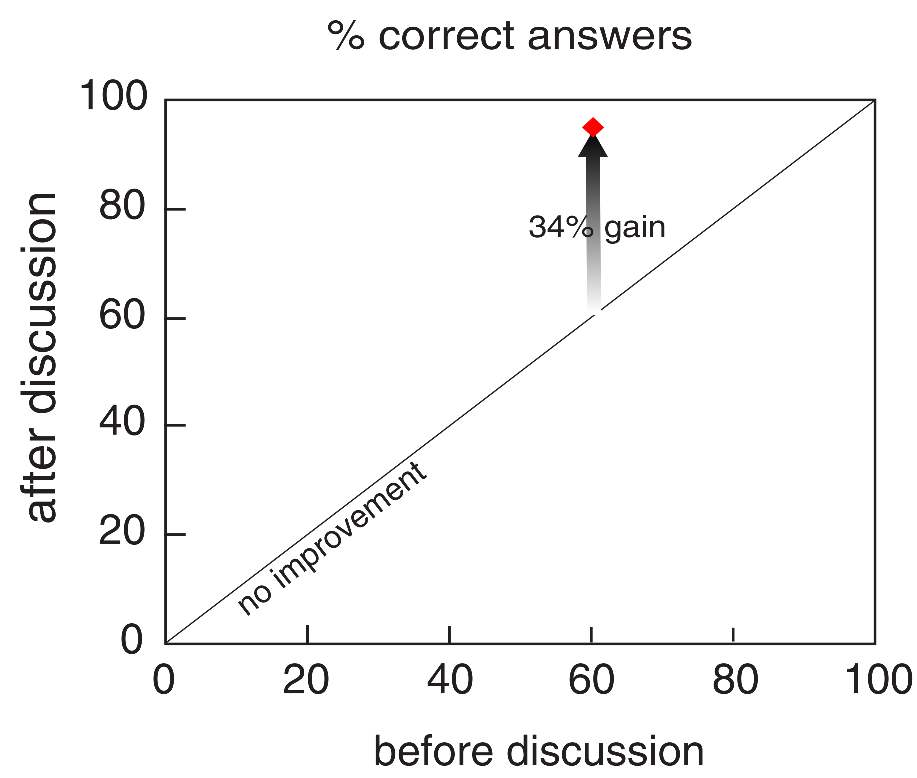

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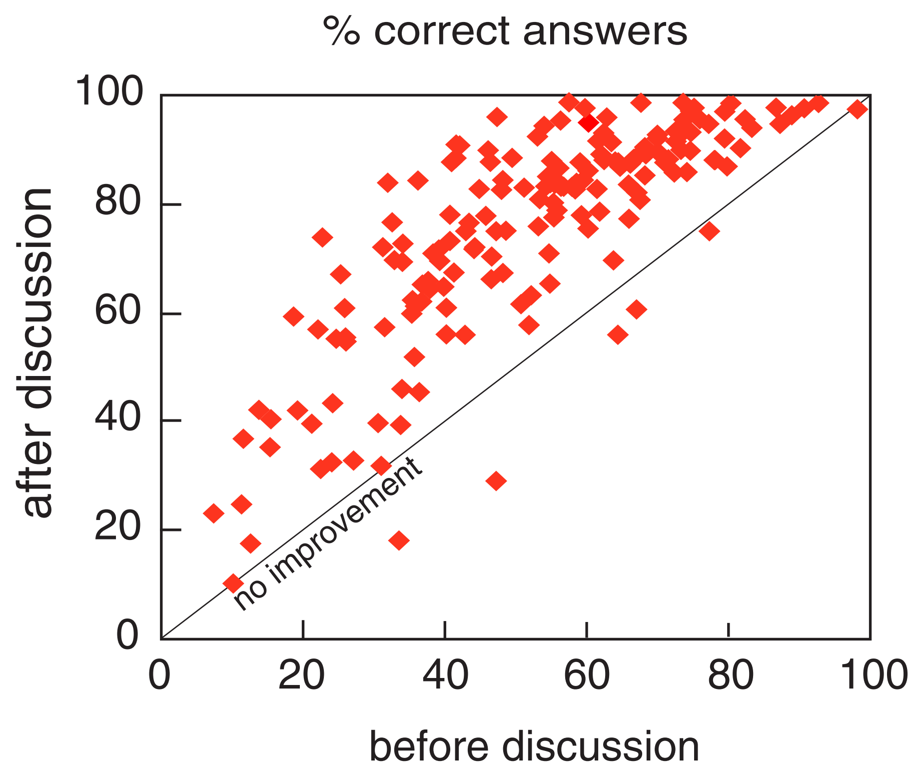

