

# Educating the innovators of the 21st century



New York Major Gifts Committee Meeting  
Harvard University  
New York, NY, 17 January 2013





**@eric\_mazur**

New York Major Gifts Committee Meeting  
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A large, glowing lightbulb with a warm yellow light emanating from it. The bulb is centered in the frame, and its glow fills the background. The text "how can we foster/teach innovation?" is superimposed on the lower half of the bulb.

**how can we foster/teach innovation?**



**Need to...**

- **teach *problem* solving**
- **encourage risk taking**





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





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unique ID on back of clicker



**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**















Fought















1 education

2 PI

3 test




1 education

2 PI

3 test





**What happens  
in a lecture?**

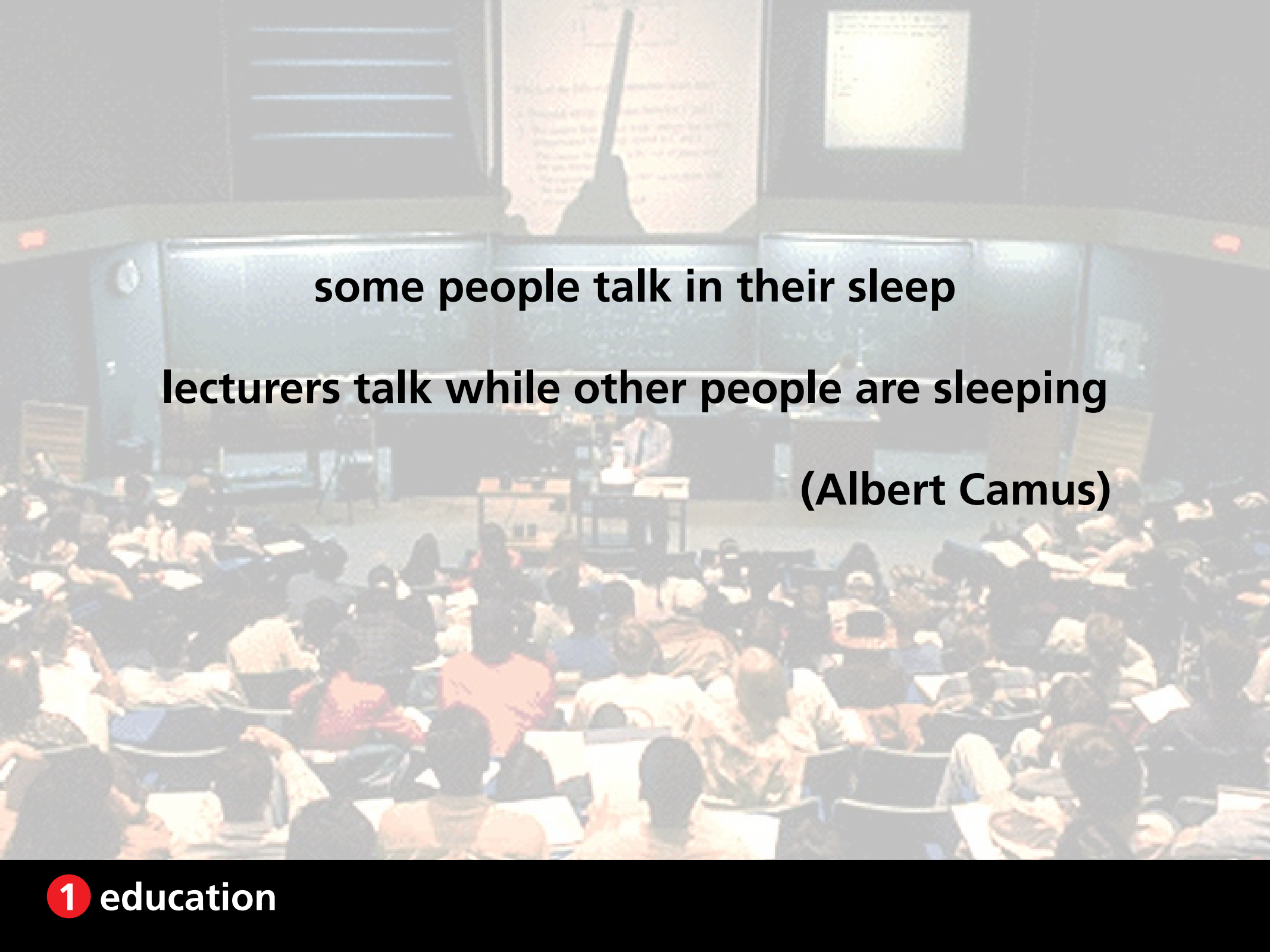






A wide-angle photograph of a large lecture hall. In the foreground and middle ground, many students are seated at desks, but a significant portion of them appear to be asleep, with their heads resting on their desks or closed. The room has a curved wall at the front with several large projection screens. One screen displays a list of bullet points, another shows a diagram, and a third shows a table. A lecturer is visible at a podium in the center of the front stage area.

**some people talk in their sleep**

A large lecture hall filled with students. Many students are sleeping, with their heads resting on their desks or hands. The room has a curved wall with several large screens or posters. A lecturer is visible at the front of the hall, standing near a podium.

**some people talk in their sleep**  
**lecturers talk while other people are sleeping**  
**(Albert Camus)**









The result?

EDUCACION



**Lack of learning**

**EDUCACION**



**Lack of learning**

**Lack of retention**







The background is a grayscale image of a book cover. The word "EDUCACION" is printed in large, bold, sans-serif capital letters at the bottom. A blue ribbon is tied around the book, visible on the right side. The overall texture is slightly grainy.

