

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

**2. Create student account with signup code DEMO**

**3. Join session 1234567**

**4. Pick your seat from the seat map**



# Learning Catalytics and ConcepTest development



EDUCACION

Universidad de los Andes  
Santiago, Chile, 22 August 2012





# Learning Catalytics and ConcepTest development



@eric\_mazur

Universidad de los Andes  
Santiago, Chile, 22 August 2012

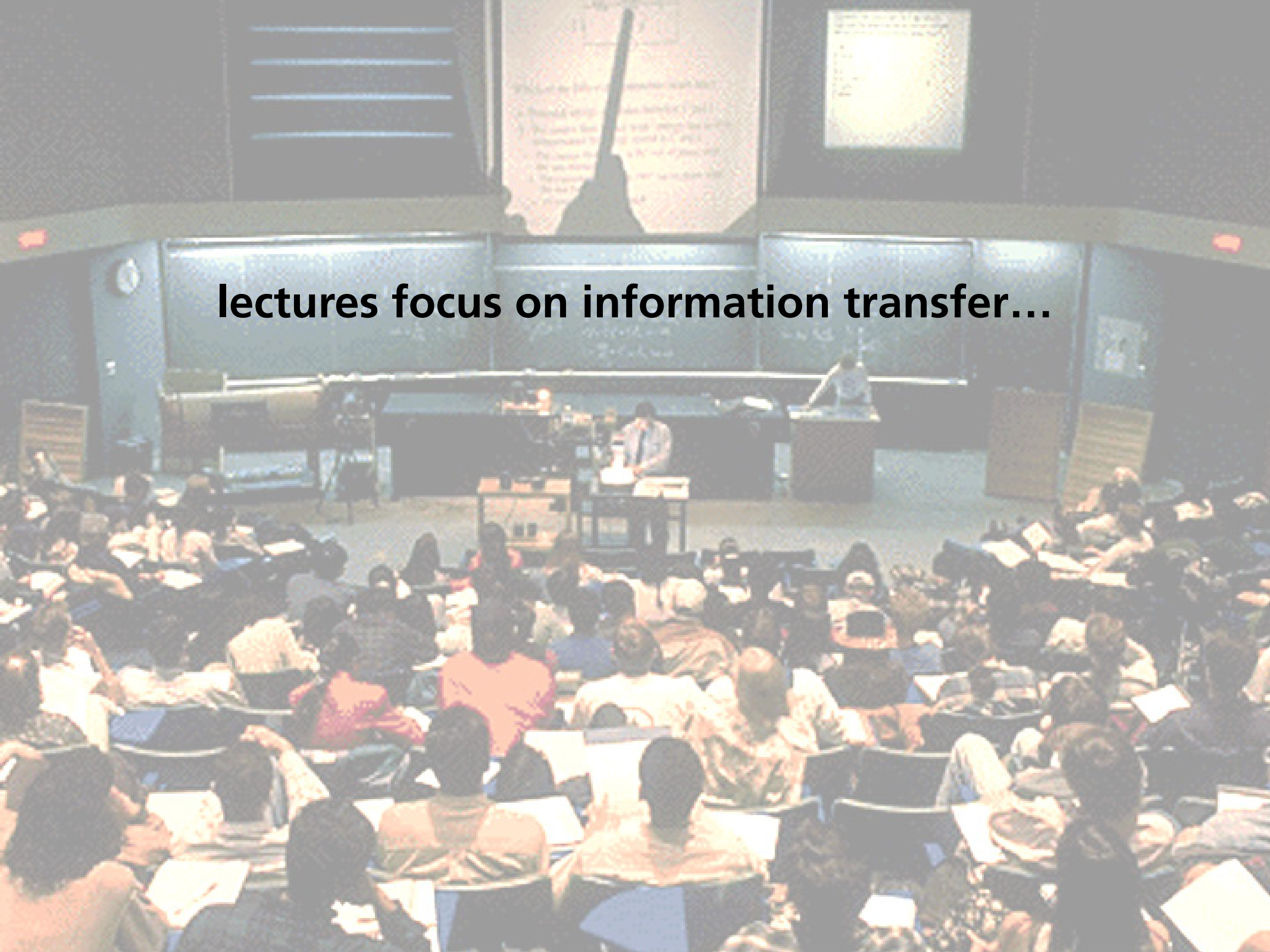




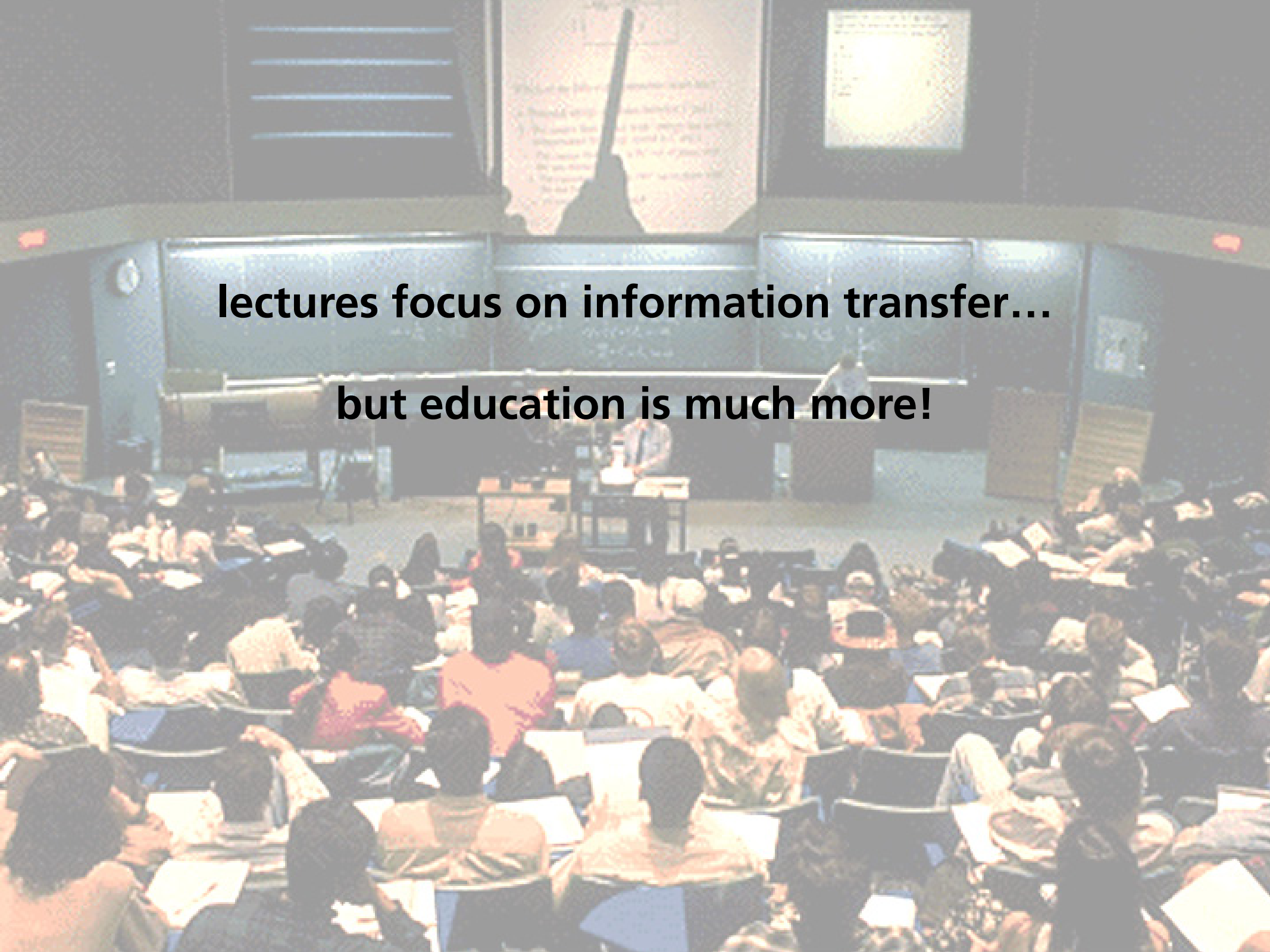




**lectures focus on information transfer...**





A photograph of a large lecture hall. A professor is standing at a podium on the stage, facing a large audience of students seated at desks. The room is dimly lit, with the main light source being the stage lights. There are several large screens or projectors at the front of the room. The text is overlaid on the image.

**lectures focus on information transfer...  
but education is much more!**









What are the following...  
A...  
The...  
The...  
The...  
The...

...  
...  
...  
...  
...

1 PI demo

2 PI 2.0





1 PI demo

2 PI 2.0

3 CT design



question



question



think

**question**



**think**



**poll**



**question**



**think**



**poll**



**discuss**

**question**



**think**



**poll**



**discuss**



**repoll**



**question**



**think**



**poll**



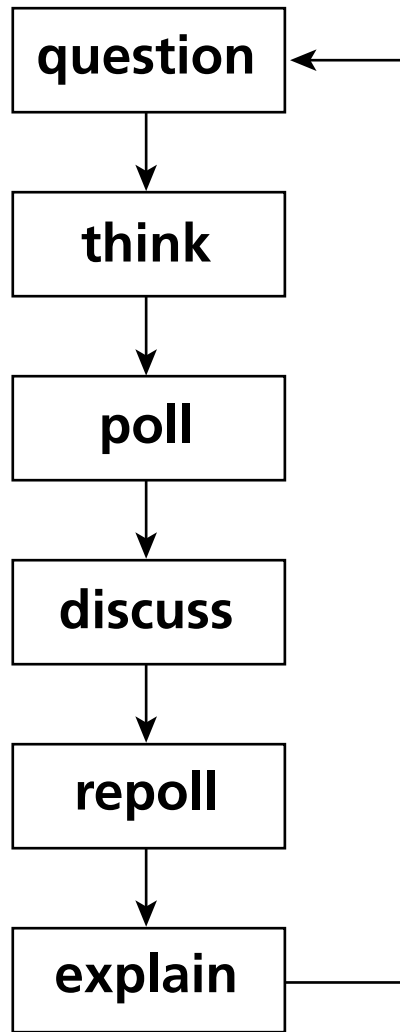
**discuss**



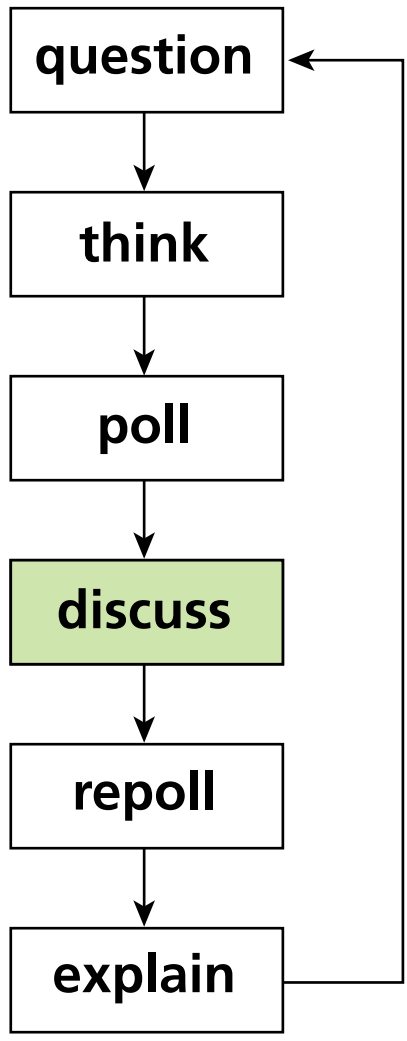
**repoll**



**explain**







Let's try it!