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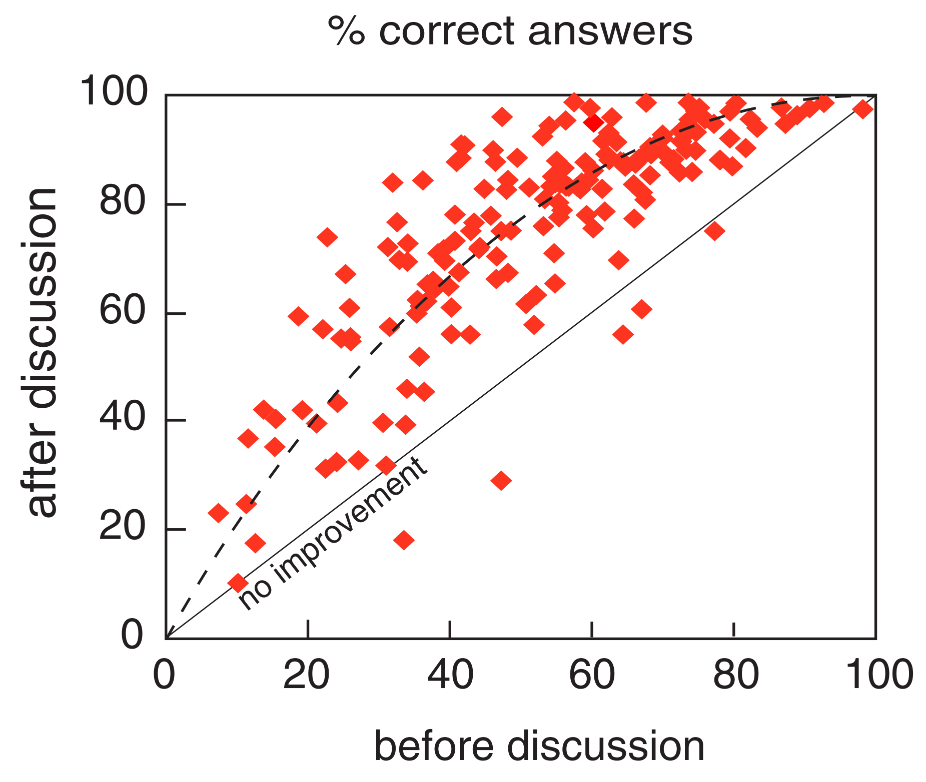

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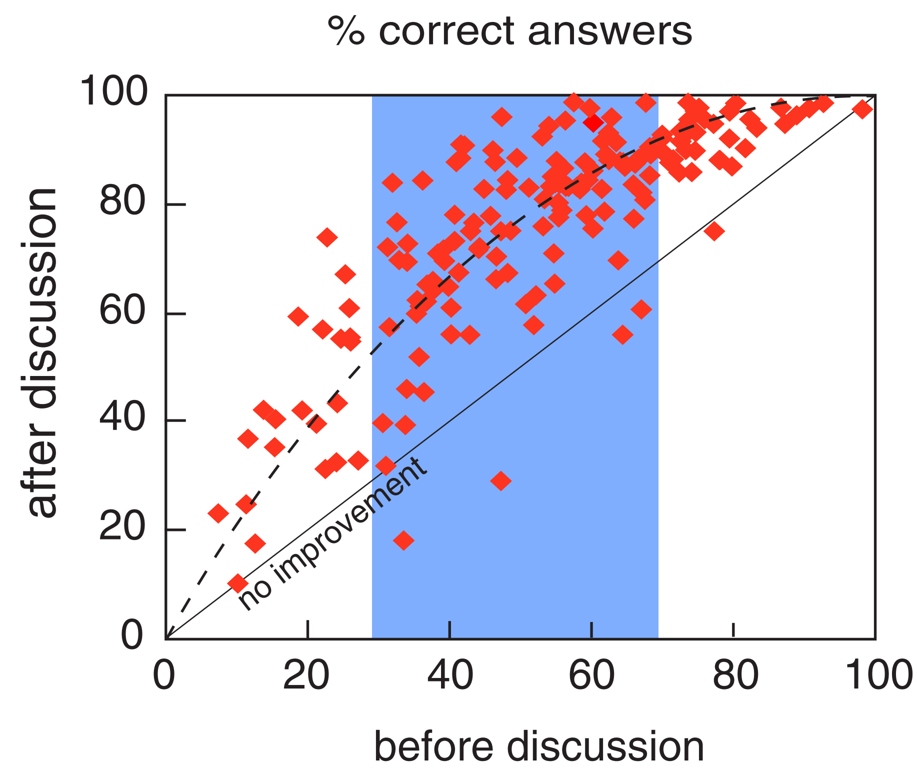