**assessment promotes memorization and stifles creativity**



**problem**

**EDUCACION**





**problem**

**outcome**



**problem**

**solution**

**outcome**

**EDUCACION**



**problem**

**solution**

**outcome**

**KNOWN**



problem

solution

outcome

UNKNOWN

KNOWN

EDUCACION



**problem**

**solution**

**outcome**

**problem**

**UNKNOWN**

**KNOWN**



problem

solution

outcome

problem

procedure



**problem**

**solution**

**outcome**

**UNKNOWN**

**KNOWN**

**problem**

**procedure**

**answer**



problem

UNKNOWN

solution

outcome

KNOWN

problem

KNOWN

procedure

answer



problem

solution

outcome

problem

procedure

answer

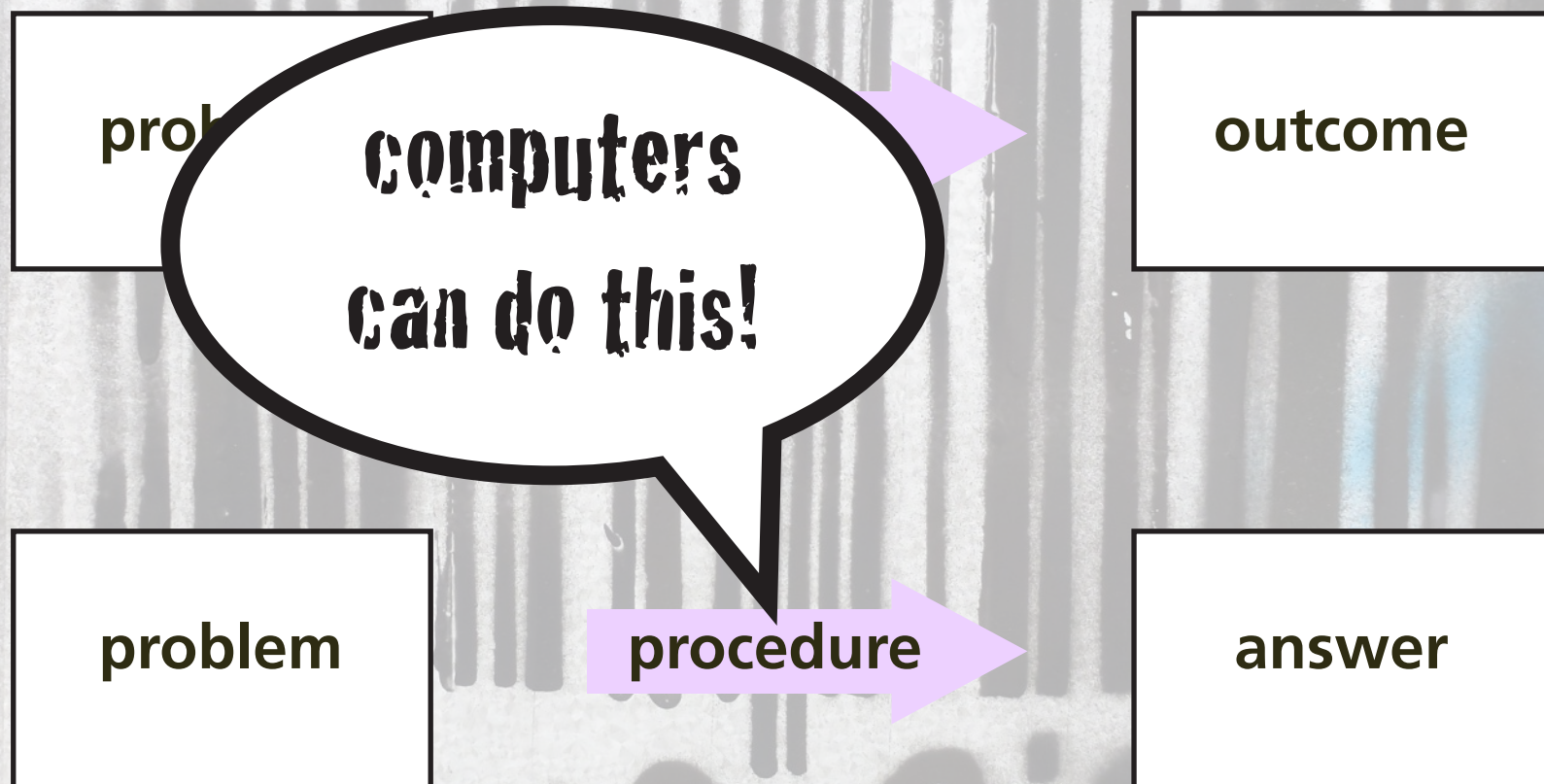
UNKNOWN

UNKNOWN

UNKNOWN

UNKNOWN







**problem**

**solution**

**outcome**

**problem**

**pre**

**REAL**  
**problem solving**

**ver**



**problem**

**approach 1**

**approach 3**

**approach 2**

**outcome**



**problem**

**approach 1**

**approach 3**

**approach 2**

**outcome**

**assessment incompatible with real problem solving**



## **Traditional assesement**

- **focuses on outcome, not process**



## **Traditional assesement**

- **focuses on outcome, not process**
- **discourages risk taking**



## **Traditional assesement**

- **focuses on outcome, not process**
- **discourages risk taking**
- **focuses on individual, not group**



## **Traditional assesement**

- **focuses on outcome, not process**
- **discourages risk taking**
- **focuses on individual, not group**
- **does not mirror future work environment**









# 1. transfer of information





**1. transfer of information**

**2. assimilation of that information**





**1. transfer of information (in class)**

**2. assimilation of that information**





1. transfer of information (in class)

2. assimilation of that information (out of class)





**Should focus  
on THIS!**

1. transfer of information (in class)

