

Interactive Learning: Technology in the Classroom



IAP Symposium
Harvard University
Cambridge, MA, 15 June 2015



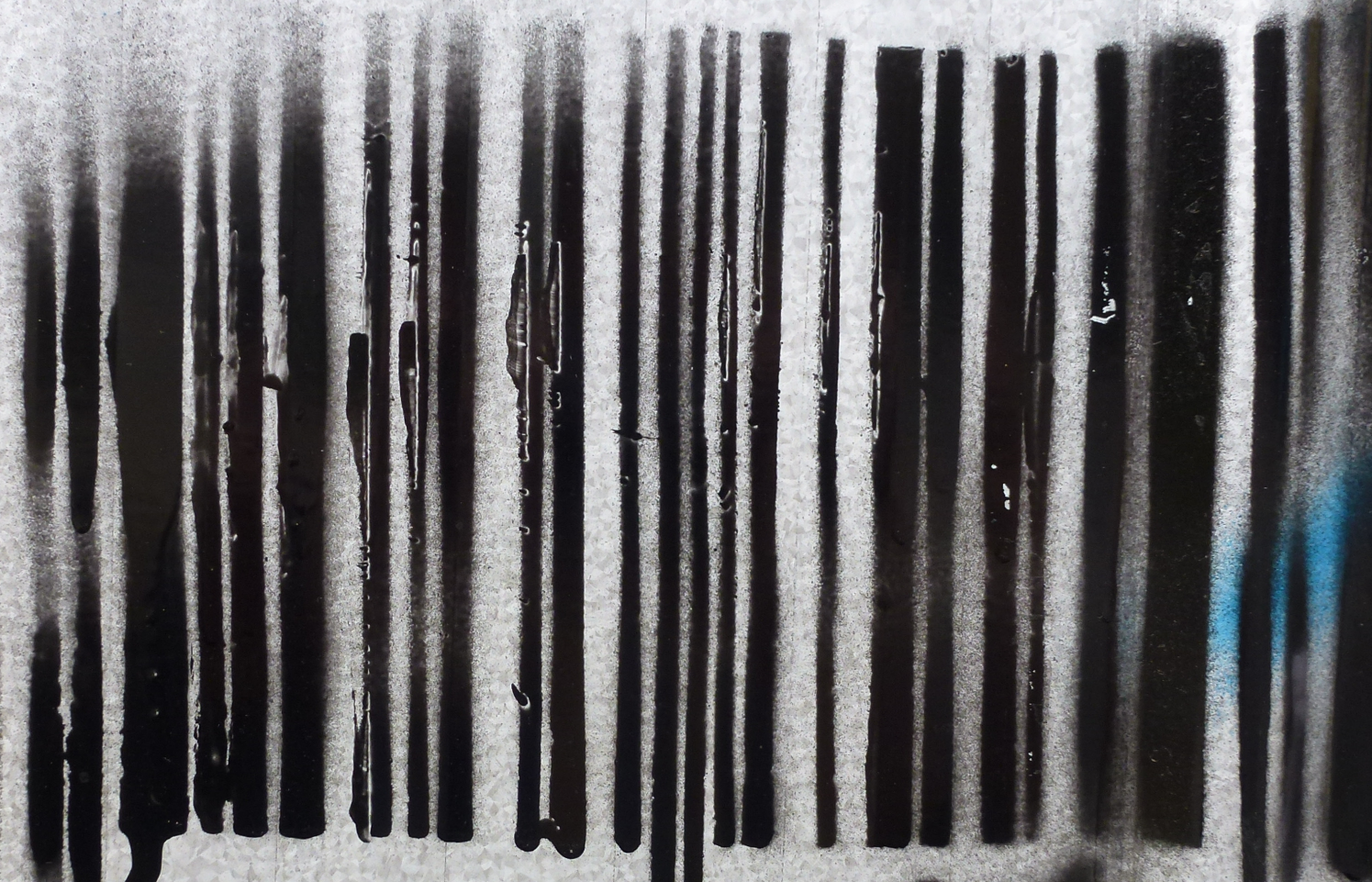
Interactive Learning: Technology in the Classroom



@eric_mazur

IAP Symposium
Harvard University
Cambridge, MA, 15 June 2015





EDUCACION



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



Turning Technologies, LLC
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05959E
3310

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**

EDUCACION





What are the following...
1. ...
2. ...
3. ...
4. ...

...
...
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...

...

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...

...

...

...





1 lecture

2 PI



1 lecture

2 PI

3 PI 2.0



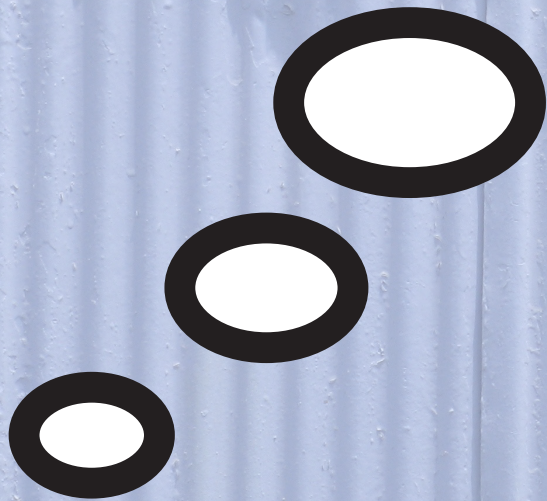
**EXCITING
stuff!**

1 lecture

2 PI

3 PI 2.0

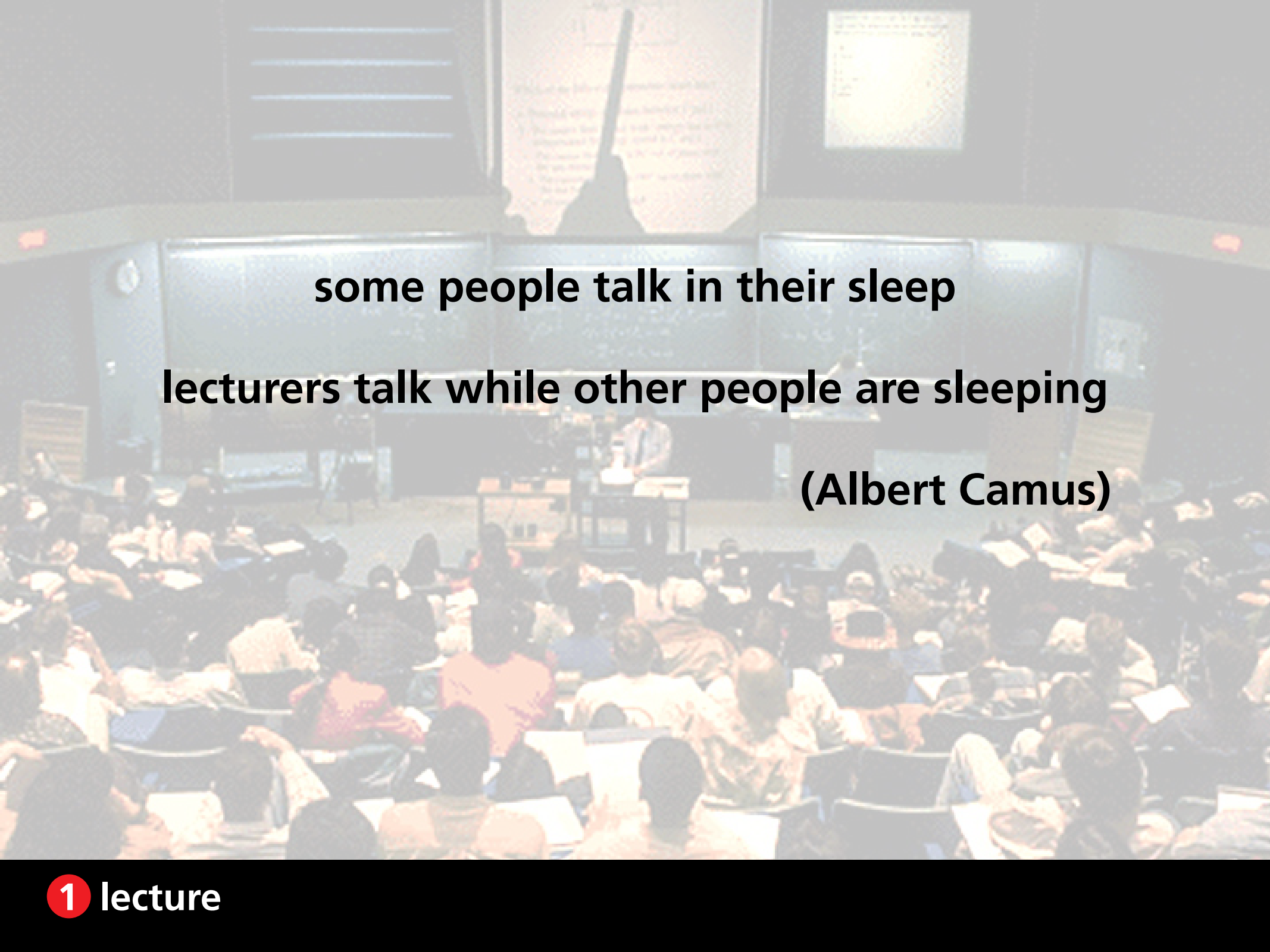
**What happens
in a lecture?**





A large lecture hall with a professor at a podium and students in the audience. The professor is standing at a podium on a stage, facing the audience. The audience is seated in rows of chairs, filling the hall. The stage has a large screen behind the professor, and there are several smaller screens or monitors on the stage. The lighting is dim, and the overall atmosphere is that of a formal lecture.

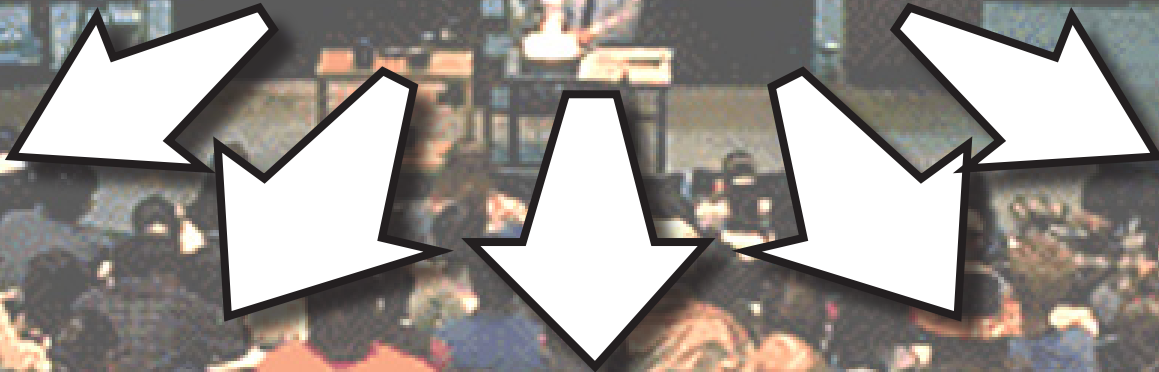
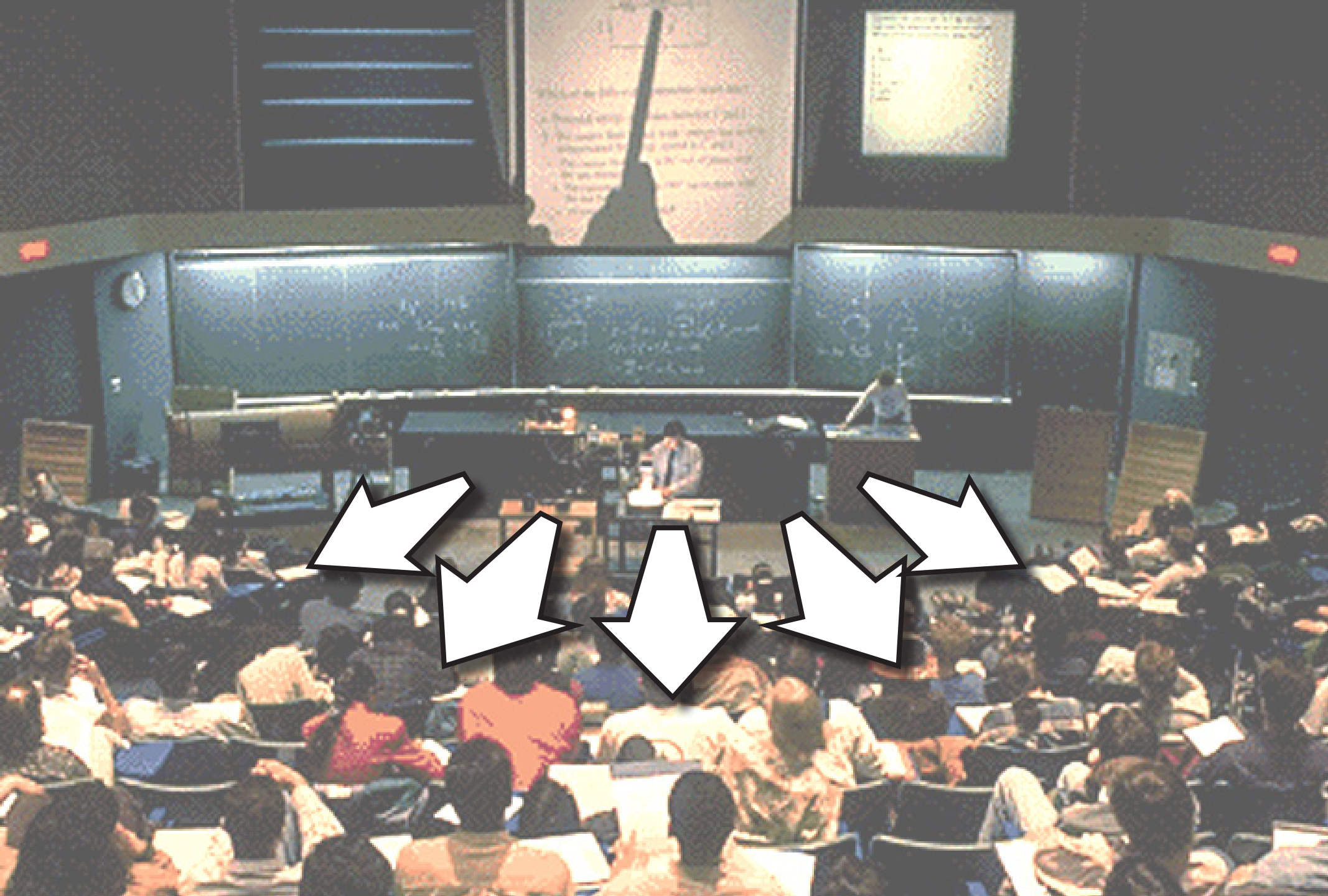
some people talk in their sleep

A large lecture hall with a lecturer at a podium and a large audience of students. The room is filled with people, many of whom appear to be sleeping or resting. The lecturer is standing at a podium in the center of the stage, facing the audience. The audience is seated in rows of chairs, filling the foreground and middle ground. The background features a large screen displaying text and a chalkboard. The overall atmosphere is one of a lecture in progress, but with a significant portion of the audience appearing disengaged or asleep.

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



1 lecture



The result?

