

1. Go to <http://LCatalytics.com>

2a. If you have instructor account: Log in, click "Student view"

2b. Otherwise: Create *student* account with signup code DEMO

3. Join session 1234567

Peer Instruction Workshop



University of Virginia
Charlottesville, 12 April 2013



Peer Instruction Workshop



@eric_mazur



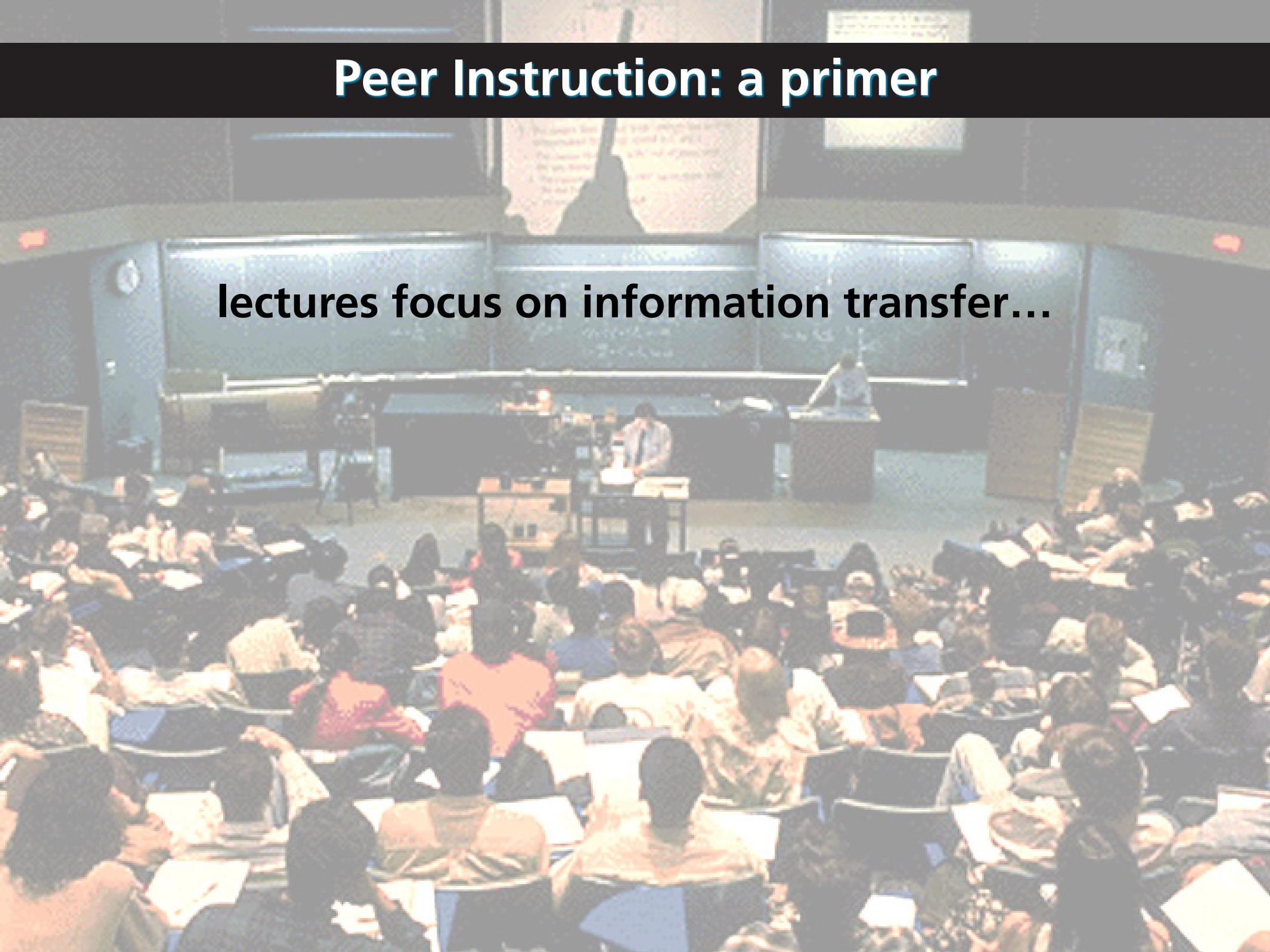
University of Virginia
Charlottesville, 12 April 2013



ERIC MAZUR

Peer Instruction: a primer

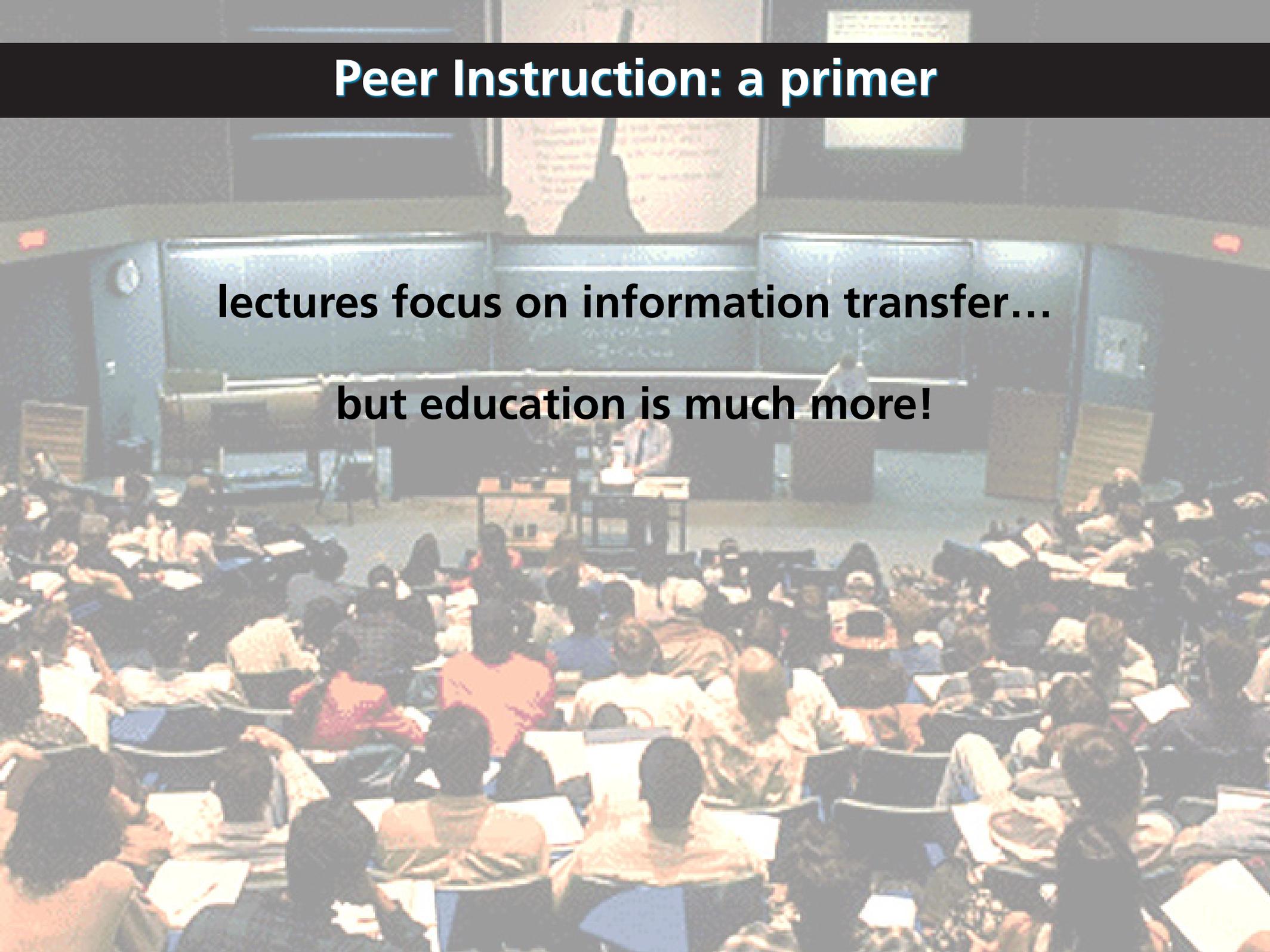
lectures focus on information transfer...



Peer Instruction: a primer

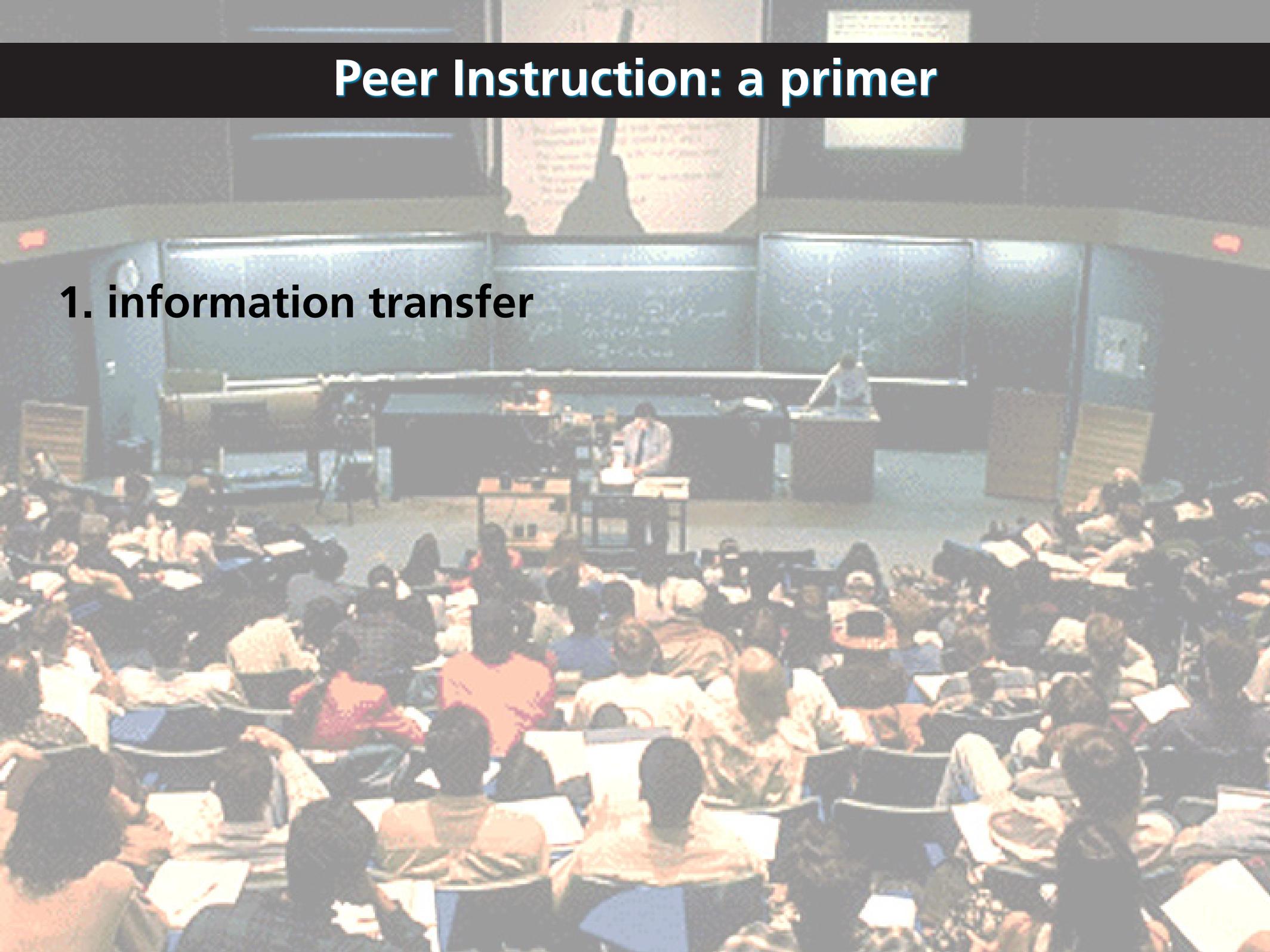
lectures focus on information transfer...

but education is much more!



