

# Flipping the STEM class: giving students ownership of their learning



LASPAU Webinar  
Cambridge, MA, 2 October 2012



# Flipping the STEM class: giving students ownership of their learning



**@eric\_mazur**

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**kosten**

1. die Kosten (*pl.*)
2. kostbar

455

**krank**

1. die Krankheit, —, —en

**COW**

377

**magnificent**  
**glor**

1. magnifice
2. master

430

**das Kind, —(e)s, —er**

1. kindisch
2. kindlich

**der Kellner, —s, —**

1. der Keller, —s, —

**kennen**

kannte-gekantt *irreg.*

1. kennen-lernen
2. erkennen
3. bekannt
4. der Bekannte (*adj.* as *n.*)

07

**outh**

erba

vet!

# kosten

1. die Kosten (*pl.*)
2. kostbar  
-lich

# krank

die Krankheit, —, —en

# kennen

1. kannte-gekannt
2. erkennen
3. bekannt
4. der Bekannte (*adj.*, as n.)



35% retained  
after 1 week



**we only guarantee  
they'll pass the test**





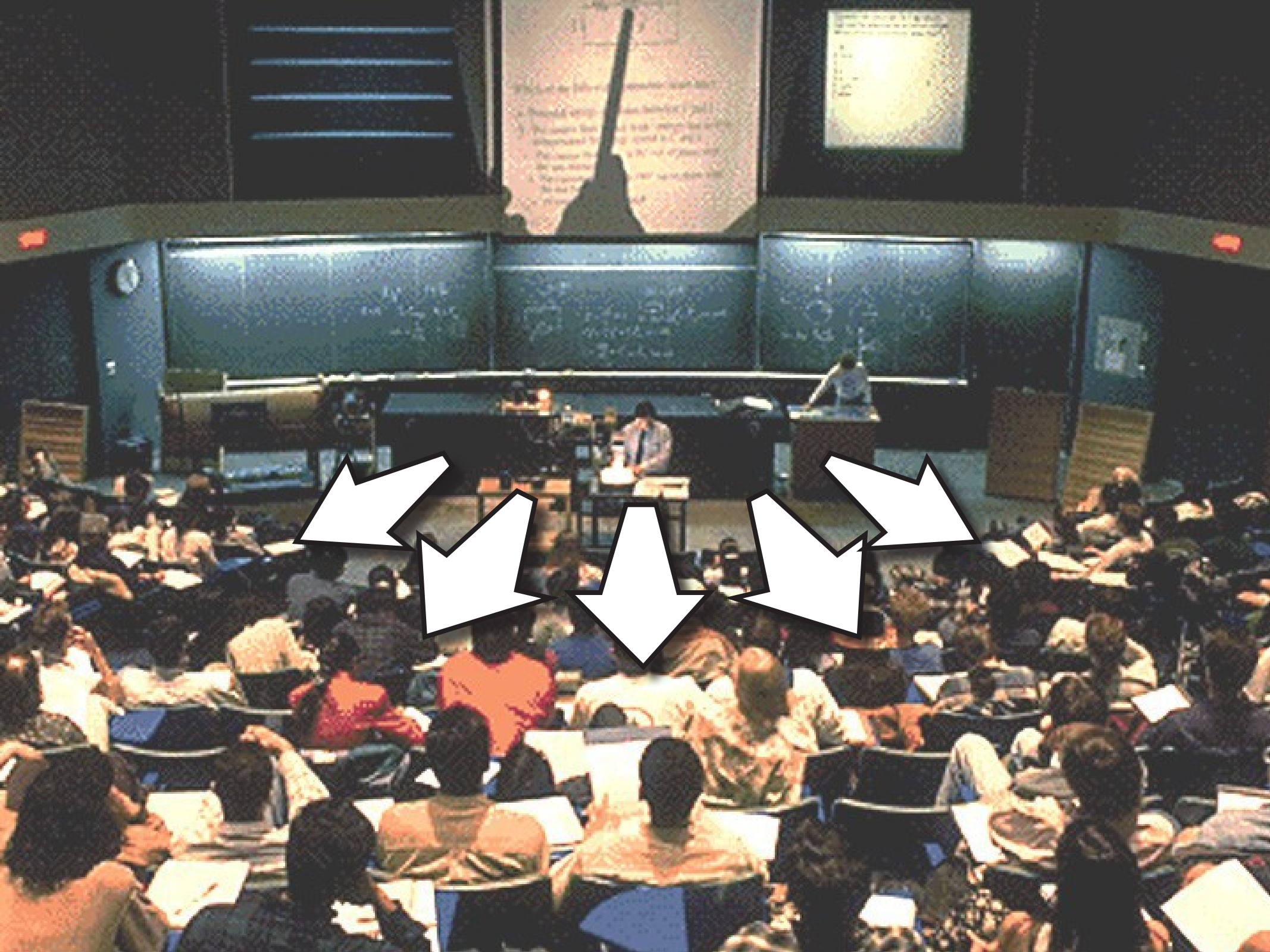
# 5-minute university





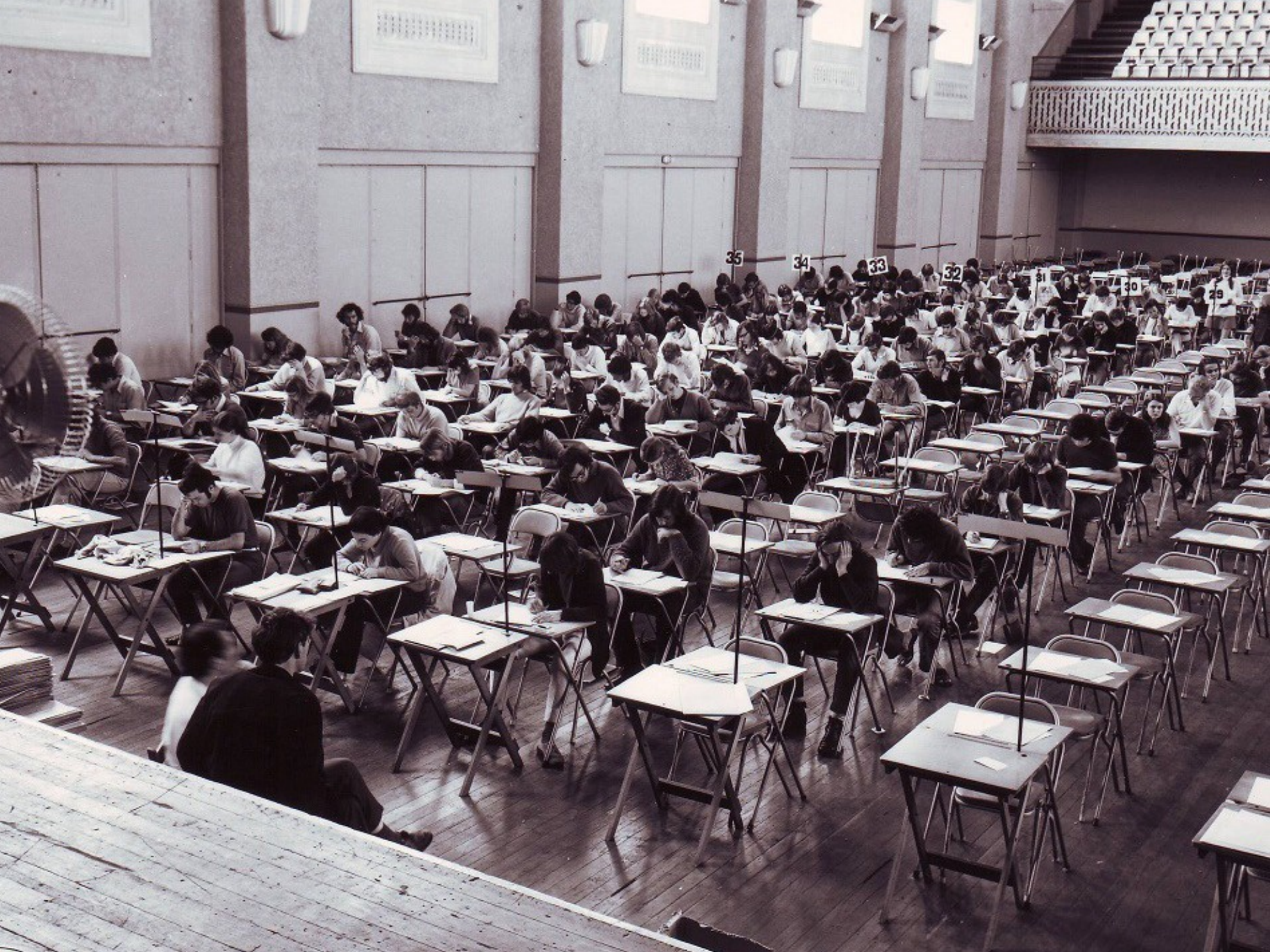
What are the following...  
A...  
The...  
The...  
The...  
The...