QUESTION

think

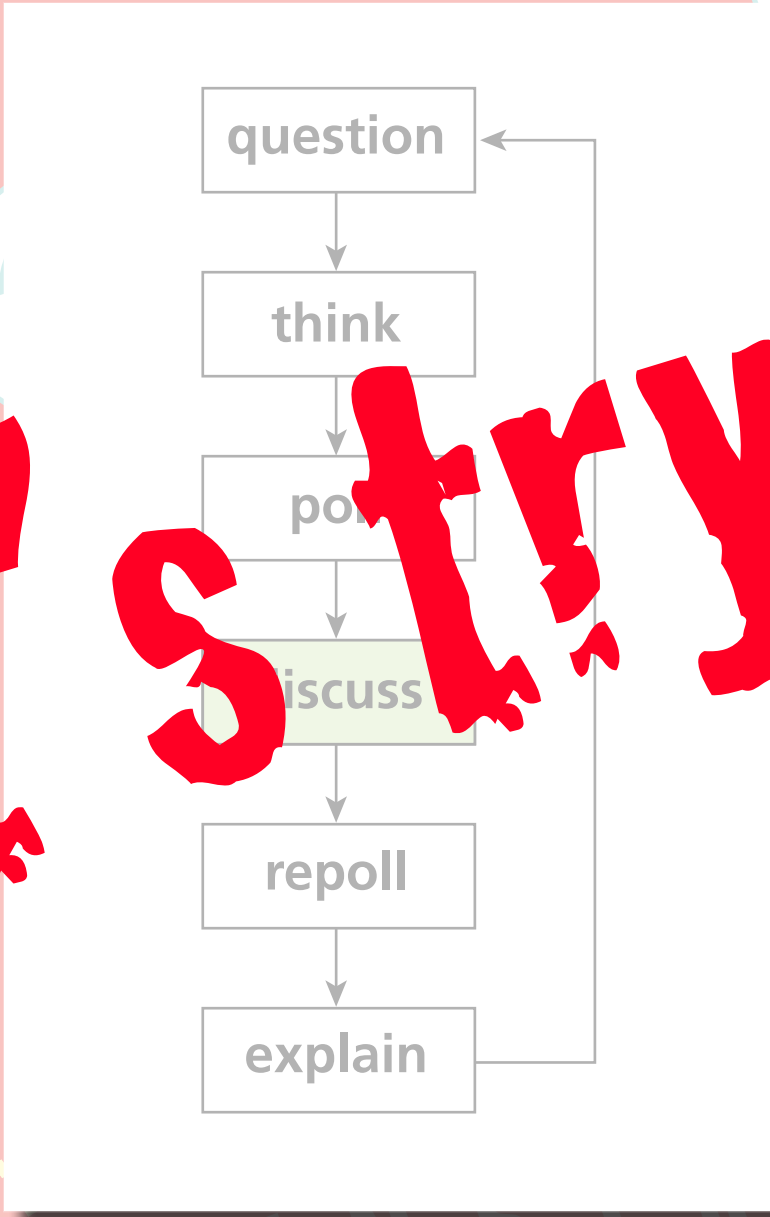
poll

discuss

repoll

explain

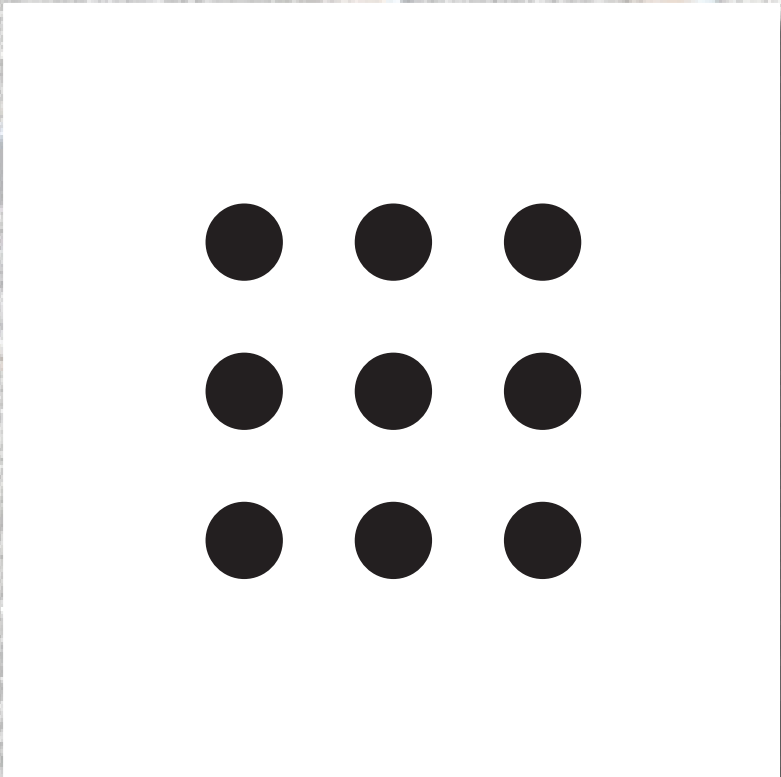
ACTION

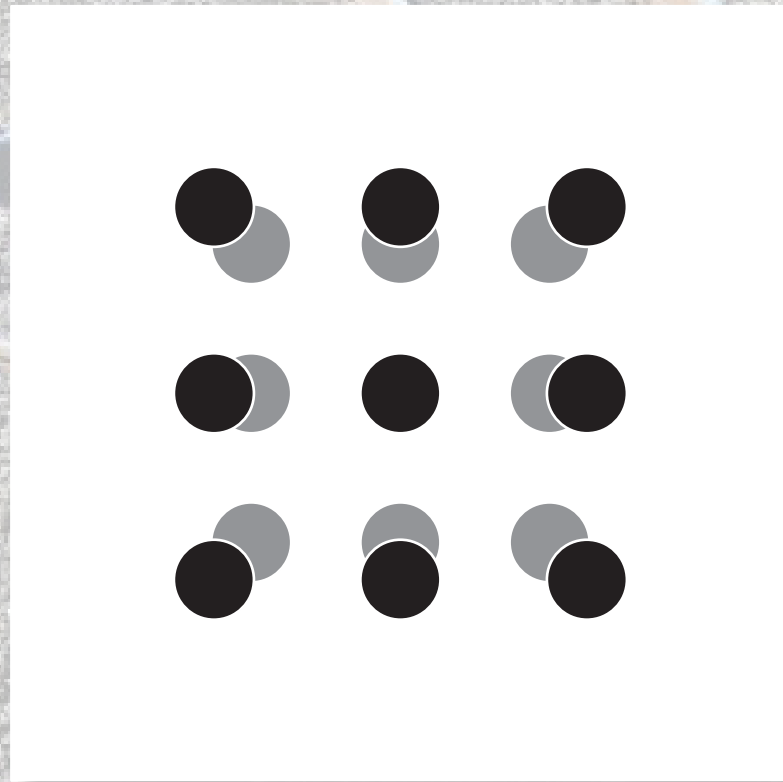




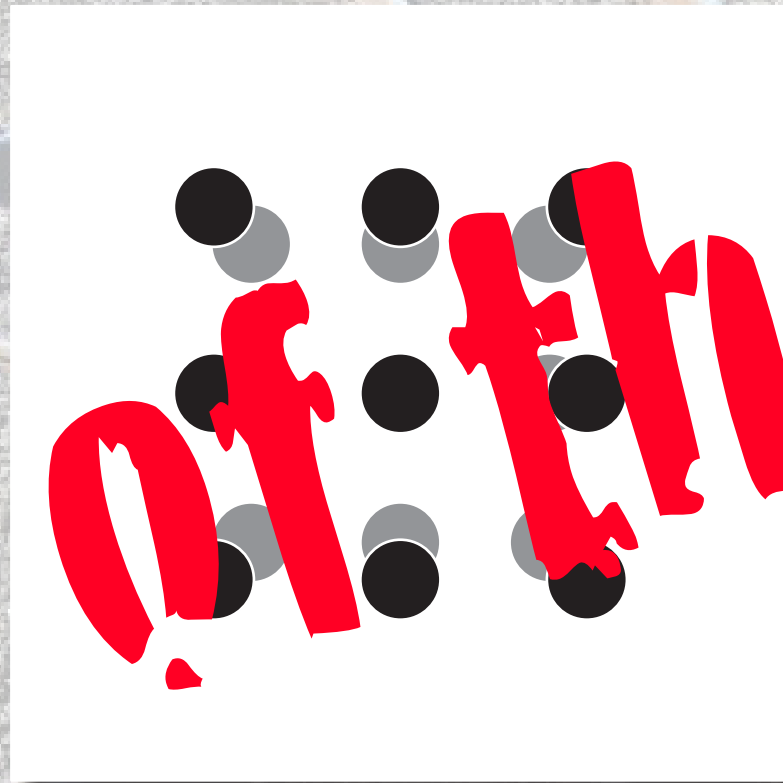
**thermal expansion**





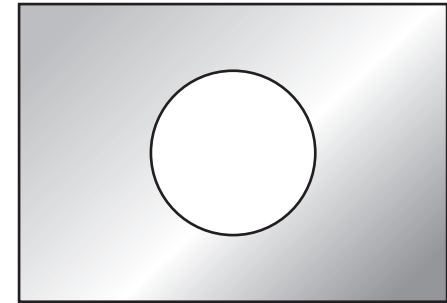


**all of them!**



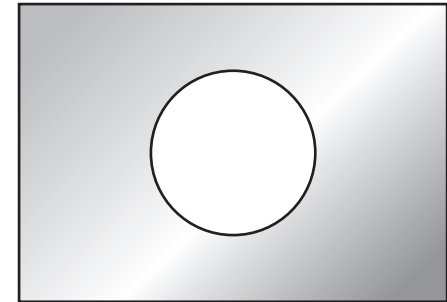


**Consider a rectangular metal plate  
with a circular hole in it.**



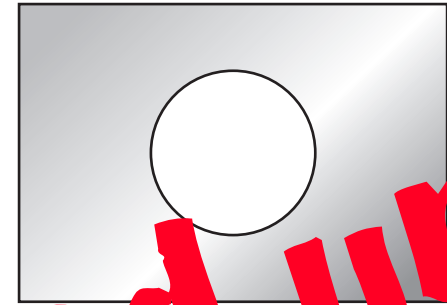
**Consider a rectangular metal plate with a circular hole in it.**

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



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

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



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

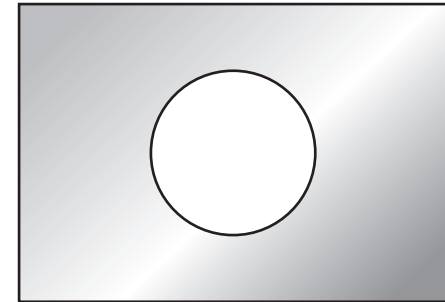
1. increases.
2. stays the same.
3. decreases.

**you got all fired up!**



**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.**

**Before I tell you the answer...**

**Before I tell you the answer, let's analyze what happened.**



**Before I tell you the answer, let's analyze what happened.**

**You...**

**Before I tell you the answer, let's analyze what happened.**

**You...**

**1. made a commitment**

**Before I tell you the answer, let's analyze what happened.**

**You...**

- 1. made a commitment**
- 2. externalized your answer**

**Before I tell you the answer, let's analyze what happened.**

**You...**

- 1. made a commitment**
- 2. externalized your answer**
- 3. moved from the answer/fact to reasoning**



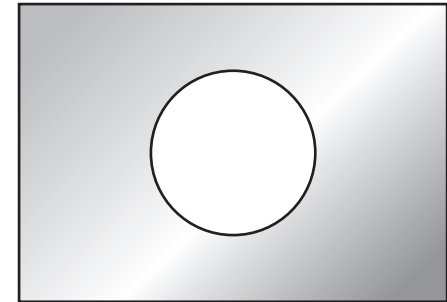
**Before I tell you the answer, let's analyze what happened.**

**You...**

- 1. made a commitment**
- 2. externalized your answer**
- 3. moved from the answer/fact to reasoning**
- 4. became emotionally invested in the learning process**

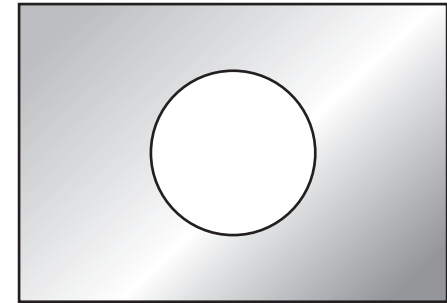
**Consider a rectangular metal plate with a circular hole in it.**

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



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

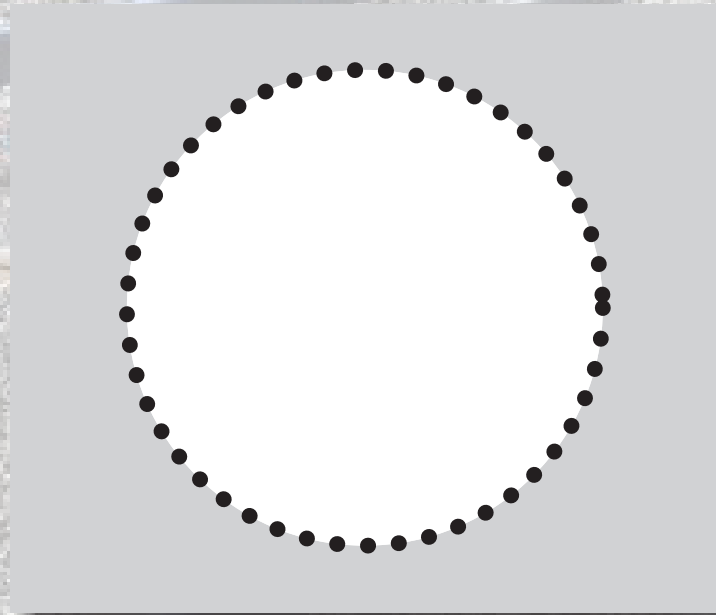
**Consider a rectangular metal plate with a circular hole in it.**