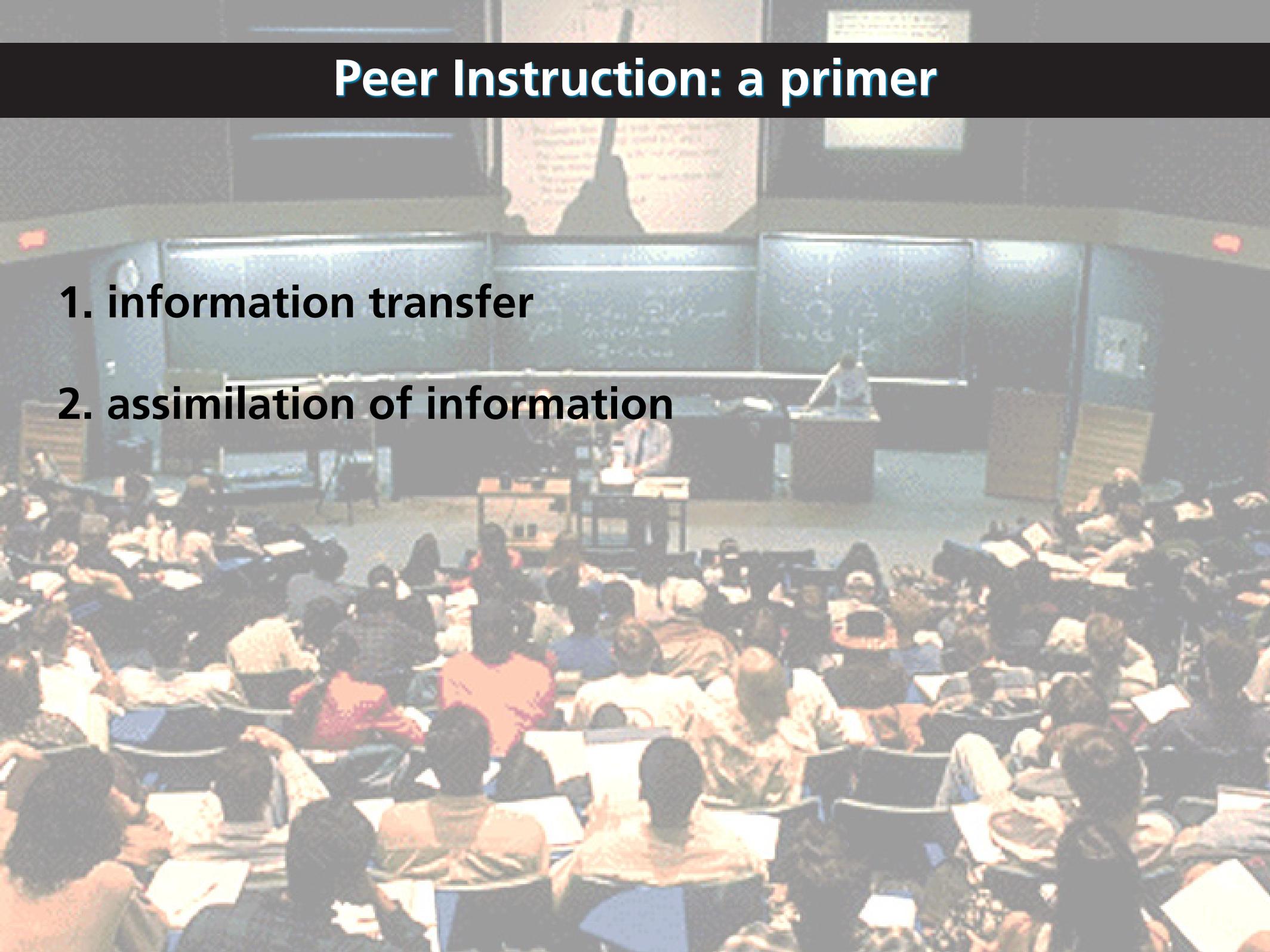
Peer Instruction: a primer

1. information transfer



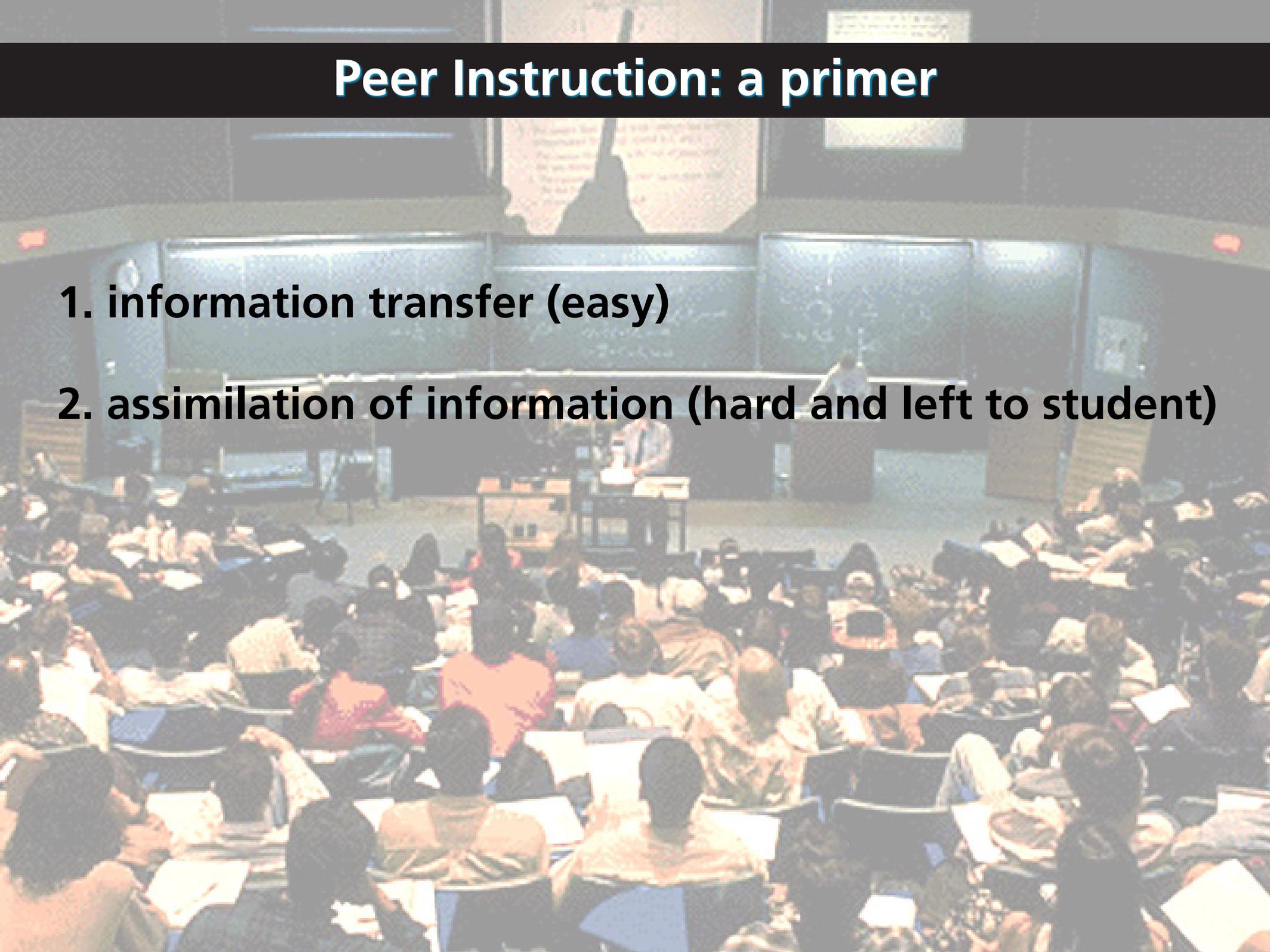
Peer Instruction: a primer

1. information transfer
2. assimilation of information



Peer Instruction: a primer

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



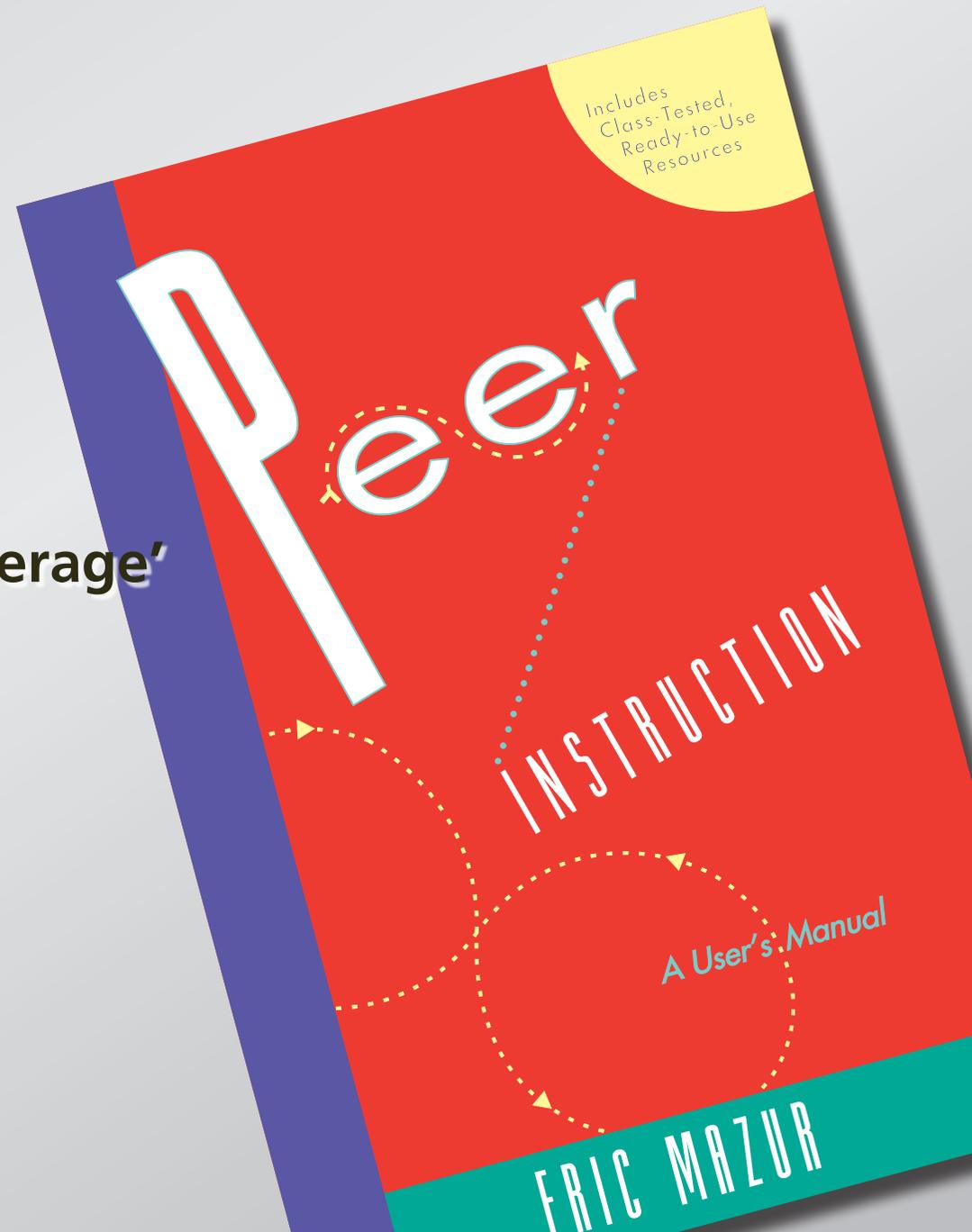
Peer Instruction: a primer

Solution: move information transfer out of classroom!

Peer Instruction: a primer

Main features:

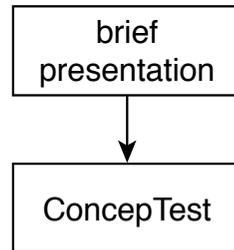
- pre-class reading
- in-class: depth, not 'coverage'
- ConcepTests



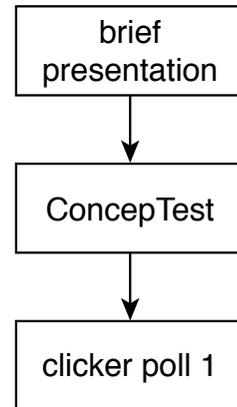
Peer Instruction: a primer

brief
presentation

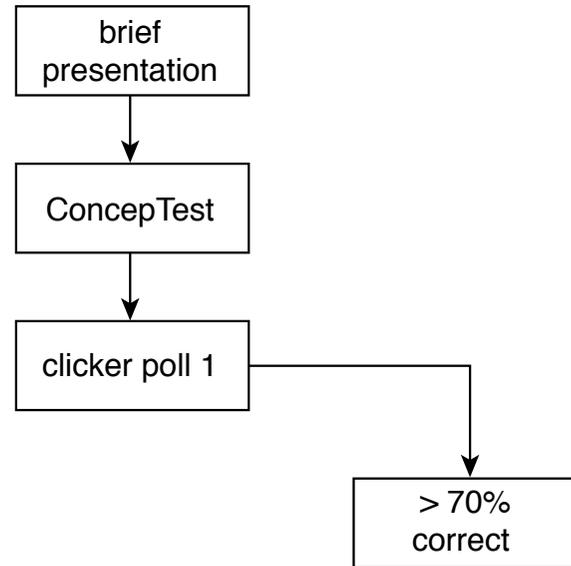
Peer Instruction: a primer



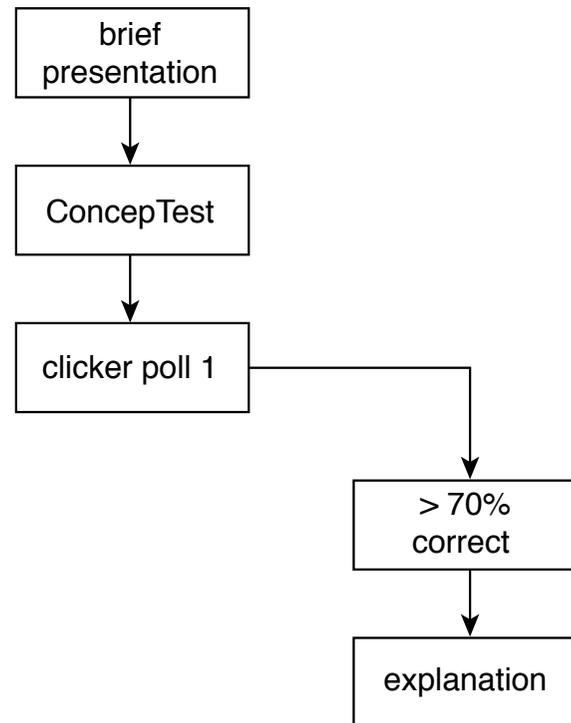
Peer Instruction: a primer



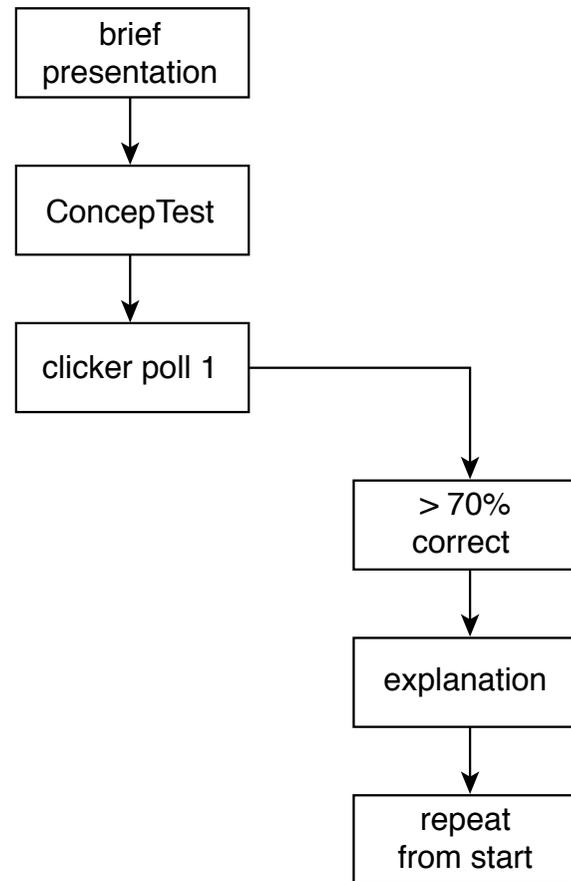
Peer Instruction: a primer



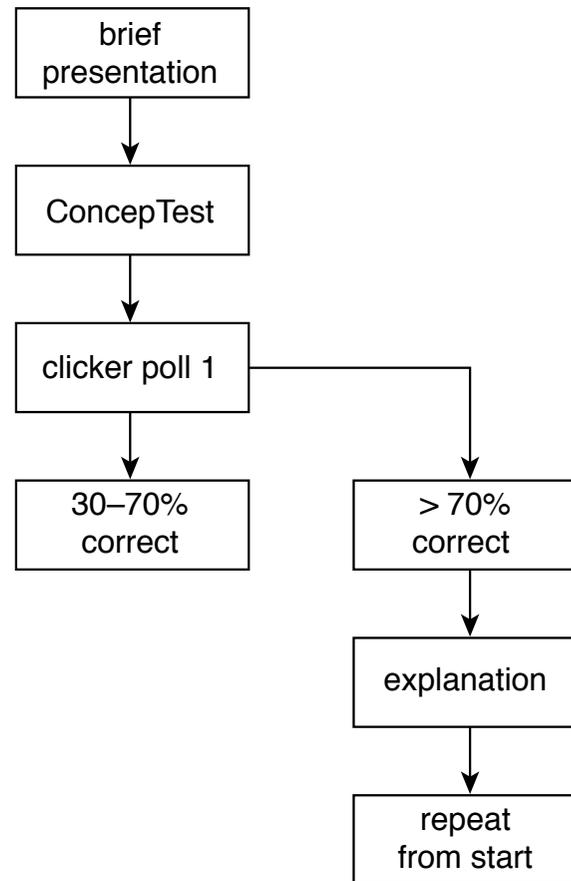
Peer Instruction: a primer



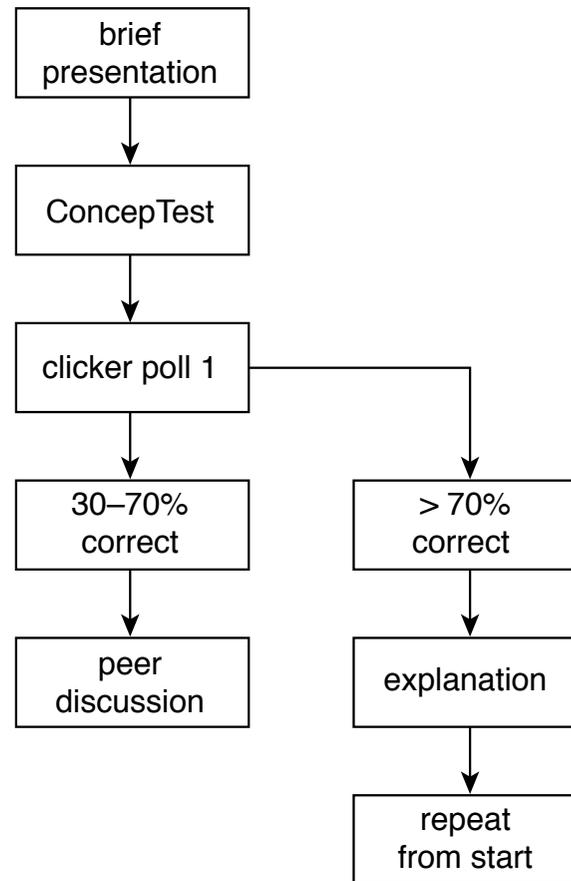
Peer Instruction: a primer



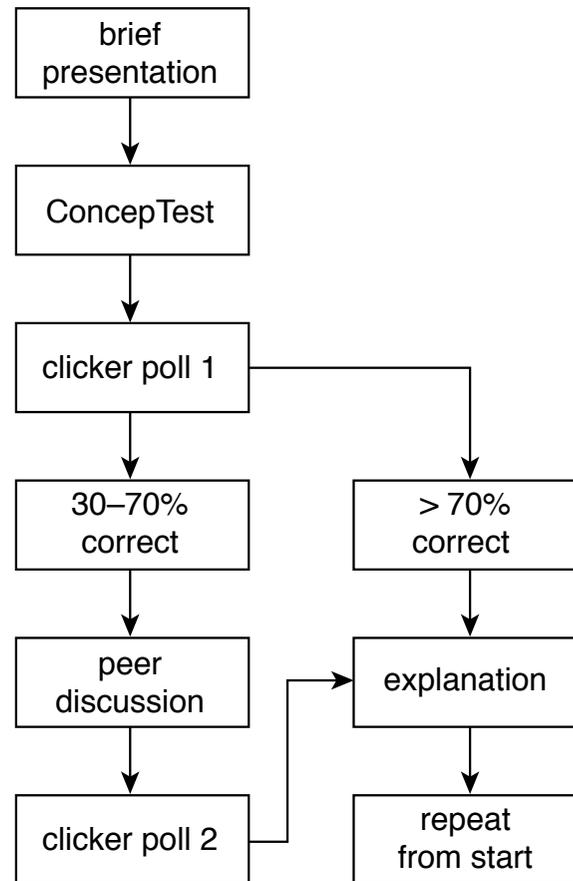
Peer Instruction: a primer



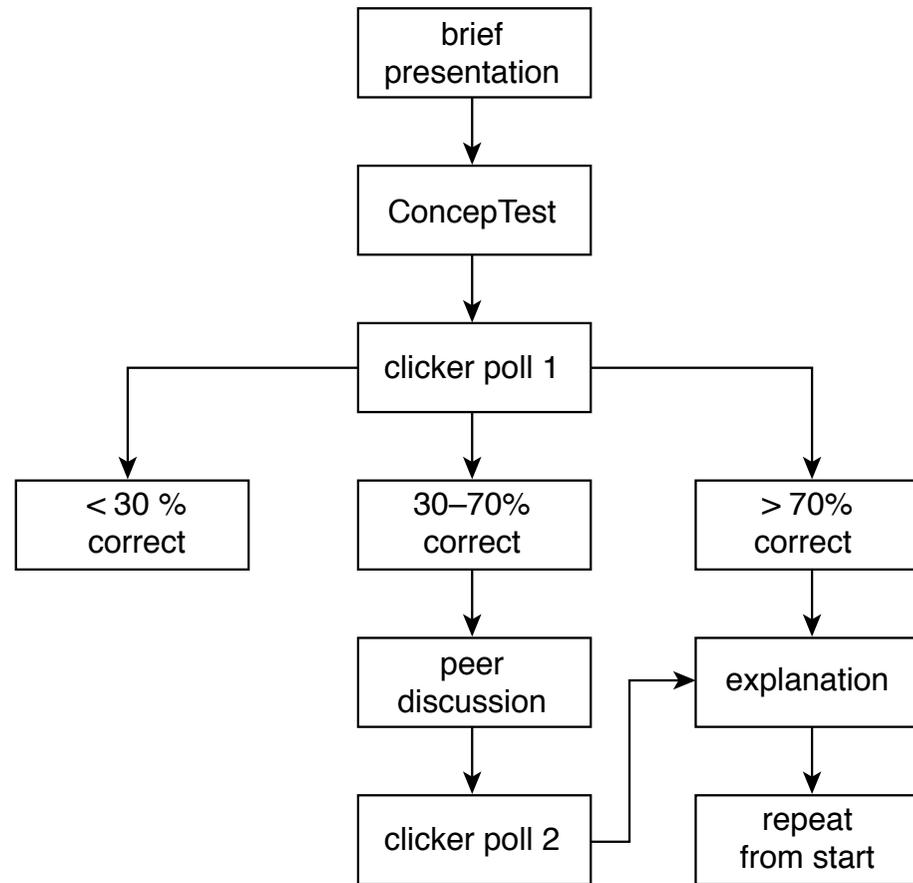
Peer Instruction: a primer



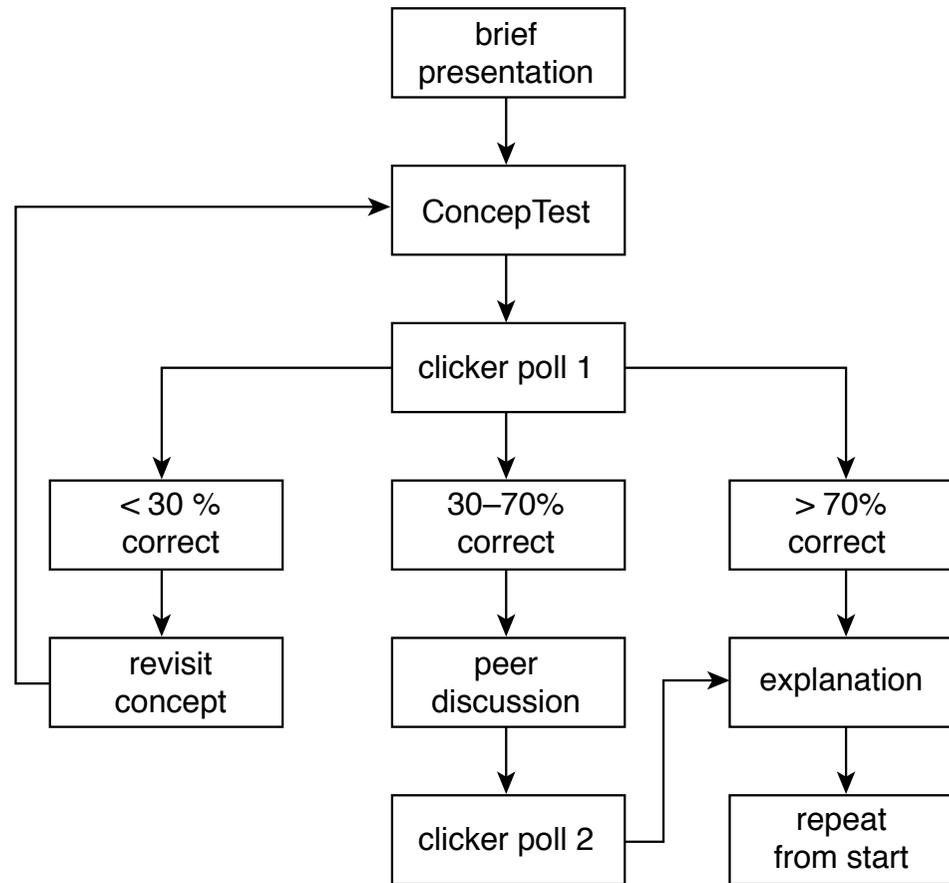
Peer Instruction: a primer



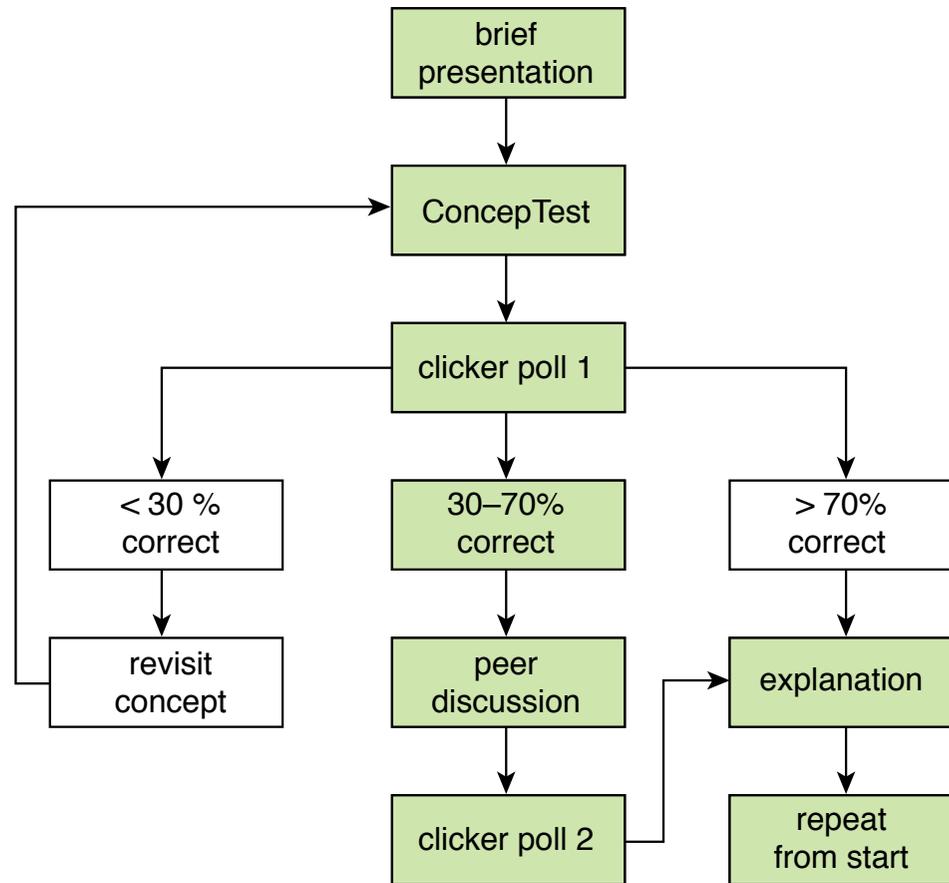
Peer Instruction: a primer



Peer Instruction: a primer



Peer Instruction: a primer

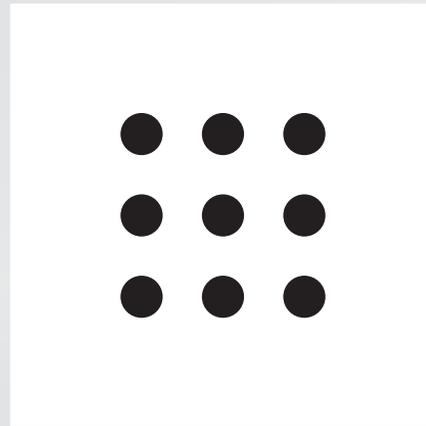


Let's try it!

thermal expansion

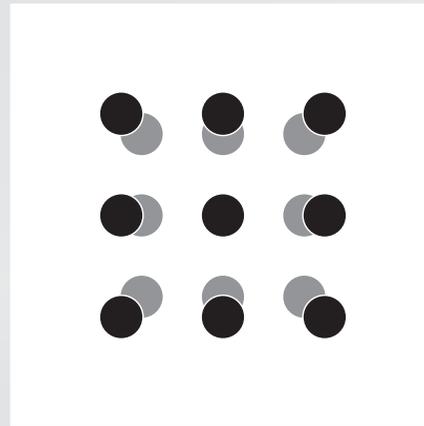
Let's try it!