EDUCACION

Lack of learning

EDUCACION

Lack of learning

Lack of retention

not transfer but assimilation of information is key

EDUCACION



1 lecture

2 PI



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)

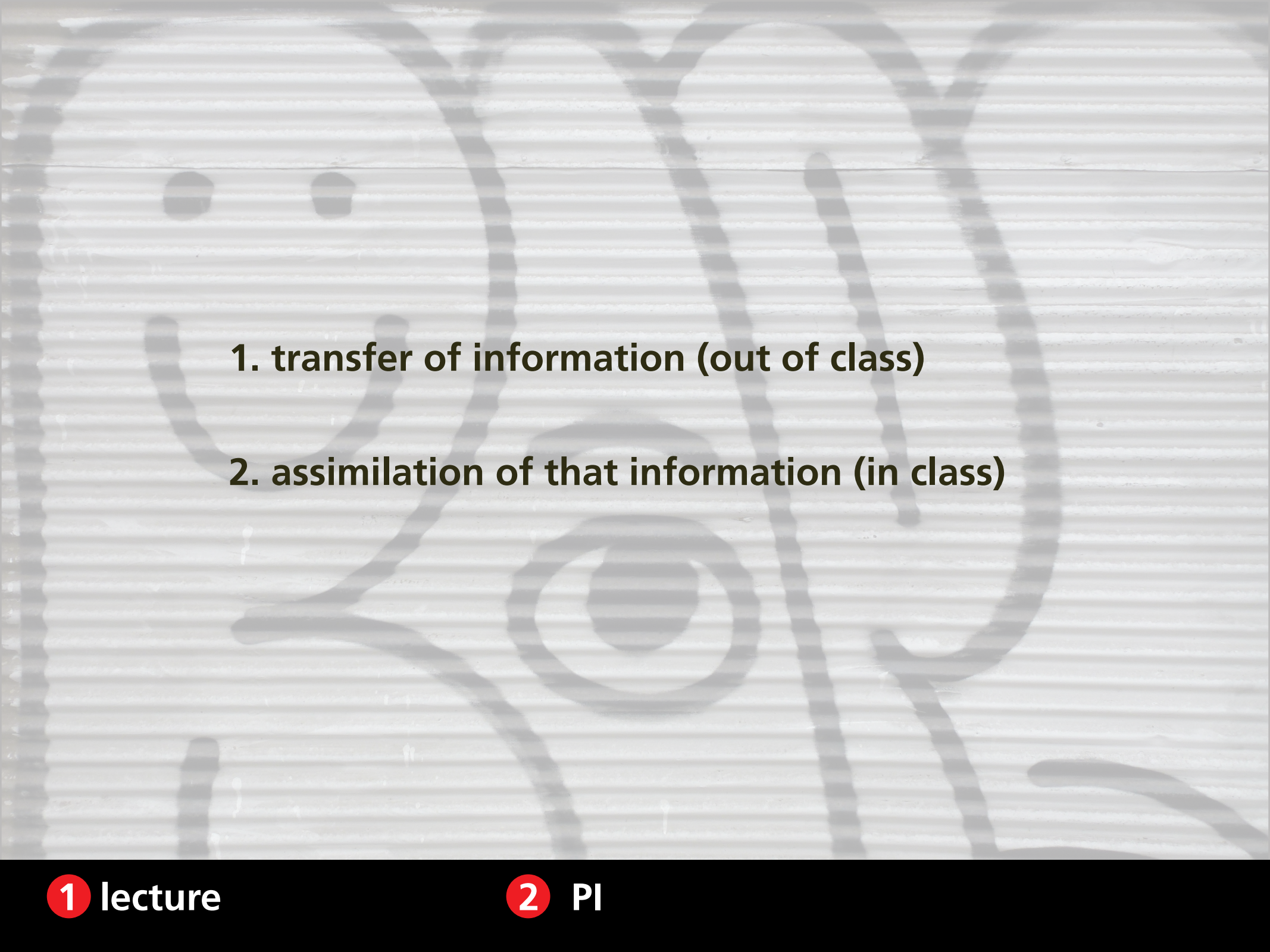


**Should focus
on THIS!**

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)

A photograph of a man in a dark suit and red tie leaning over a group of students in a lecture hall. He is pointing at a document held by one of the students. The students are seated in green chairs, and the room has wood-paneled walls. The text "1. transfer of information (out of class)" is overlaid on the image.

1. transfer of information (out of class)

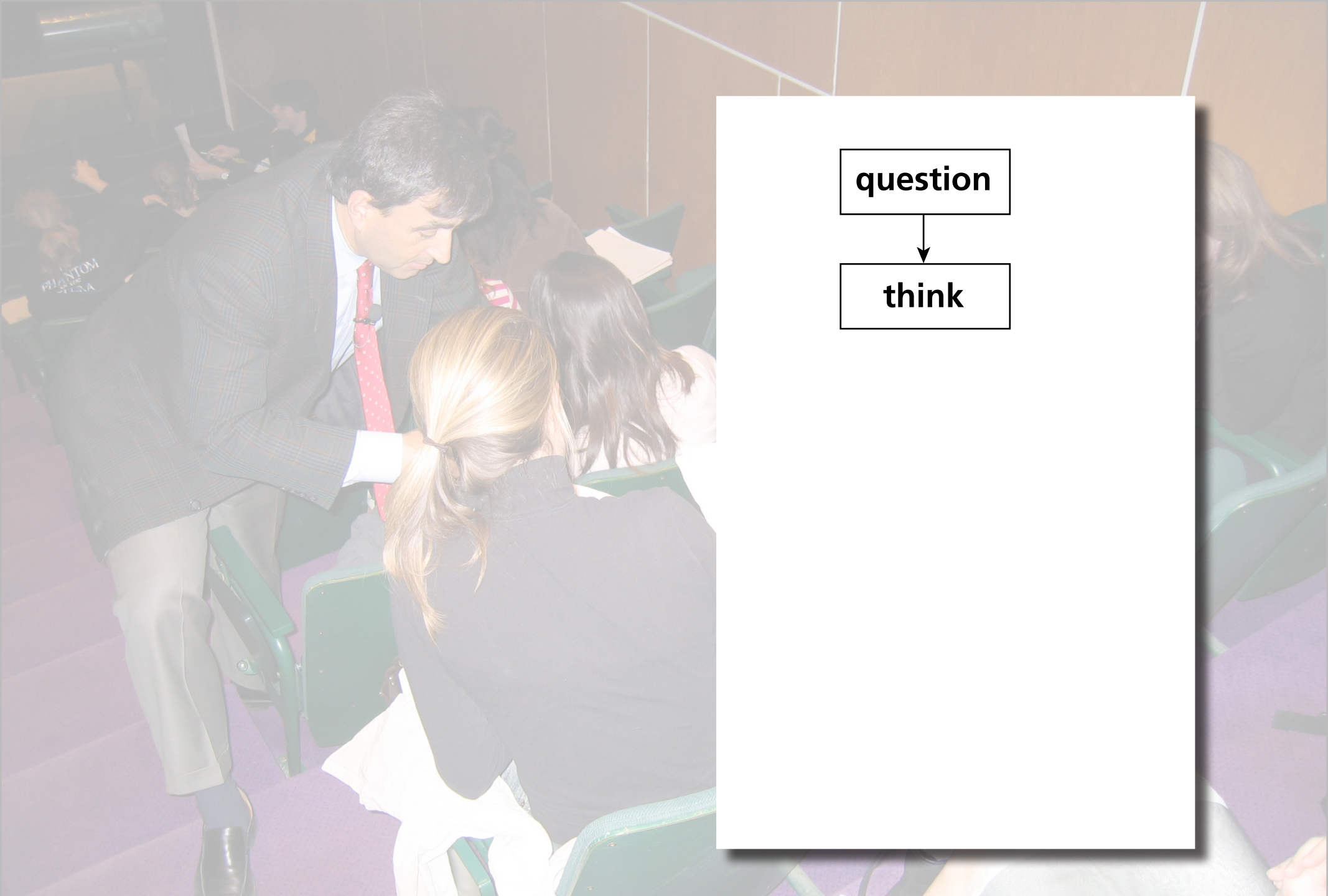
2. assimilation of that information (in class)

A man in a dark plaid suit and red tie is leaning over a woman with blonde hair in a lecture hall. He appears to be adjusting her chair or providing assistance. Other people are visible in the background, some sitting at desks. The room has wood-paneled walls and green chairs.