**2. assimilation of that information (out of class)**



- 
- 1. transfer of information (in class)**
  - 2. assimilation of that information (out of class)**



- 
1. transfer of information (out of class)
  2. assimilation of that information (in class)





# Peer

1. transfer of information (out of class)

2. assimilation of that information (in class)



question

1 education

2 PI



**question**



**think**



**question**



**think**



**poll**



**question**



**think**



**poll**



**discuss**

**question**



**think**



**poll**



**discuss**



**repoll**



**question**



**think**



**poll**



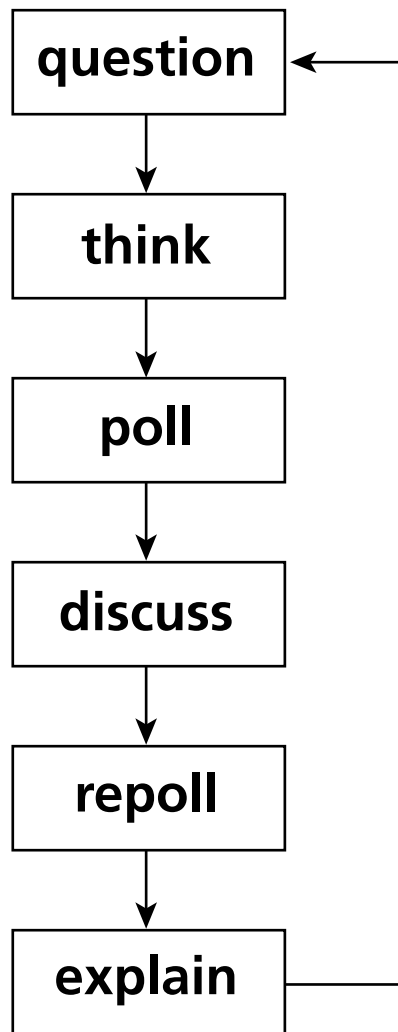