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



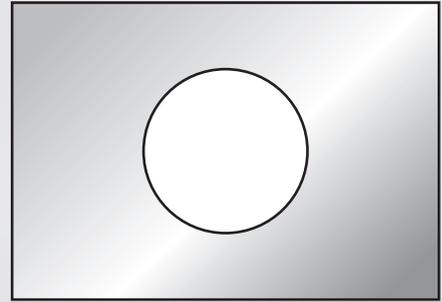
Let's try it!

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



Let's try it!

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

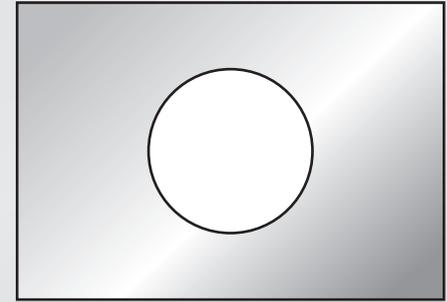


Let's try it!

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!

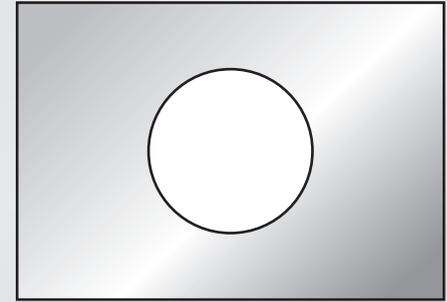
It's easy to fire up the audience!

Let's try it!

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.

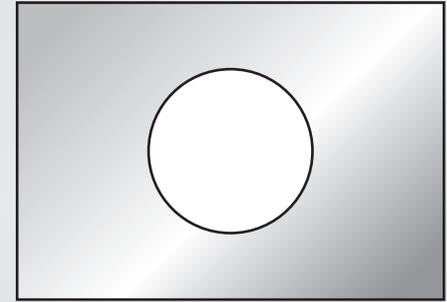


Let's try it!

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

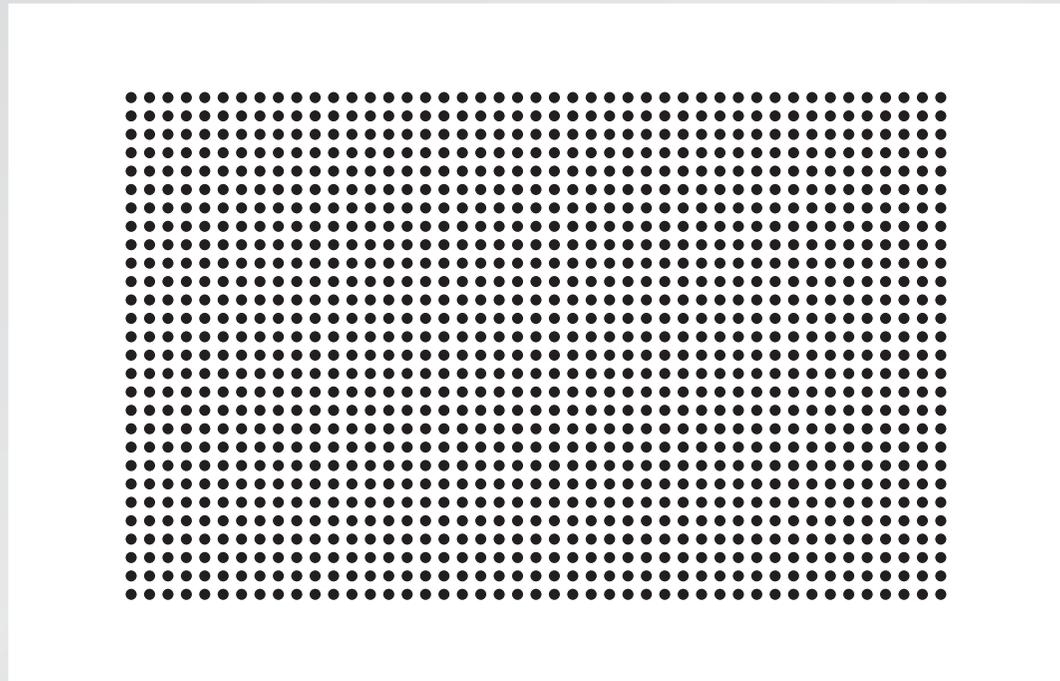
When the plate is uniformly heated, the diameter of the hole

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



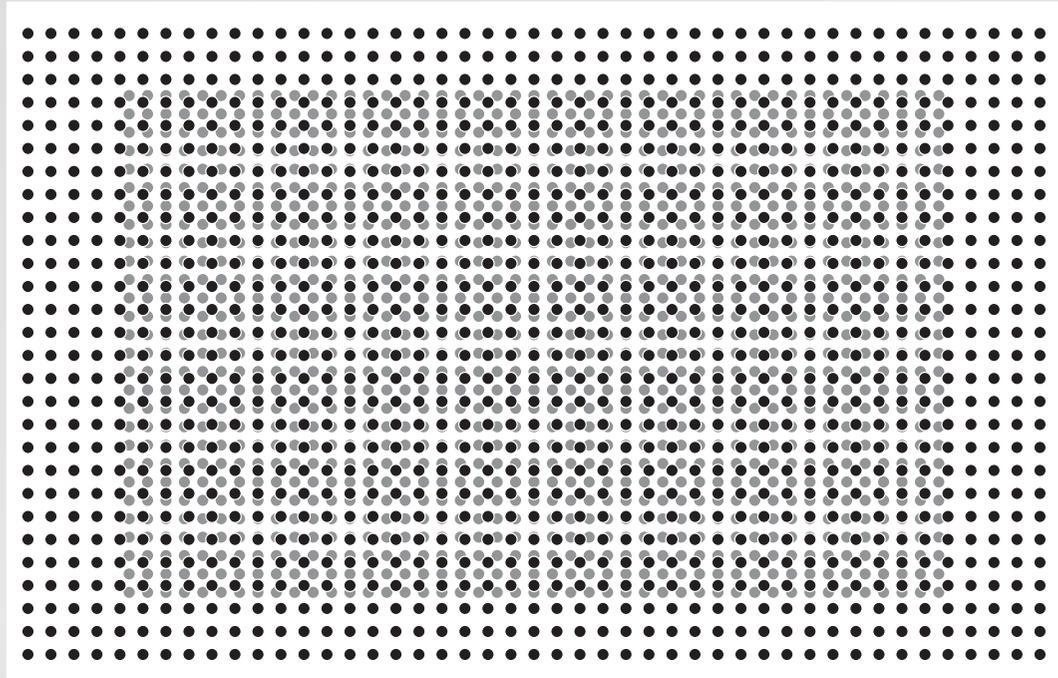
Let's try it!

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



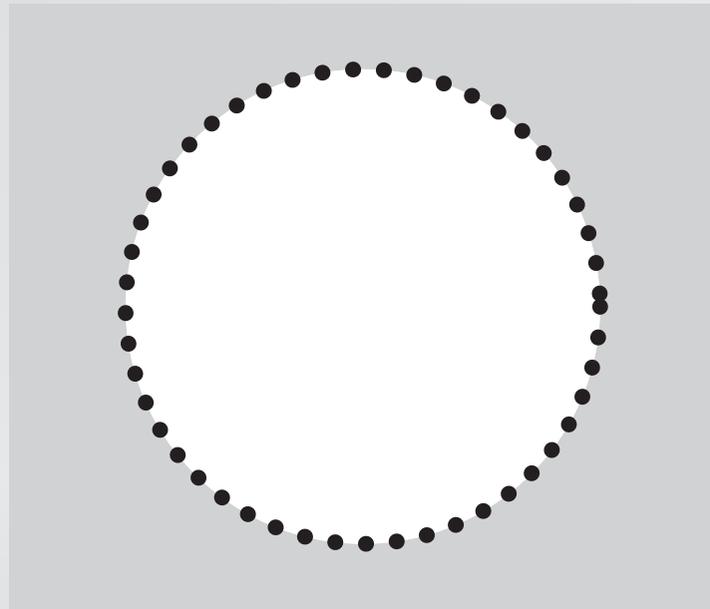
Let's try it!

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



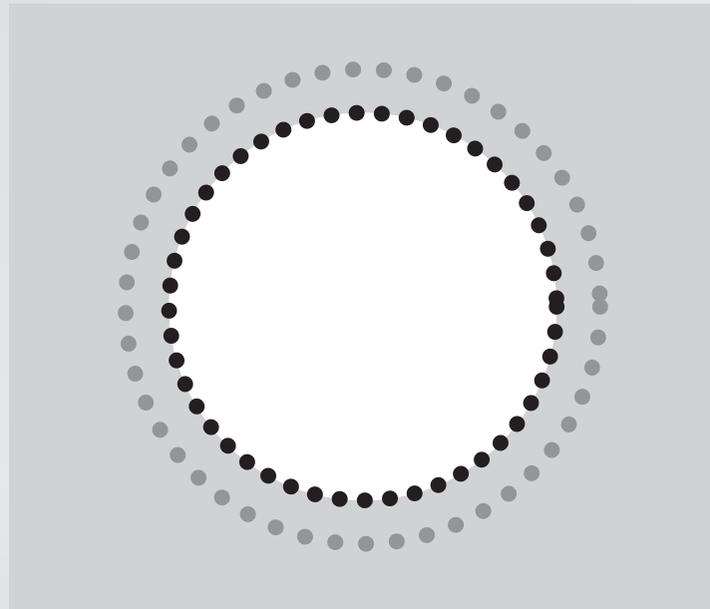
Let's try it!

consider the atoms at the rim of the hole



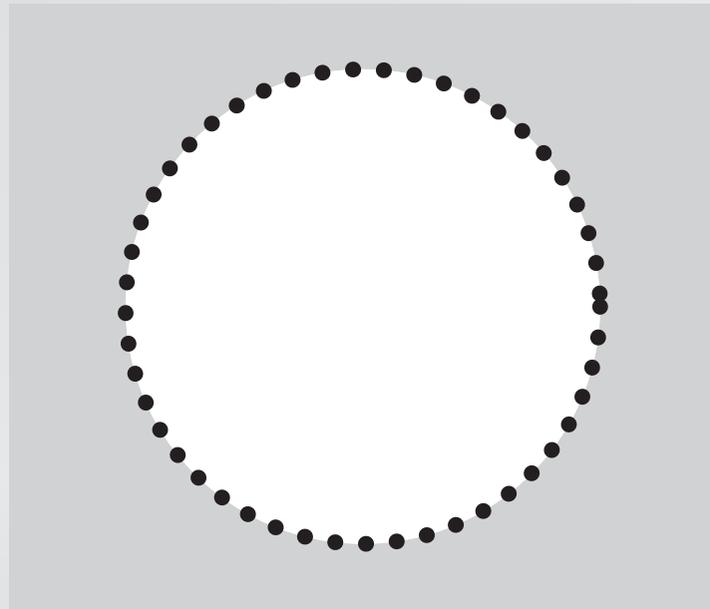
Let's try it!

consider the atoms at the rim of the hole



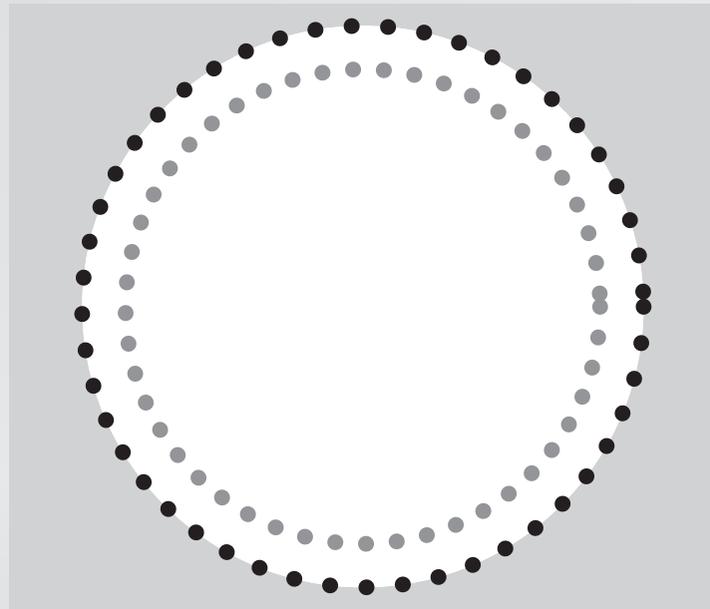
Let's try it!

consider the atoms at the rim of the hole



Let's try it!

consider the atoms at the rim of the hole



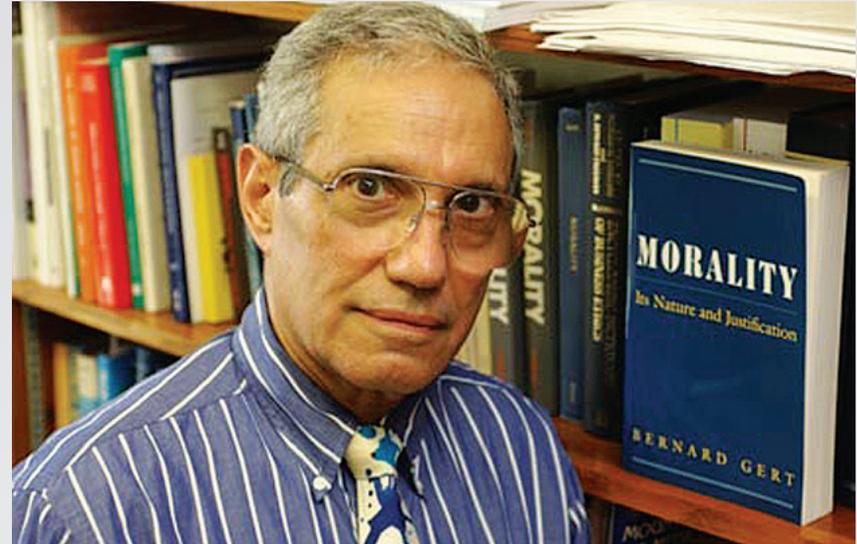
Frequently Asked Questions

*“Can this method be used in my class,
where questions don’t necessarily have right answers?”*

Let's try it!

Bernard Gert (1934 – 2011)

**Moral philosopher
Professor at Dartmouth**



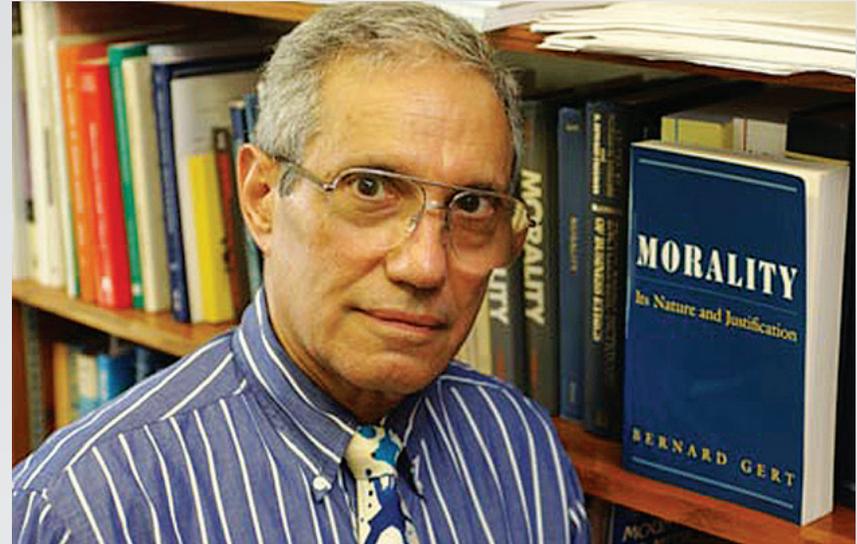
“Morality is an informal public system applying to all rational persons, governing behavior that affects others, and includes what are commonly known as the moral rules, ideals, and virtues and has the lessening of evil or harm as its goal.”

Let's try it!

Bernard Gert (1934 – 2011)

Moral philosopher

Professor at Dartmouth



Let's try it!

Bernard Gert's moral system created by 10 rules:

- 1. Do not kill**
- 2. Do not cause pain**
- 3. Do not disable**
- 4. Do not deprive of freedom**
- 5. Do not deprive of pleasure**
- 6. Do not deceive**
- 7. Keep your promises**
- 8. Do not cheat**
- 9. Obey the law**
- 10. Do your duty (as required by job, circumstances).**

Let's try it!

Heinz's wife was near death, and her only hope was a drug that had been discovered by a pharmacist who was selling it for an exorbitant price. The drug cost \$20,000 to make, and the pharmacist was selling it for \$200,000. Heinz could only raise \$50,000 and insurance wouldn't make up the difference. He offered what he had to the pharmacist, and when his offer was rejected, Heinz said he would pay the rest later. Still the pharmacist refused. In desperation, Heinz broke into the store and stole the drug.

Let's try it!

Heinz's wife was near death, and her only hope was a drug that had been discovered by a pharmacist who was selling it for an exorbitant price. The drug cost \$20,000 to make, and the pharmacist was selling it for \$200,000. Heinz could only raise \$50,000 and insurance wouldn't make up the difference. He offered what he had to the pharmacist, and when his offer was rejected, Heinz said he would pay the rest later. Still the pharmacist refused. In desperation, Heinz broke into the store and stole the drug.

Should Heinz have broken into the store to steal the drug for his wife?

Let's try it!

Bernard Gert's moral system created by 10 rules:

- 1. Do not kill**
- 2. Do not cause pain**
- 3. Do not disable**
- 4. Do not deprive of freedom**
- 5. Do not deprive of pleasure**
- 6. Do not deceive**
- 7. Keep your promises**
- 8. Do not cheat**
- 9. Obey the law**
- 10. Do your duty (as required by job, circumstances).**

Let's try it!

Bernard Gert's moral system created by 10 rules:

1. Do not kill
2. Do not cause pain
3. Do not disable
4. Do not deprive of freedom
5. Do not deprive of privacy
6. Do not deceive
7. Keep your promises
8. Do not cheat
9. Obey the law
10. Do your duty (as required by job, circumstances).

Should Heinz have broken into the store to steal the drug for his wife?

- 1. Yes**
- 2. No**



Let's try it!

Bernard Gert's moral system created by 10 rules:

1. Do not kill
2. Do not cause pain
3. Do not disable
4. Do not deprive of freedom
5. Do not deprive of pleasure
6. Do not deceive
7. Keep your promises
8. Do not cheat
9. Obey the law
10. Do your duty (as required by job, circumstances).

Should Heinz have broken into the store to steal the drug for his wife?

1. Yes
2. No

you got all engaged!