question

1 lecture

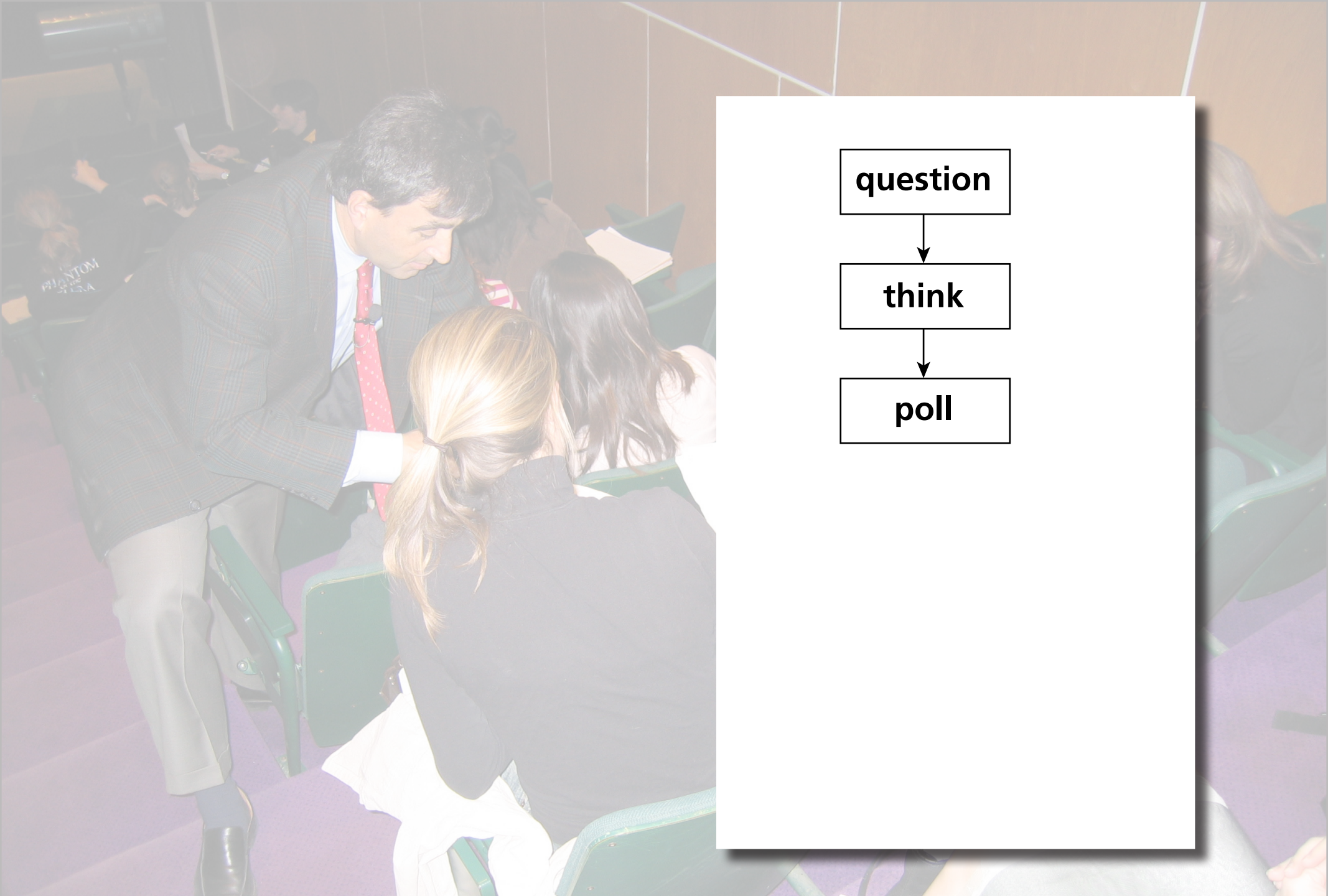
2 PI



question



think



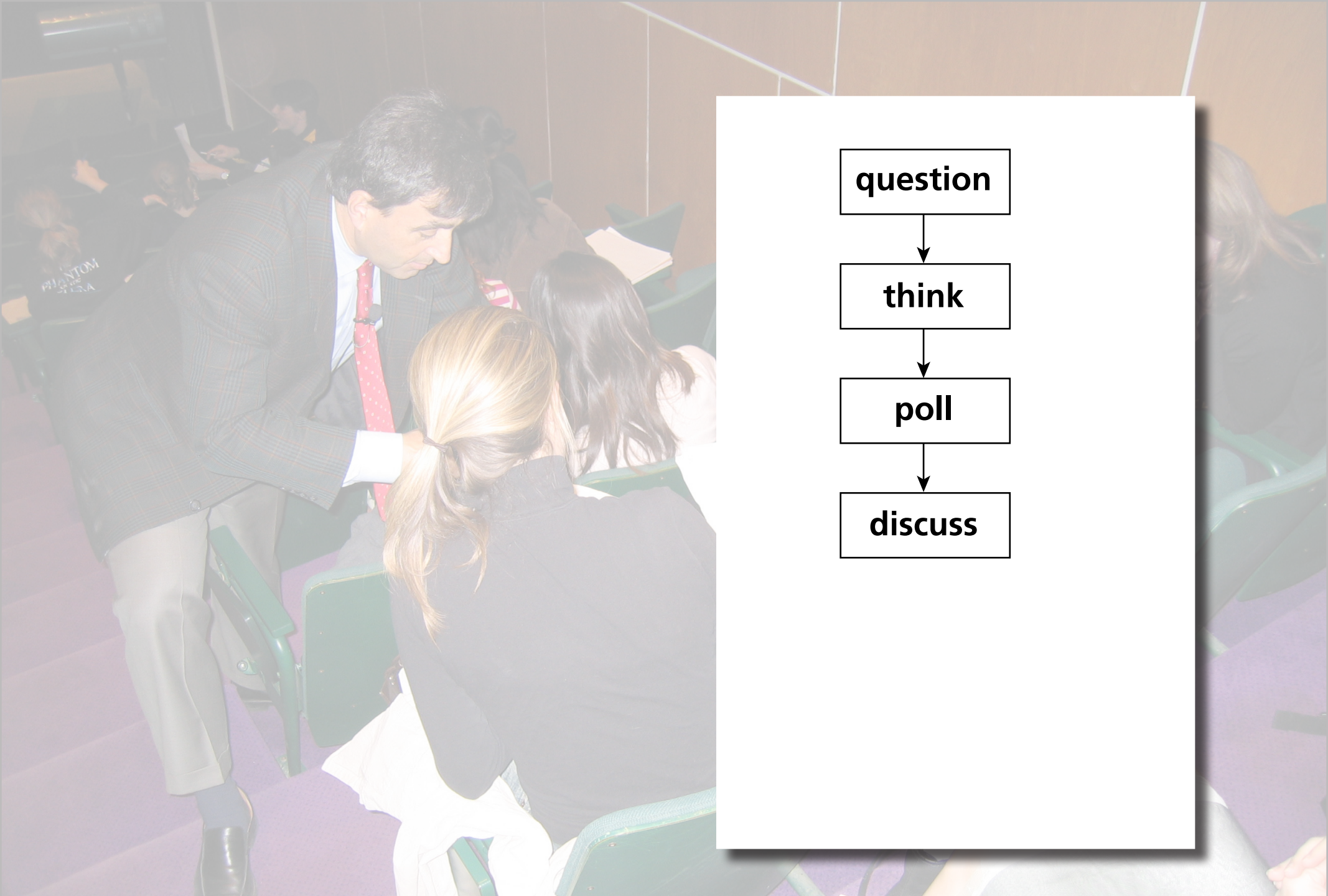
question



think



poll



question



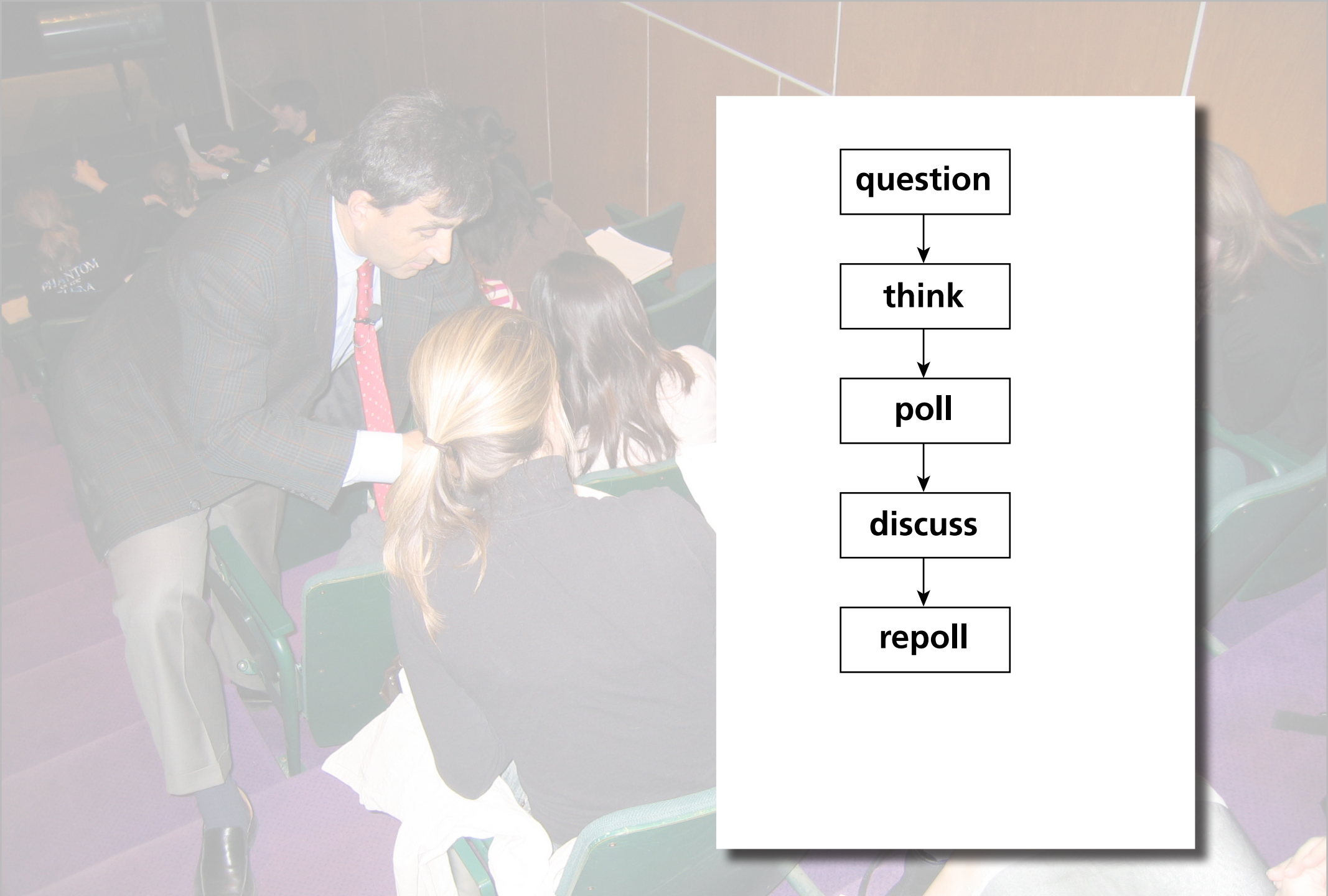
think



poll



discuss



question



think



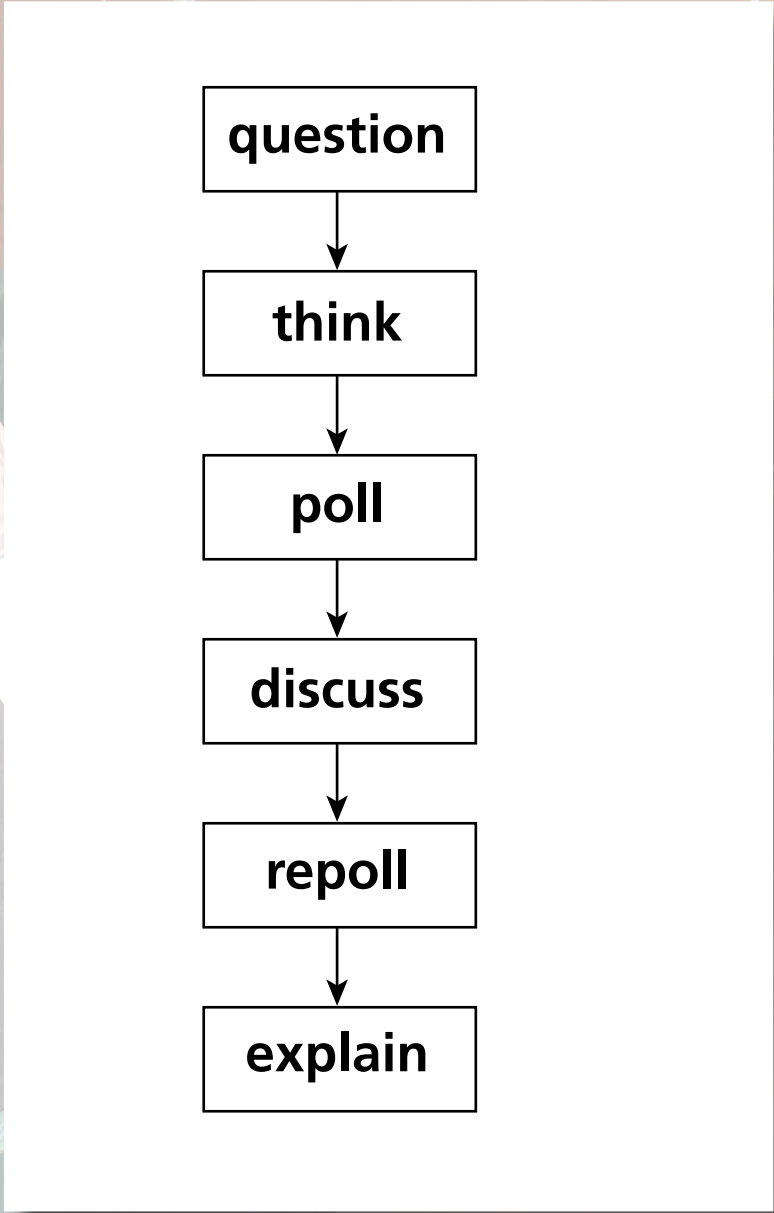
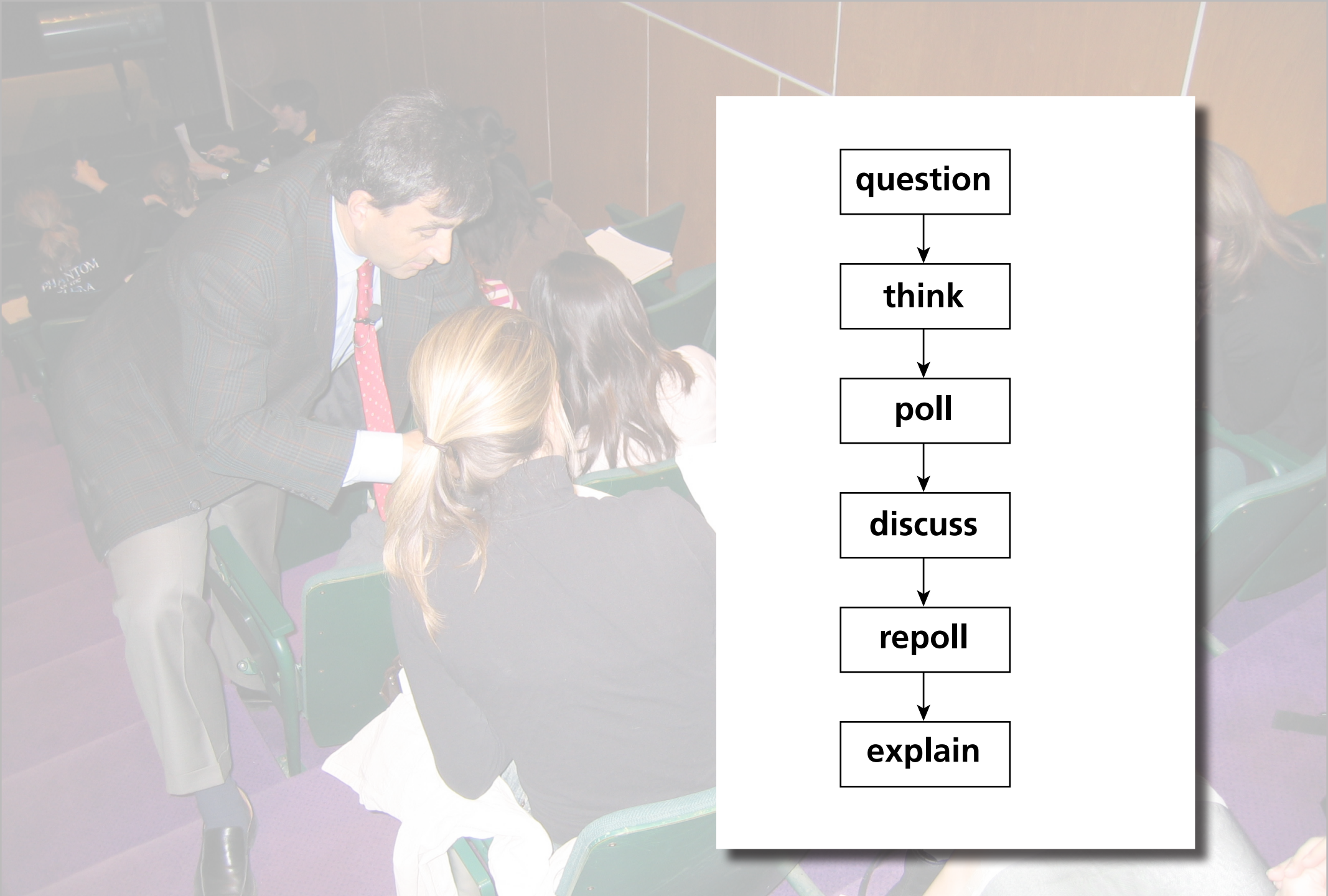
poll

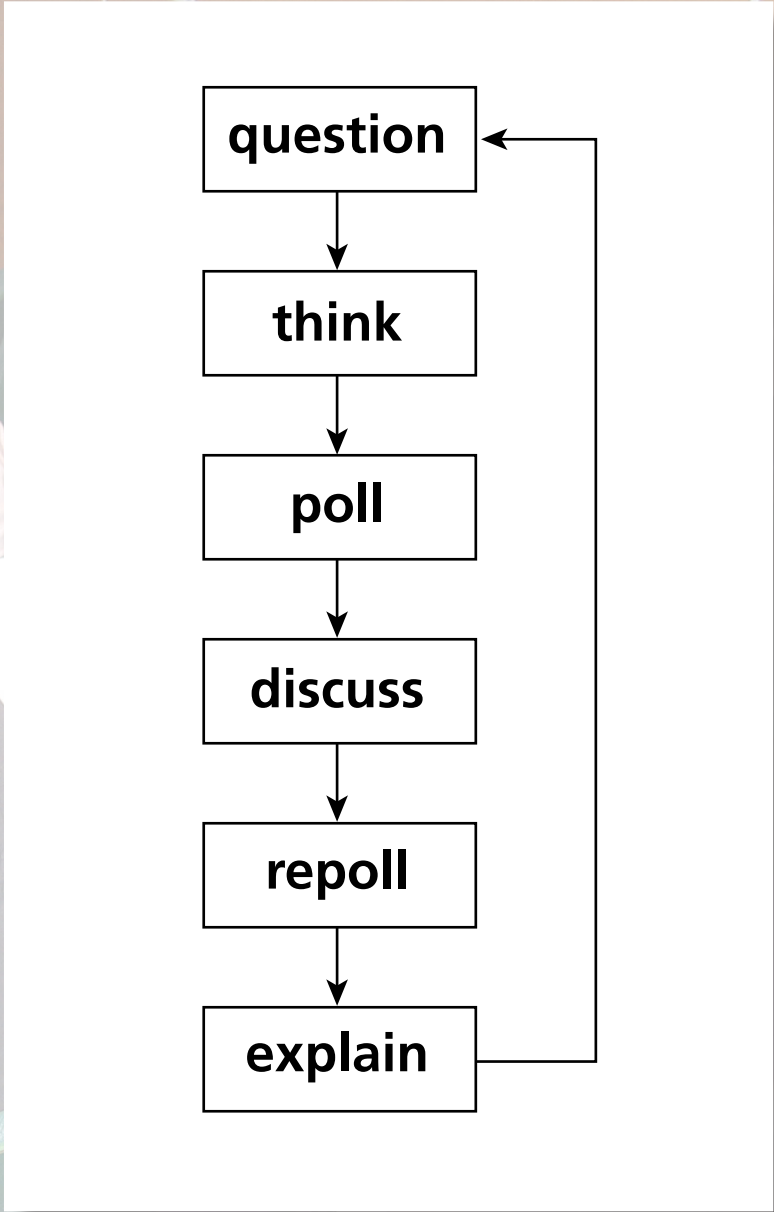
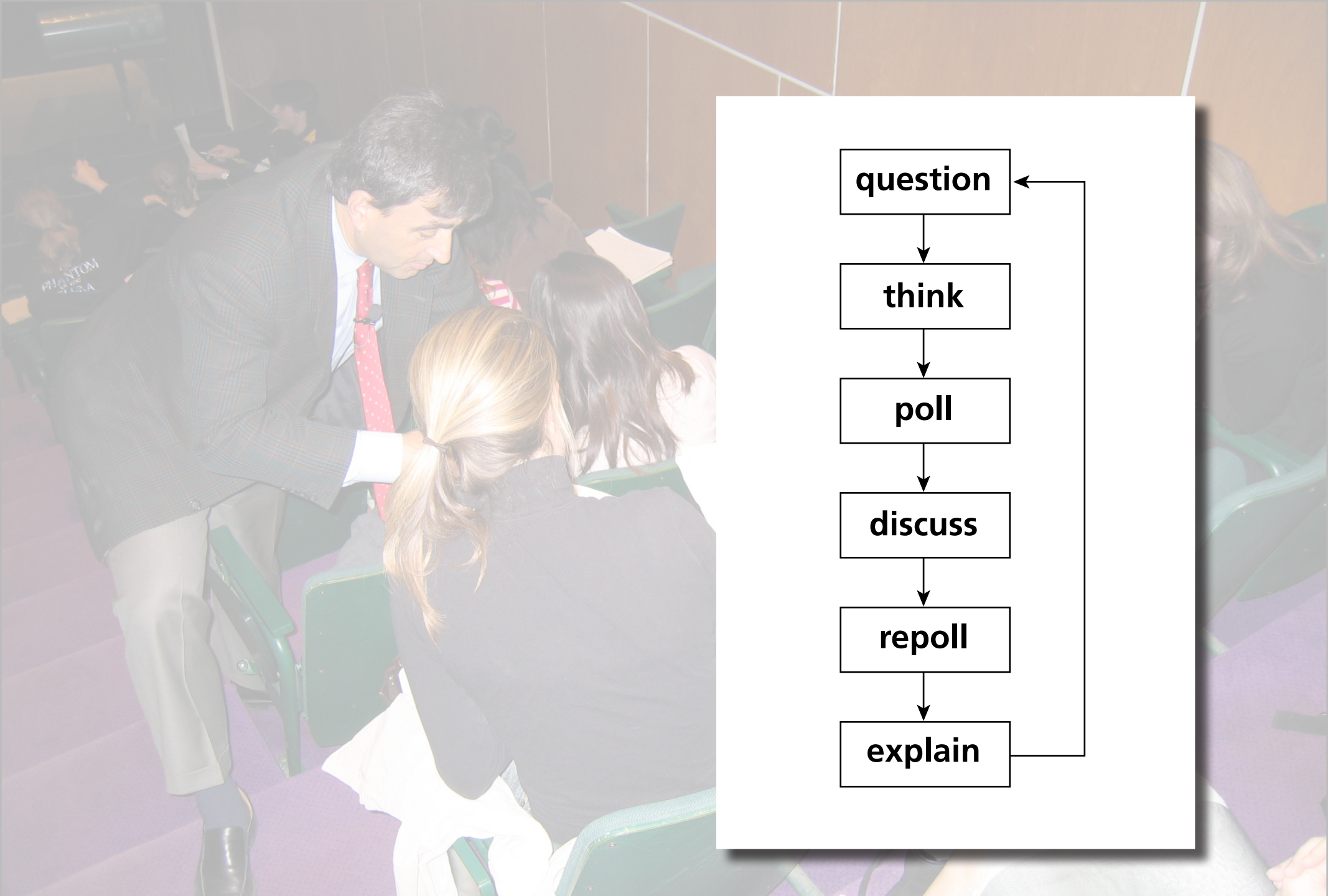