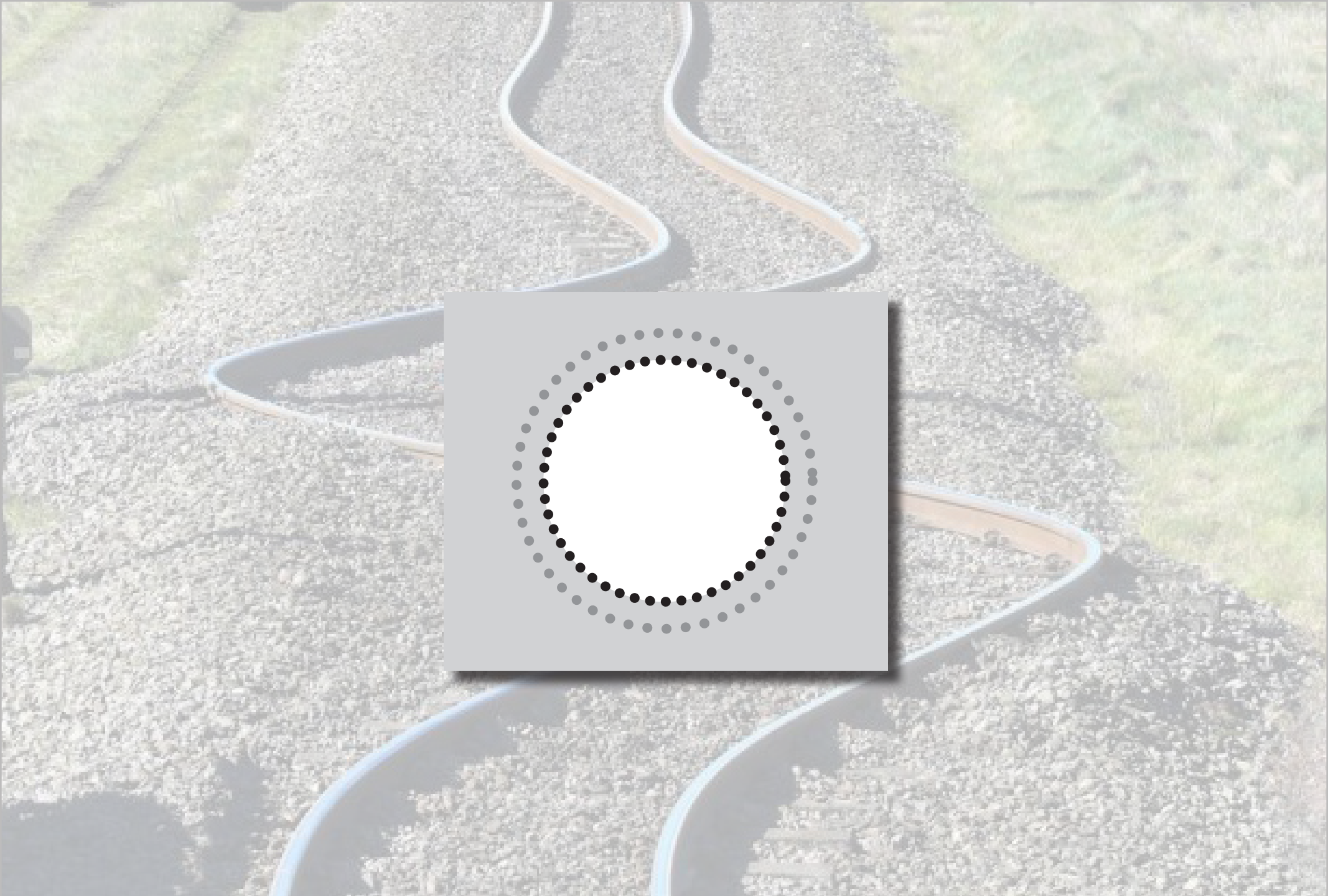
**When the plate is uniformly heated, the diameter of the hole**

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

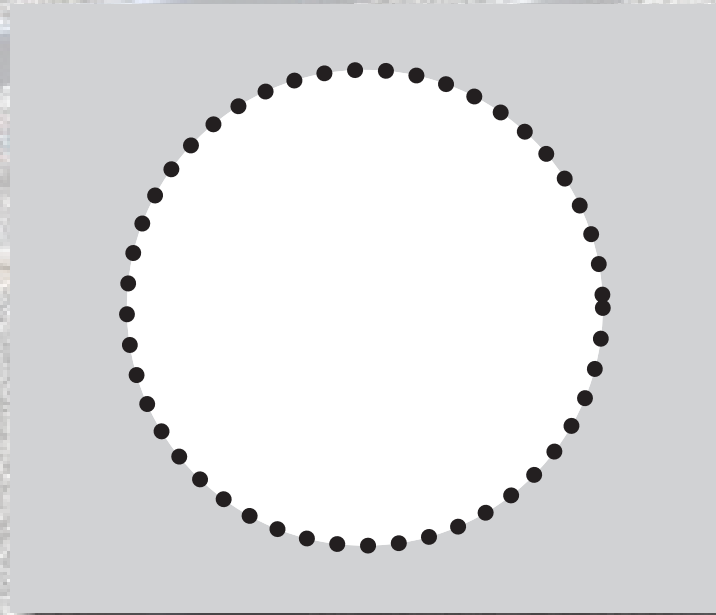
consider atoms at rim of hole



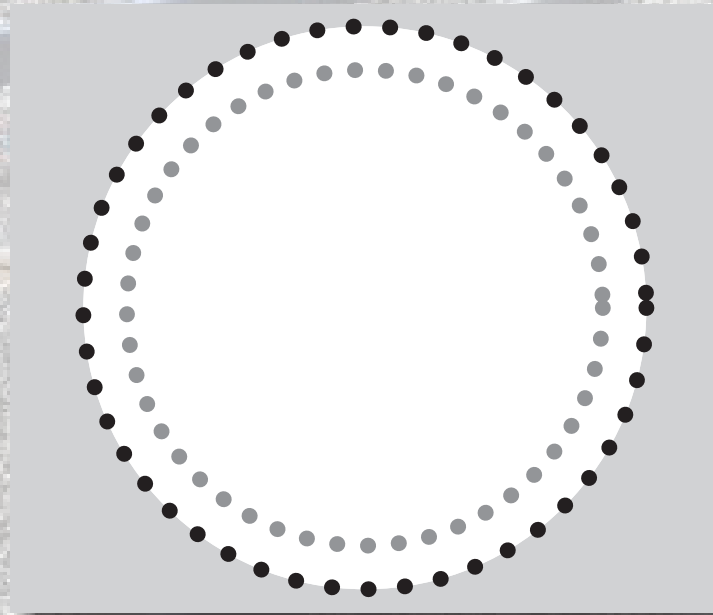




consider atoms at rim of hole



consider atoms at rim of hole



consider atoms at rim of hole

**you won't forget this**







**1** PI demo

**2** PI 2.0



**feedback**

**1** PI demo

**2** PI 2.0



**1** PI demo

**2** PI 2.0





1993

1 PI demo

2 PI 2.0



A black handheld remote control is shown at an angle. It features a numeric keypad with buttons for digits 1 through 9, 0, and a red power button. A green logo with the letters 'FRS' is visible on the lower right side of the device. The year '1998' is overlaid in large white text in the center of the image.

1998

1 PI demo

2 PI 2.0



1 PI demo

2 PI 2.0



# technology

1 PI demo

2 PI 2.0





How do I...

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

# learning | catalytics

1 PI demo

2 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, an individual would need all but which of the following:
- a. A business model
  - b. A marketing plan
  - c. A budget
  - d. 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:
- a. business model
  - b. appreciation?

## Sample question types:

- direction
- expression
- long answer, short answer, word cloud (fill in text)
- multiple-choice, many-choice
- numerical (enter a number)
- ranking
- region (select point on image)
- sketch
- highlight passage



Think of something you are good at

EDUCACION



**Think of something you are good at**

***How did you become good at this?***

**EDUCACION**



Became good at it by:

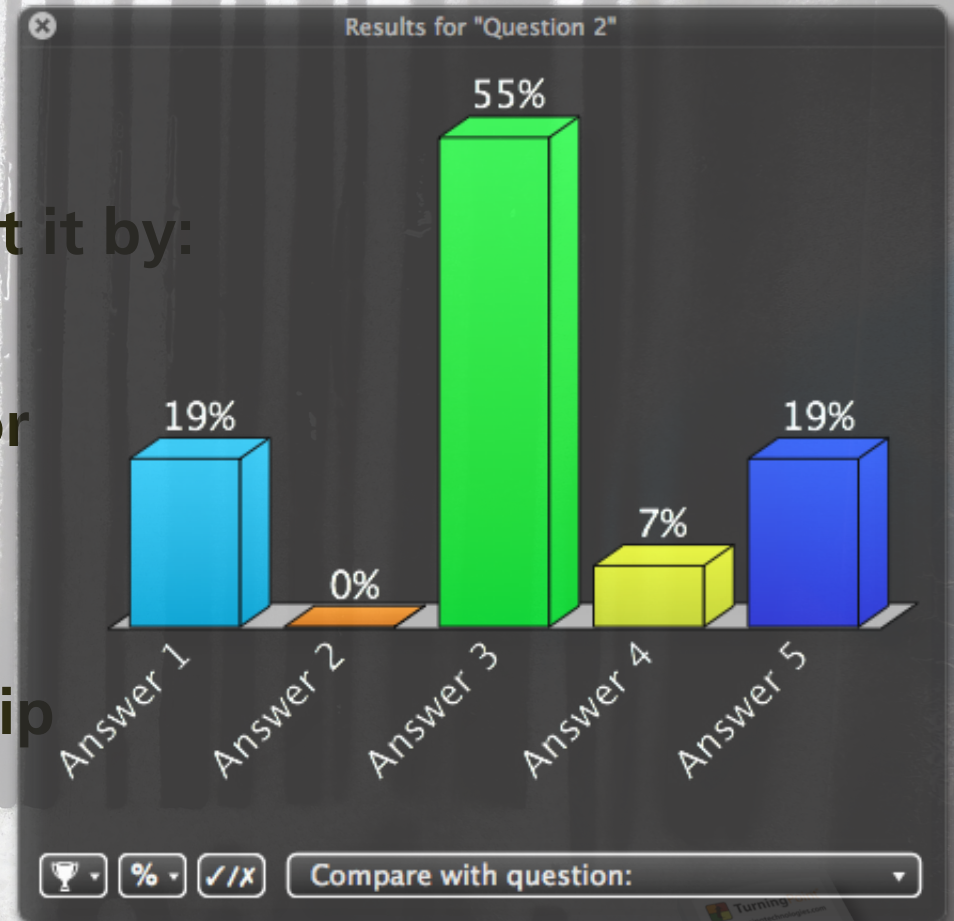
1. trial and error
2. lectures
3. practicing
4. apprenticeship
5. other





Became good at it by:

1. trial and error
2. lectures
3. practicing
4. apprenticeship
5. other



# learning | catalytics

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

2. word of  
question. ... e good at whatever it is you entered in the previous

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



1 PI dem



# learning | catalytics

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

2. word of... question. ...e good at whatever it is you entered in the previous

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

**Round 1**

123 responses

experiences

learning observing

reading people being

experience time

# practice

work others school

working good through family

watching many listening

61 get it now

4 still don't get it



**1** PI dem



1 [lccatalytics.com](https://lccatalytics.com) 2 create student account 3 ID 1234567

# 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 PI demo

2 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 PI de

# learning | catalytics

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

current session: **766079** | 69 students

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

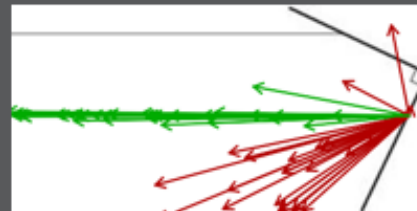
6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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

Round 1 [✖](#) [📊](#) [📄](#)

57 responses, 58% correct



[📢 feedback & support](#)



1 PI de

# learning | catalytics

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

current session: **766079** | 69 students

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

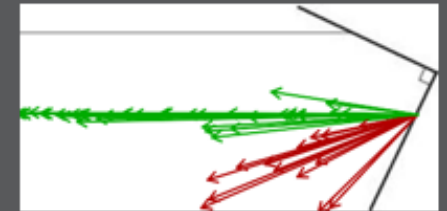
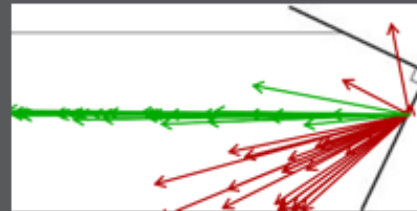
6 7 8 9 10 11 12 13 14 15