Let's try it!

Don't need a correct answer!

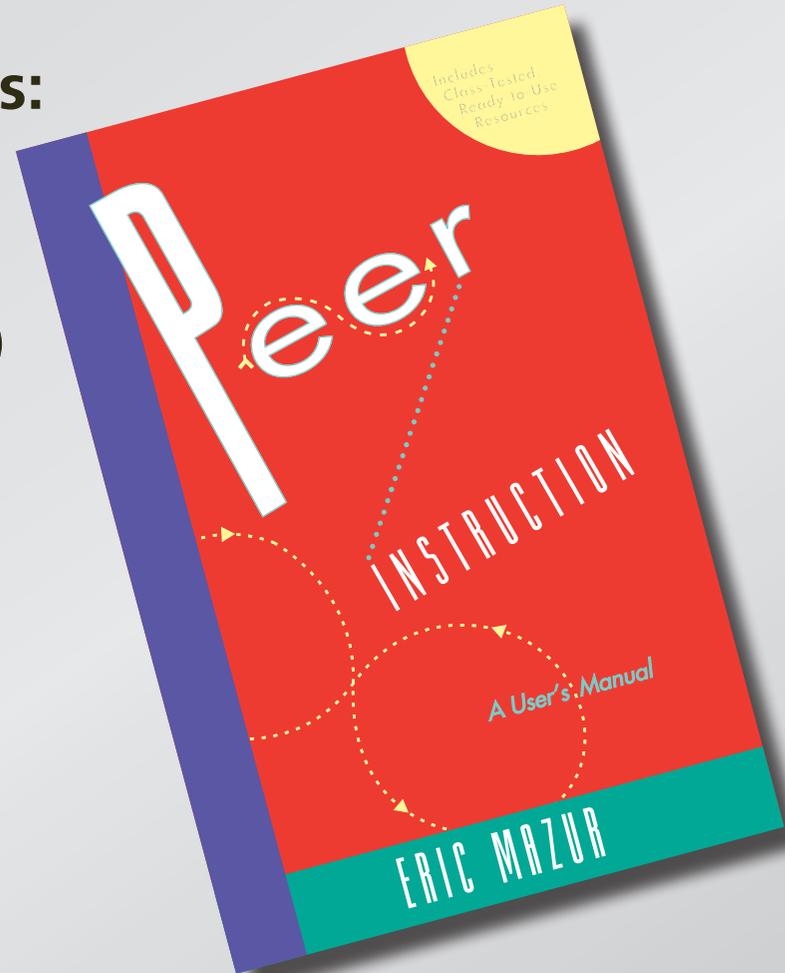
Frequently Asked Questions

“How do I write/find good questions for...?”

ConceptTests

Books with ConceptTests:

- Physics (Prentice Hall)



ConceptTests

Books with ConceptTests:

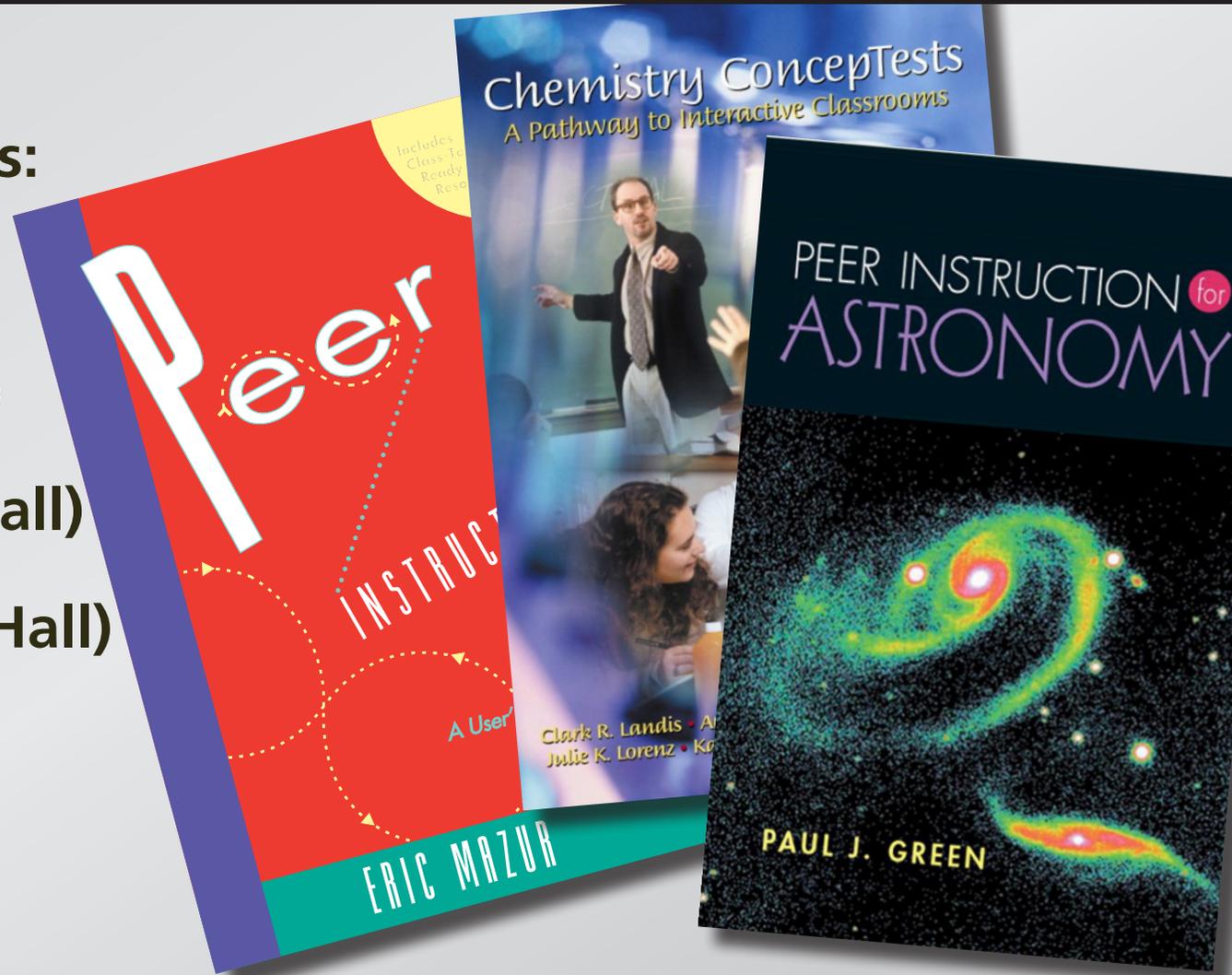
- Physics (Prentice Hall)
- Chemistry (Prentice Hall)



ConceptTests

Books with ConceptTests:

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



ConceptTests

Books with ConceptTests:

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



ConceptTests

... or try searching Google:

<subject> "Peer Instruction"

<subject> ConcepTest

<subject> "Concept Test"

<subject> clickers

Frequently Asked Questions

“How can I be sure that my students will prepare for class?”

Getting students to read

Students do not come to class prepared, because...

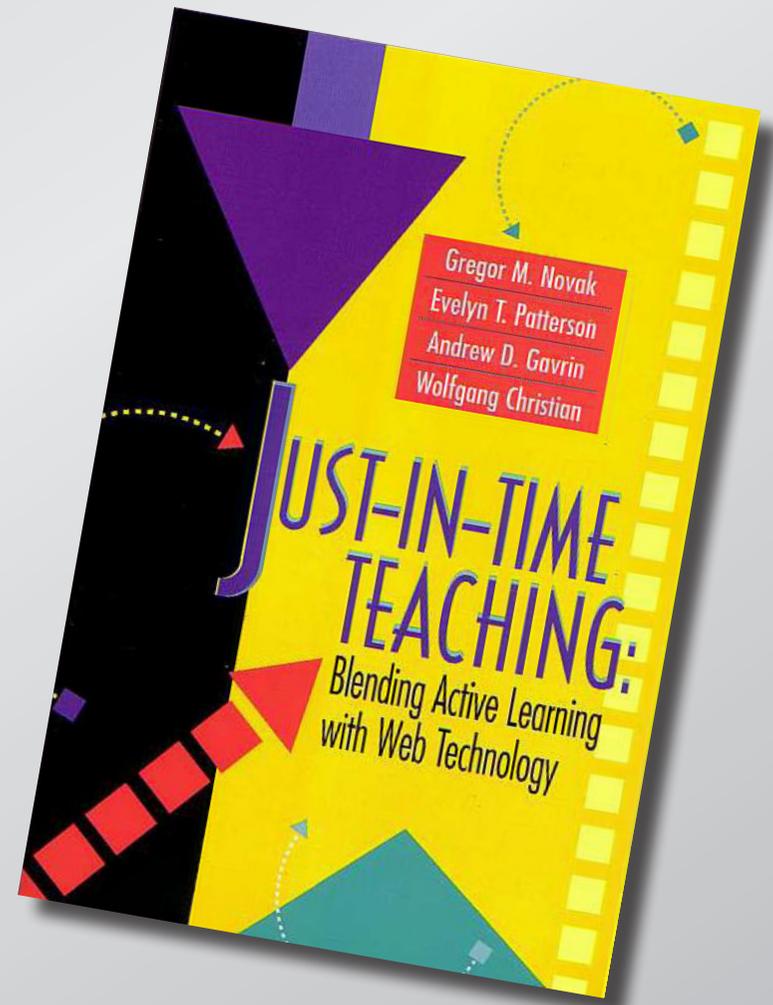
- 1. they don't have time.**
- 2. they are not motivated to learn.**
- 3. their instructors take away the incentive.**
- 4. they do not have the requisite skills.**
- 5. of some other reason.**
- 6. They do come prepared in my class!**

(select what you consider to be the main reason)

Getting students to read

Just-in-time-Teaching (JiTT)

www.jitt.org



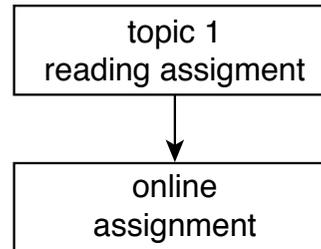
Getting students to read

JiTT workflow

topic 1
reading assignment

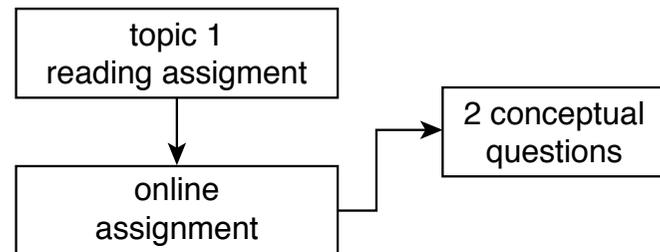
Getting students to read

JiTT workflow



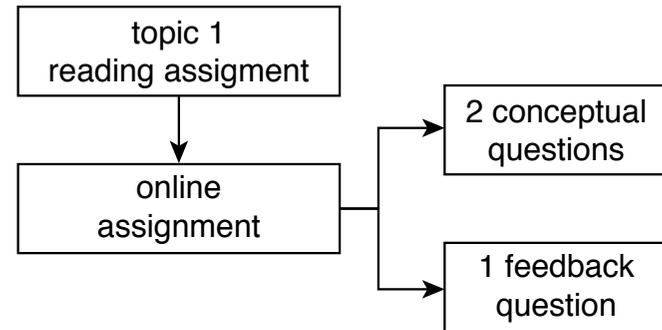
Getting students to read

JiTT workflow



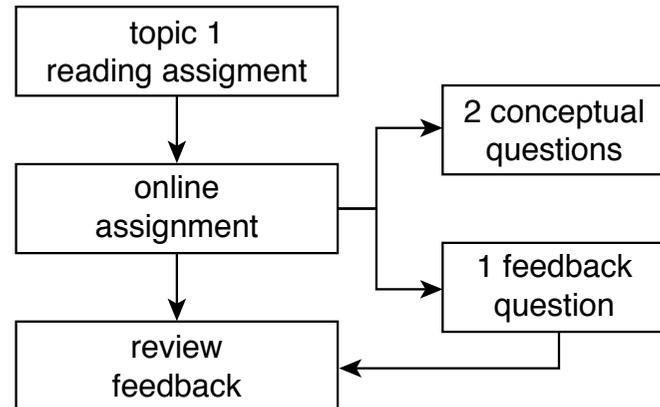
Getting students to read

JiTT workflow



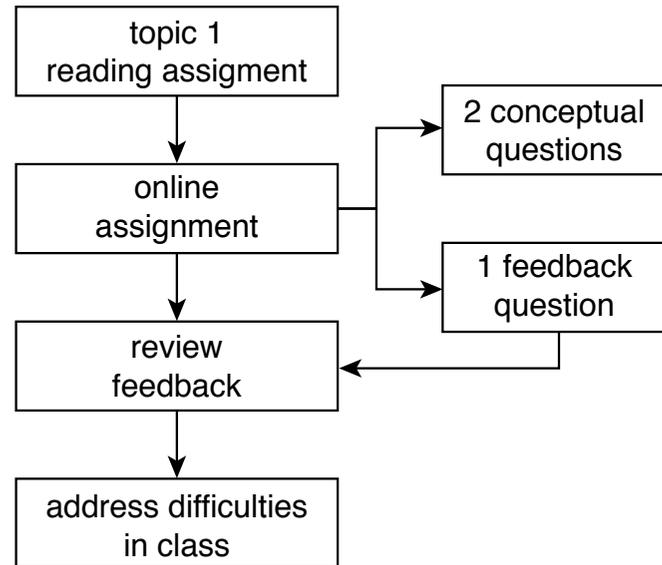
Getting students to read

JiTT workflow



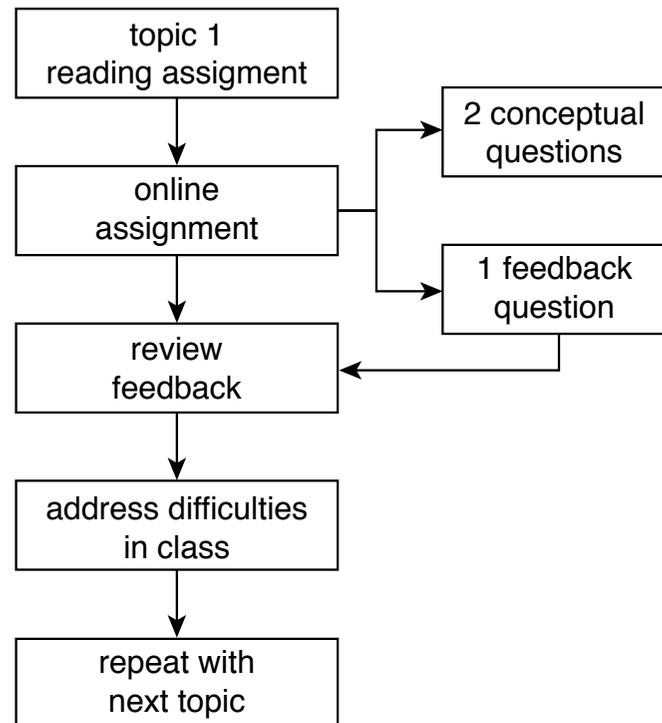
Getting students to read

JiTT workflow



Getting students to read

JiTT workflow

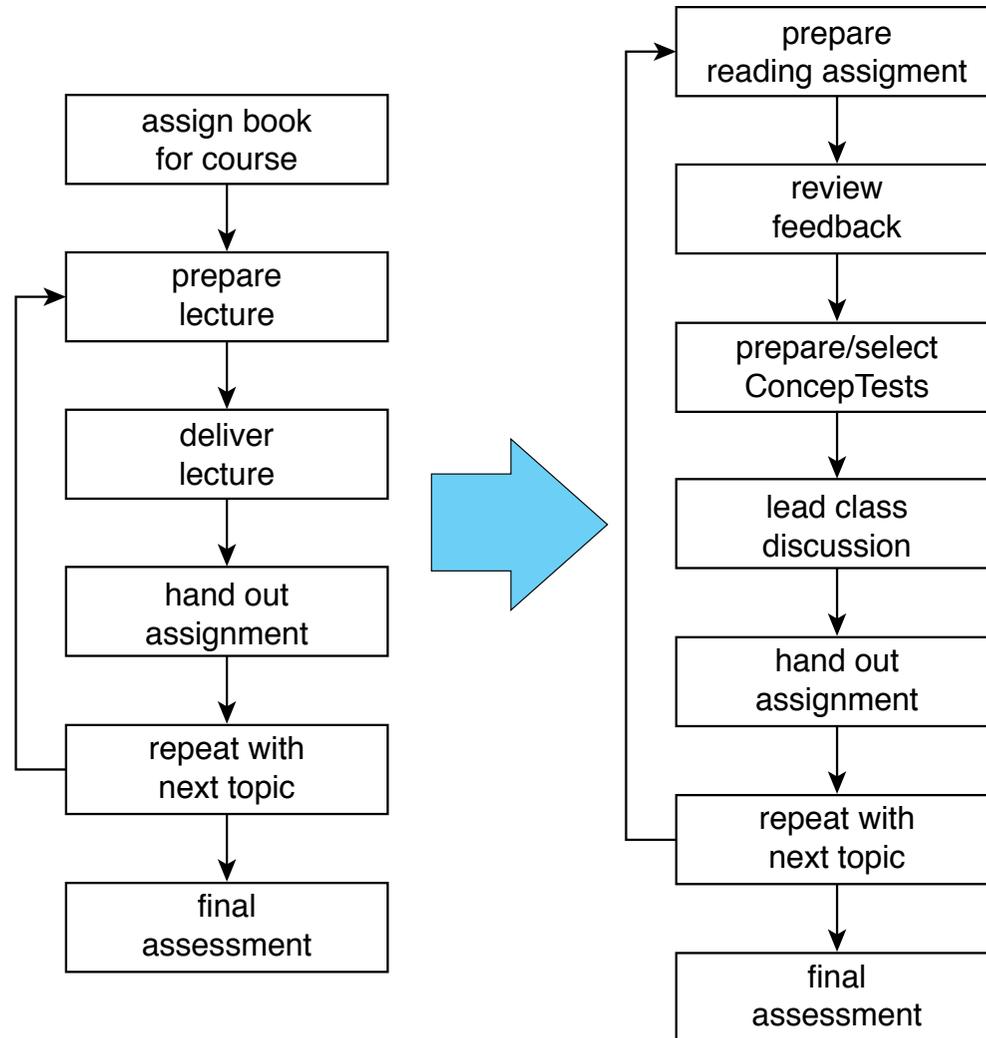


Implementing PI & JiTT

“How is preparing a PI class different from preparing a lecture-based class?”

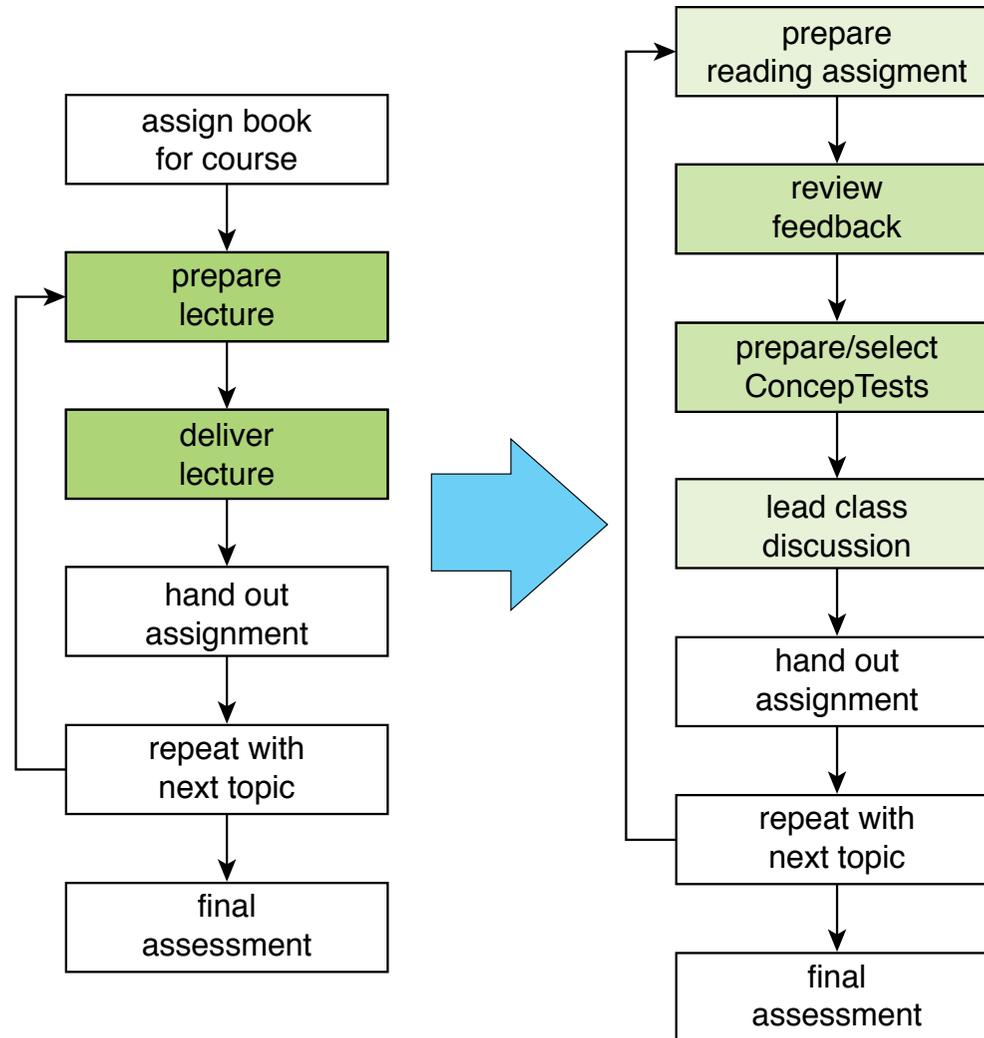
Implementing PI & JiTT

transitioning: where does the effort go?