**discuss**



**repoll**



**explain**







1 lecture

2 PI





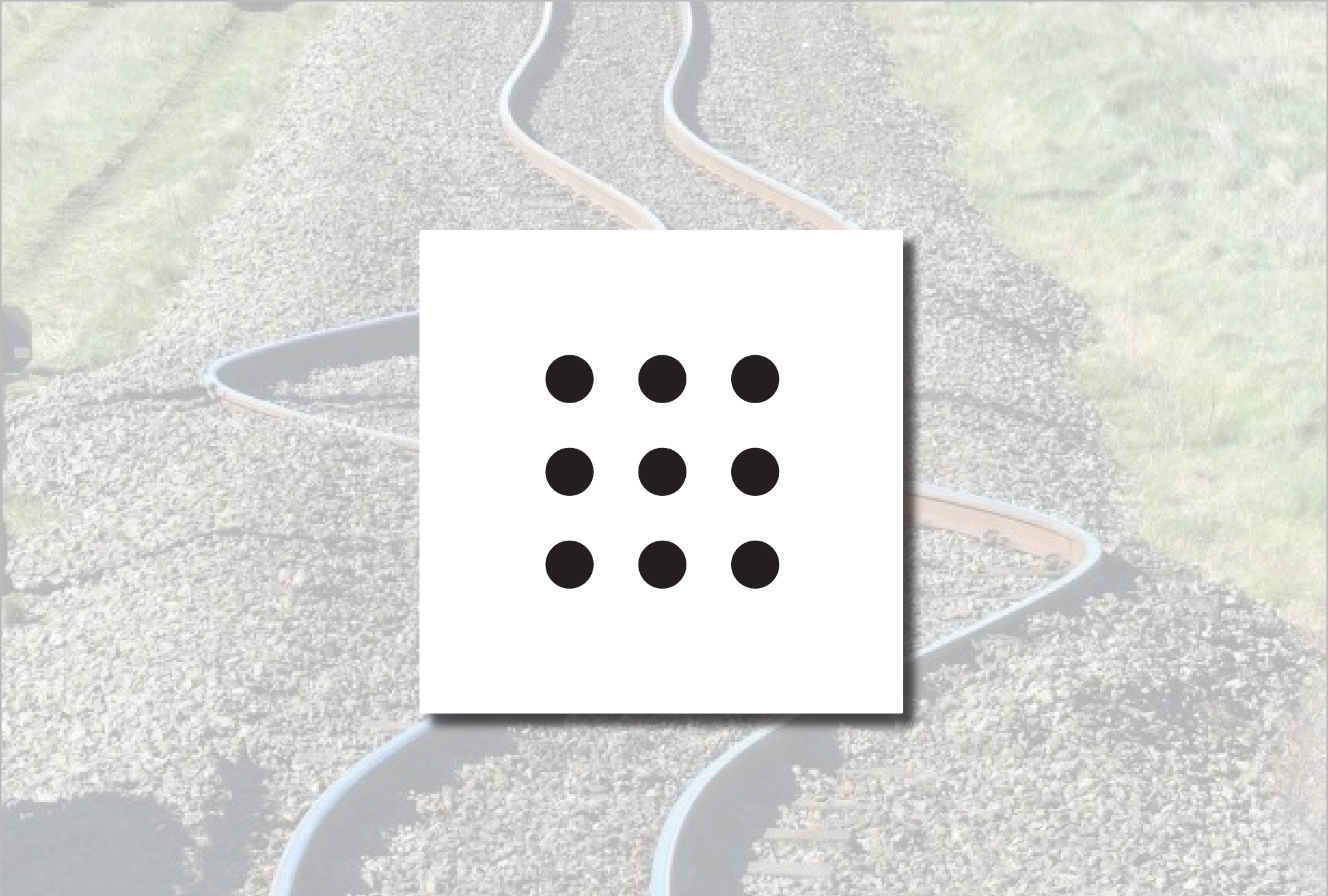
1 education

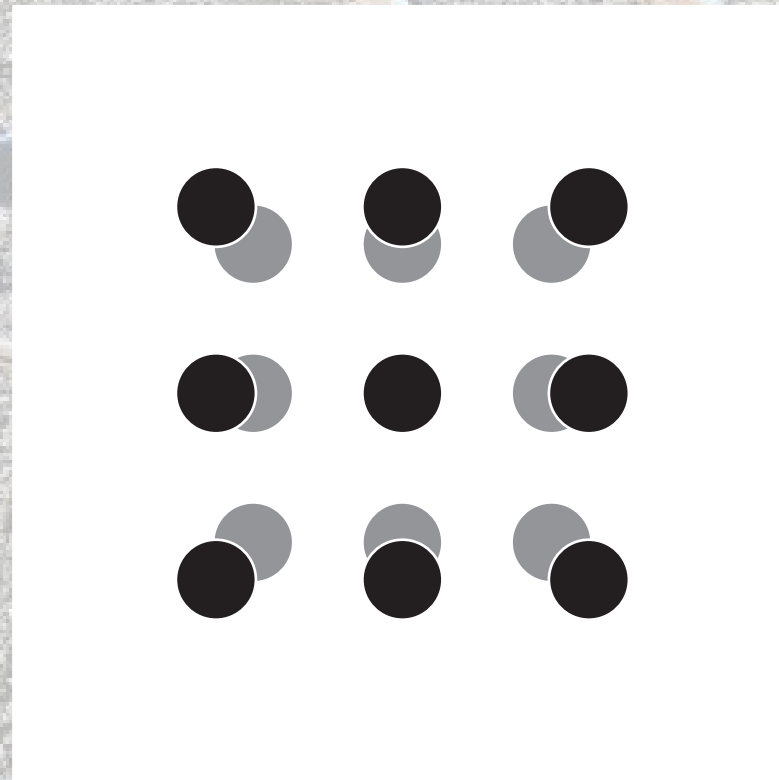
2 PI



**thermal expansion**

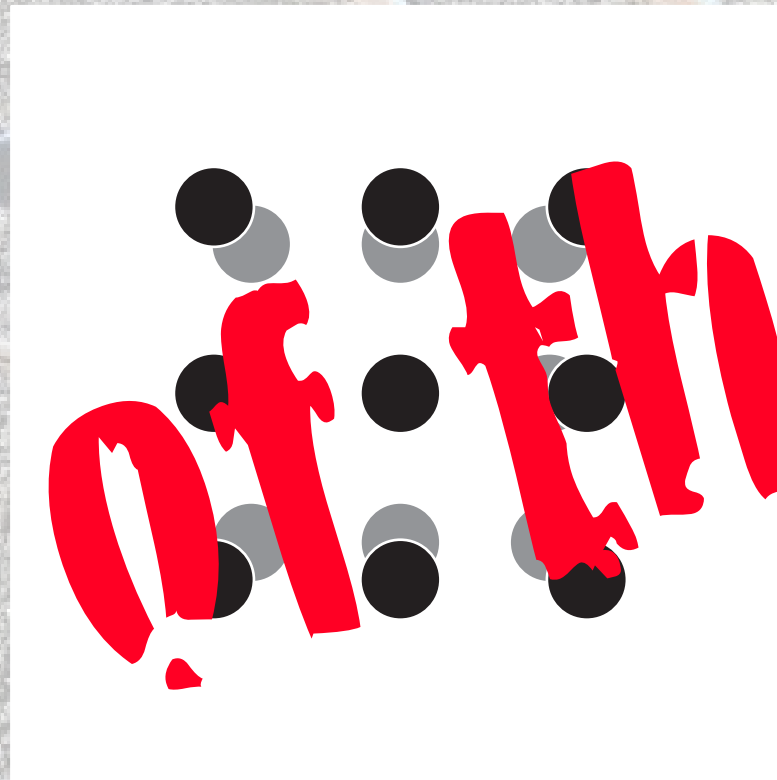








all of them



1 education

2 PI

*all of them*



1 education

2 PI

3 test?



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



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

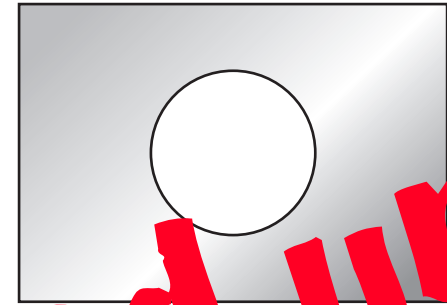


**When the plate is uniformly heated, the diameter of the hole**

- 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.