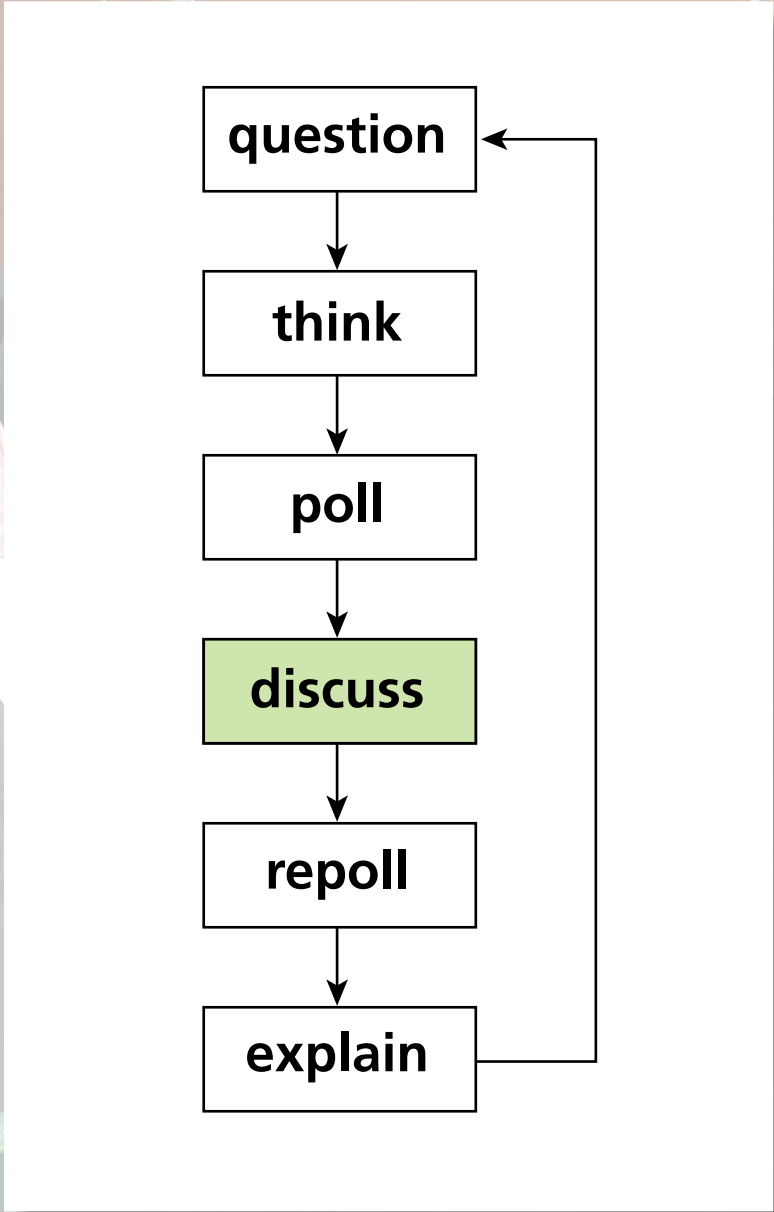
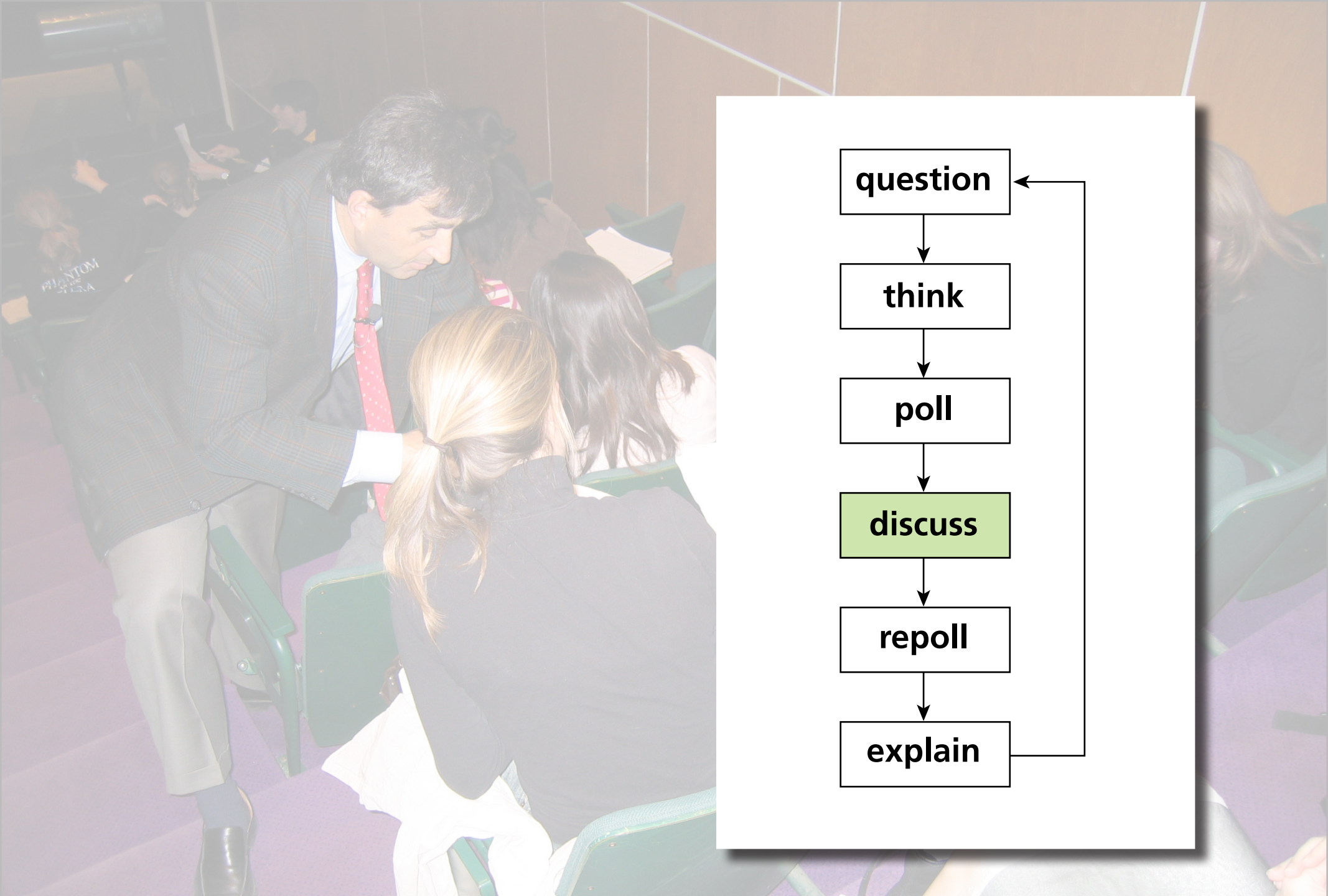
discuss