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

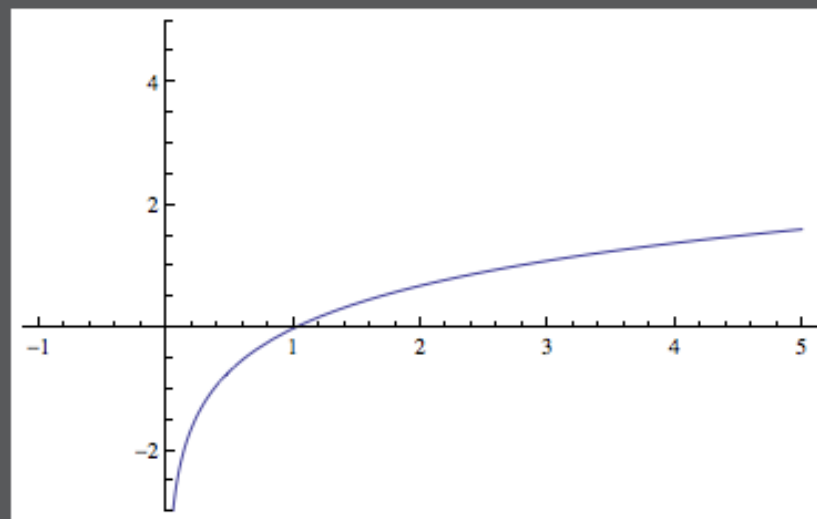
[📣 feedback & support](#)



# 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** PI demo

**2** PI 2.0

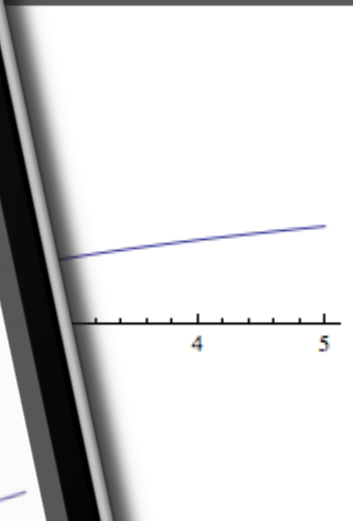


# learning | catalytics

Courses Participate

ases Users Tour Help

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



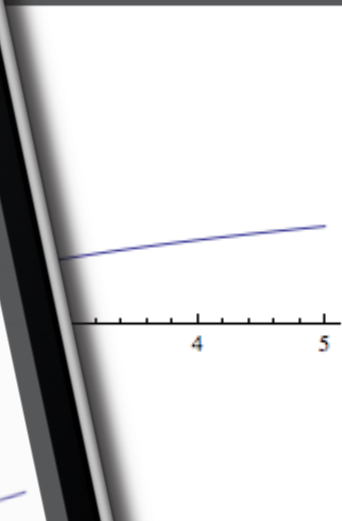
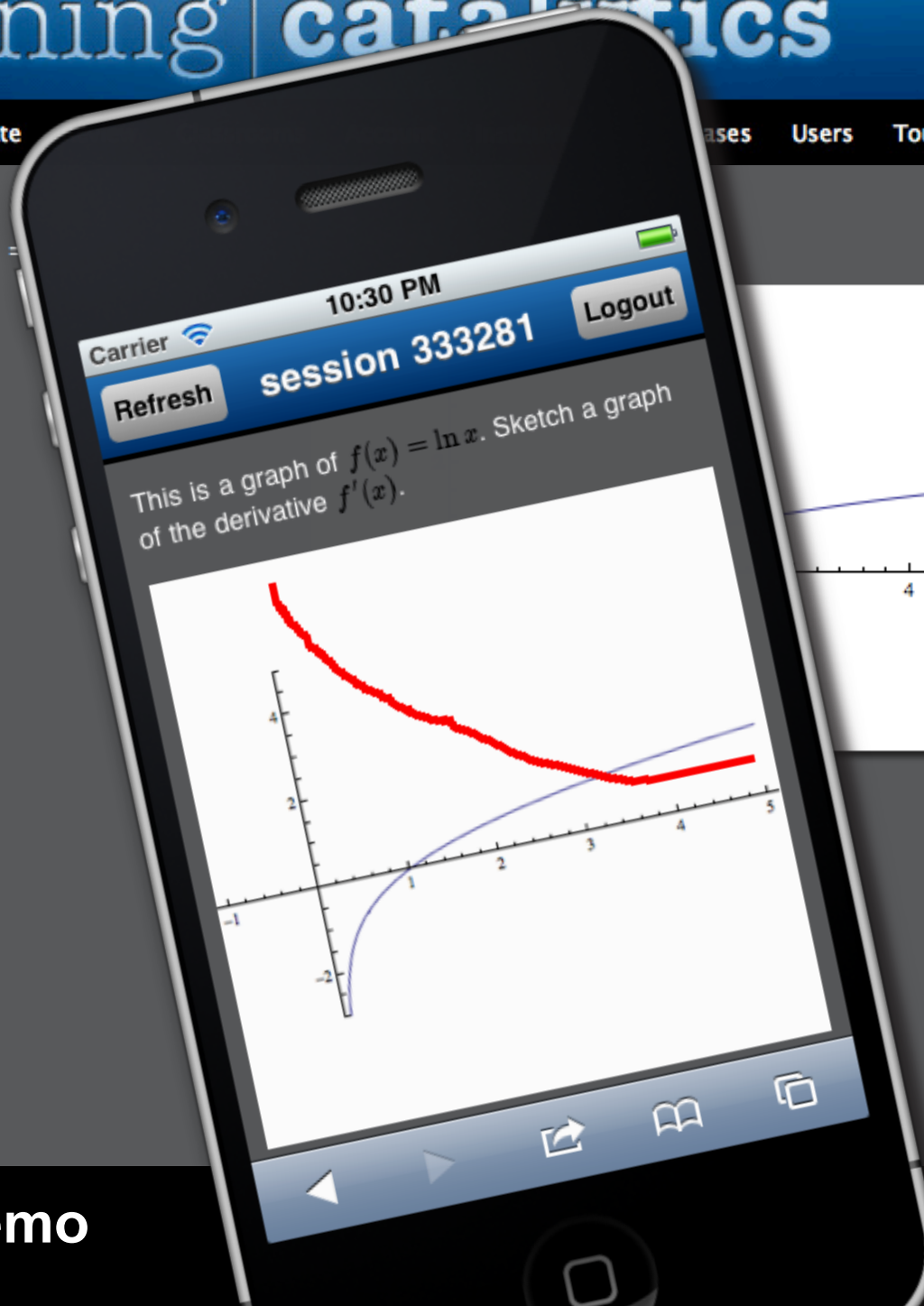
1 PI demo

# learning | catalytics

Courses Participate

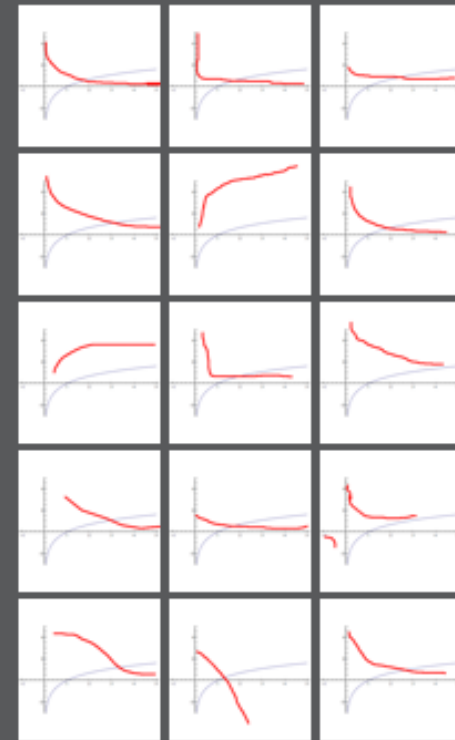
ases Users Tour Help

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



Round 1

15 responses



✓ 6 get it now  
 ✗ 0 still don't get it

1 PI demo

# learning | catalytics

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

1. highlighting What do you see as the most important part of this Shakespeare sonnet? [Stop delivery](#) [Deliver again](#) [Assign groups](#) [Show all results](#)

For shame! deny that thou bear'st love to any,  
Who for thyself art so unprovident.  
Grant, if thou wilt, thou art beloved of many,  
But that thou none lovest is most evident;  
For thou art so possess'd with murderous hate  
That 'gainst thyself thou stick'st not to conspire.  
Seeking that beauteous roof to ruinate  
Which to repair should be thy chief desire.  
O, change thy thought, that I may change my mind!  
Shall hate be fairer lodged than gentle love?  
Be, as thy presence is, gracious and kind,  
Or to thyself at least kind-hearted prove:  
Make thee another self, for love of me,  
That beauty still may live in thine or thee.

1 PI demo

2 PI 2.0

# learning | catalytics

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

1. highlighting  
sonnet?

this Shakespeare

[Stop delivery](#)

[Deliver again](#)

[Assign groups](#)

[Show all results](#)

For shame  
Who for t  
Grant, if t  
But that th  
For thou a  
That 'gainst  
Seeking tha  
Which to rep  
O, change th  
Shall hate be  
Be, as thy pres  
Or to thyself a  
Make thee ano  
That beauty stil



What do you see as the most important part of this Shakespeare sonnet?

Highlight the passage below by clicking or tapping once to set the beginning of your highlight, and then clicking or tapping again to set the end.

For shame! deny that thou bear'st love to any,  
Who for thyself art so unprovident.  
Grant, if thou wilt, thou art beloved of many,  
But that thou none lovest is most evident;  
For thou art so possess'd with murderous hate  
That 'gainst thyself thou stick'st not to  
conspire.

Seeking that beauteous roof to ruinate  
Which to repair should be thy chief desire.

O, change thy thought, that I may change my  
mind!

1 PI dem



# learning | catalytics

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

1. highlighting  
sonnet?

this Shakespeare

[Stop delivery](#)

[Deliver again](#)

[Assign groups](#)

[Show all results](#)

## Round 1

3 responses

For shame! deny that thou bear'st  
love to any,  
Who for thyself art so  
unprovident.

Grant, if thou wilt, thou art  
beloved of many,  
But that thou none lovest is most  
evident;

For thou art so possess'd with  
murderous hate  
That 'gainst thyself thou stick'st  
not to conspire.

**Seeking that beauteous roof to  
ruinate**  
Which to repair should be thy  
chief desire.

O, change thy thought, that I may  
change my mind!  
Shall hate be fairer lodged than  
gentle love?

Be, as thy presence is, gracious  
and kind,



1 PI dem

## Sample question types:

- direction
- expression
- long answer, short answer, word cloud (fill in text)
- multiple choice, many choice
- numerical (enter a number)
- ranking
- region (select point on image)
- sketch
- highlight passage





**1** PI demo

**2** PI 2.0





# human interaction

1 PI demo

2 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

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 PI demo

2 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.