**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...**

**1** education

**2** PI

**3** test

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



**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.**

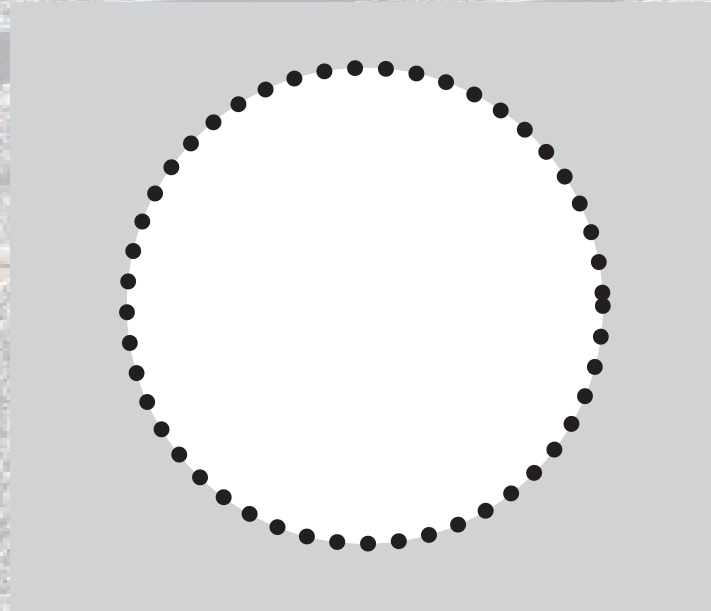


**When the plate is uniformly heated, the diameter of the hole**

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



consider atoms at rim of hole

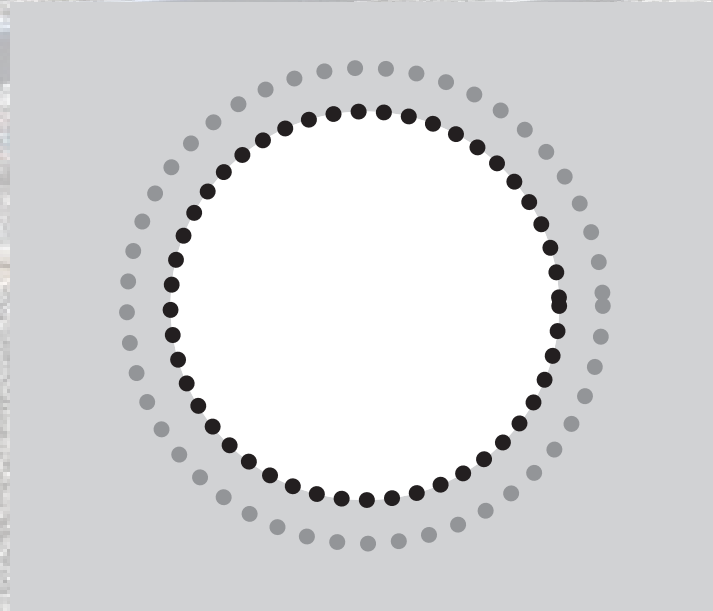


1 education

2 PI

3 test

consider atoms at rim of hole



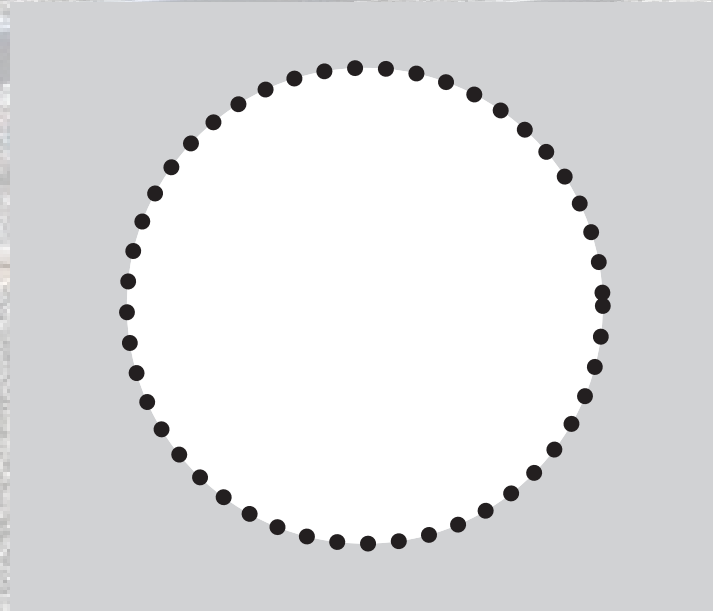
1 education

2 PI

3 test



consider atoms at rim of hole

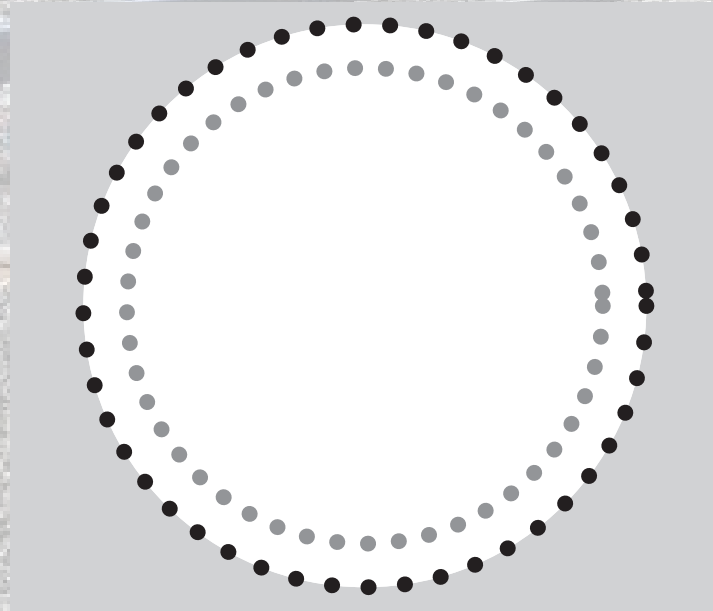


1 education

2 PI

3 test

consider atoms at rim of hole





consider atoms at rim of hole

you won't forget this

1 education

2 PI

3 test

peer

back to pi

INSTRUCTION

1 education

2 PI

3 test



Peer

**Higher learning gains**



INSTRUCTION

1 education

2 PI

3 test

The diagram features a large, light blue word 'Peer' in the background. Overlaid on this is the word 'Instruction' in a smaller, white, sans-serif font, tilted upwards from left to right. Two red, bold, italicized phrases are also tilted upwards: 'Higher learning gains' is positioned above 'Better retention'. A series of blue dots forms a curved path from the bottom left towards the top right, passing between the two red phrases. A dashed yellow line with arrowheads at both ends connects the two red phrases. The background is a light red/pink color with a vertical blue stripe on the left side.