Implementing PI & JiTT

transitioning: where does the effort go?



Implementing PI & JiTT

New activities:

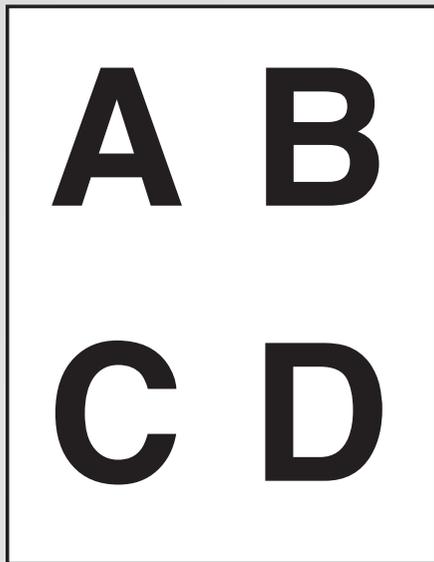
- 1. Reading assignment**
- 2. ConcepTests**

Frequently Asked Questions

“Do I need clickers?”

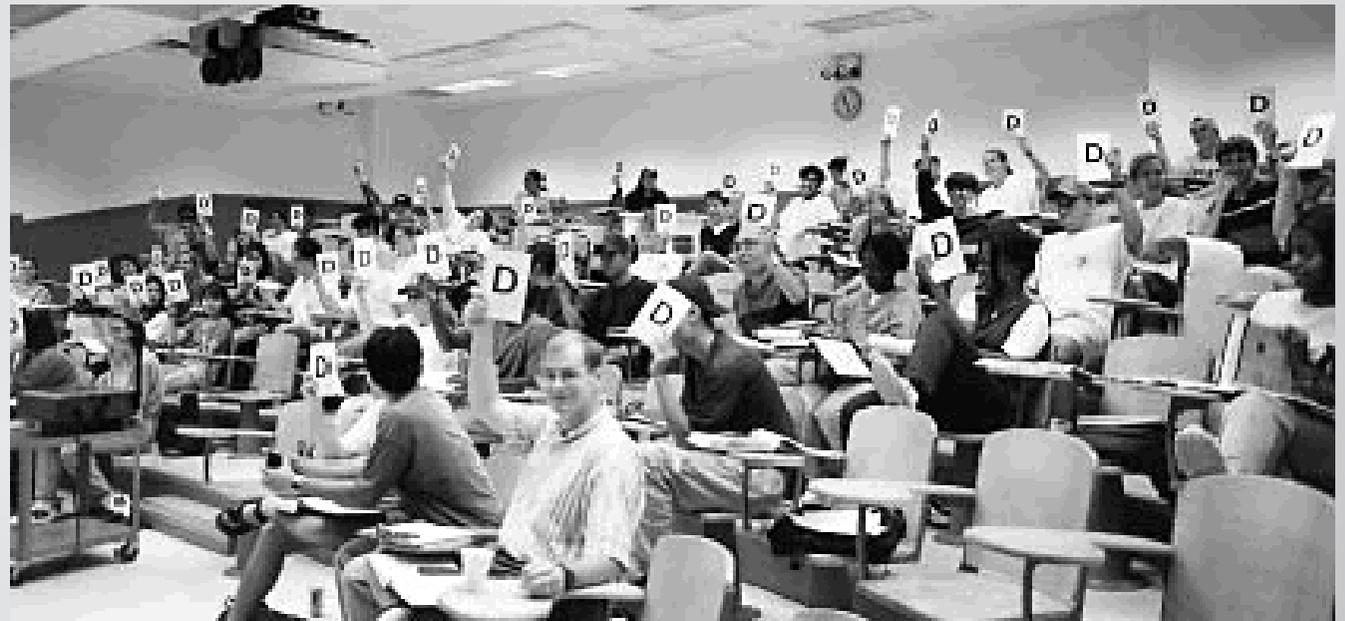
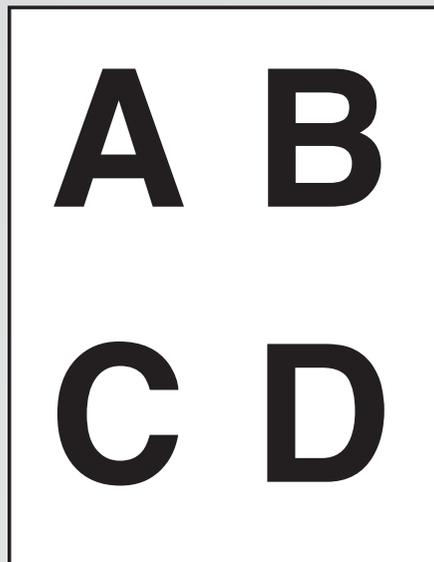
Clickers necessary?

Flashcards: simple and effective



Clickers necessary?

Flashcards: simple and effective



Meltzer and Mannivanan, South Eastern Louisiana University

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:

semit kYoY weH eHT

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!

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:

semit kYoY wen eHT

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.

Clickers necessary?

It's not the technology, but the pedagogy!

Clickers necessary?

It's not the technology, but the pedagogy!

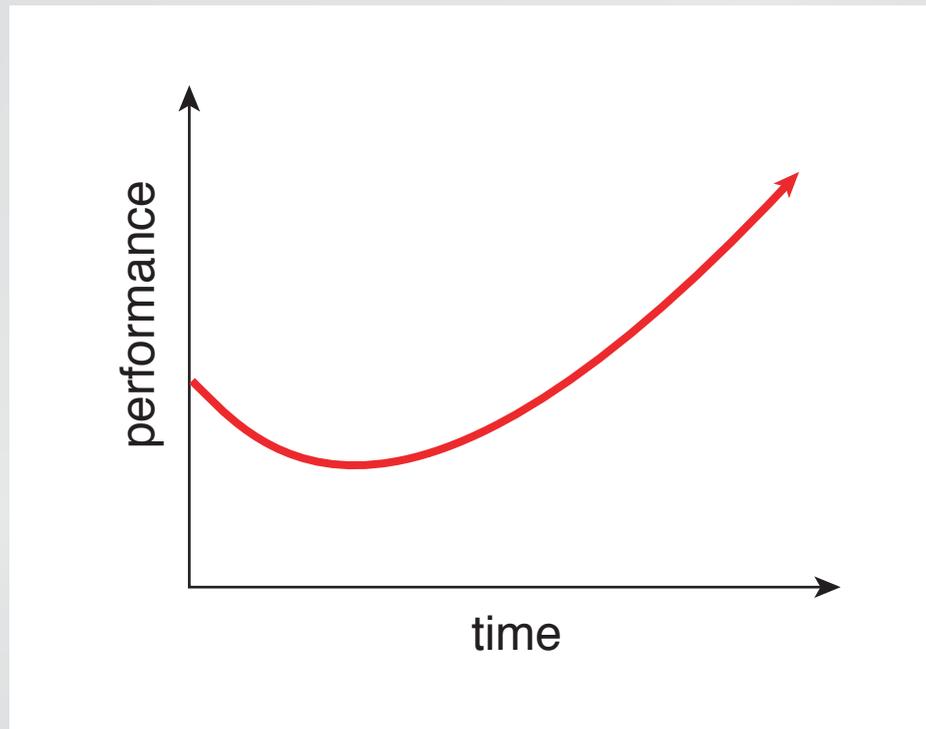
(but clickers do offer advantages)

Frequently Asked Questions

*“How do I deal with students who resist
this new approach to studying?”*

Student resistance

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



Student resistance

Written on Wednesday Feb 16, two weeks into the course:

Subject: concerns

Professor Mazur,

Here are a few concerns. I speak for many of my classmates.

1) You are giving us WAY to much work. After spending multiple hours on the problem set, and not being able to figure out many of the questions, I now see that we have an additional 6 or 7 pages or homework in the workbook. I just spent 4 hours on the lab, and I am not confident on almost half of the questions. This is more work than I have had all semester in all of my other classes combined.

2) If you are going to give us this much work, I would suggest re-structuring the lectures. I find the readings very difficult to understand. I am not a bad student (I got a solid A in physics 1a), but it is very difficult to internalize the readings. You should spend most of the lecture going over, point by point, the readings in their entirety. While the PRS clickers are fun, they do not help me understand the complex material.

I am extremely flustered by the incredibly large amount of work, and my inability to understand it, and I am strongly considering dropping the course.

Student resistance

Written on Monday May 23, just after the final exam:

Subject: Thanks!

Professor Mazur,

First of all I want to thank you for a great semester. You are an excellent professor, and it is clear that you truly care about each and every student.

The exam went well today. I'm not sure to what extent you will curve the final grades (if at all), but it looks like I may be right around the cutoff point between an A and an A-. I studied as hard as I could and I'm keeping my fingers crossed about the A, but no matter what happens with my grade you should know that you are one of the best professors that I have ever had at Harvard.

Thanks again!

Student resistance

Hello Prof. Mayer,
I wanted to hand you this card as
a token of my deep appreciation of
how you have helped me throughout
the semester. You are truly
an inspiring and have
changed how I look at
"learning". I also wanted
to thank you for
how understanding
you were of all
my circumstances.
You really made a difference
in my life. So THANKS
Thank you!



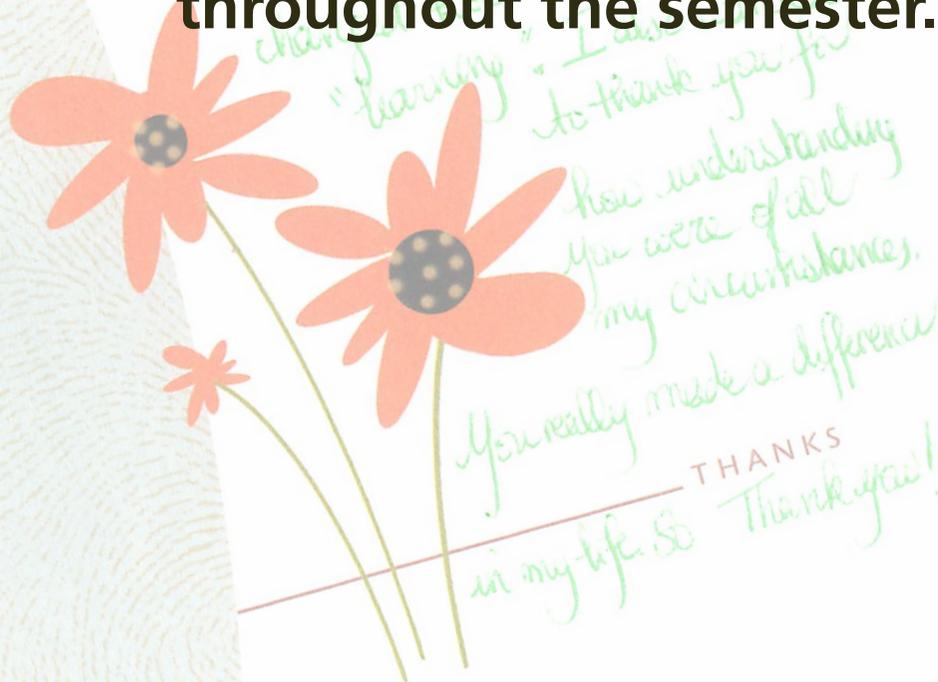
You made a difference.

Love,
Best

Student resistance

"I wanted to hand you this card as a token of my deep appreciation of how you have helped me throughout the semester."

You made a difference.



Student resistance

"I wanted to hand you this card as a token of my deep appreciation of how you have helped me throughout the semester. You are truly awe inspiring and have changed how I look at "learning".

You made a difference.

*You really made a difference
in my life. So THANKS
Thank you!*

Best

Student resistance

"I wanted to hand you this card as a token of my deep appreciation of how you have helped me throughout the semester. You are truly awe inspiring and have changed how I look at "learning". [....] You really made a difference in my life."

You made a difference.

*THANKS
in my life. So Thank you!*

Best

Student resistance

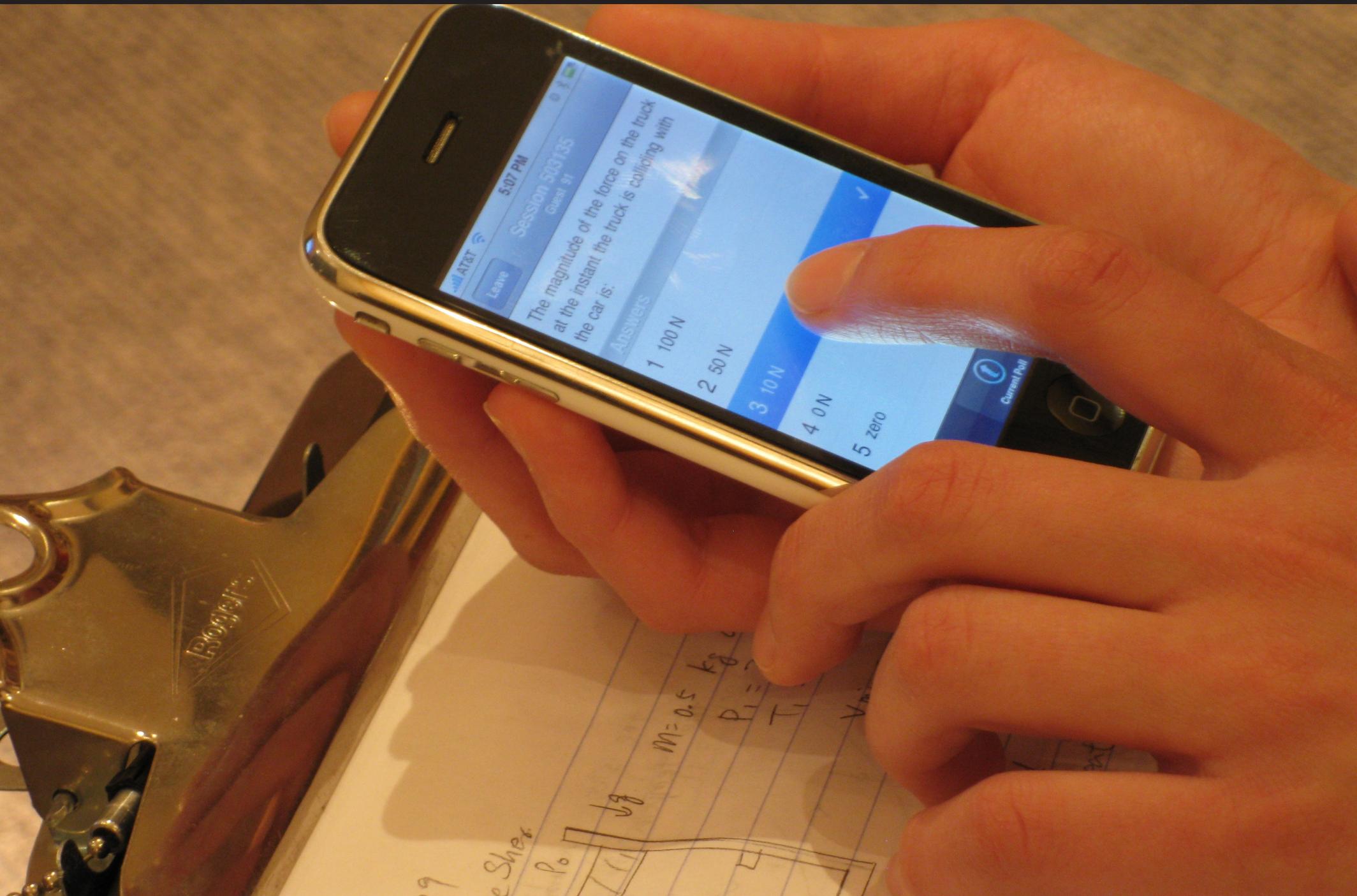
and don't forget...

Student resistance

and don't forget...

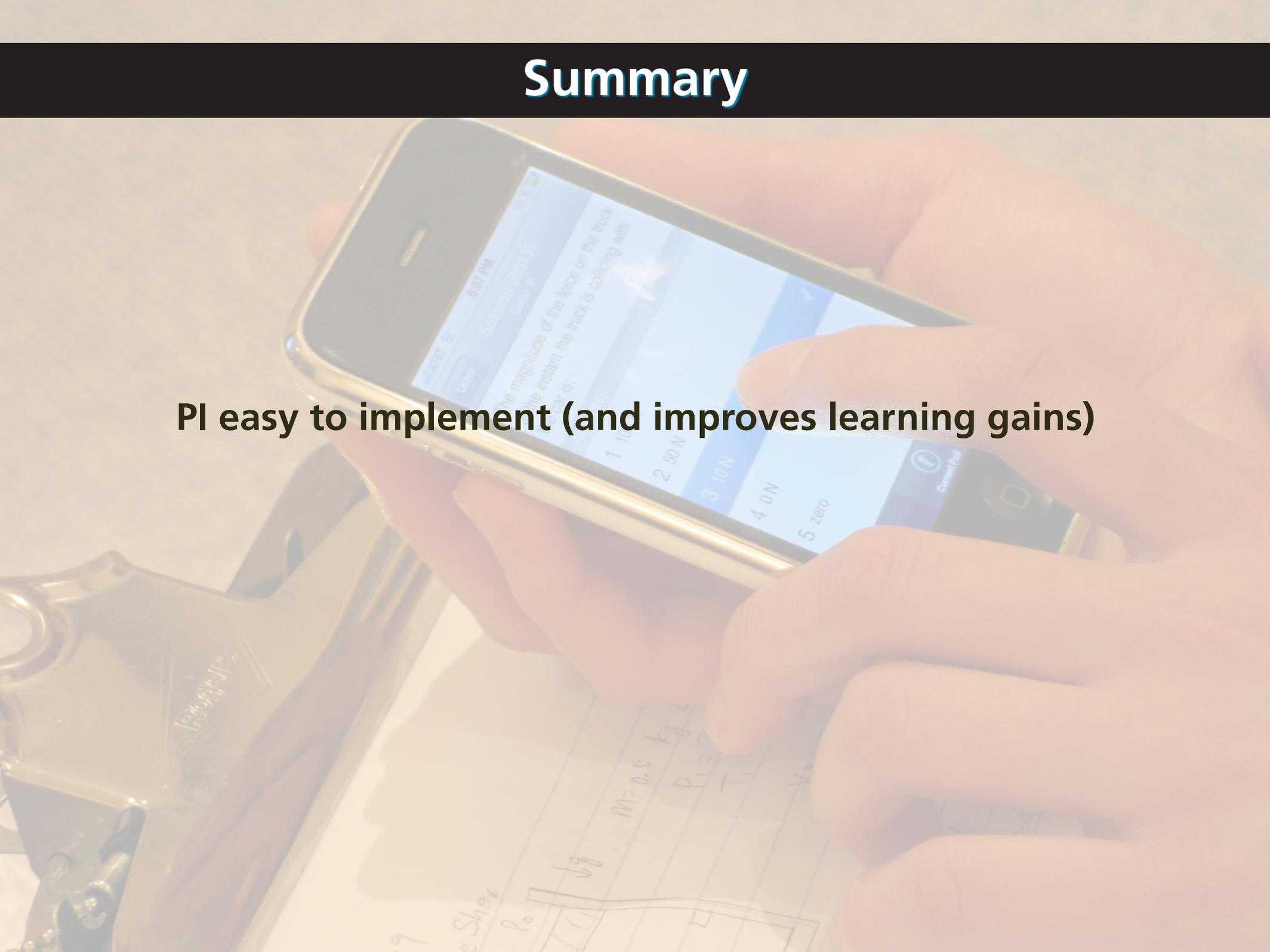
PI leads to better learning and retention!