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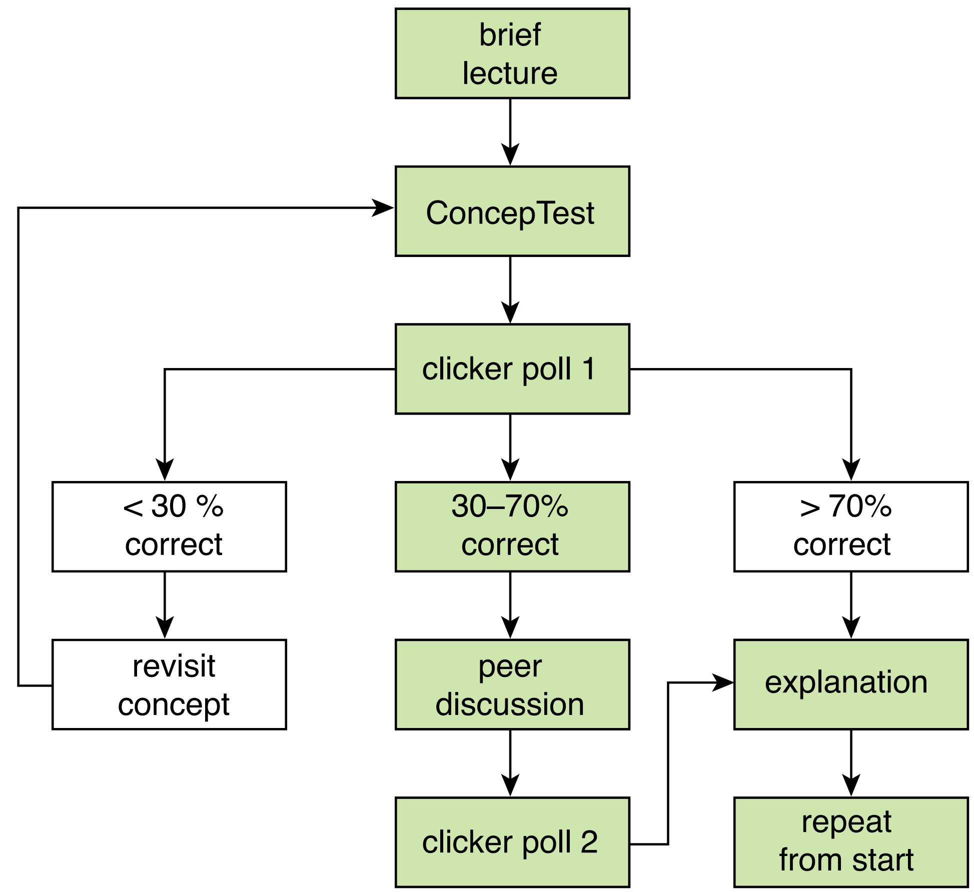