**Higher learning gains**

**Better retention**

INSTRUCTION

1 education

2 PI

3 test





1 education

2 PI

3 test



in a lecture, students...

1 education

2 PI

3 test

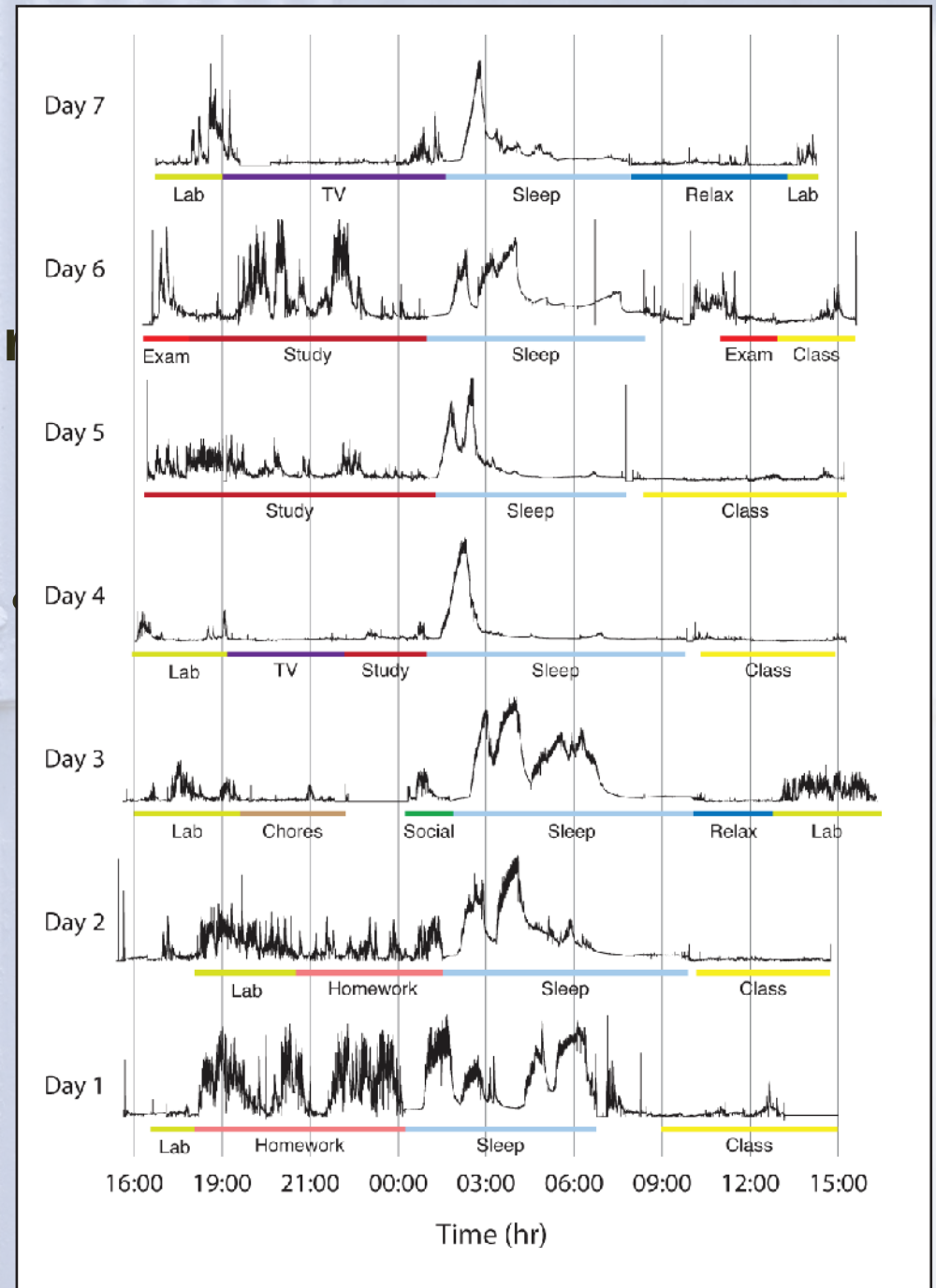


**in a lecture, students...**

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

in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 education

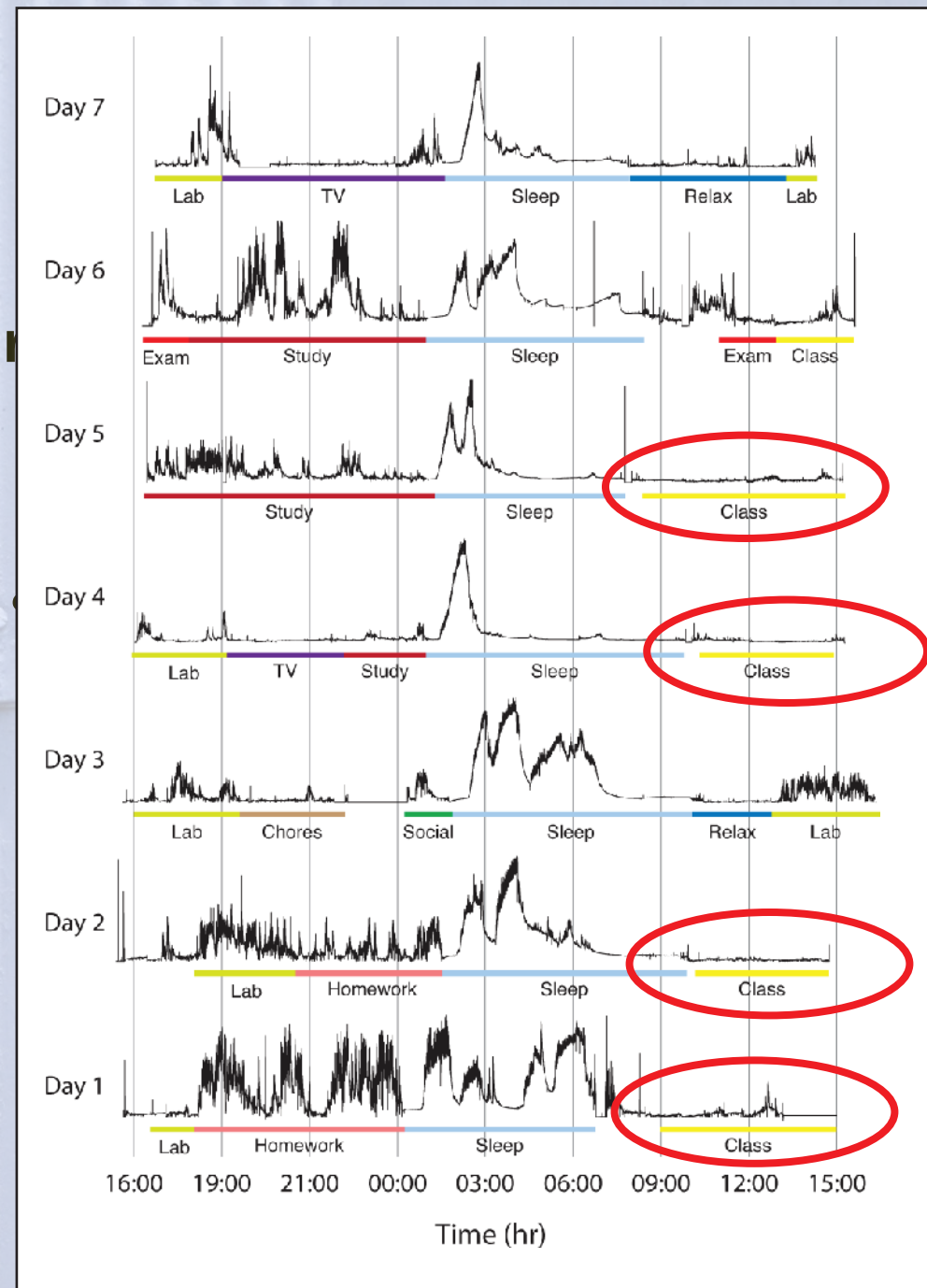
2 PI

3 test



in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

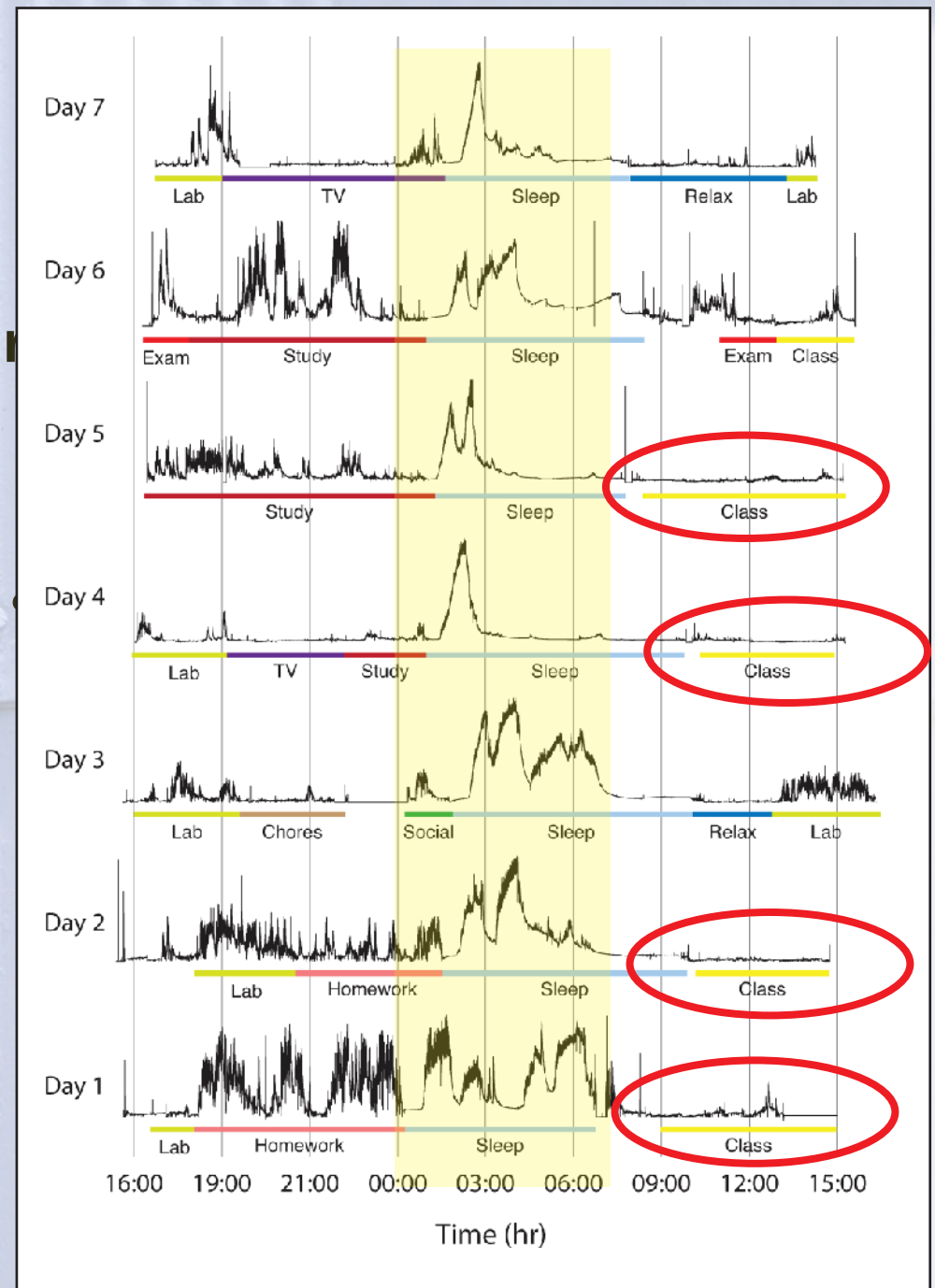
1 education

2 PI

3 test

in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 education