Summary



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)

Funding:

National Science Foundation

for a copy of this presentation:

<http://mazur.harvard.edu>

Follow me!



eric_mazur



1 lecture

2 PI

3 PI 2.0

feedback

1 lecture

2 PI

3 PI 2.0



1991



1 lecture

2 PI

3 PI 2.0



1993



1998



1 lecture

2 PI

3 PI 2.0



technology

1 lecture

2 PI

3 PI 2.0



How do I...

- design good questions?
- optimize the discussions?
- manage time?

learning | catalytics

1 lecture

2 PI

3 PI 2.0

learning | catalytics



Gary King



Brian Lukoff



Eric Mazur

1 lecture

2 PI

3 PI 2.0

Use intelligent algorithms and data analytics to...

learning | catalytics

- improve questioning
- manage discussions

- facilitate time management/flow

- lowest
- a. A 30-year fixed rate mortgage at 12%
 - b. A 15-year fixed rate mortgage at 12%
 - c. A 30-year fixed rate mortgage at 12%
 - d. A 15-year fixed rate mortgage at 12%
2. The biggest factor that leads American companies to manufacture their products overseas in India is:
- a. Higher quality of craftsmanship
 - b. Lower labor costs
 - c. Decreased transportation costs
 - d. Effective legal systems
3. Which of the following correctly summarizes the accounting equation for a sole proprietorship?
- a. $\text{Assets} = \text{Liabilities} + \text{Owners' equity}$
 - b. $\text{Liabilities} = \text{Assets} + \text{Owners' equity}$
 - c. $\text{Owner's equity} = \text{Assets} + \text{Liabilities}$
 - d. $\text{Revenue} = \text{Assets} - \text{Liabilities}$
4. In order to present a business plan to a group of potential investors, a businessperson would most likely use which of the following?
- a. Powerpoint
 - b. Quickbooks
 - c. Peoplesoft
 - d. Excel
5. In order to start an online business, and individual would need all but which of the following:
- a. business model
 - b. depreciation?

extensible plug-in architecture for question types

- a. A 30-year fixed rate mortgage at 12%
- b. A 15-year fixed rate mortgage at 12%
- c. A 30-year fixed rate mortgage at 12%
- d. A 15-year fixed rate mortgage at 12%

2. The biggest factor that leads American companies to manufacture their products over India is:

- a. Higher quality of craftsmanship
- b. Lower labor costs
- c. Decreased transportation costs
- d. Effective legal systems

3. Which of the following correctly summarizes the accounting equation for a sole proprietorship?

- a. $Assets = Liabilities + Owners' equity$
- b. $Liabilities = Assets + Owners' equity$
- c. $Owner's equity = Assets + Liabilities$
- d. $Revenue = Assets - Liabilities$

4. In order to present a business plan to a group of potential investors, a businessperson should most likely use which of the following?

- a. Powerpoint
- b. Quickbooks
- c. Peoplesoft
- d. Excel

5. In order to start an online business, an individual would need all but which of the following:

business model

Sample question types:

- direction
- mathematical expression
- long answer, short answer, word cloud
- numerical, data collection
- ranking, priority
- region (select point on image)
- sketch, composite sketch
- highlight passage

Sample question types:

- direction

- mathematical expression

- long answer, short answer, word cloud

- numerical, data collection

- ranking, priority

- region (select point on image)

- sketch, composite sketch

- highlight passage



1 lccatalytics.com

2 create student account

3 ID 1234567

learning | catalytics

[Courses](#) [Participate](#) [Review](#) [Classrooms](#) [Account](#) [Institutions](#) [Purchases](#) [Users](#) [Tour](#) [Help](#)

4. direction This image shows Oahu as seen from the Space Shuttle. The image provides several clues about the direction of prevailing winds in Oahu. Indicate this direction by drawing an arrow on your screen. [Deliver](#) [Show all results](#)

1 education

2 PI

3 PI 2.0

learning | catalytics

[Courses](#) [Participate](#) [Review](#) [Classroom](#) [Institutions](#) [Purchases](#) [Users](#) [Tour](#) [Help](#)

4. direction
prevailing

...le. The image provides several clues about the direction of
...on your screen.

 [Deliver](#)  [Show all results](#)



1 educa

3 PI 2.0

learning | catalytics

Courses Participate Review Classroom Institutions Purchases Users Tour Help

4. direction
prevailing

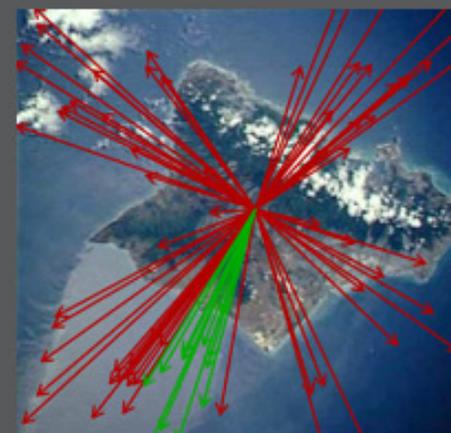
...le. The image provides several clues about the direction of
...on your screen.

Deliver Show all results



Round 1

77 responses, 16% correct



17 get it now
 3 still don't get it

learning | catalytics

[Courses](#) [Participate](#) [Review](#) [Classrooms](#) [Account](#) [Institutions](#) [Purchases](#) [Users](#) [Tour](#) [Help](#)

optics i

current session: 766079 | 69 students

[Back to all lectures](#) [Stop session](#) [Review results](#) [Seat map](#) [Show floating session ID](#) [Edit](#) [Delete](#)



Jump to ▾

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15



4. direction Light enters horizontally into the combination of two perpendicular mirrors as shown below.

[Deliver](#) [Show all results](#)



Indicate the direction of the incident light after it reflects off of both mirrors.



feedback & support

1 lecture

2 PI

3 PI 2.0

learning | catalytics

[Courses](#) [Participate](#) [Review](#) [Classifications](#) [Purchases](#) [Users](#) [Tour](#) [Help](#)

current session: **766079** | 69 students

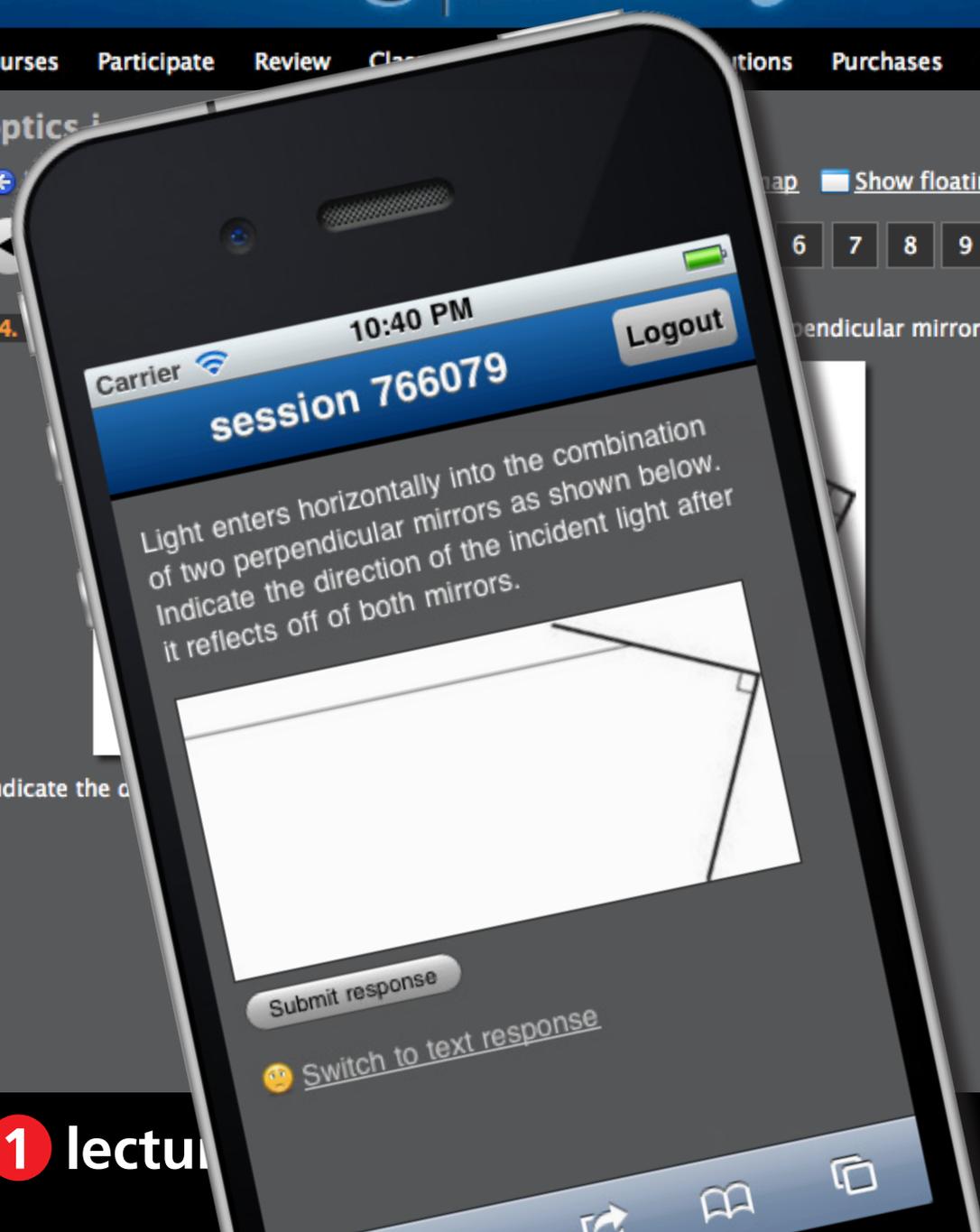
[Map](#) [Show floating session ID](#) [Edit](#) [Delete](#)

6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

[Deliver](#) [Show all results](#)

[feedback & support](#)



1 lecture

3 PI 2.0

learning | catalytics

[Courses](#) [Participate](#) [Review](#) [Classifications](#) [Purchases](#) [Users](#) [Tour](#) [Help](#)

current session: **766079** | 69 students

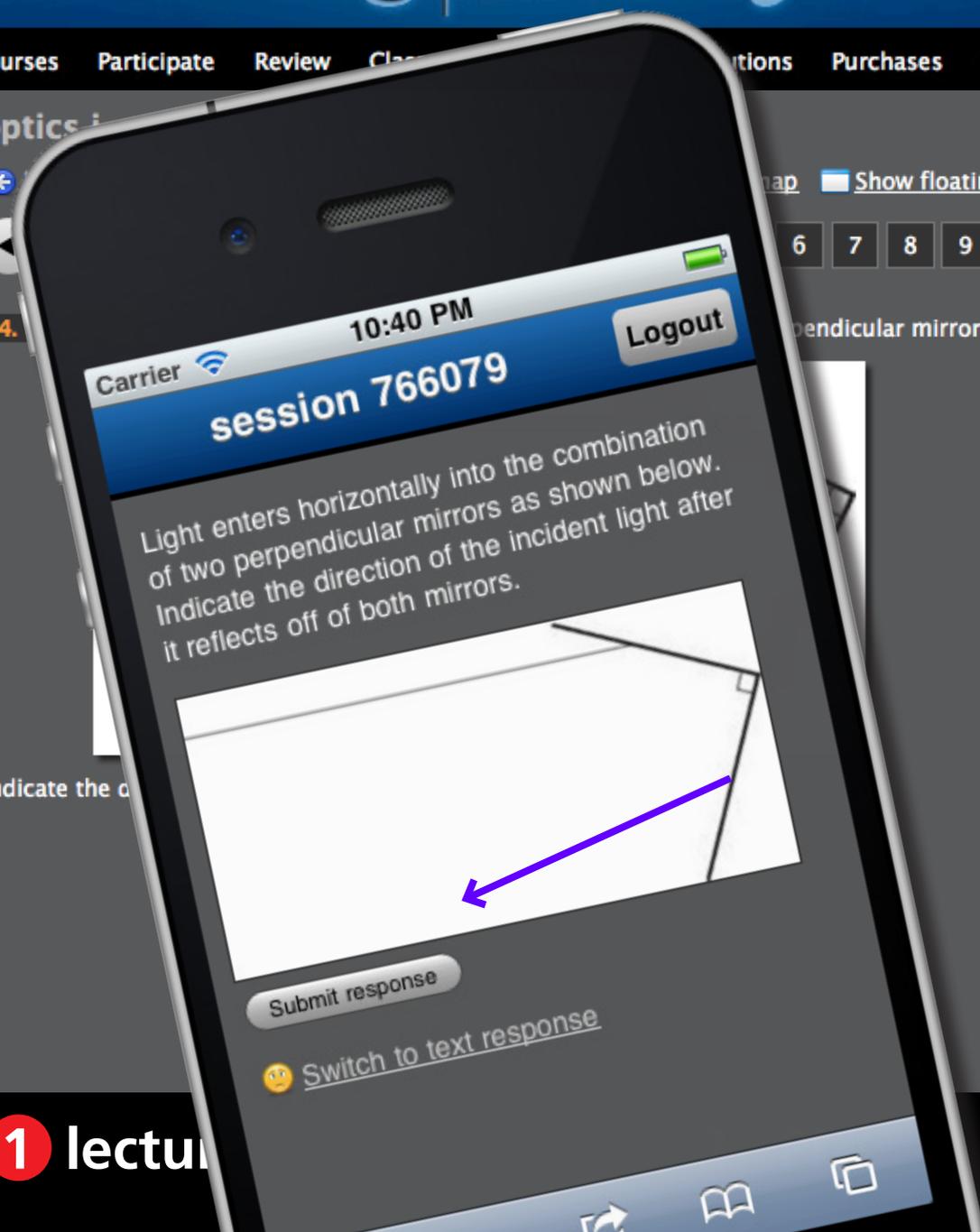
[Map](#) [Show floating session ID](#) [Edit](#) [Delete](#)

6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

[Deliver](#) [Show all results](#)

[feedback & support](#)



1 lecture

3 PI 2.0

learning | catalytics

[Courses](#) [Participate](#) [Review](#) [Classifications](#) [Purchases](#) [Users](#) [Tour](#) [Help](#)

current session: **766079** | 69 students

[Map](#) [Show floating session ID](#) [Edit](#) [Delete](#)

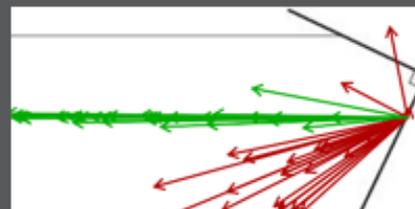
6 7 8 9 10 11 12 13 14 15



perpendicular mirrors as shown below.

[Deliver](#) [Show all results](#)

Round 1
● 57 responses, 58% correct



[feedback & support](#)



1 lectur

3 PI 2.0

learning | catalytics

Courses Participate Review Classifications Purchases Users Tour Help

current session: **766079** | 69 students

Map Show floating session ID Edit Delete

6 7 8 9 10 11 12 13 14 15

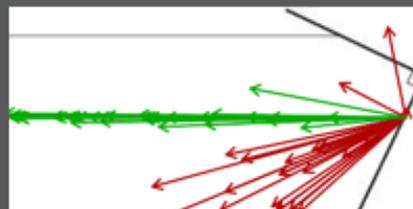


perpendicular mirrors as shown below.

Deliver Show all results

Round 1
● 57 responses, 58% correct

Round 2
● 51 responses, 73% correct



✓ 8 get it now
✗ 0 still don't get it

feedback & support



1 lecture

3 PI 2.0

Sample question types:

- direction
- mathematical expression
- long answer, short answer, word cloud
- numerical, data collection
- ranking, priority
- region (select point on image)
- sketch, composite sketch
- highlight passage

If $2x - y = 4$, then $x =$

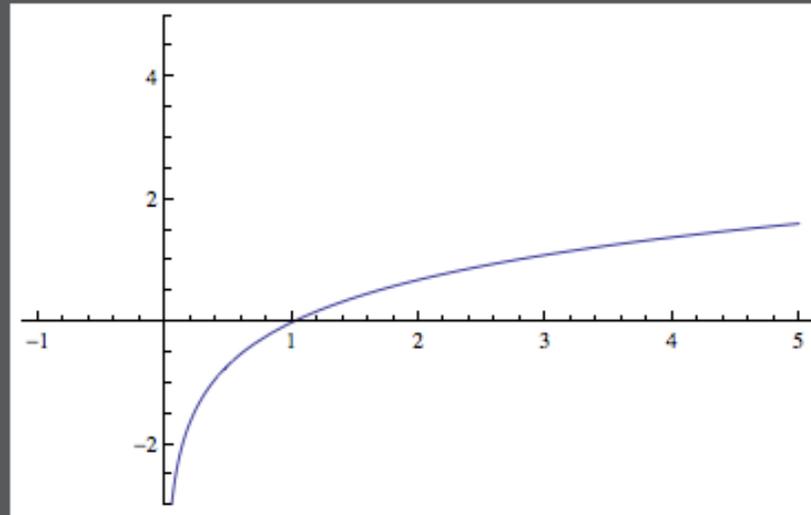
Sample question types:

- direction
- mathematical expression
- long answer, short answer, word cloud
- numerical, data collection
- ranking, priority
- region (select point on image)
- sketch, composite sketch
- highlight passage

learning | catalytics

[Courses](#) [Participate](#) [Review](#) [Classrooms](#) [Account](#) [Institutions](#) [Purchases](#) [Users](#) [Tour](#) [Help](#)

This is a graph of $f(x) = \ln x$. Sketch a graph of the derivative $f'(x)$.