Outline

- Setting the stage
- Making it happen
- **Overcoming barriers**

Overcoming barriers

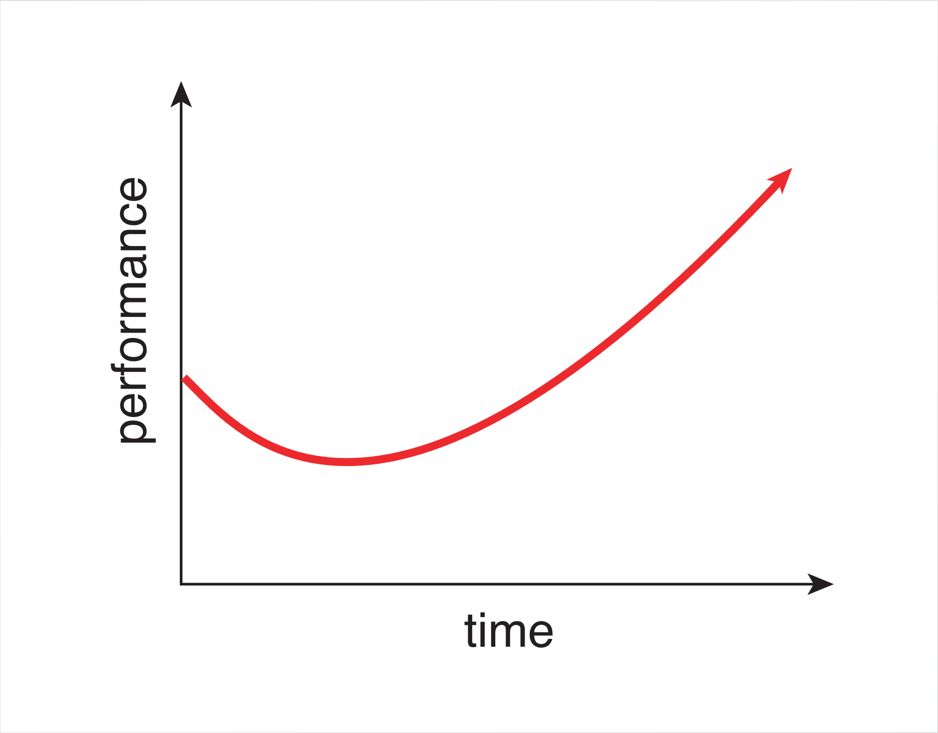
What are some potential barriers?

Overcoming barriers

- skepticism
- growing pains
- negative feedback
- limited circle of influence

Overcoming barriers

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



Overcoming barriers

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

(must recognize confusion as step towards understanding)

Overcoming barriers

Things to do:

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

Overcoming barriers

Why is change so hard?

Overcoming barriers

	“lectures”	PI
coverage	complete	partial
preclass reading	none	cover everything
confusion	little none	substantial
evaluations	known	unknown

Overcoming barriers

	“lectures”	PI	considered
coverage	complete	partial	requirement
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Overcoming barriers