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 PI demo

2 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 PI demo

2 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. 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 PI demo

2 PI 2.0

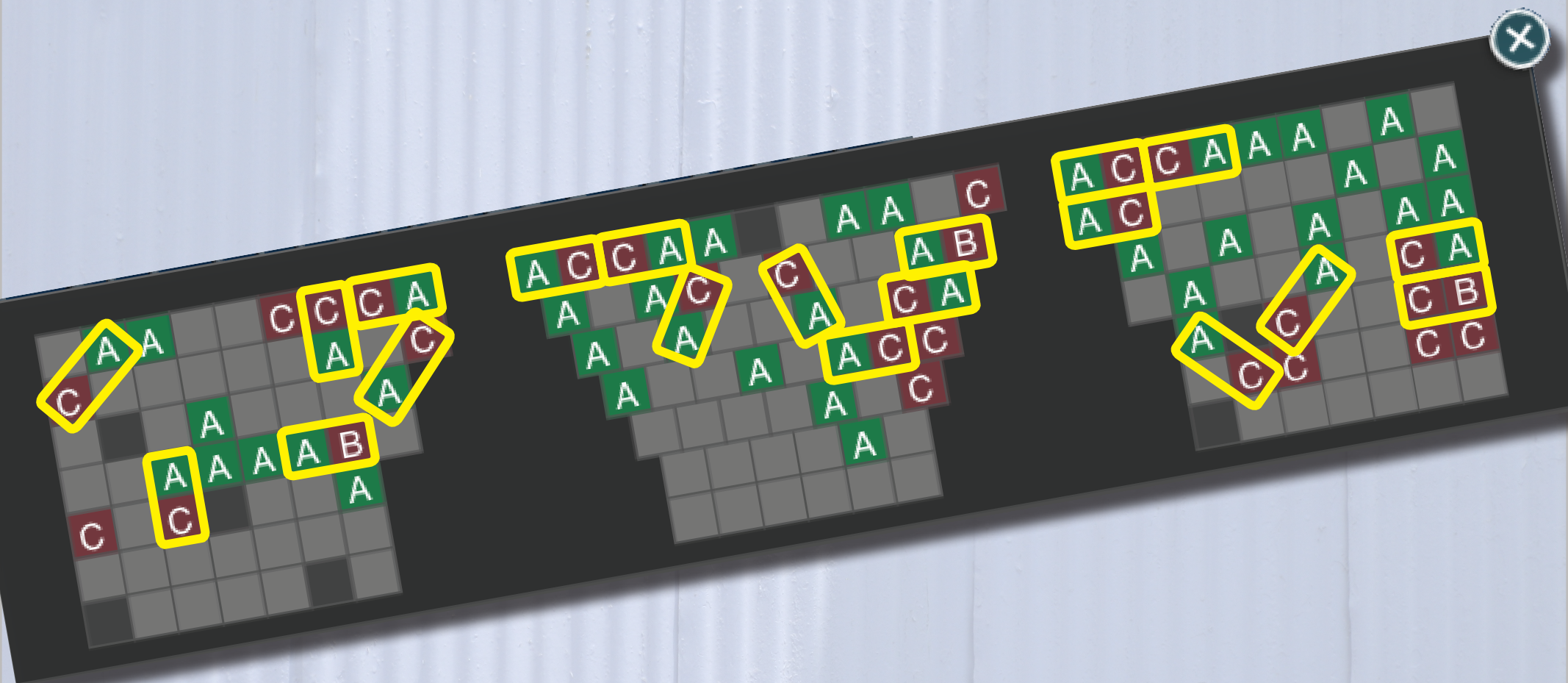


let system manage pairing

1 PI demo

2 PI 2.0



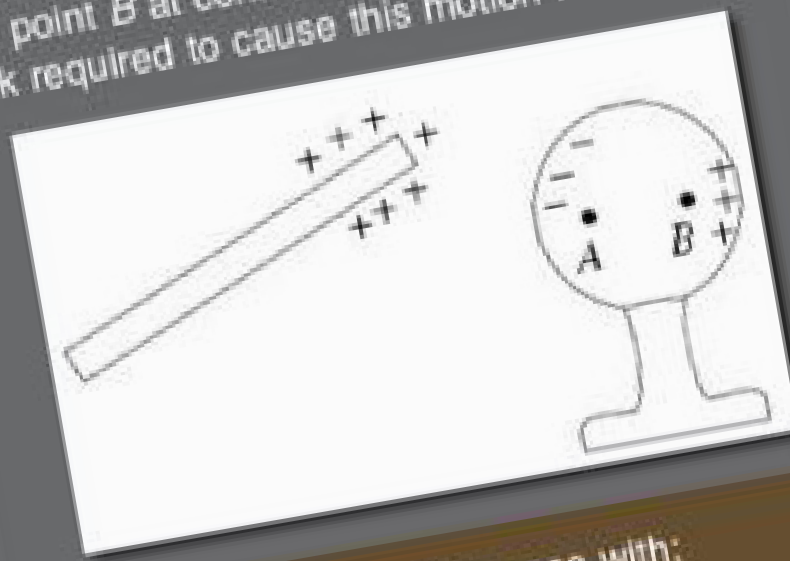


1 PI demo

2 PI 2.0



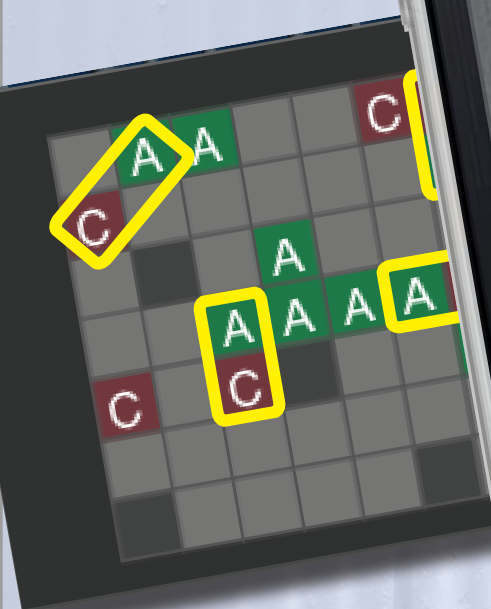
A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B at constant speed. The mechanical work required to cause this motion is



Please discuss your response with:

- Brian Lukoff (to your left)

I am talking to this person/people



1 PI demo

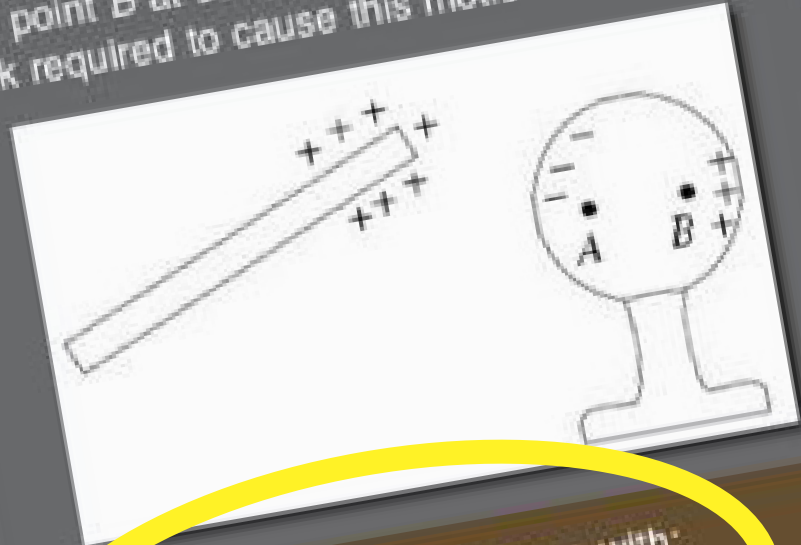
2 PI 2.0



Leave

session 87756

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:

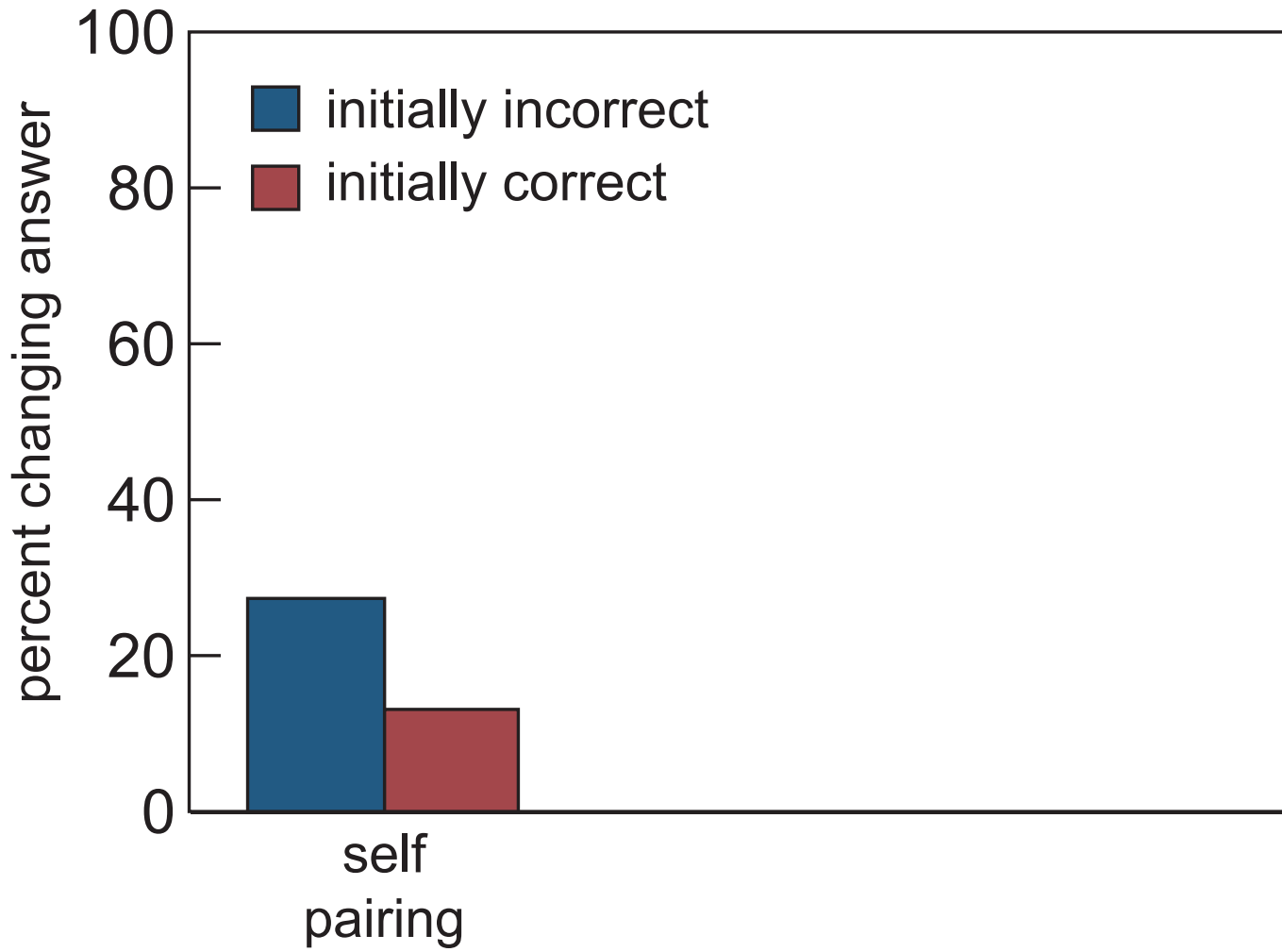
- Brian Lukoff (to your left)

C	A	A			C
		A			
C	A	A	A		
	C				

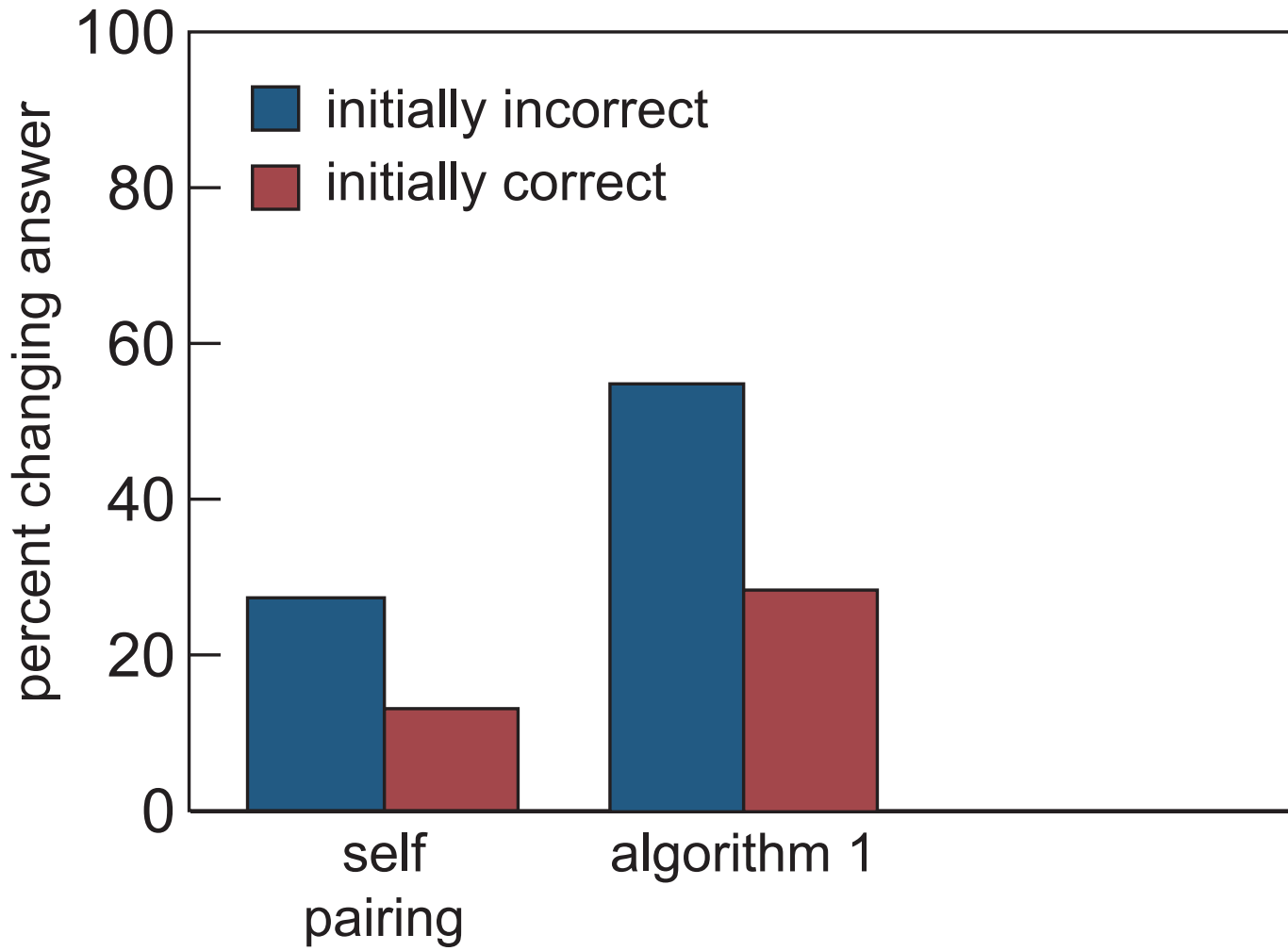
A	C	C	A	A	A		A
A	C				A		A
	A		A		A		A
	A			A			
		C	C				
						C	A
						C	B
							C