repoll







1 education

2 PI

Peer

INSTRUCTION

1 lecture

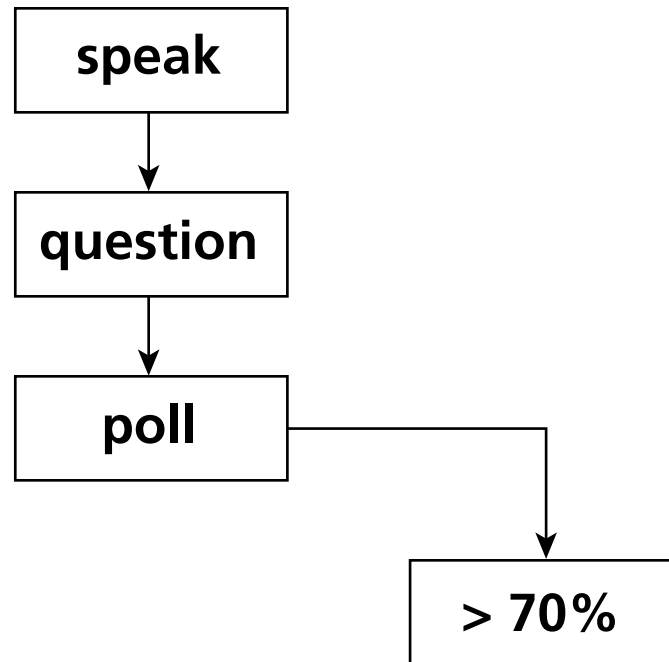
2 PI

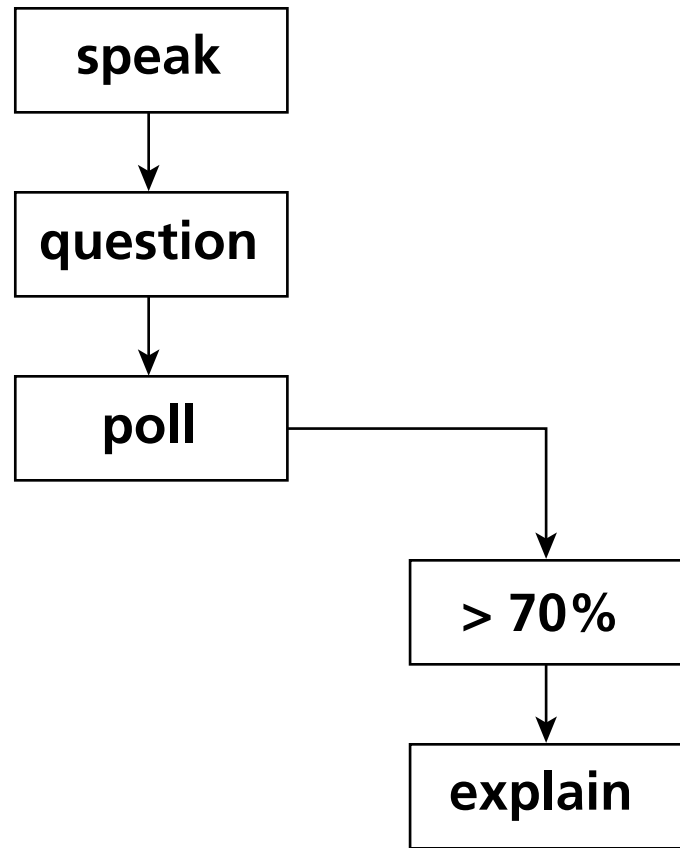
Speak

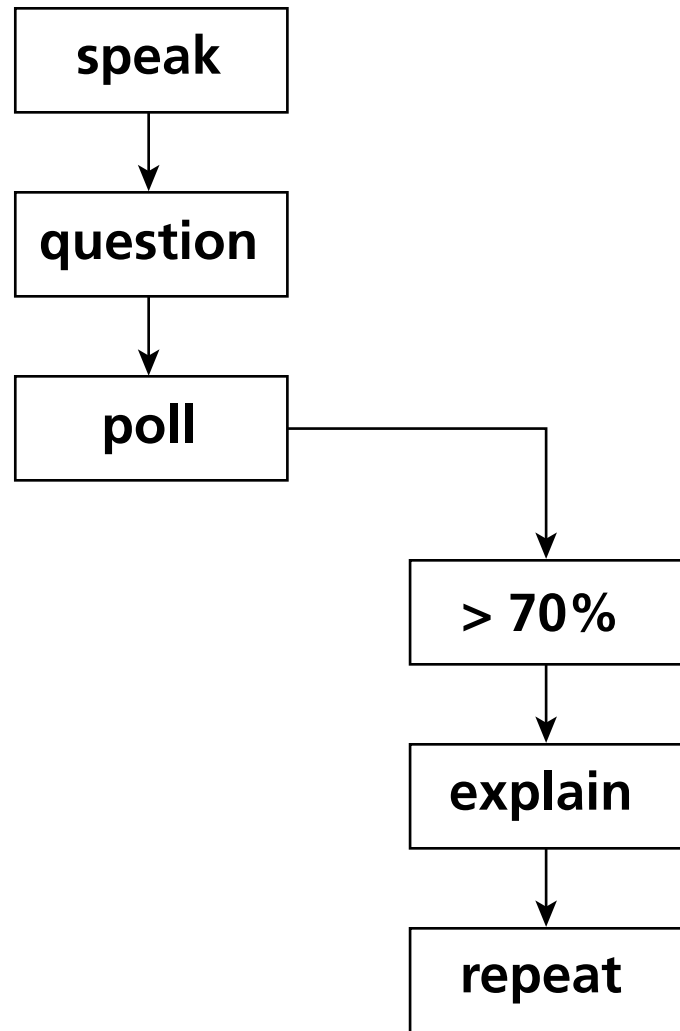
Speak

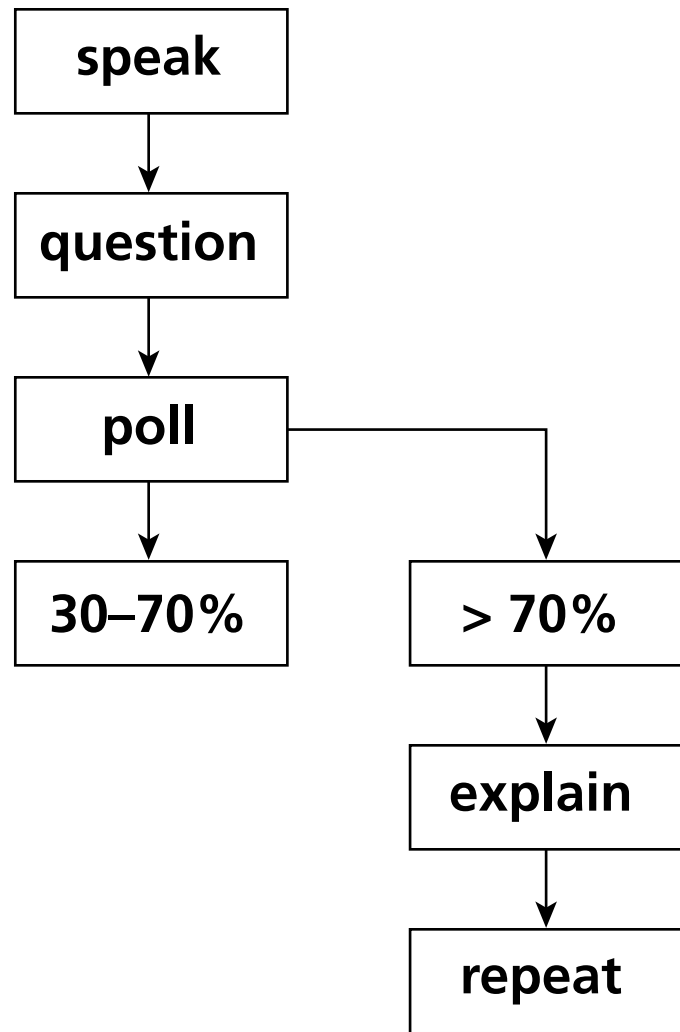


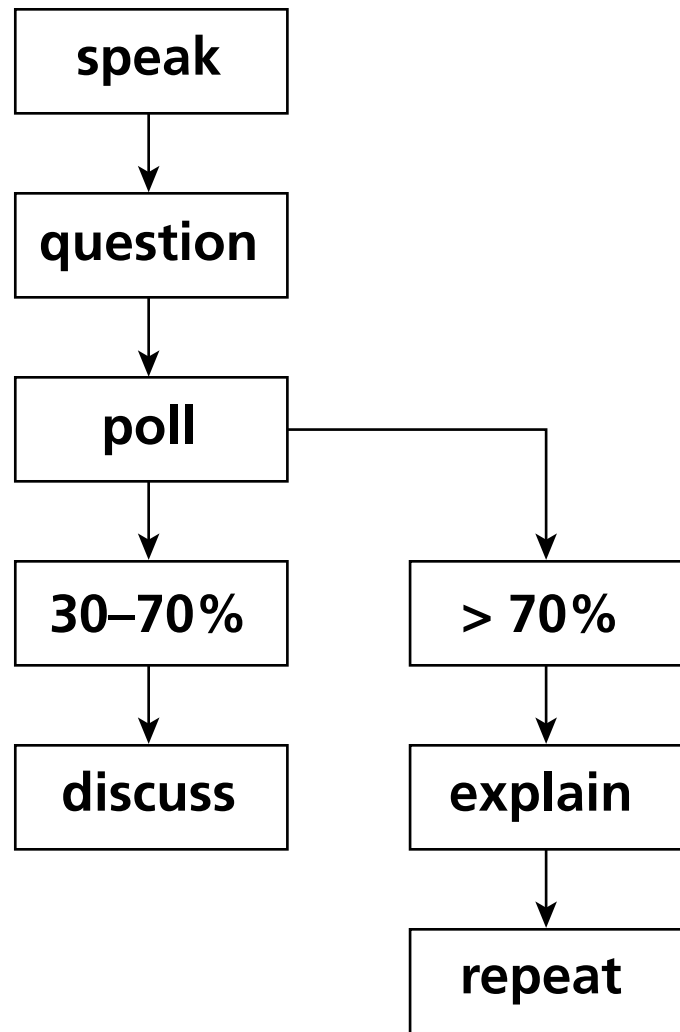
question

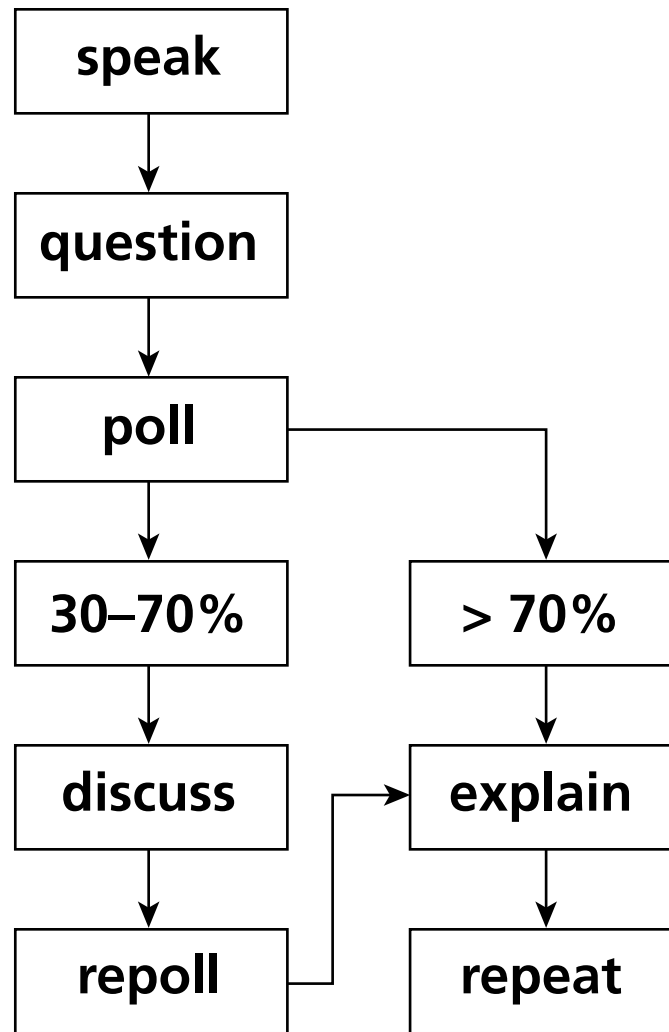


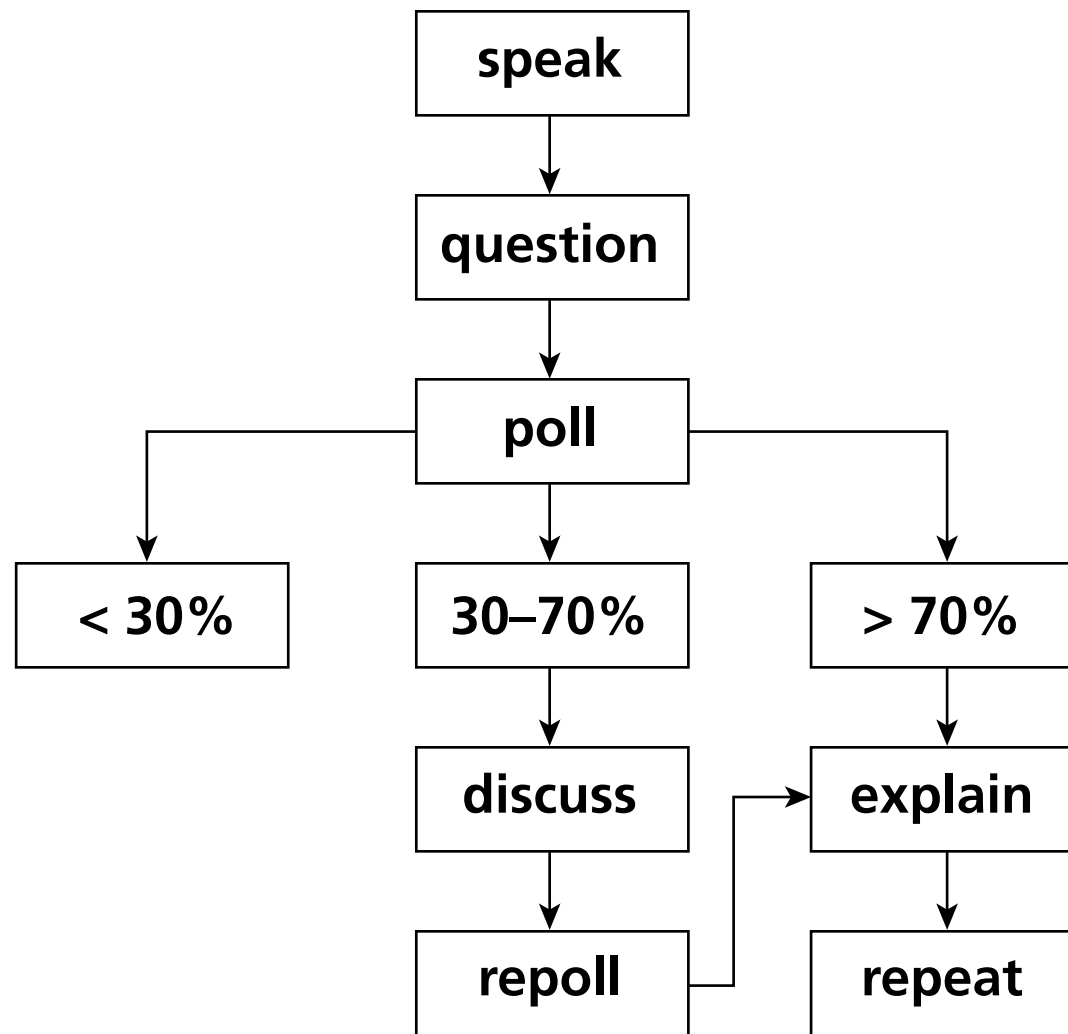


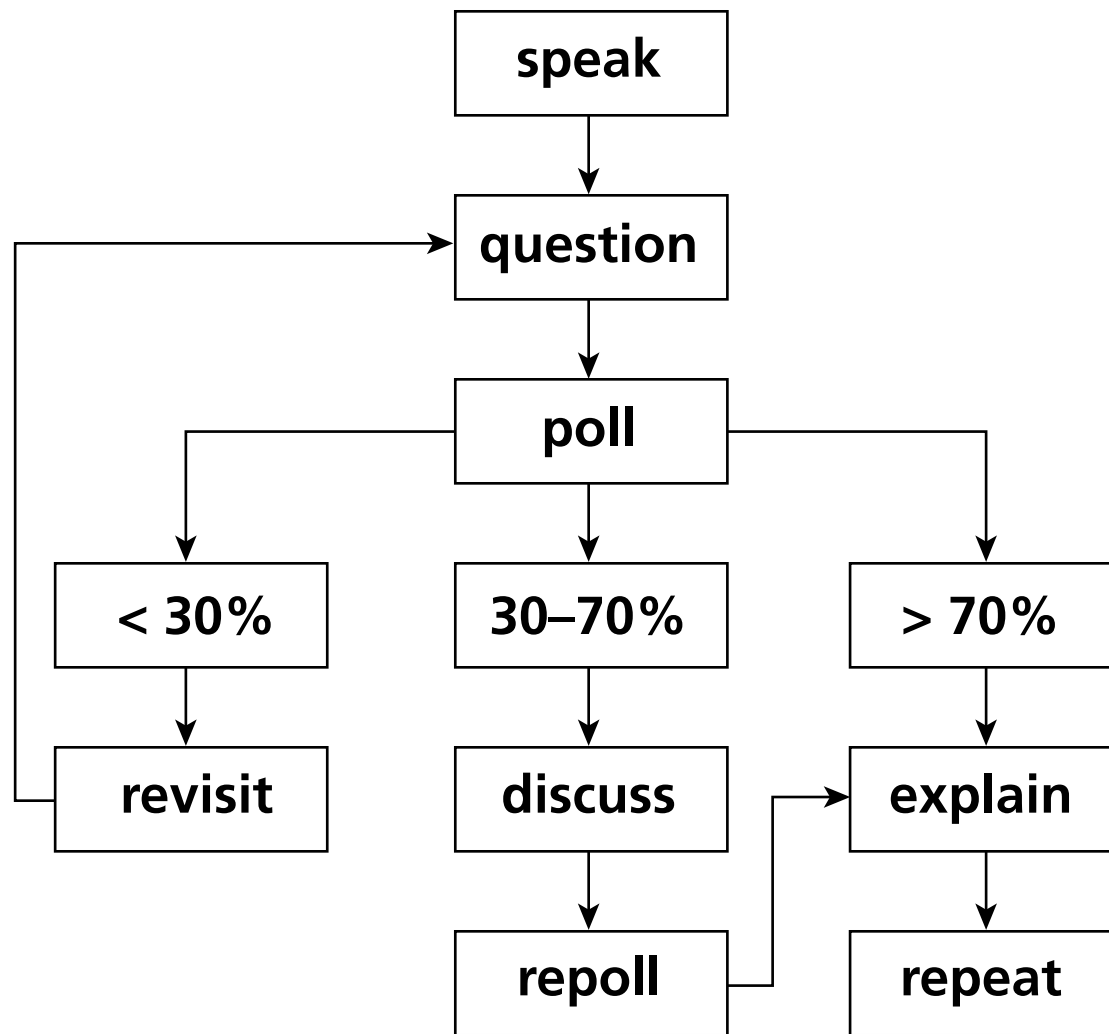


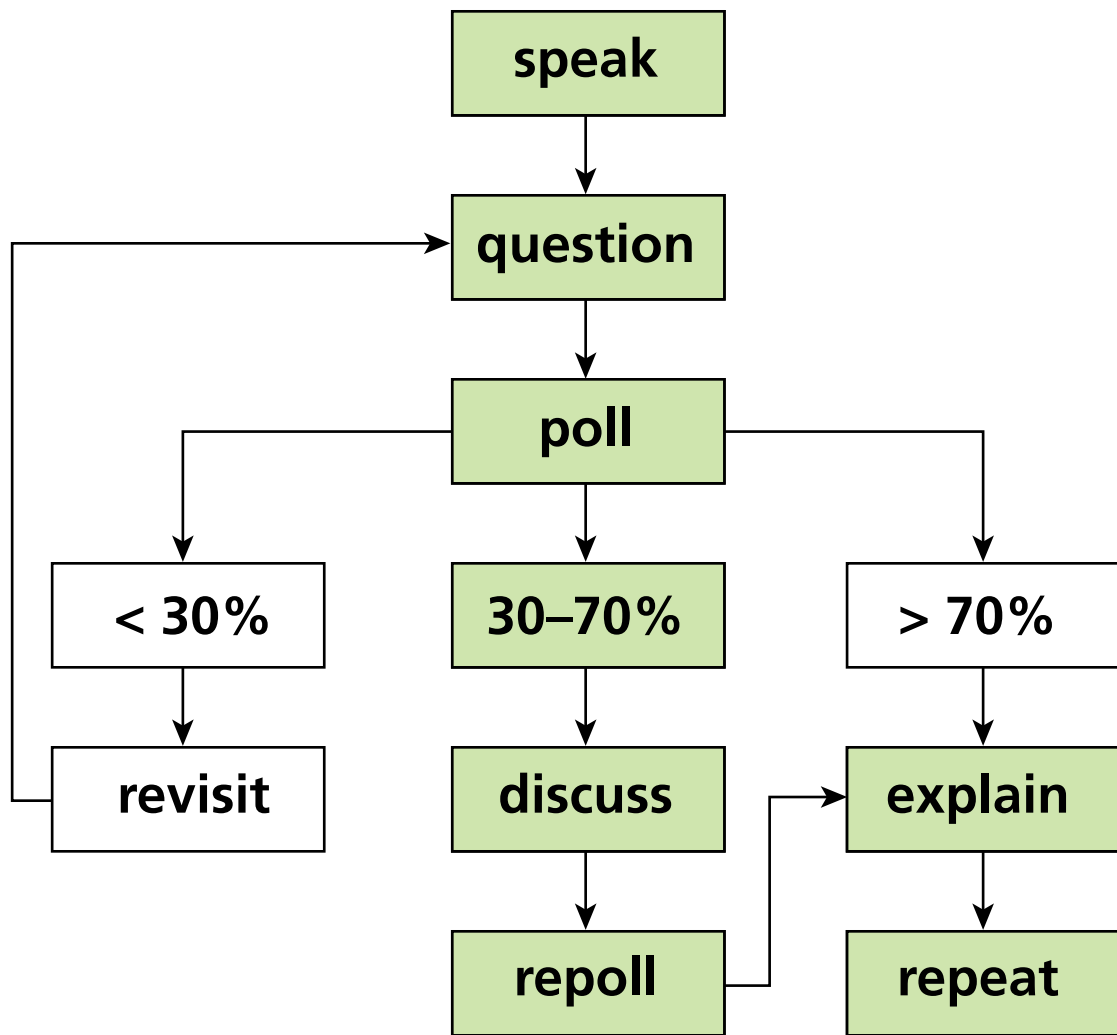








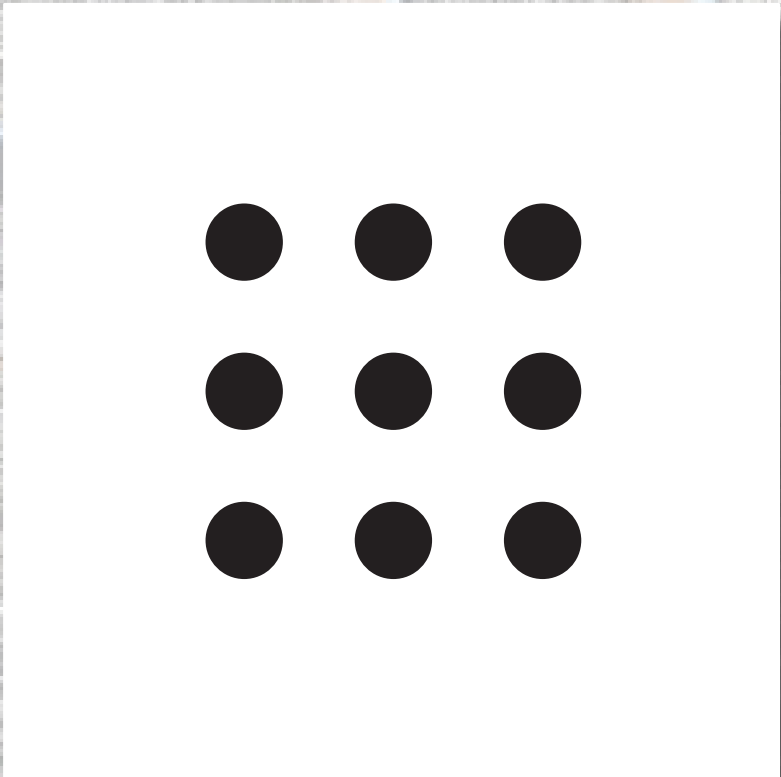


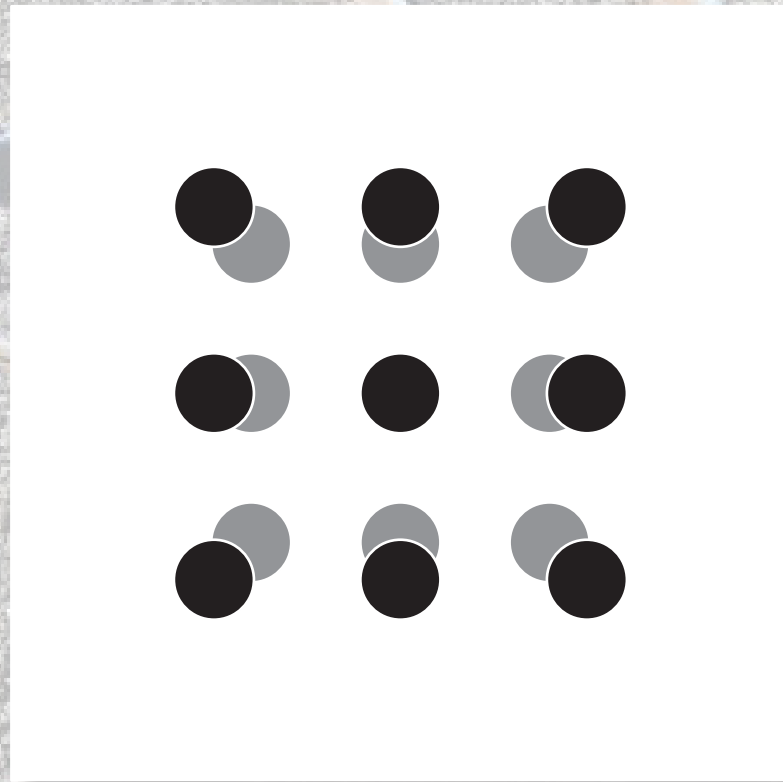




An aerial photograph showing a long, wavy metal expansion joint installed on a gravel surface. The joint is made of a light-colored metal and is designed to accommodate thermal expansion and contraction. The gravel is dark grey, and the surrounding area is green grass. The text "thermal expansion" is overlaid in the center of the image.

thermal expansion

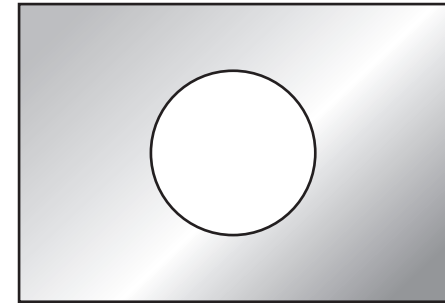




all of them

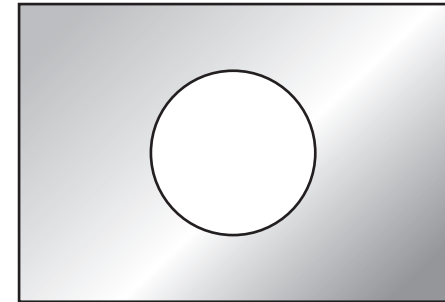


**Consider a rectangular metal plate
with a circular hole in it.**



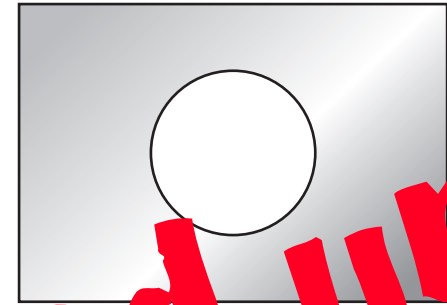
Consider a rectangular metal plate with a circular hole in it.

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.