1 lecture

2 PI

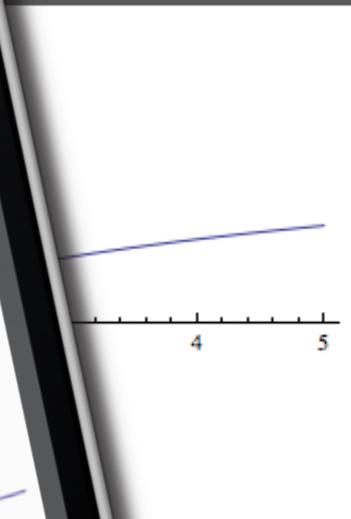
3 PI 2.0

learning | catalytics

Courses Participate

ases Users Tour Help

This is a graph of $f(x) =$



1 lecture

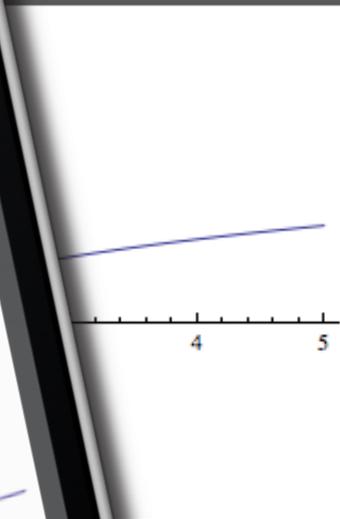
3 PI 2.0

learning | catalytics

Courses Participate

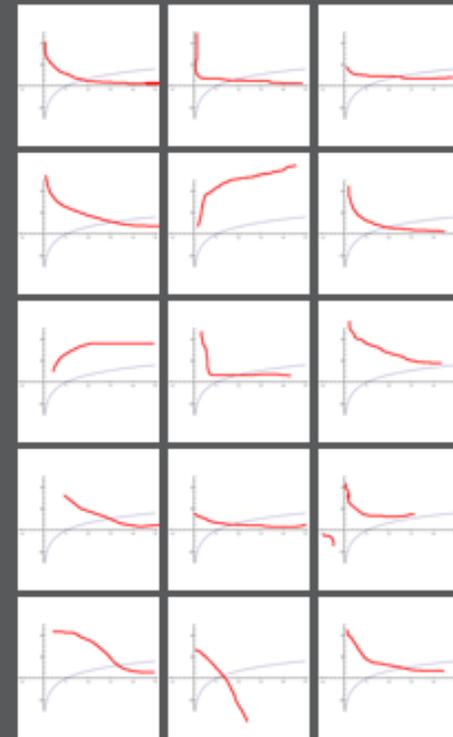
ases Users Tour Help

This is a graph of $f(x) =$



Round 1

15 responses



✓ 6 get it now
✗ 0 still don't get it

1 lecture

3 PI 2.0

Sample question types:

- direction
- mathematical expression
- long answer, short answer, word cloud
- numerical data collection
- ranking priority
- region (select point on image)
- sketch, composite sketch
- highlight passage

data analytics



1 lecture

2 PI

3 PI 2.0



human interaction

1 lecture

2 PI

3 PI 2.0

Carrier 9:31 PM 100%

learning catalytics

skywalker.seas.harvard.edu/class_sessions/399757/review_results

Eric Mazur | Harvard University | Log out

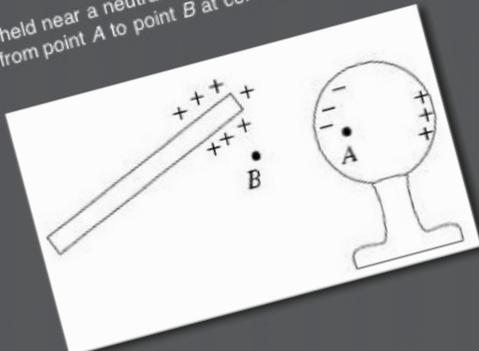
Participate Review Classrooms Account Institutions Users About

review results for session 399757 in electrostatic work and energy ii

Back to all lectures Download all results

Jump to 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B



Round 1
74 responses, 61% correct

A. 61%
B. 4%
C. 35%
D. 0%
E. 0%

Round 2
75 responses, 83% correct

A. 83%
B. 0%
C. 17%
D. 0%
E. 0%

A. positive
B. zero
C. negative
D. depends on the path taken from A to B
E. cannot be determined without knowing more about the polarization induced in the sphere

Search:

1 lecture

2 PI

3 PI 2.0

Carrier 9:31 PM learning catalytics skywalker.seas.harvard.edu/class_sessions/399757/review_results Google Eric Mazur | Harvard University | Log out

learning catalytics

A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B as illustrated below. The potential difference from A to B is

A. positive
 B. zero
 C. negative
 D. depends on the path taken from A to B
 E. cannot be determined without knowing more about the polarization induced in the sphere

Round 1
 74 responses, 61% correct

A. 61%
B. 4%
C. 35%
D. 0%
E. 0%

Round 2
 75 responses, 83% correct

A. 83%
B. 0%
C. 17%
D. 0%
E. 0%

Search: _____

1 lecture

2 PI

3 PI 2.0

Carrier 9:31 PM 100%

learning catalytics

skywalker.seas.harvard.edu/class_sessions/399757/review_results

Eric Mazur | Harvard University | Log out

Participate Review Classrooms Account Institutions Users About

learning | catalytics

review results for session 399757 in electrostatic work and energy ii

Back to all lectures Download all results

Jump to 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Round 1 74 responses, 61% correct

Round 2 75 responses, 83% correct

A. 61% B. 4% C. 35% D. 0% E. 0%

A. 83% B. 0% C. 17% D. 0% E. 0%

A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B

A. positive
B. zero
C. negative
D. depends on the path taken from A to B
E. cannot be determined without knowing more about the polarization induced in the sphere

Search:

1 lecture

2 PI

3 PI 2.0

Carrier 9:31 PM learning catalytics skywalker.seas.harvard.edu/class_sessions/399757/review_results Google Eric Mazur | Harvard University | Log out

learning catalytics

A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B as illustrated below. The potential difference from A to B is

A. positive
 B. zero
 C. negative
 D. depends on the path taken from A to B
 E. cannot be determined without knowing more about the polarization induced in the sphere

Round 1
 74 responses, 61% correct

A. 61%
B. 4%
C. 35%
D. 0%
E. 0%

Round 2
 75 responses, 83% correct

A. 83%
B. 0%
C. 17%
D. 0%
E. 0%

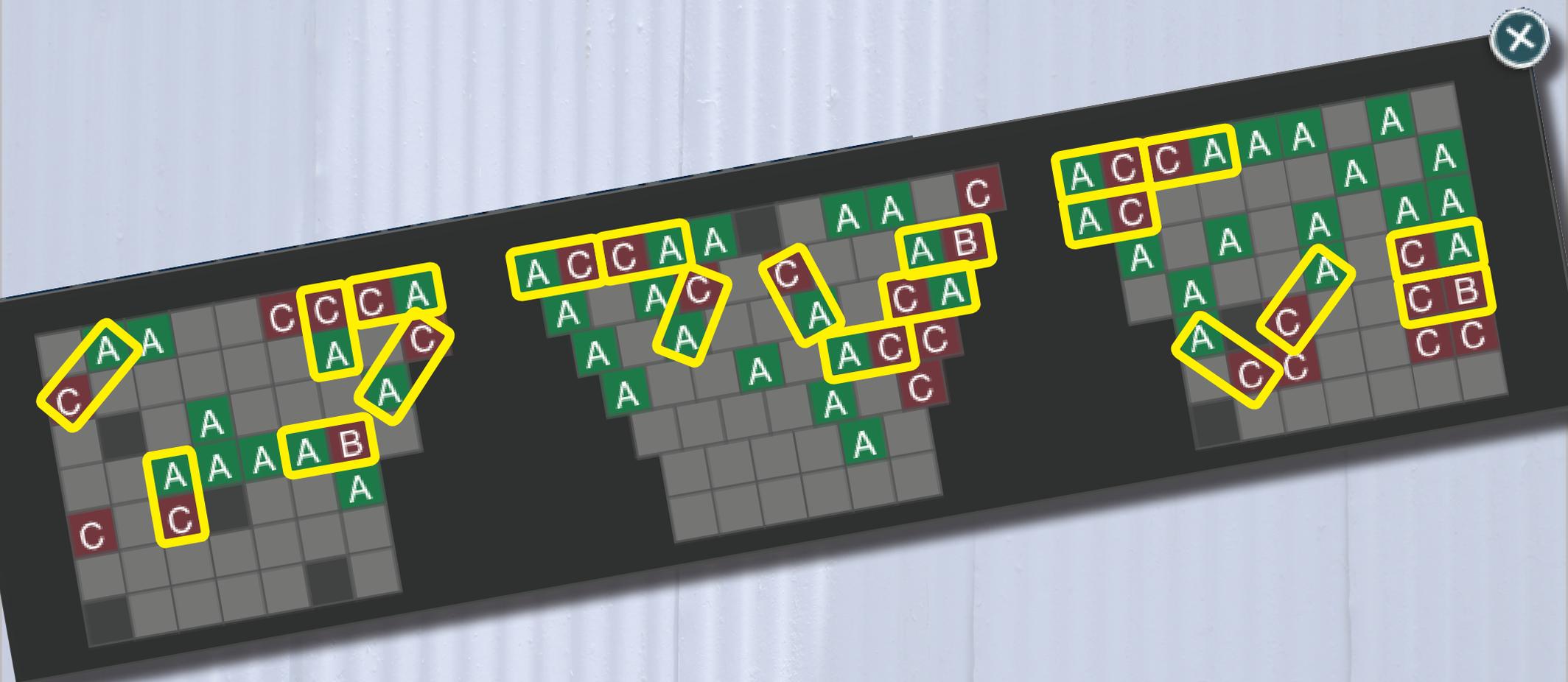
Search: _____

1 lecture

2 PI

3 PI 2.0

let system manage pairing

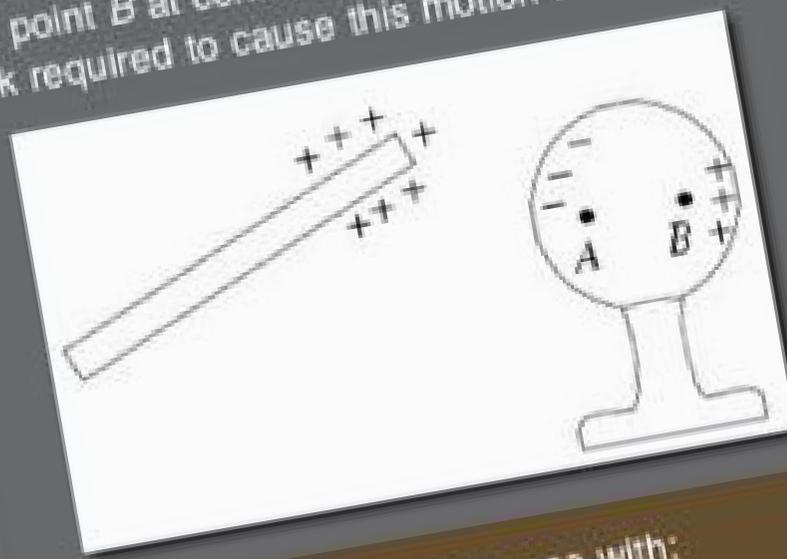


1 lecture

2 PI

3 PI 2.0

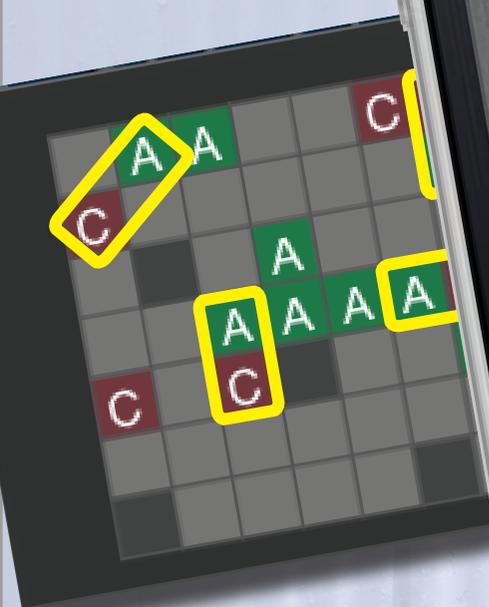
A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B at constant speed. The mechanical work required to cause this motion is



Please discuss your response with:

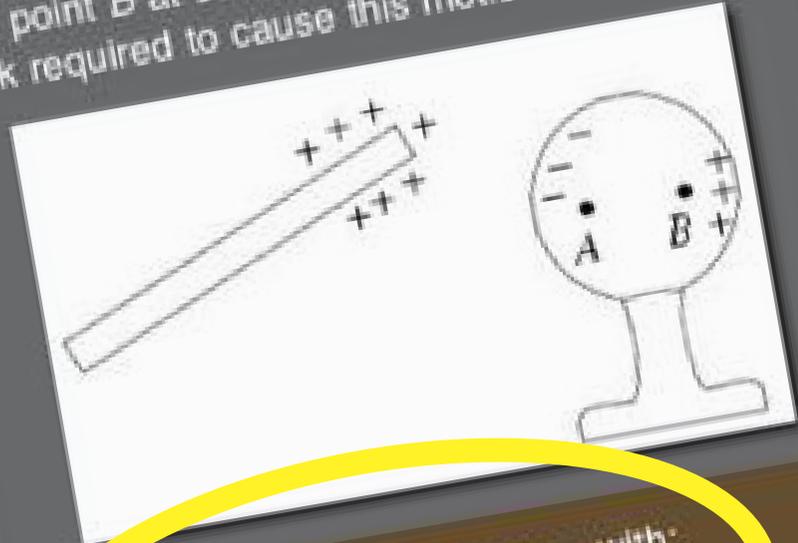
- Brian Lukoff (to your left)

I am talking to this person/people



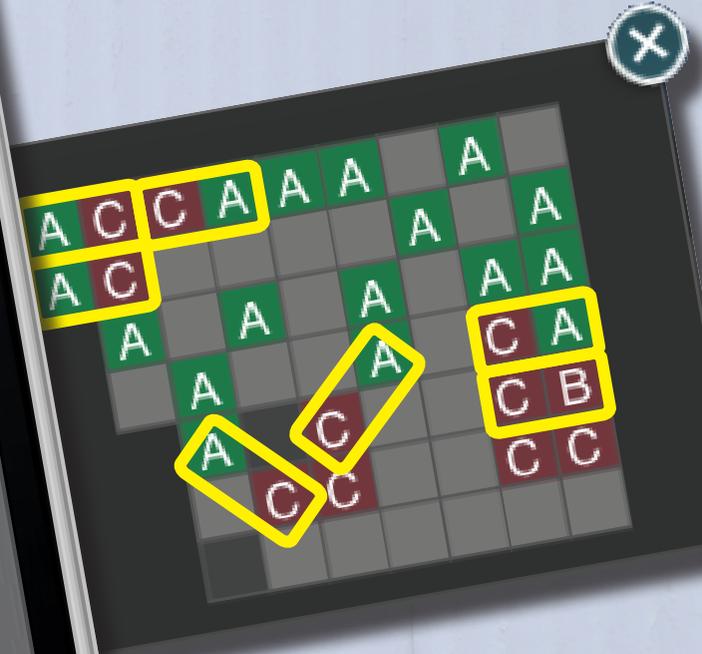
Leave

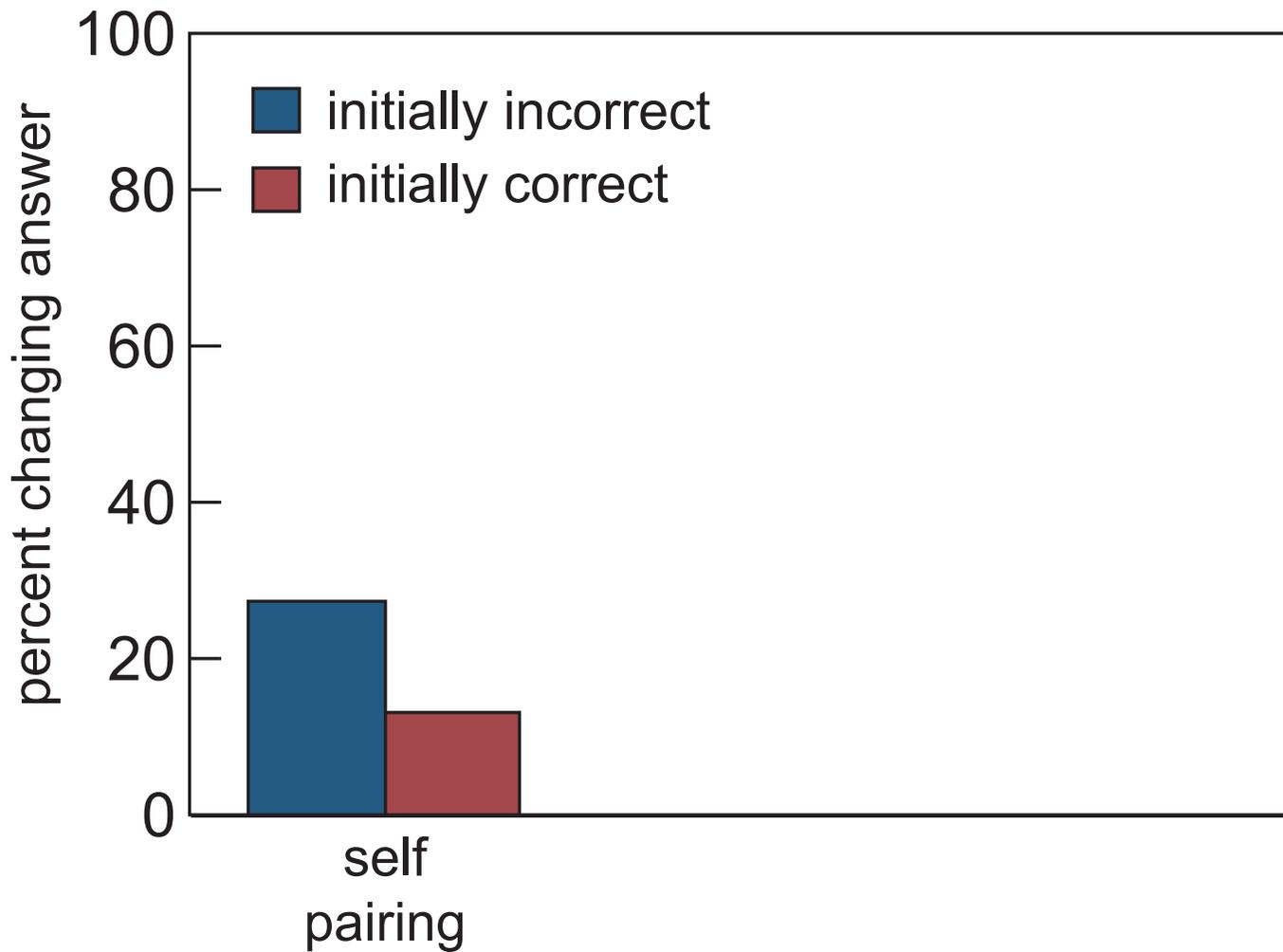
A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B at constant speed. The mechanical work required to cause this motion is