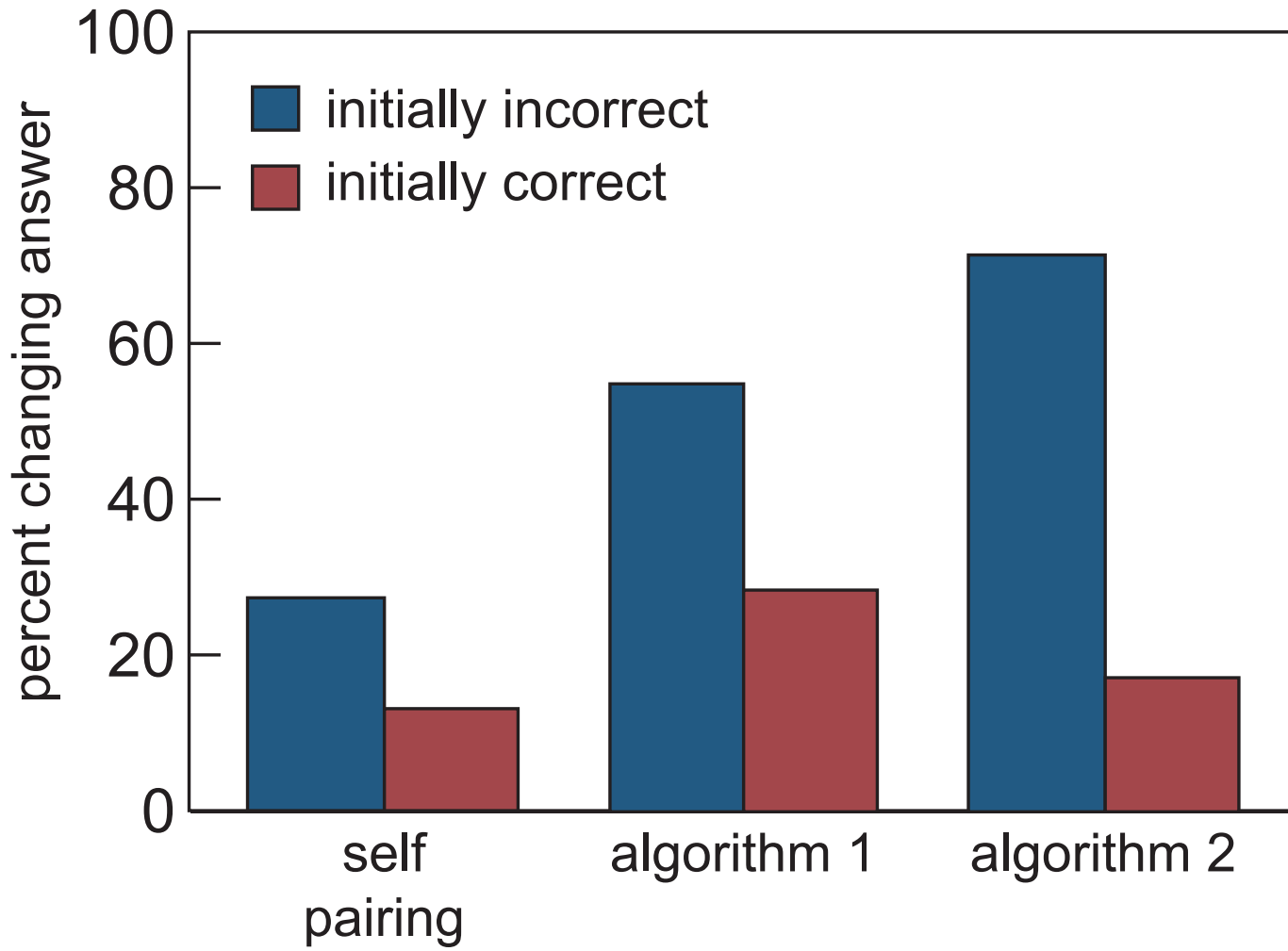
1 PI demo

2 PI 2.0











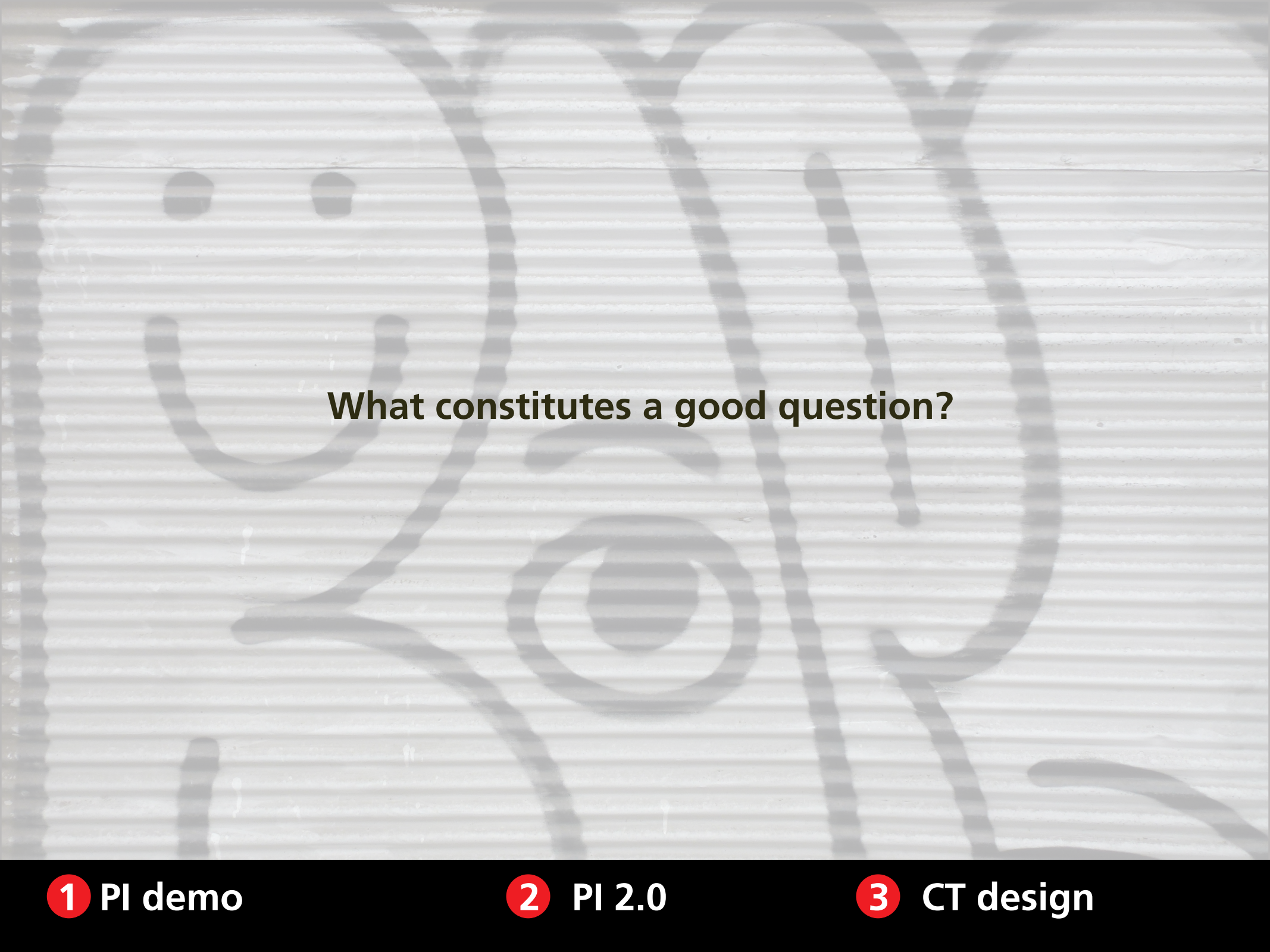


**1** PI demo

**2** PI 2.0

**3** CT design





**What constitutes a good question?**

**1** PI demo

**2** PI 2.0

**3** CT design



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

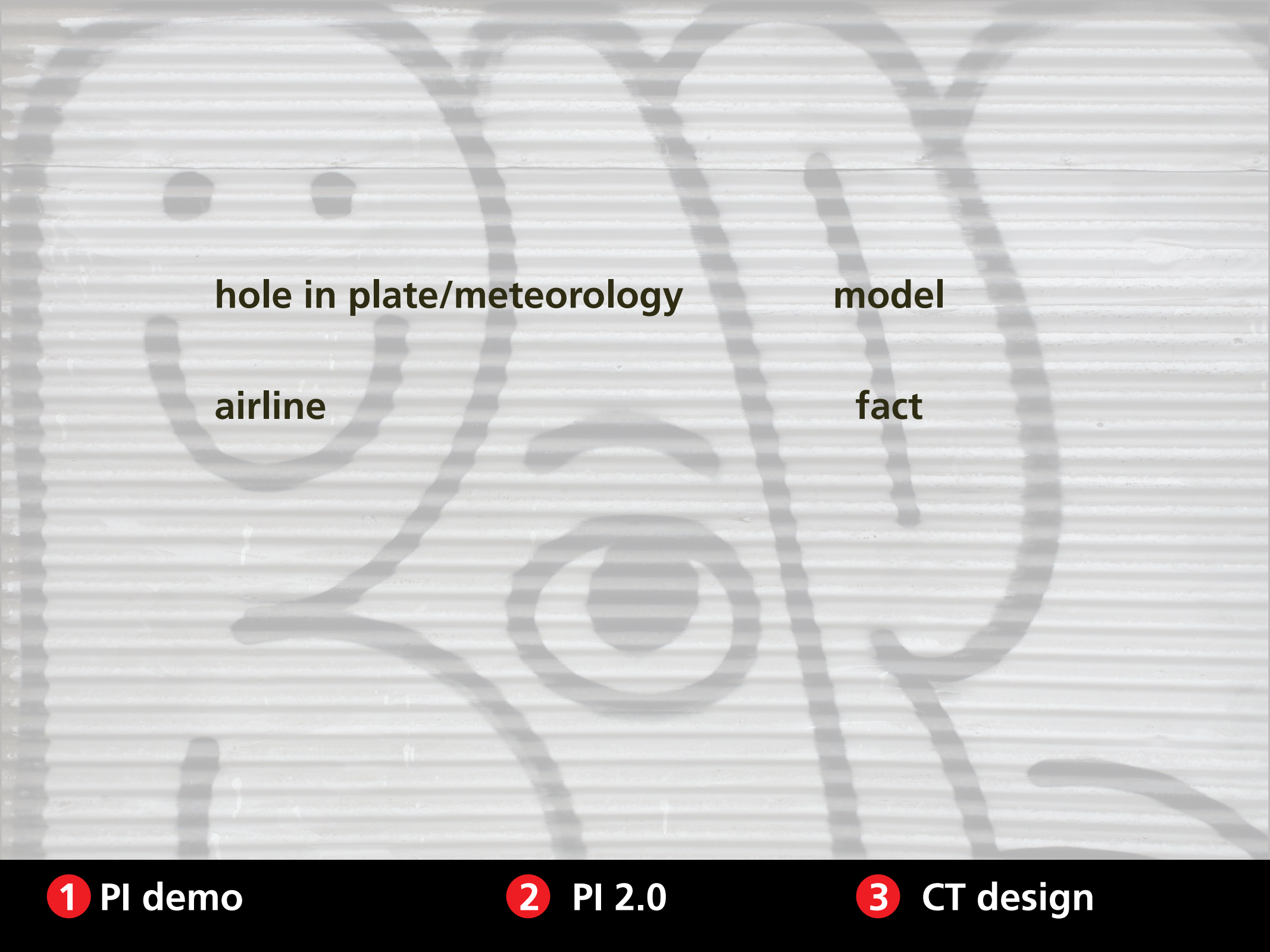
- 1. Delta Airlines**
- 2. Lufthansa**
- 3. All Nippon Airways**
- 4. British Midland Airways**
- 5. Air France**
- 6. JAL**
- 7. Aboriginal Air Services**
- 8. Aeroflot**
- 9. Are you kidding me? None of the above.**



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.