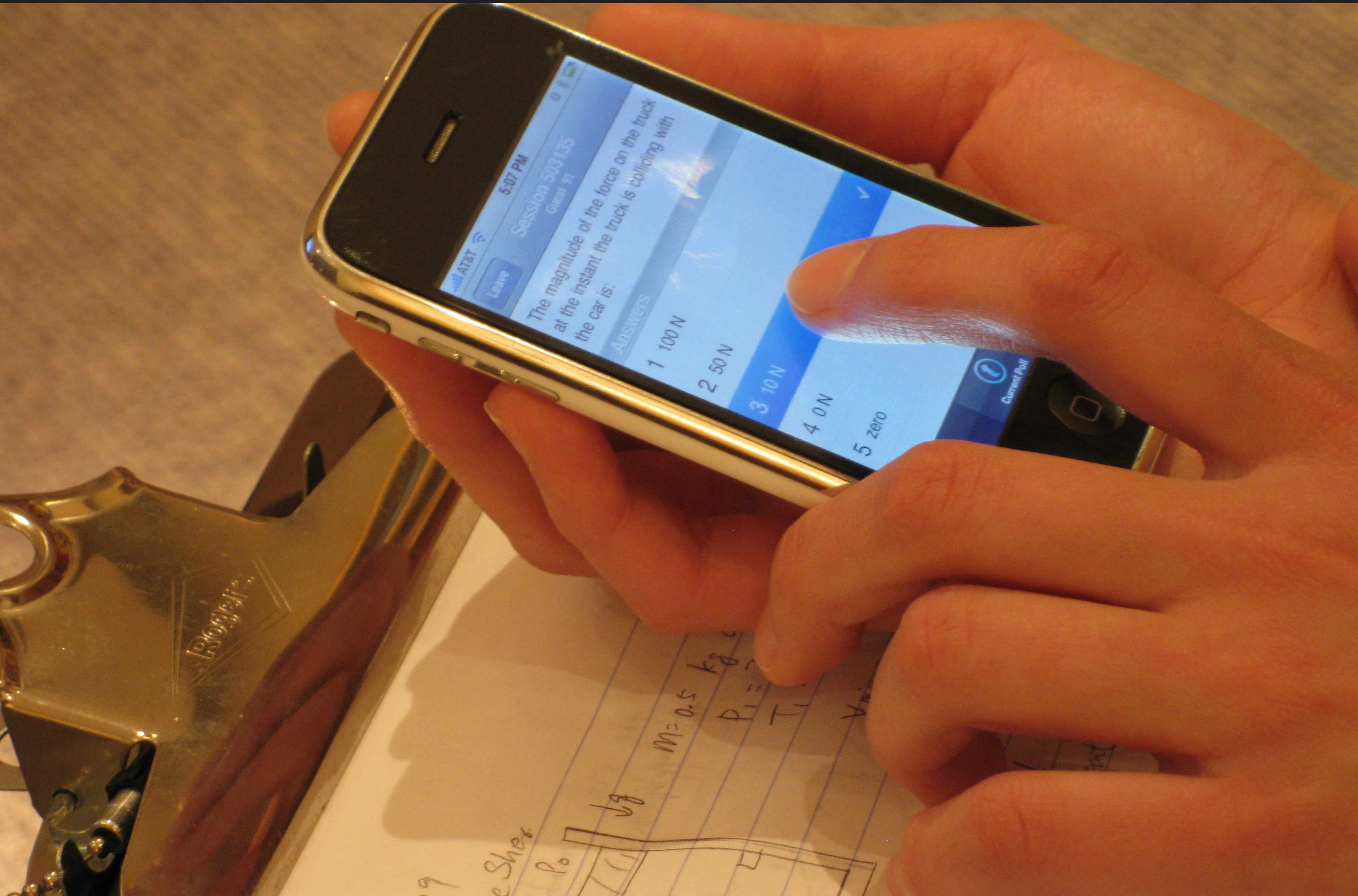
But PI leads to better learning and retention

Overcoming barriers

But PI leads to better learning and retention

(neither of which is traditionally measured)

Summary



AT&T
5:07 PM
Leave
The magnitude of the force on the truck at the instant the truck is colliding with the car is:
Answers
1 100 N
2 50 N
3 10 N
4 0 N
5 zero
Current Poll