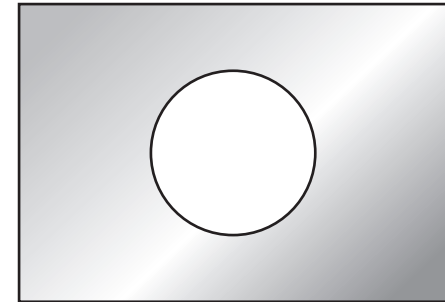
When the plate is uniformly heated, the diameter of the hole

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, 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**

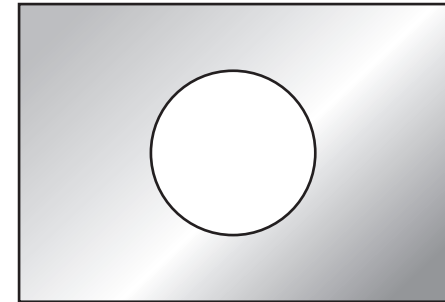
Before I tell you the answer, let's analyze what happened.

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**

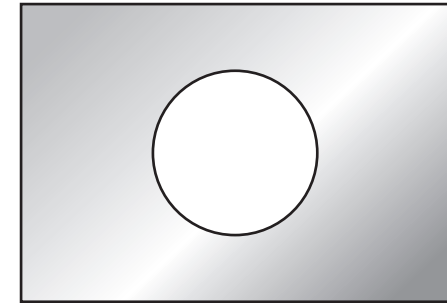
Consider a rectangular metal plate with a circular hole in it.

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



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

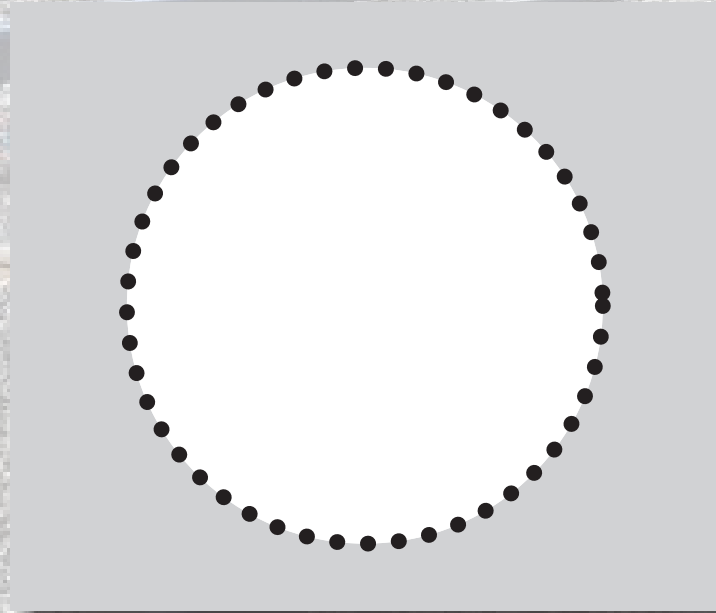
Consider a rectangular metal plate with a circular hole in it.



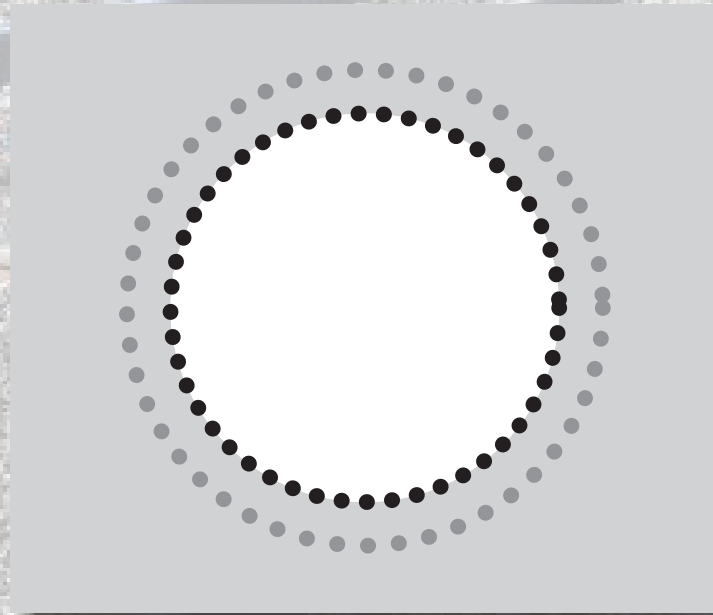
When the plate is uniformly heated, the diameter of the hole

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

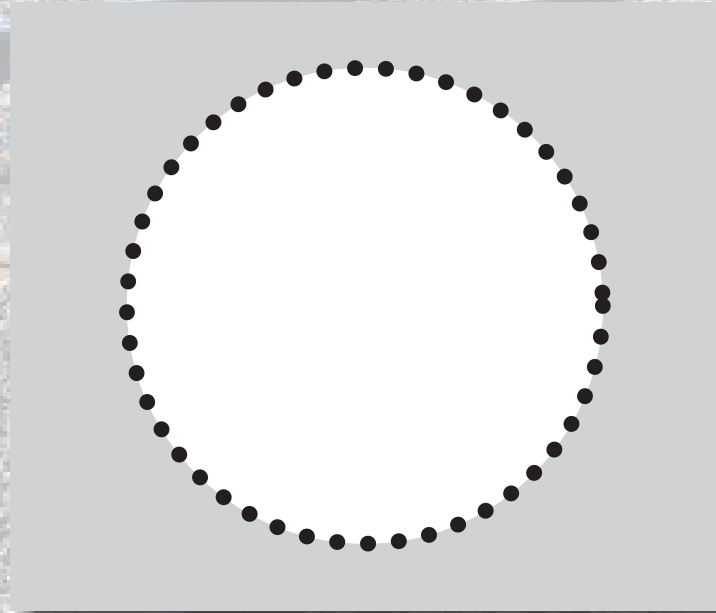
consider atoms at rim of hole



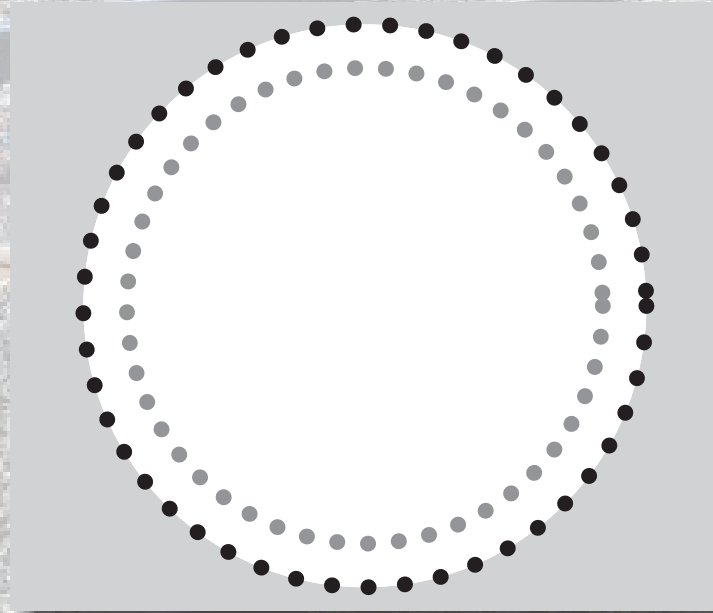
consider atoms at rim of hole



consider atoms at rim of hole



consider atoms at rim of hole



consider atoms at rim of hole

you won't forget this



Peer

back to pi

INSTRUCTION

Peer INSTRUCTION

The title 'Peer INSTRUCTION' is displayed in a large, white, sans-serif font. The word 'Peer' is on the top line and 'INSTRUCTION' is on the bottom line. The letters are outlined in a light blue color. A dashed yellow line with arrowheads forms a path that starts at the bottom left, curves up to the left side of the 'e' in 'Peer', then curves around the 'e' and 'e' in 'Peer', and finally points towards the 'r'. A dotted blue line starts from the right side of the 'e' in 'Peer' and extends diagonally down towards the 'I' in 'INSTRUCTION'.

1 lecture

2 PI

Peer
Higher learning & gains

INSTRUCTION

1 lecture

2 PI

Peer

Higher learning gains

Better retention

INSTRUCTION



Join now!

PeerInstruction.net

- 1. Go to learningcatalytics.com/demo**
- 2. Enter info, click "Start"**
- 3. Join session 123456789**

EDUCACION



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

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

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?

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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...

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- improve questioning
- manage discussions

- facilitate time management/flow

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



1 learningcatalytics.com/demo 2 enter info 3 ID 123456789

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optics i

current session: 766079 | 69 students

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1

2

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12

13

14

15



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

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

[feedback & support](#)

1 lecture

2 PI

3 PI 2.0

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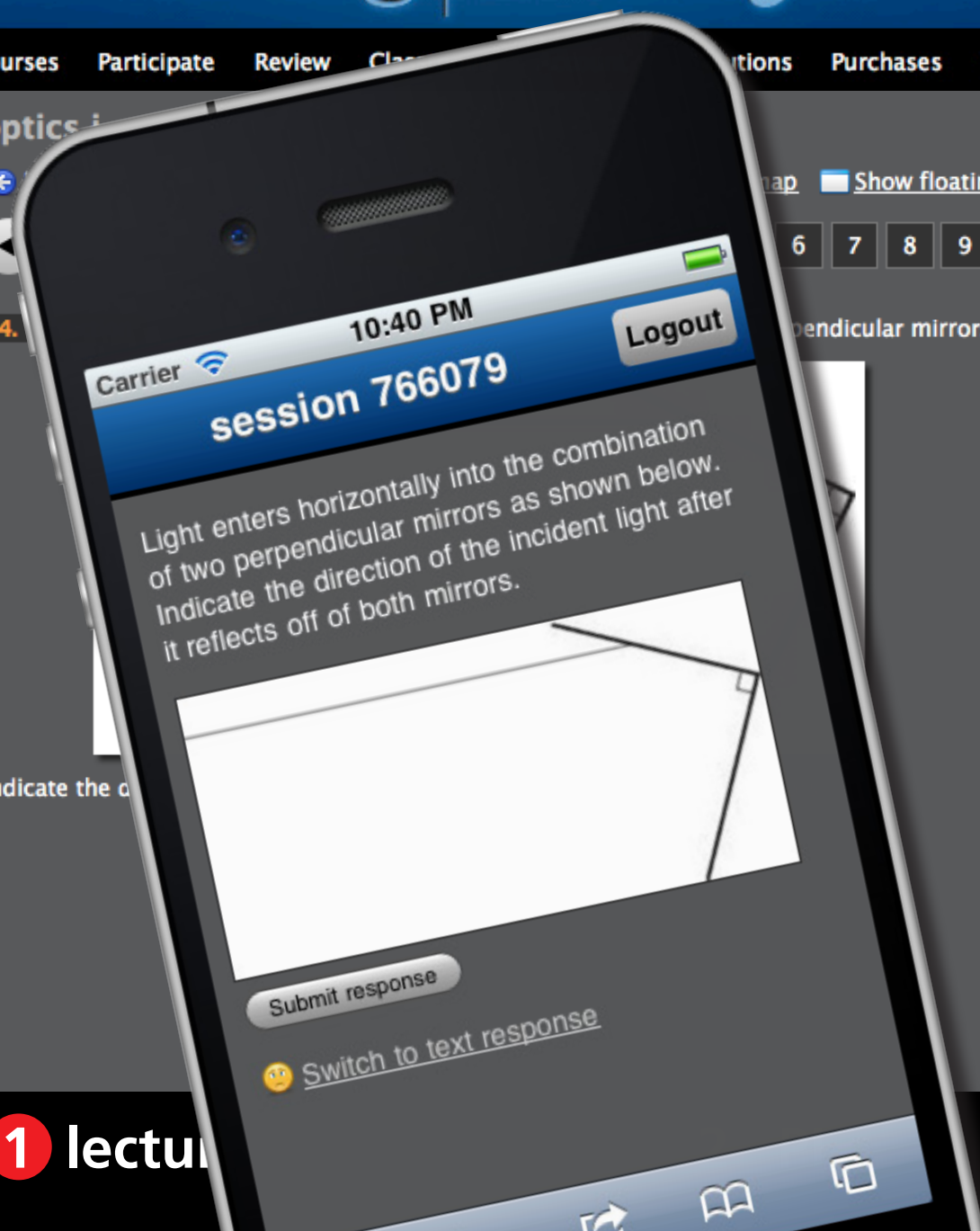
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6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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1 lectur

3 PI 2.0

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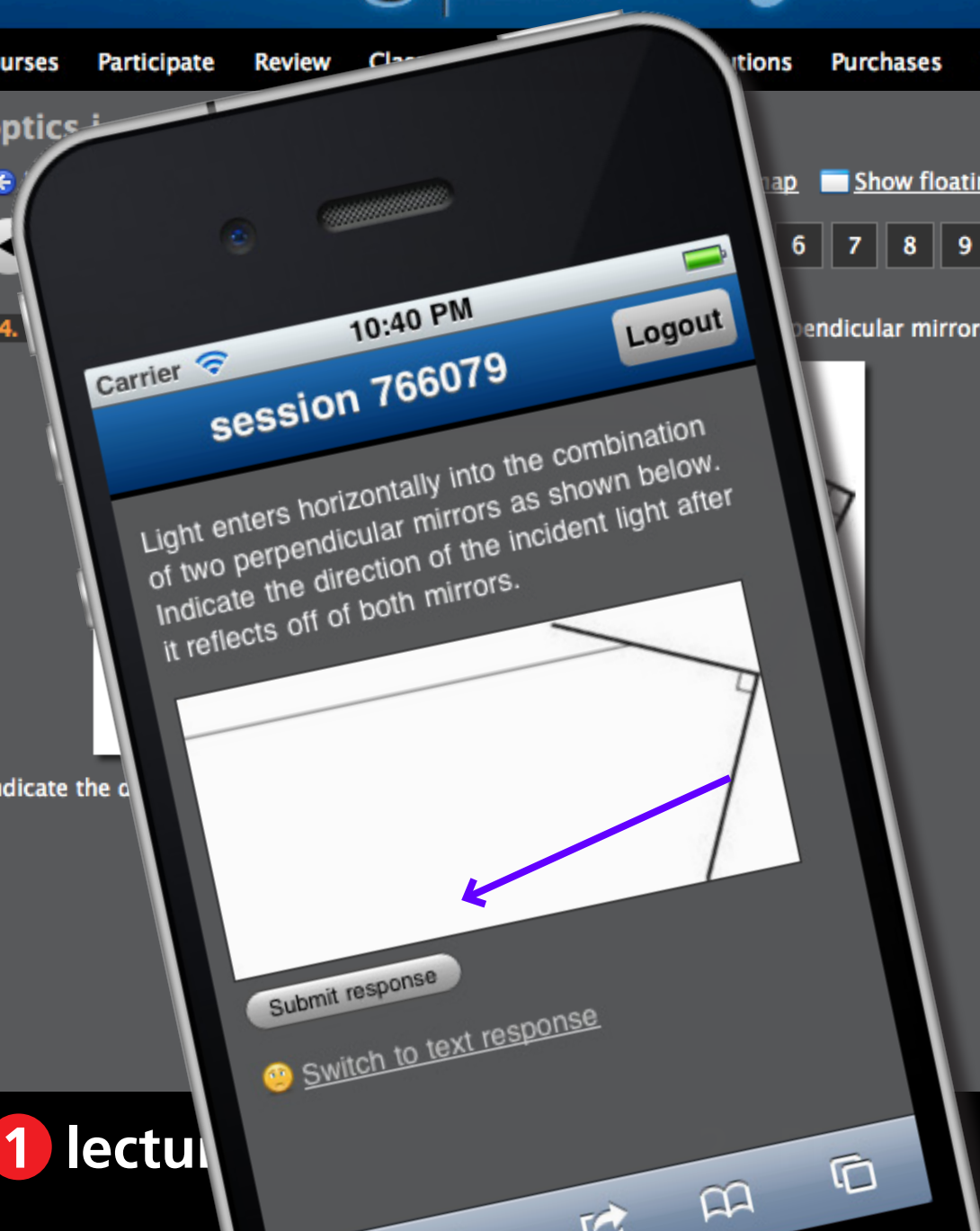
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6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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1 lecture

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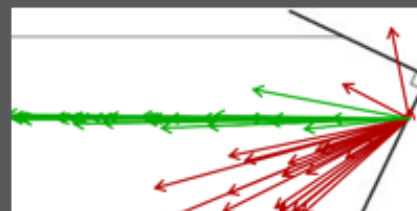
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6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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Round 1 ✖  
● 57 responses, 58% correct



 [feedback & support](#)



1 lectur

3 PI 2.0

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current session: **766079** | 69 students

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6 7 8 9 10 11 12 13 14 15

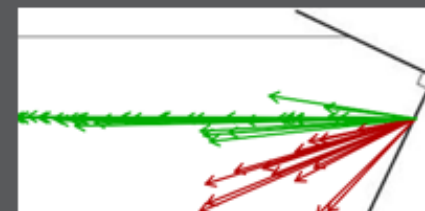
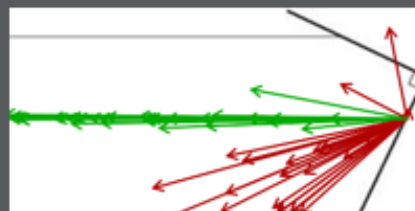


perpendicular mirrors as shown below.