**hole in plate/meteorology**

**model**

**airline**

**fact**

**1** PI demo

**2** PI 2.0

**3** CT design





hole in plate/meteorology

model

airline

fact

fact-recall not engaging

**1** PI demo

**2** PI 2.0

**3** CT design



## **Good conceptual questions (ConceptTests):**

- **focus on interpretation/model (not recall)**
- **stimulate discussion**
- **are not “leading questions”**
- **are of manageable difficulty**





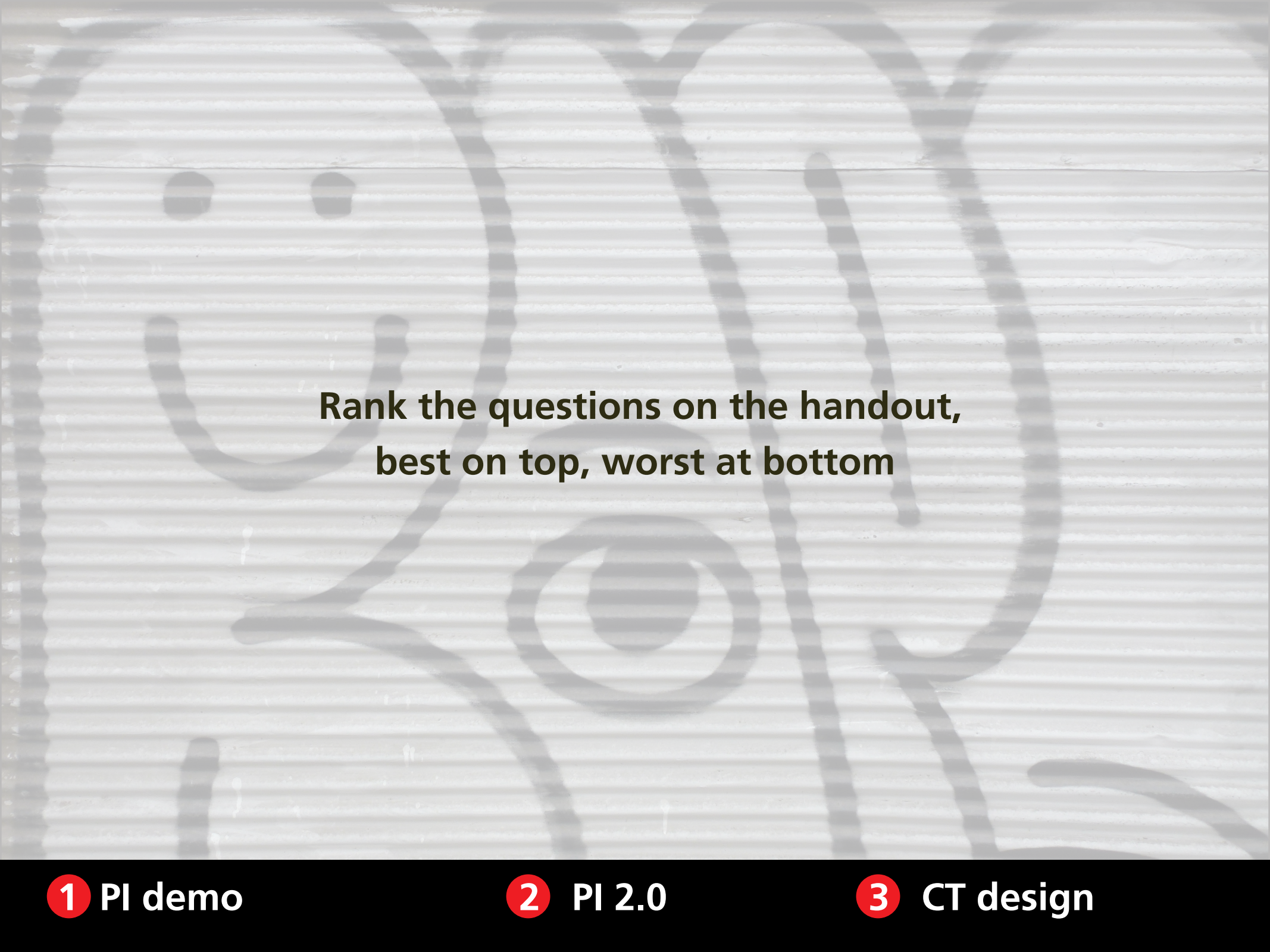
**Let's evaluate some questions!**

**1** PI demo

**2** PI 2.0

**3** CT design





**Rank the questions on the handout,  
best on top, worst at bottom**

**1** PI demo

**2** PI 2.0

**3** CT design






**1** PI demo

**2** PI 2.0

**3** CT design





**What happens  
in a lecture?**

**1** PI demo

**2** PI 2.0

**3** CT design



in a lecture, students...