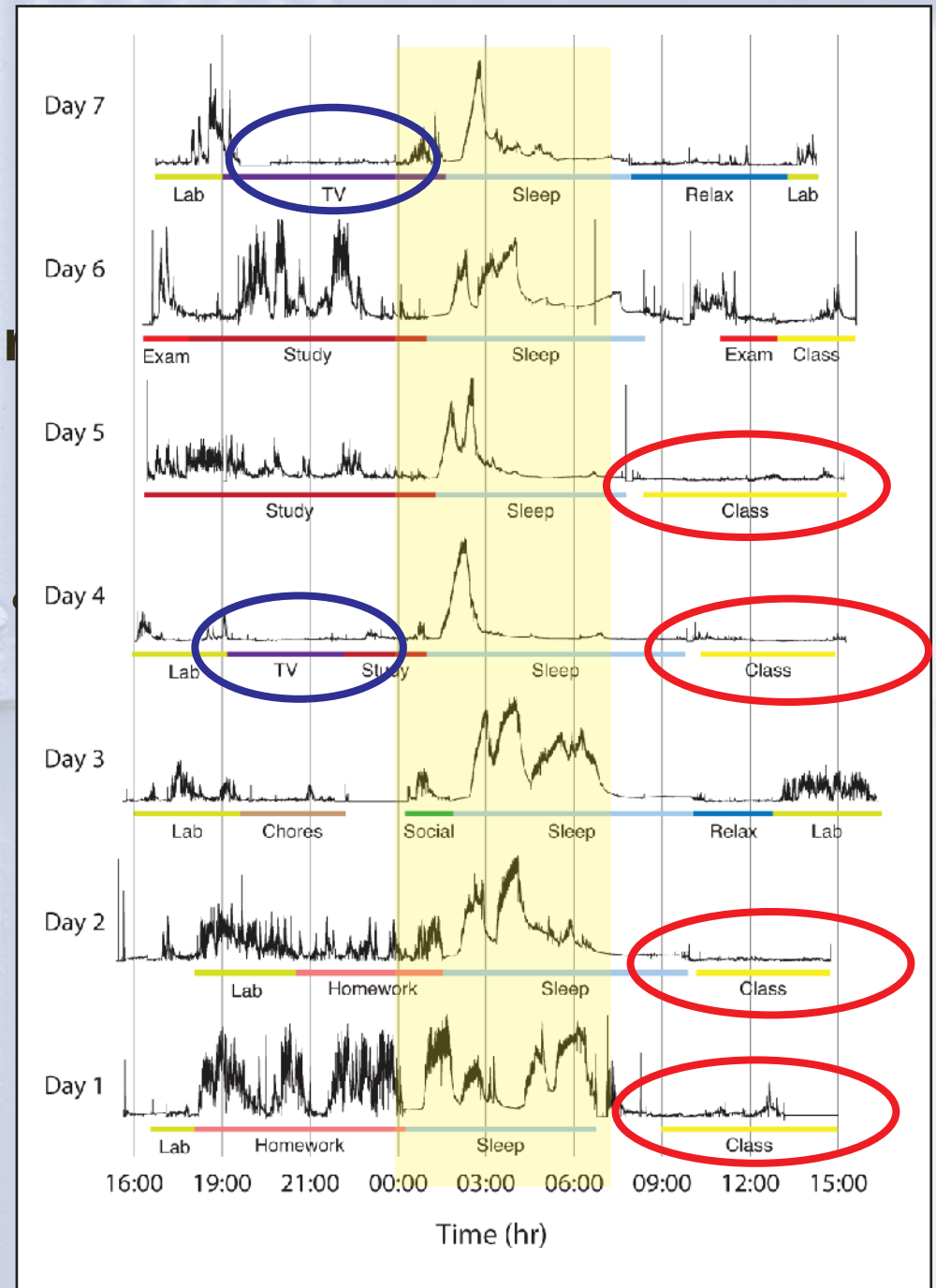
2 PI

3 test



in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 education

2 PI

3 test

**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** education

**2** PI

**3** test



The background is a faded, classical-style painting. It depicts a face, possibly a classical figure, with multiple eyes visible. The face is rendered in a pale, yellowish-tan color, contrasting with the darker, more saturated colors of the eyes and the surrounding architectural elements. The eyes are large and detailed, with some appearing to look directly at the viewer. The overall composition is framed by vertical lines, suggesting a classical architectural setting like a doorway or a column. The text 'an illusion...' is overlaid in a bold, red, serif font, centered horizontally and slightly below the vertical center of the image.

**an illusion. . .**

**1** education

**2** PI

**3** test





**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!**





**With a simple change, Peer Instruction...**

- teaches *real* problem solving
- encourages risk taking

**Funding:**

**National Science Foundation**

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