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

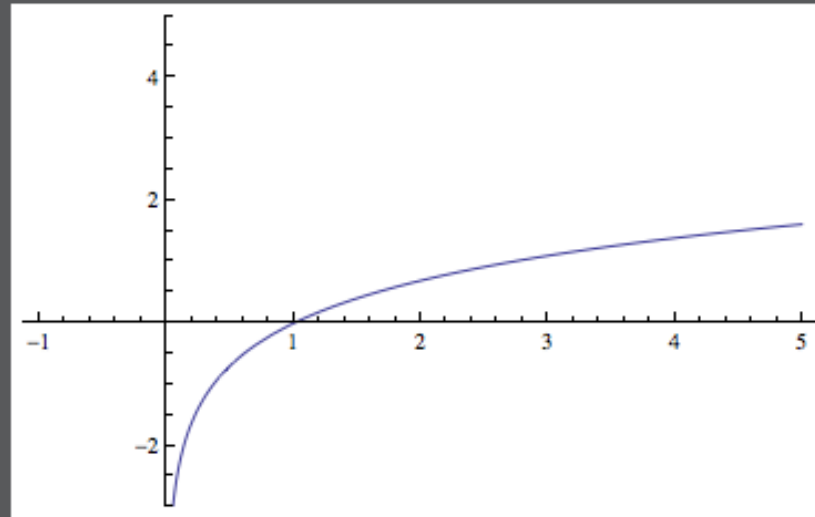
3 PI 2.0

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

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



1 lecture

2 PI

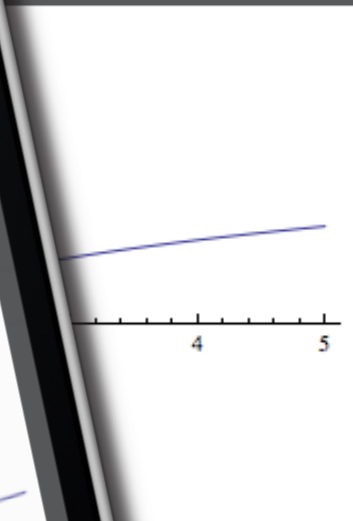
3 PI 2.0

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



1 lecture

3 PI 2.0

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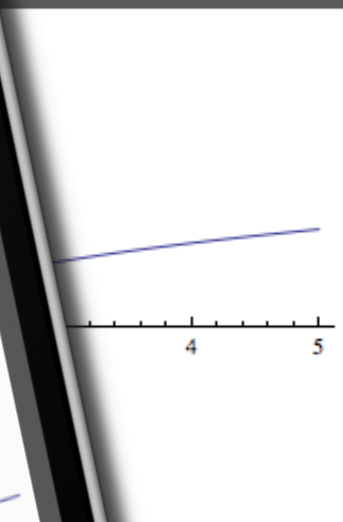
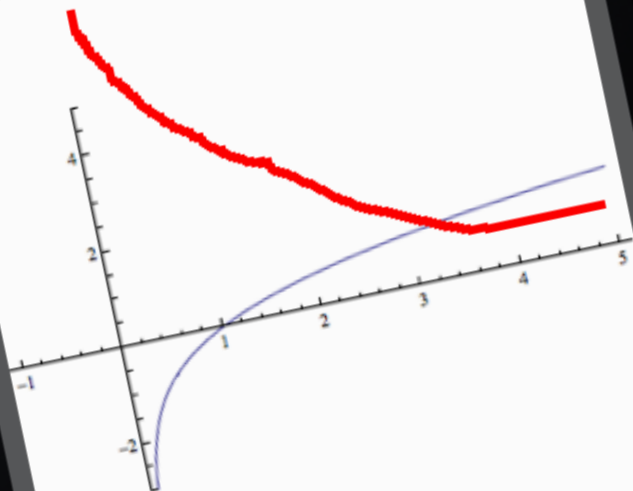
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ases Users Tour Help

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

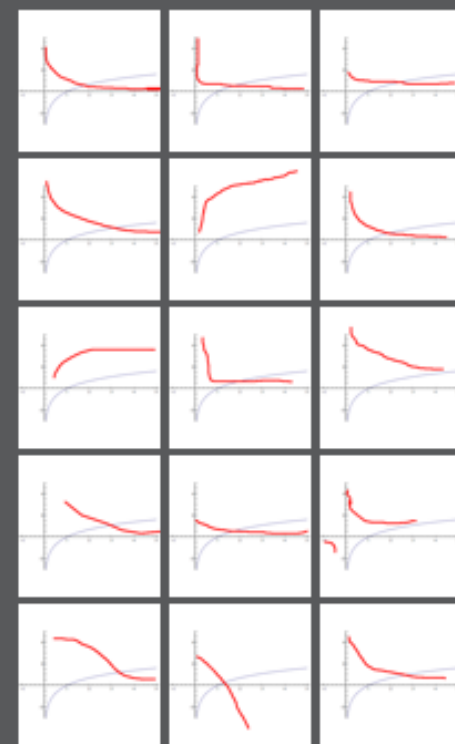


This is a graph of $f(x) = \ln x$. Sketch a graph of the derivative $f'(x)$.



Round 1

15 responses



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

1 lecture

3 PI 2.0

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transformations of parabolas

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1

2

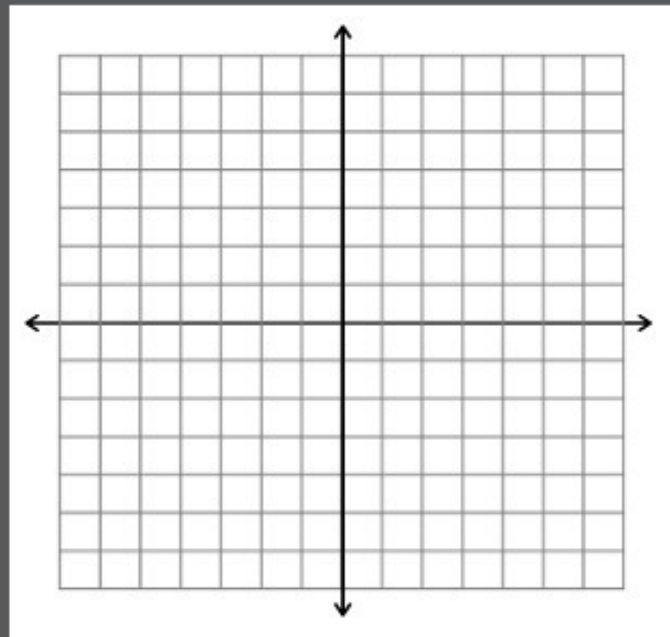
3

4



4. sketch Sketch a graph of the function $f(x) = (x - 3)^2 + 2$.

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3 PI 2.0

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transformations of parabolas

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1

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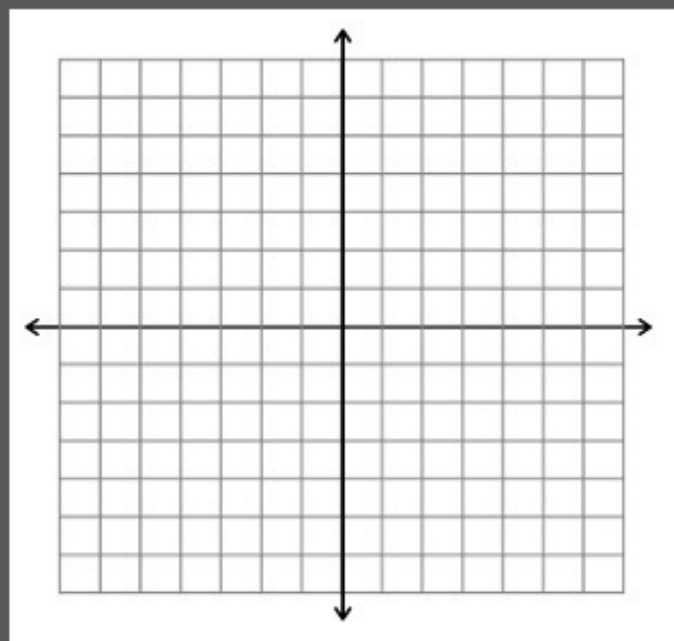
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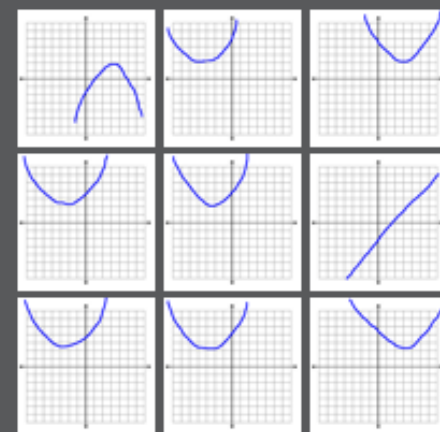
4. sketch Sketch a graph of the function $f(x) = (x - 3)^2 + 2$.

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Round 1

9 responses



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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 lecture

2 PI

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1. highlighting
sonnet?

[his Shakespeare](#) [Stop delivery](#) [Deliver again](#) [Assign groups](#) [Show all results](#)



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1. highlighting
sonnet?

[his Shakespeare](#) [Stop delivery](#) [Deliver again](#) [Assign groups](#) [Show all results](#)



Round 1

3 responses

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Shall hate be fairer lodged than
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and kind,

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%

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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. 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

Search:

1 lecture

2 PI

3 PI 2.0

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E. 0%

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C. 17%
D. 0%
E. 0%

Search: _____

1 lecture

2 PI

3 PI 2.0

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

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Search:

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2 PI

3 PI 2.0

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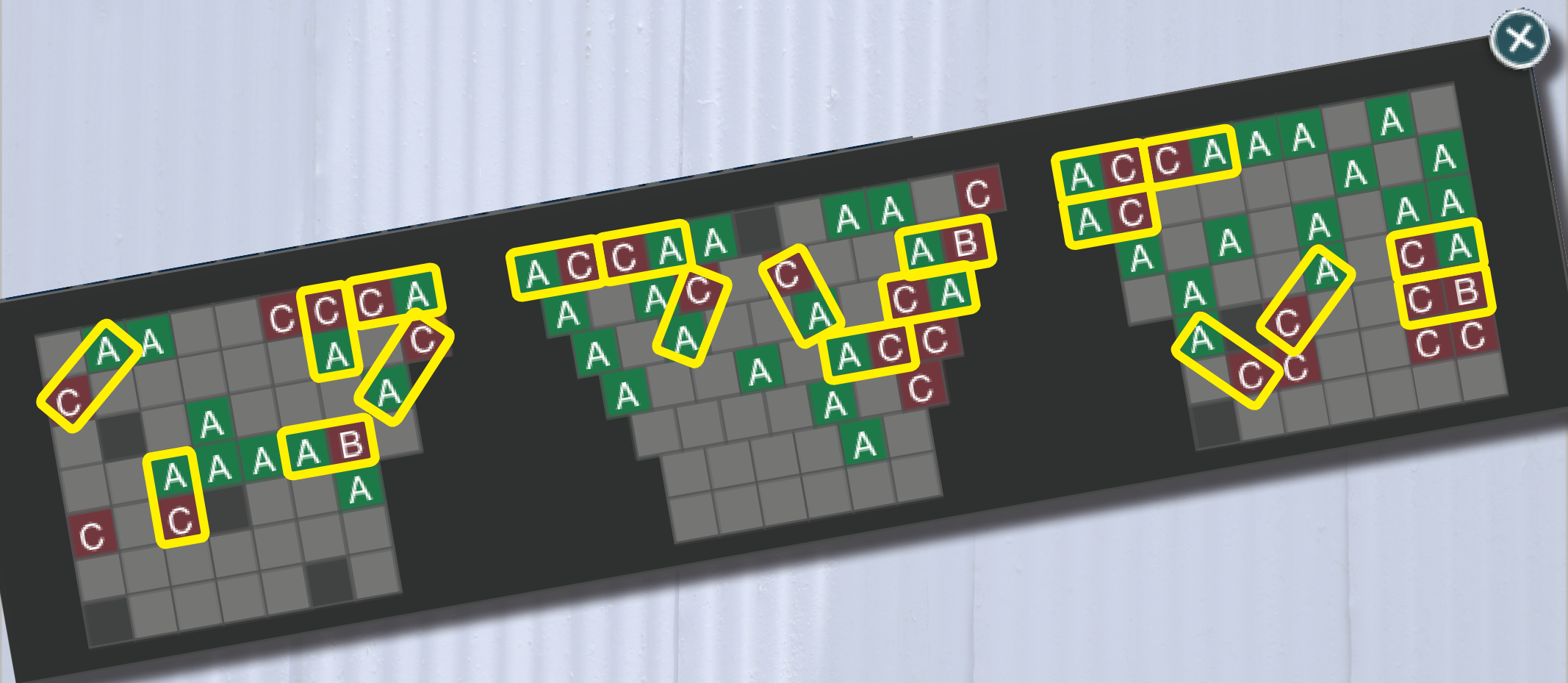
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1 lecture

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let system manage pairing



1 lecture

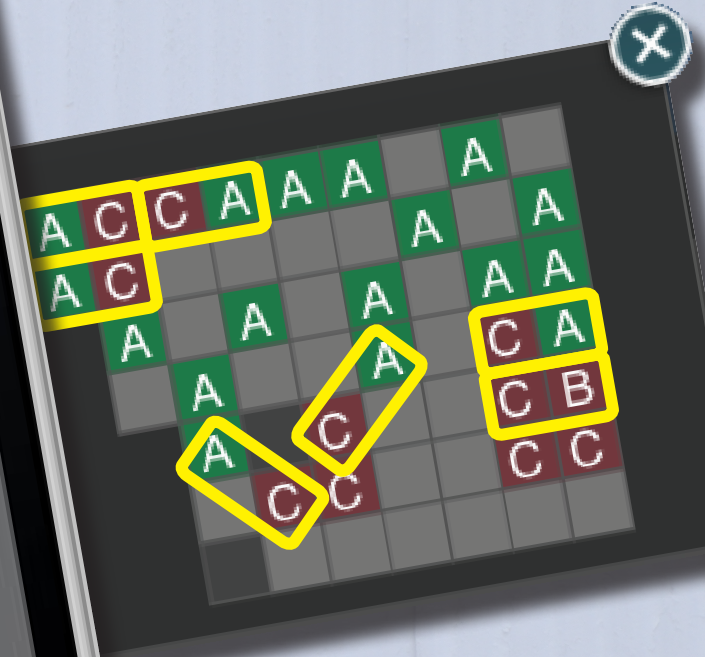
2 PI

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

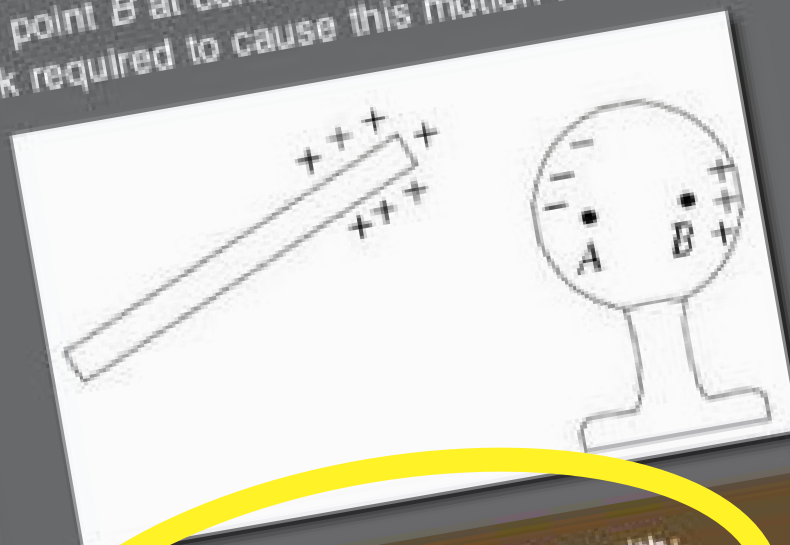


Please discuss your response with:
• Brian Lukoff (to your left)
✓ I am talking to this person/people