**1** PI demo

**2** PI 2.0

**3** CT design



**in a lecture, students...**

**1. don't pay utmost attention**

**1** PI demo

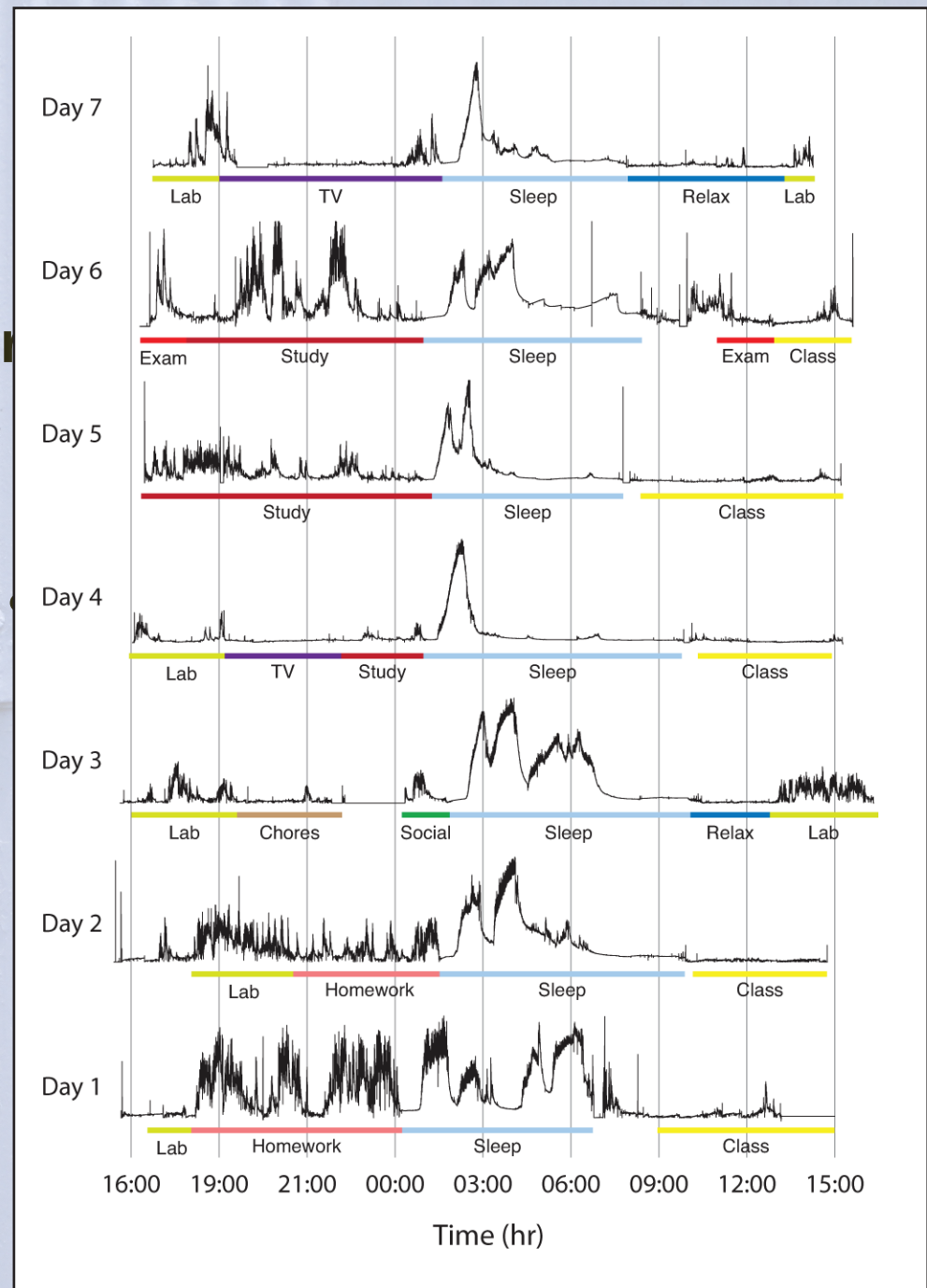
**2** PI 2.0

**3** CT design



in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 PI demo

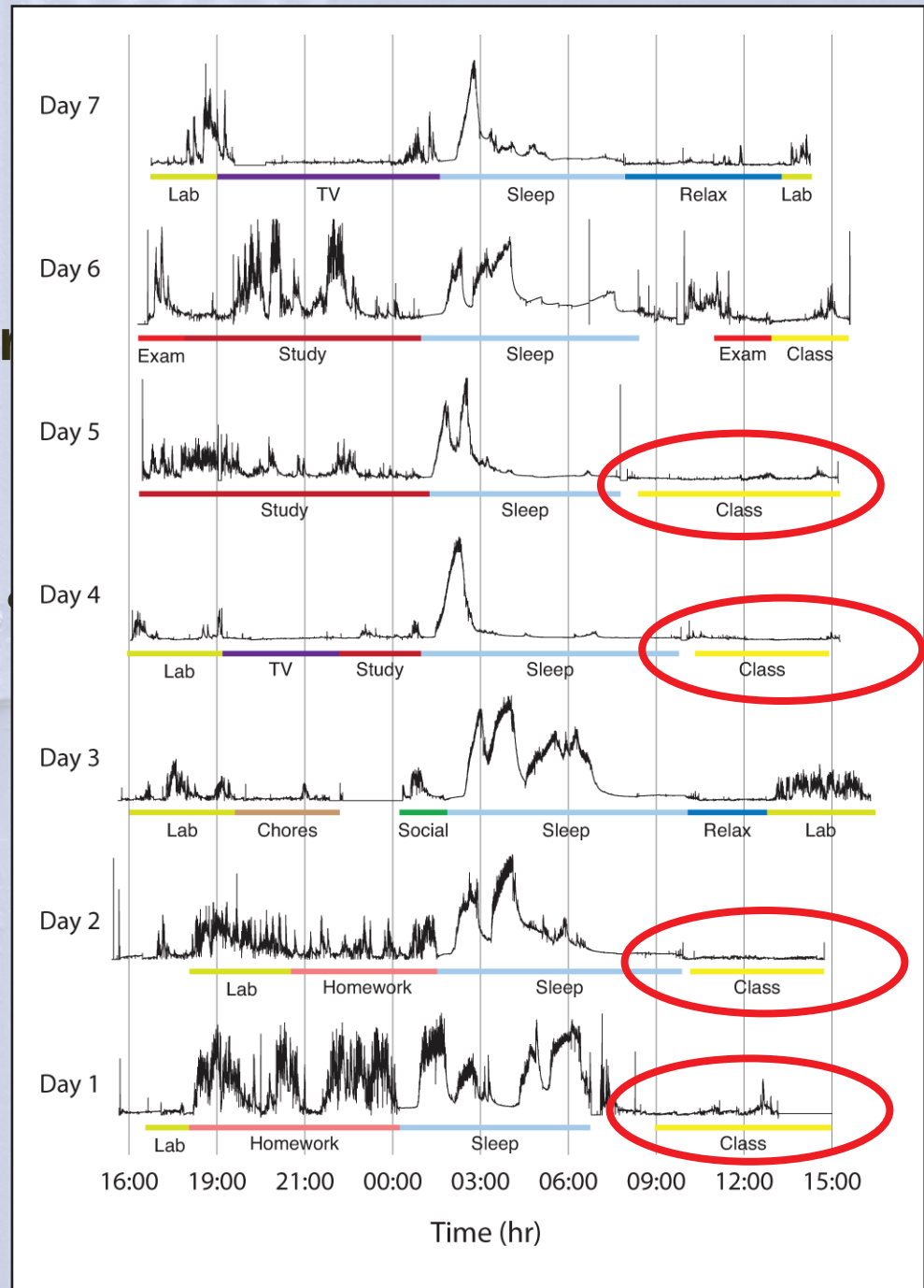
2 PI 2.0

3 CT design



in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

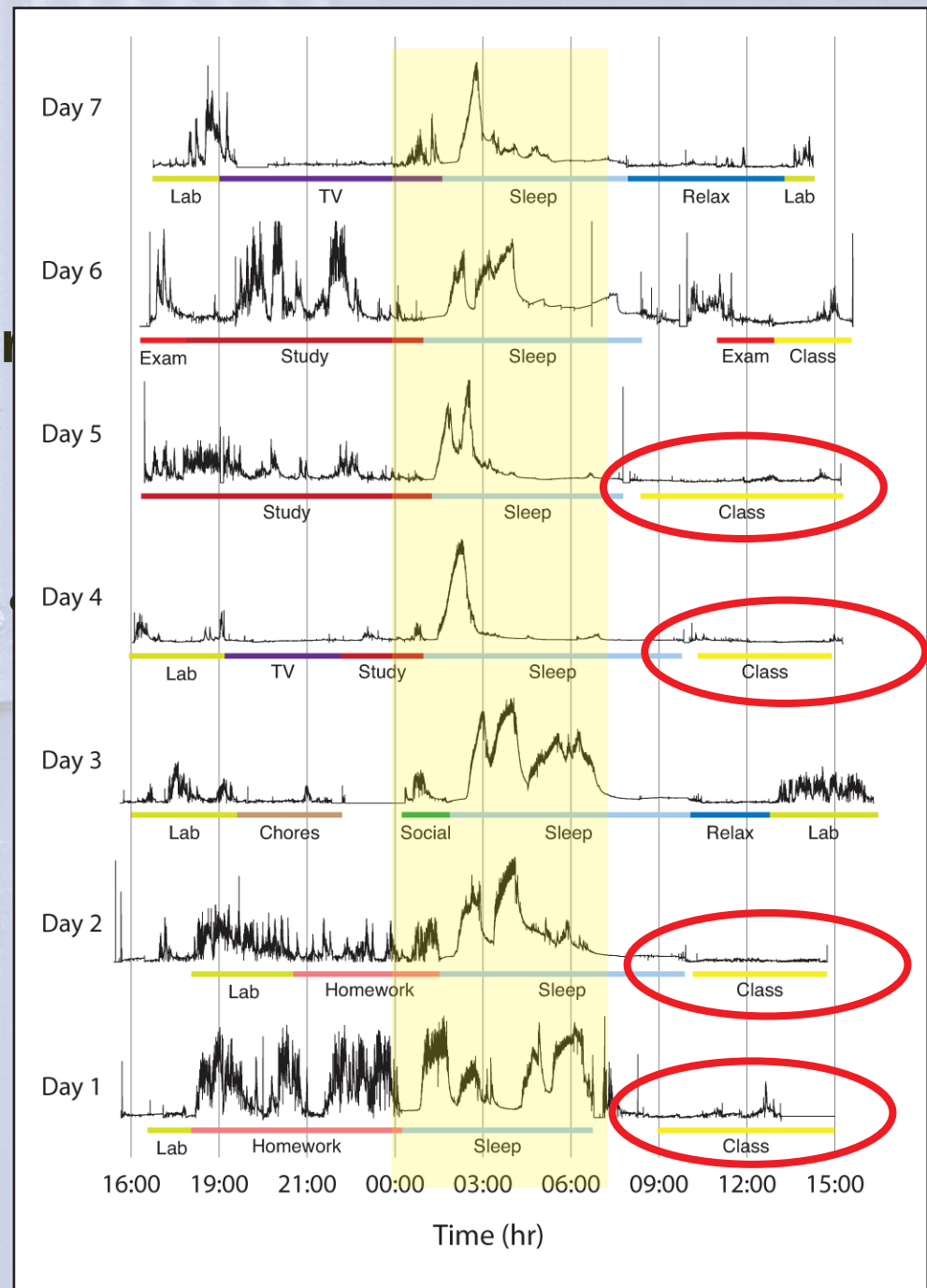
1 education

2 PI

3 test

in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 PI demo

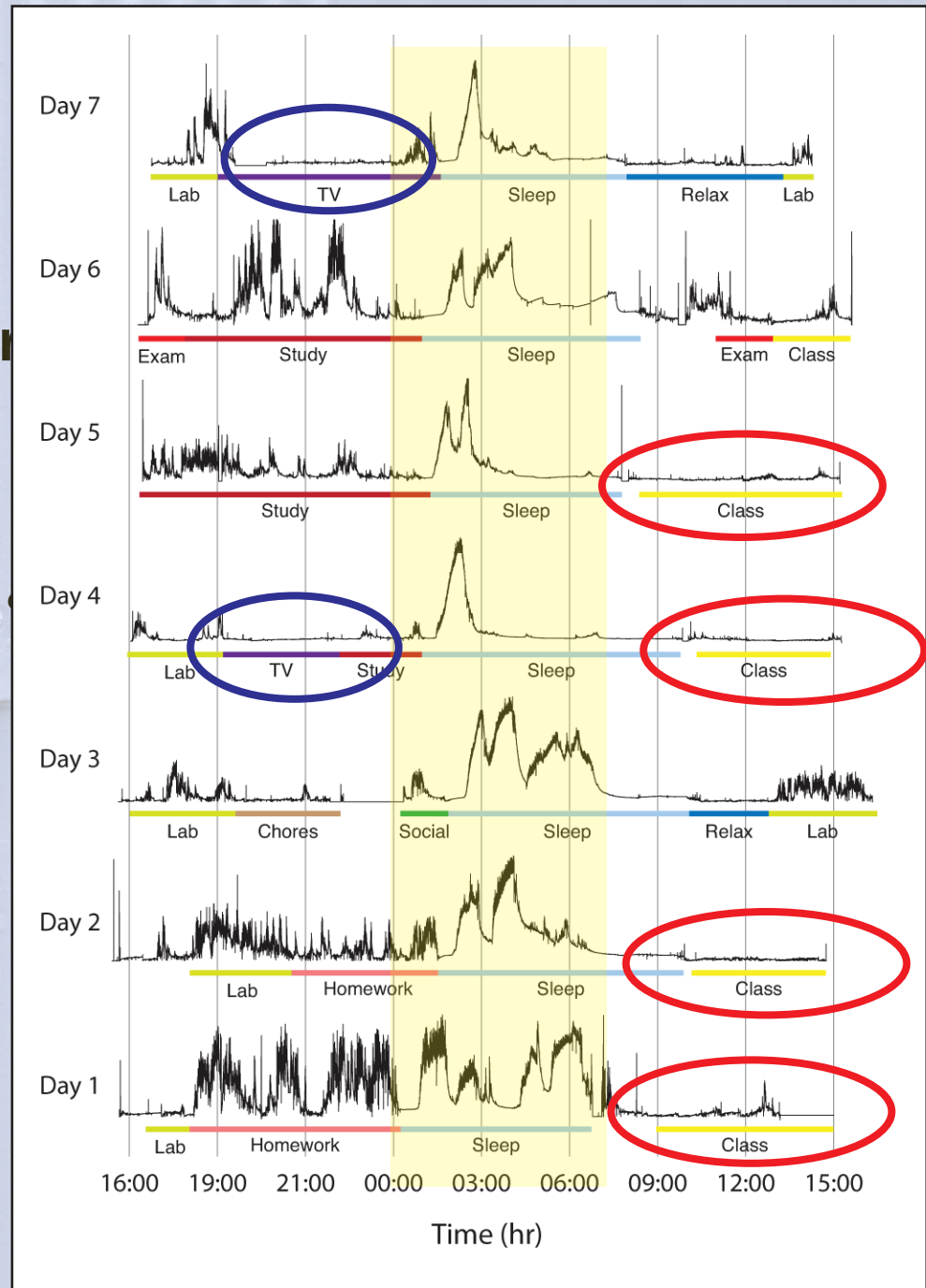
2 PI 2.0

3 CT design



in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 PI demo

2 PI 2.0

3 CT design



**in a lecture, students...**

- 1. don't pay utmost attention**
- 2. think they know it**



**in a lecture, students...**

- 1. don't pay utmost attention**
- 2. think they know it**
- 3. are not confronted with misconceptions**



in a lecture, students...

1. don't pay utmost attention

2. think they know it

3. are not confronted with misconceptions

**false**  
**sense of security**





**1** PI demo

**2** PI 2.0

**3** CT design





**an illusion. . .**

**1** PI demo

**2** PI 2.0

**3** CT design





**Education is not just about:**

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

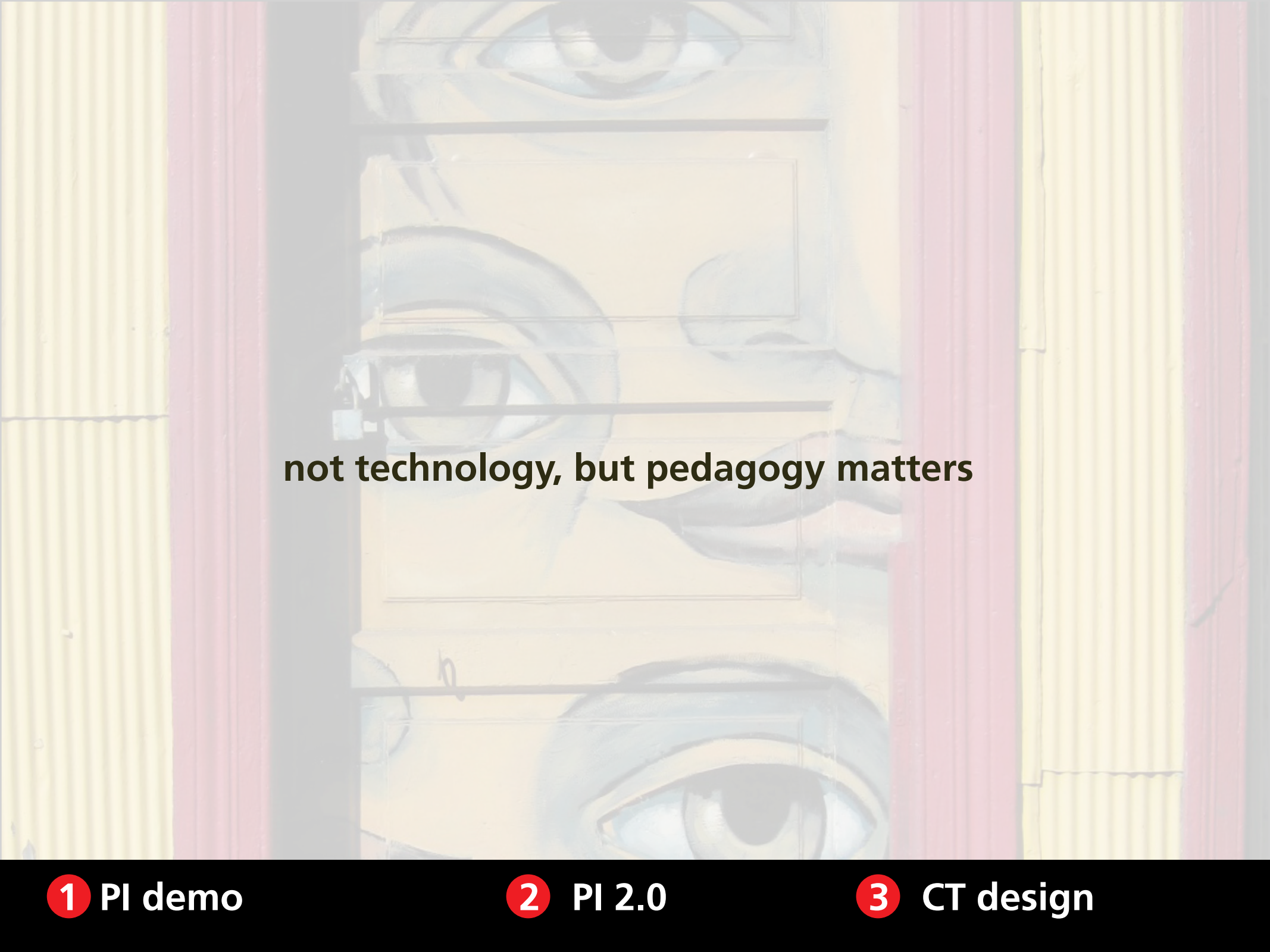


**Education is not just about:**

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

**active participation a must!**





**not technology, but pedagogy matters**

**1** PI demo

**2** PI 2.0

**3** CT design

**Funding:**

**National Science Foundation**

**for a copy of this presentation:**

**[mazur.harvard.edu](http://mazur.harvard.edu)**

**Follow me!**



**[eric\\_mazur](https://twitter.com/eric_mazur)**





**Join now!**

**PeerInstruction.net**