Summary

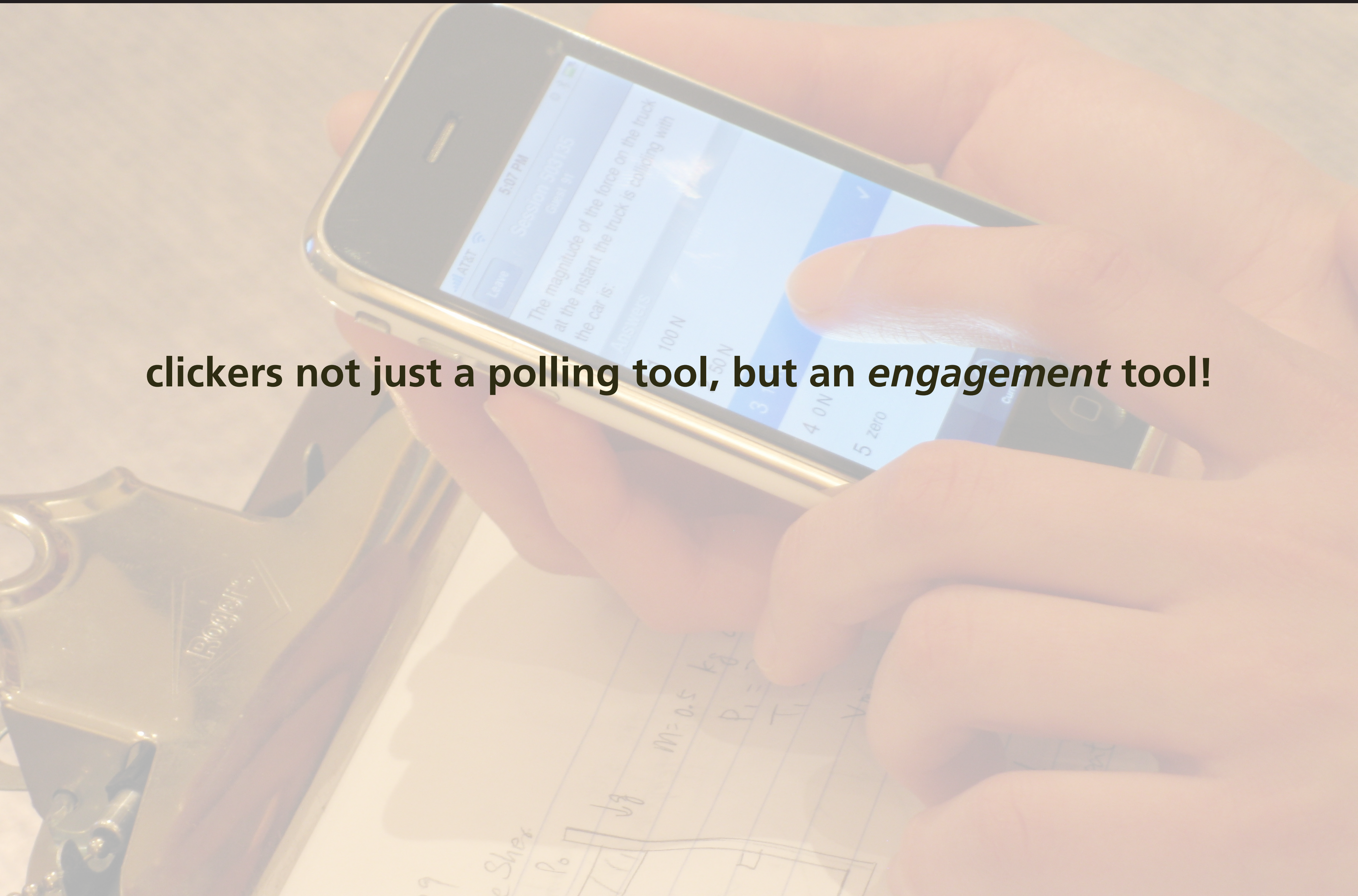
PI easy to implement (and improves learning gains)

Summary

PI easy to implement (and improves learning gains)

technology facilitates active engagement (but not required)

Summary



clickers not just a polling tool, but an *engagement* tool!

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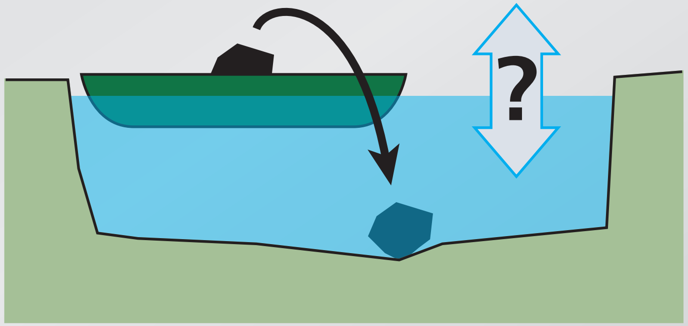
Let's try it!

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.



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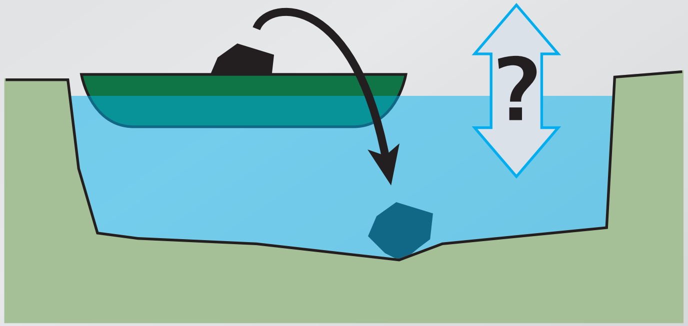

After the boulder sinks to the bottom of the pond, the level of the water in the pond is

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

it was when the boulder was in the boat.