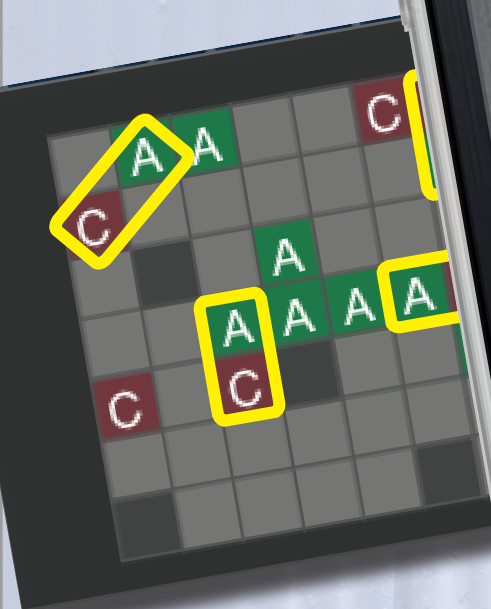
Leave

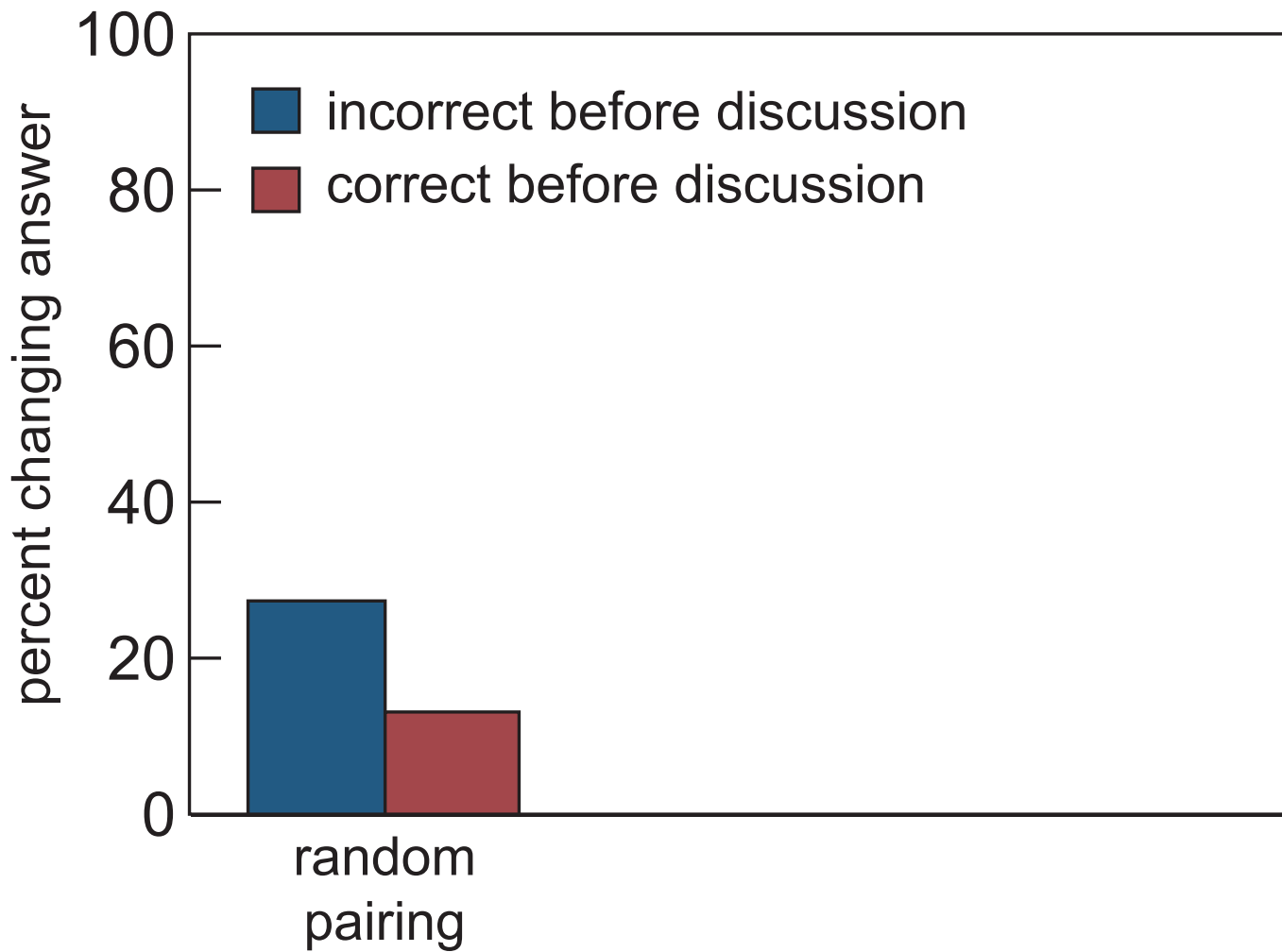
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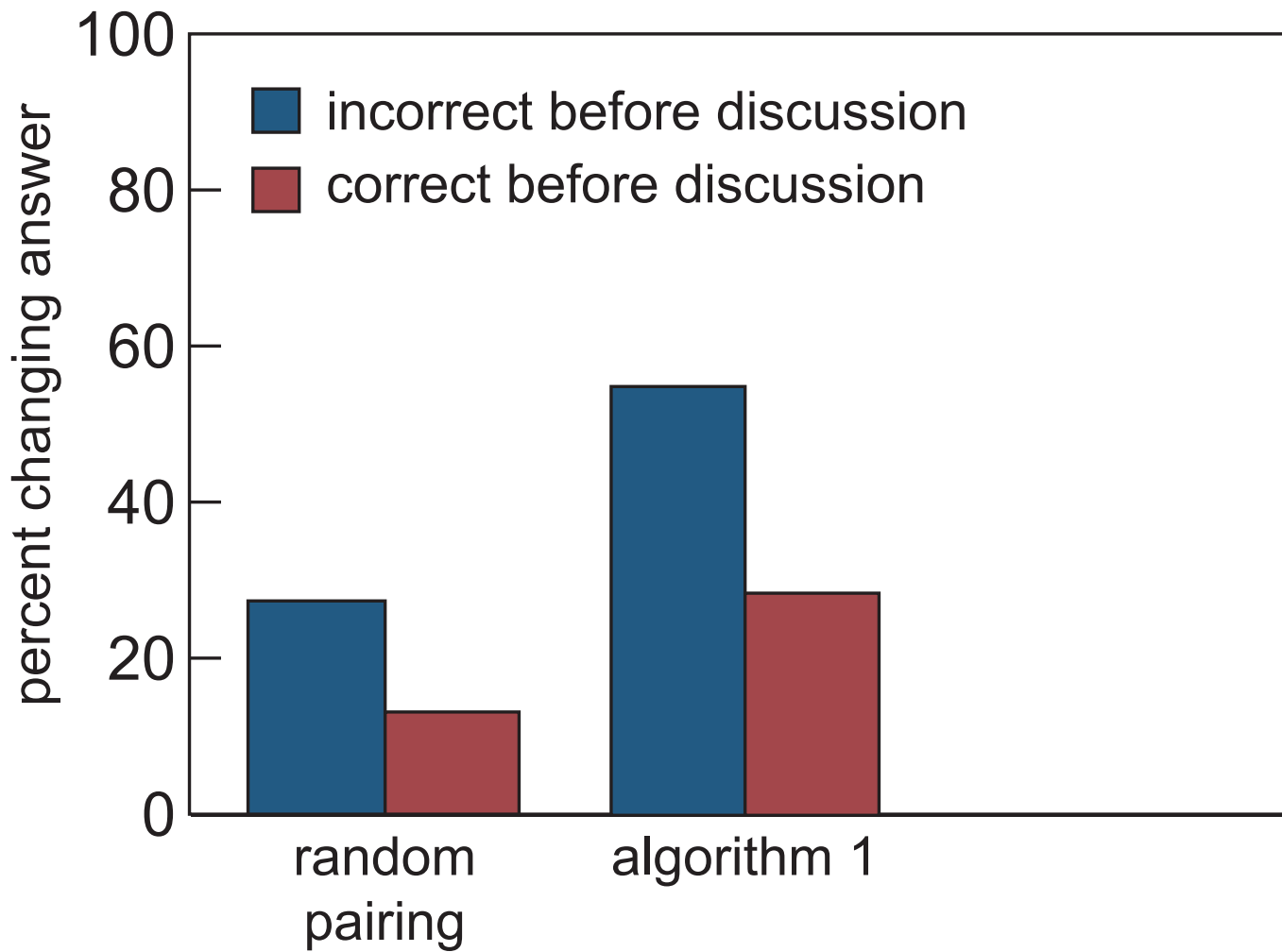


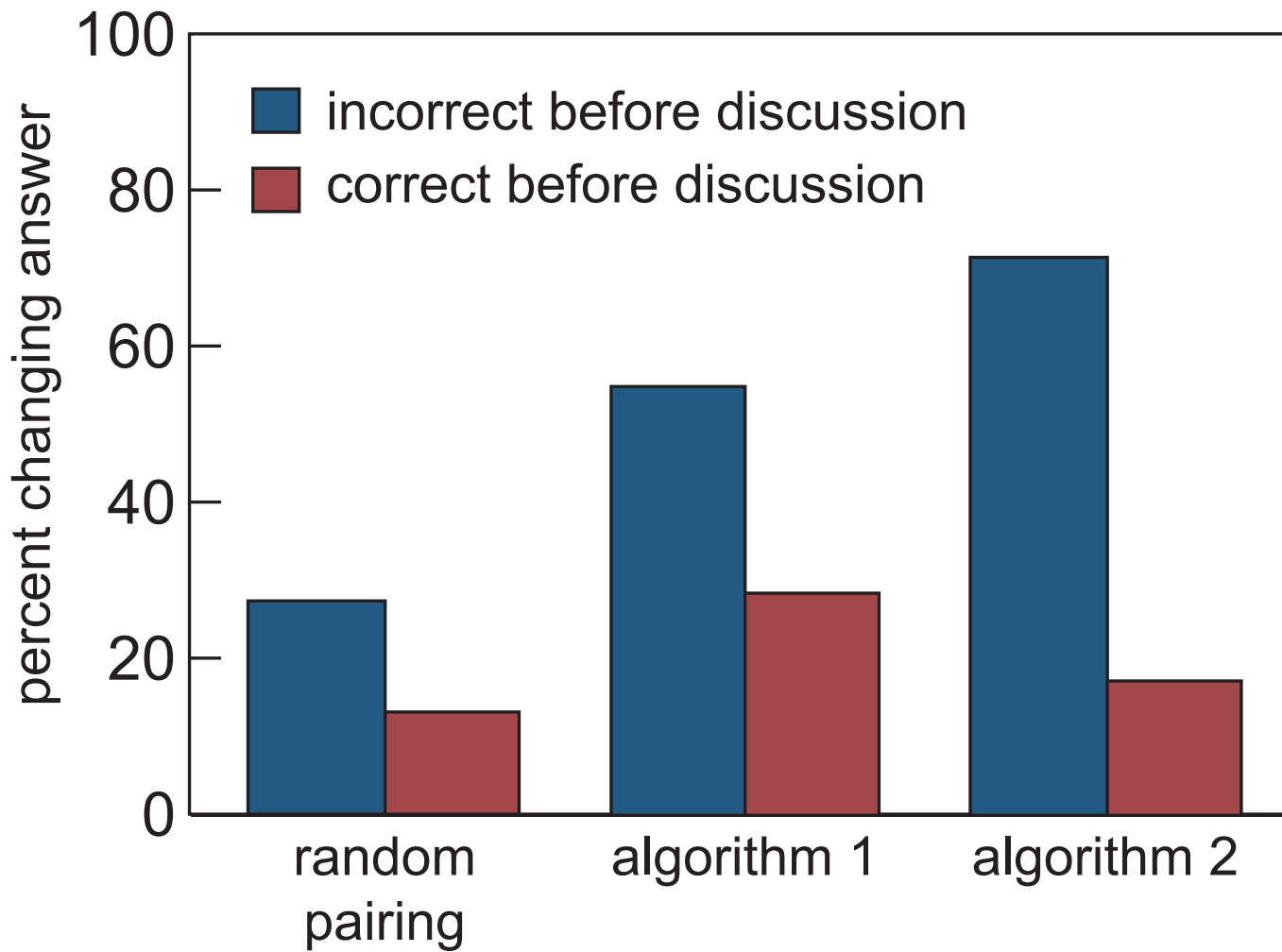
Please discuss your response with:

- Brian Lukoff (to your left)











1 lecture

2 PI

3 PI 2.0

in a lecture, students...

1 lecture

2 PI

3 PI 2.0

in a lecture, students...

1. don't pay utmost attention

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



an illusion. . .

1 lecture

2 PI

3 PI 2.0



1 lecture

2 PI

3 PI 2.0



Education is not just about:

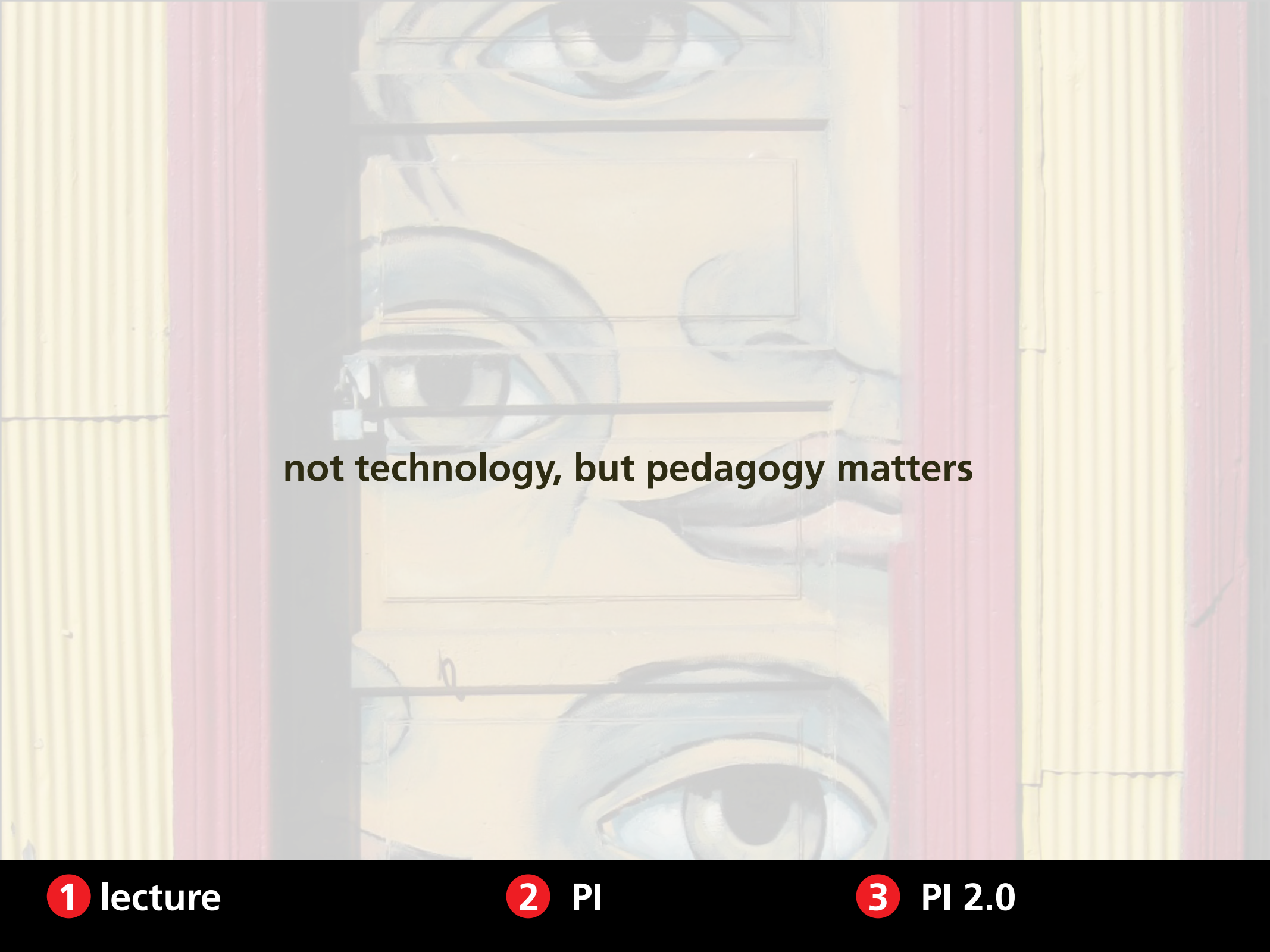
- **transferring information**
- **getting students to do what we do**



Education is not just about:

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

discovery & exploration a must!

A painting of a face with three eyes looking through window blinds. The face is rendered in a soft, painterly style with muted colors. The eyes are positioned behind horizontal white blinds, with the top and bottom eyes looking directly forward and the middle eye looking slightly to the right. The background consists of vertical yellow and red stripes, suggesting window frames or curtains.

not technology, but pedagogy matters

1 lecture

2 PI

3 PI 2.0



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

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