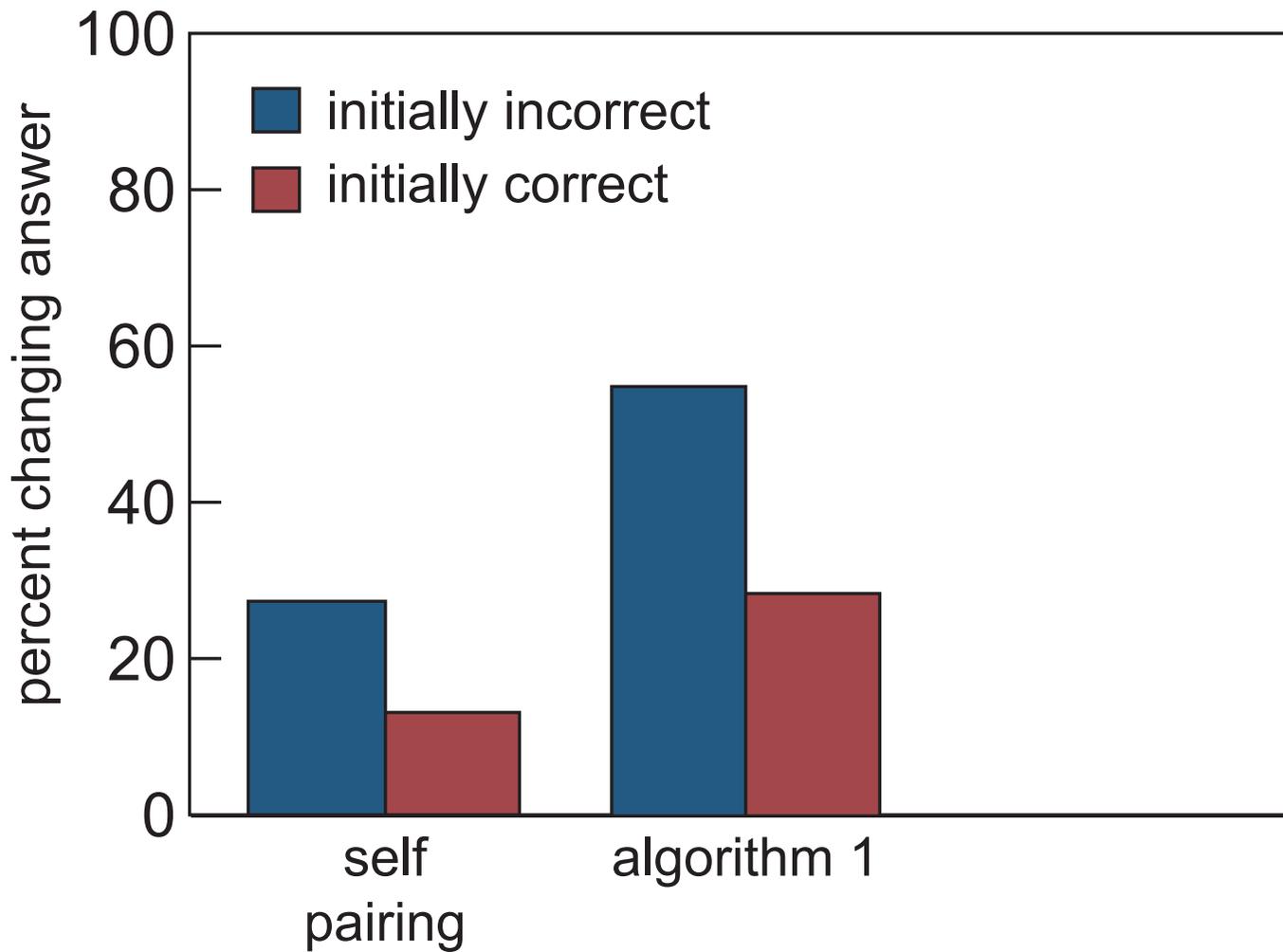


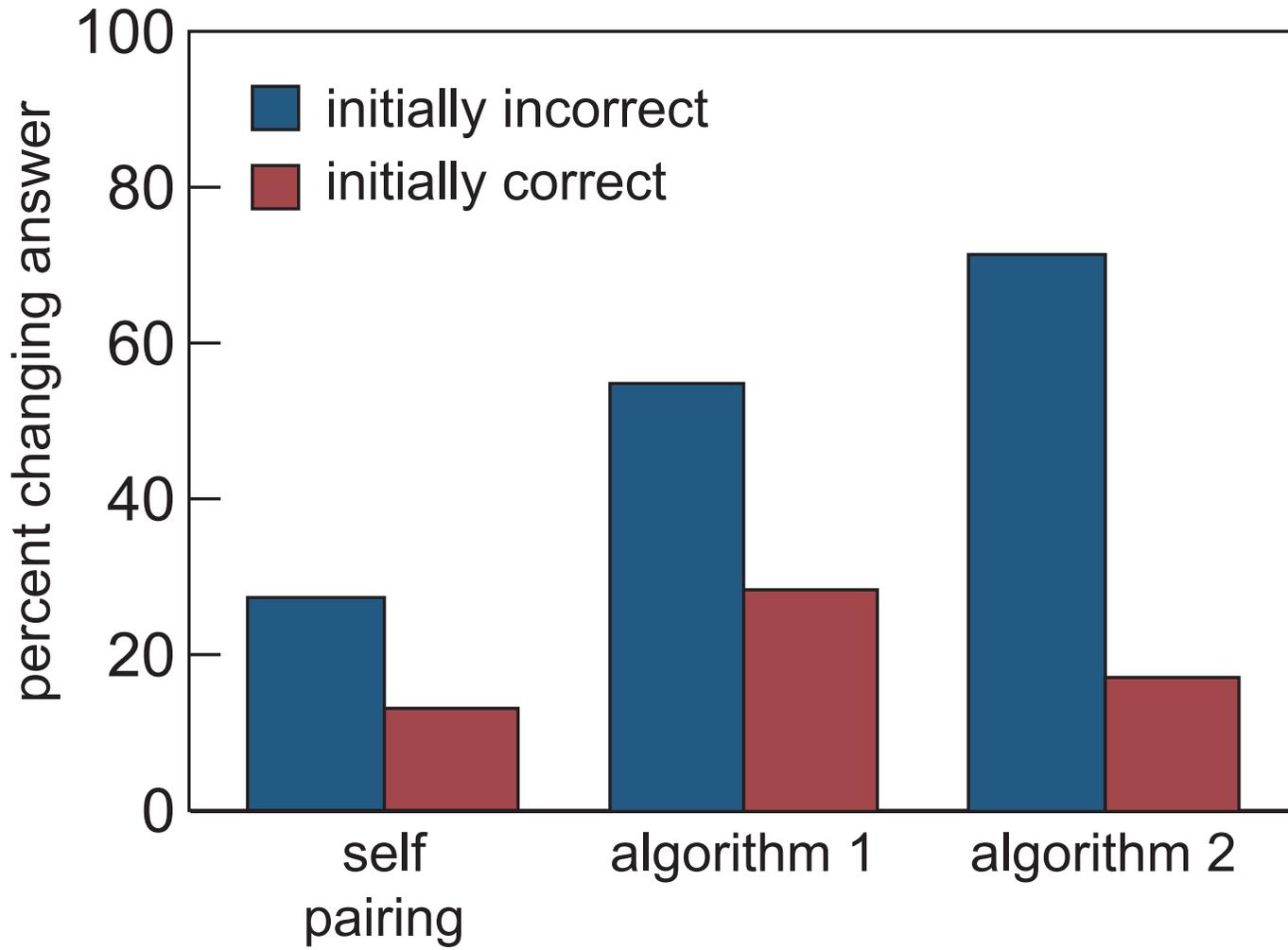
Please discuss your response with:

- Brian Lukoff (to your left)







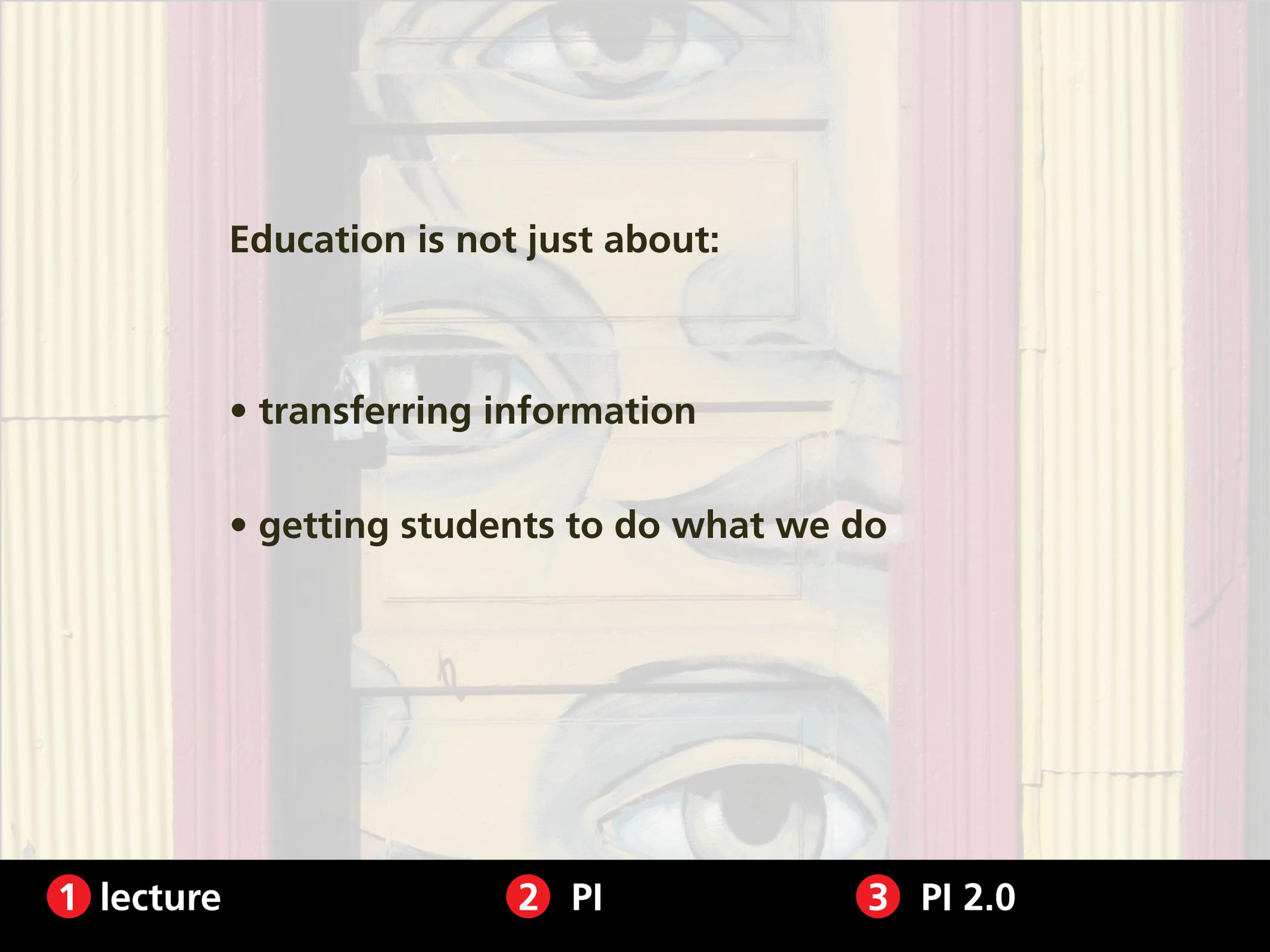




1 lecture

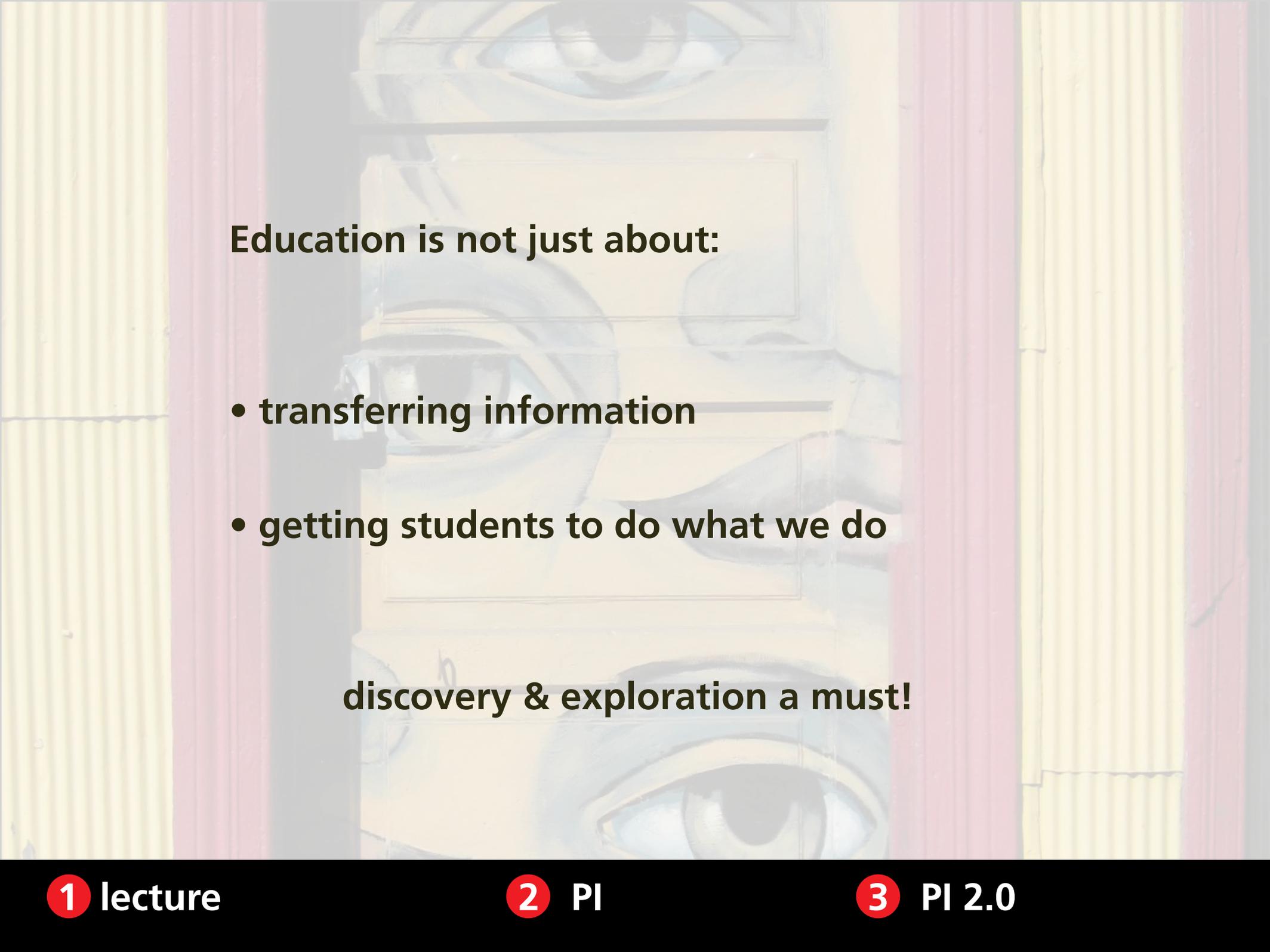
2 PI

3 PI 2.0



Education is not just about:

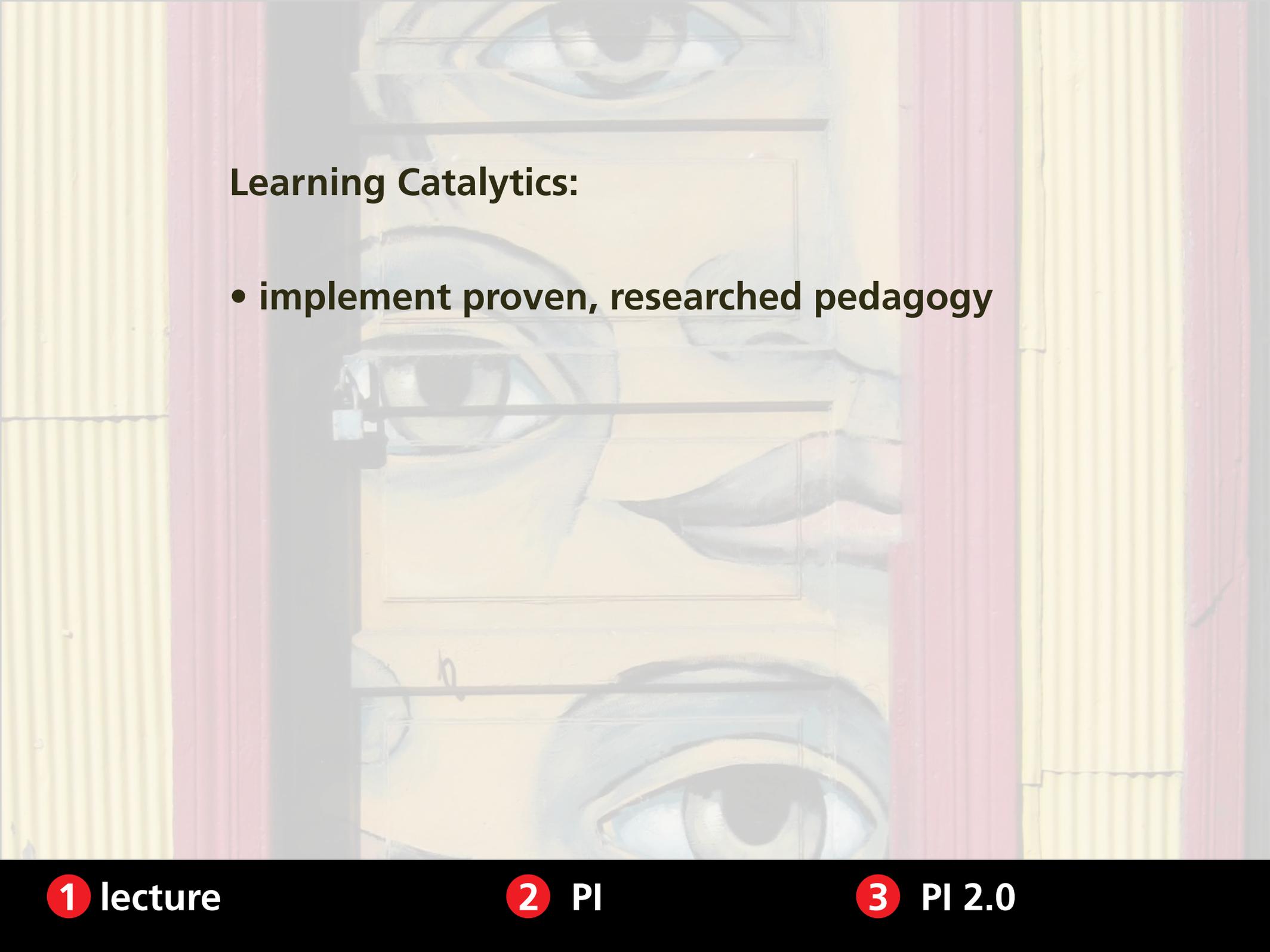
- **transferring information**
- **getting students to do what we do**



Education is not just about:

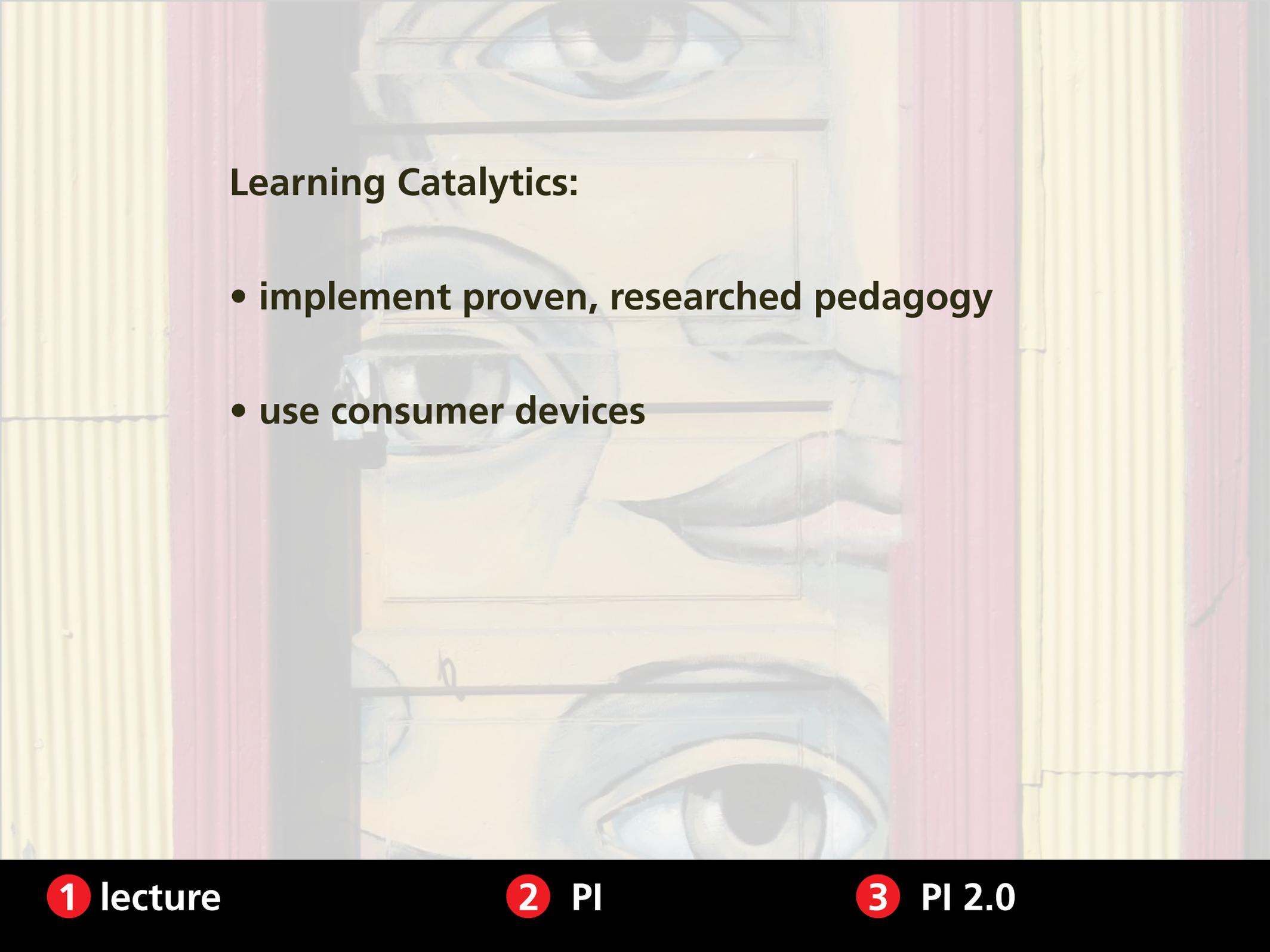
- **transferring information**
- **getting students to do what we do**

discovery & exploration a must!

The background of the slide features a window with horizontal blinds. Behind the blinds, there is a painting of three human eyes looking out from the window. The eyes are rendered in a realistic style with detailed shading and highlights. The overall color palette is muted, with soft yellows, greys, and blues.

Learning Catalytics:

- implement proven, researched pedagogy



Learning Catalytics:

- implement proven, researched pedagogy
- use consumer devices

Learning Catalytics:

- **implement proven, researched pedagogy**
- **use consumer devices**
- **avoid pitfalls of MC assessment**

Learning Catalytics:

- implement proven, researched pedagogy
- use consumer devices
- avoid pitfalls of MC assessment
- create a smart classroom *anywhere*

Funding:

National Science Foundation

for a copy of this presentation:

mazur.harvard.edu

learningcatalytics.com

Follow me!



eric_mazur