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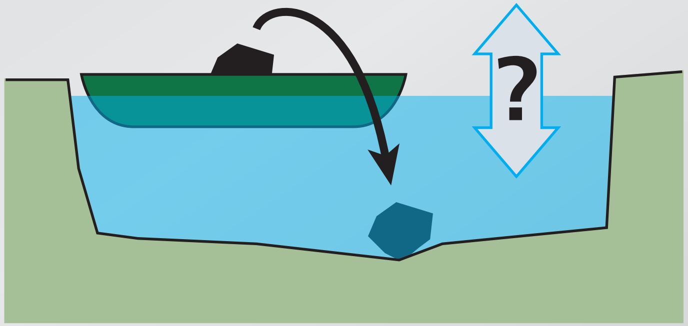

After the boulder sinks to the bottom of the pond, the level of the water in the pond is

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.

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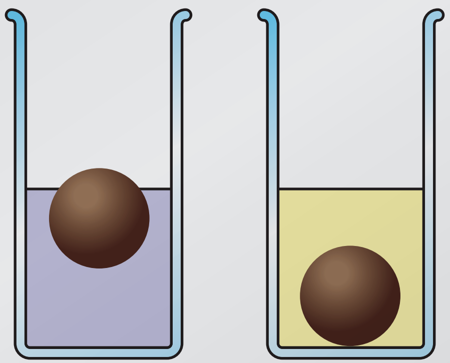
Let’s try it!

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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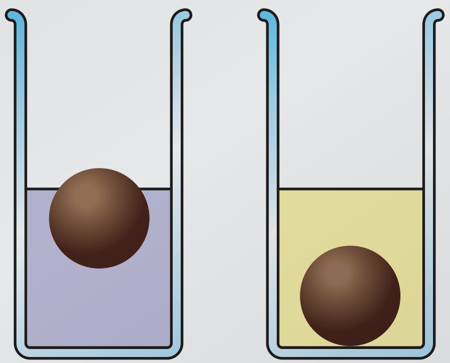
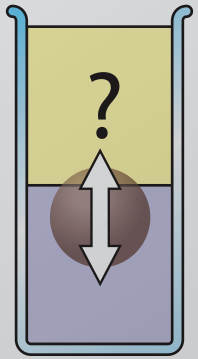


If we slowly pour the oil on top of the water so it completely covers the object, the object



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

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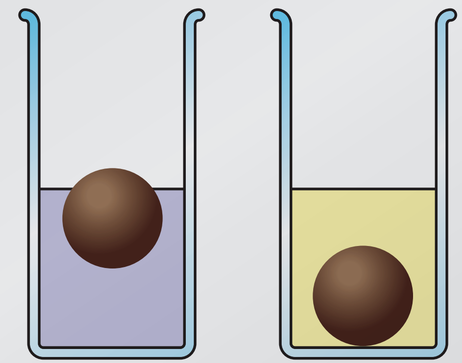

If we slowly pour the oil on top of the water so it completely covers the object, the object

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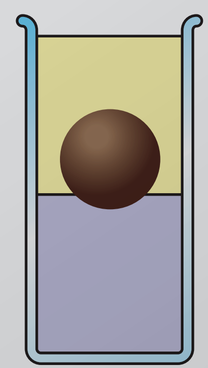

Let’s try it!

It’s easy to make simple demonstrations fascinating!

Let's try it!

The specific heat at constant volume for a monatomic crystal approaches zero at low temperature even though the specific heat for a monatomic gas remains $\frac{3}{2}k$ per atom. Why is this so?

Let’s try it!

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1. Potential energy doesn’t play a role for the monatomic gas, but it does for the crystal.

2. The particles are indistinguishable in the gas, but not in the crystal.

3. The energy difference between allowed states for the crystal is much larger than it is for the atoms.

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