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



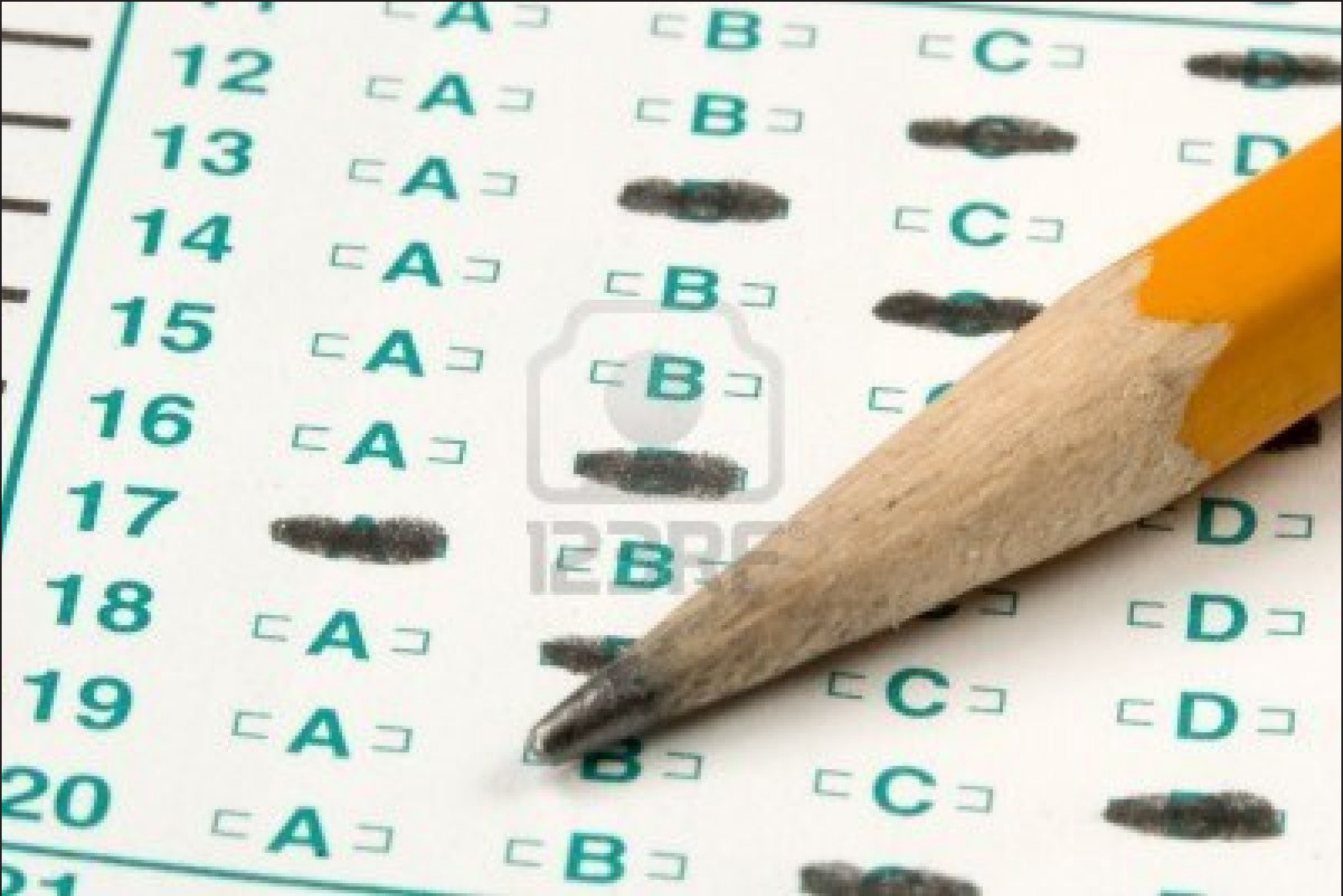








**assessment focussed on ranking and classifying,  
not on developing 21st century skills**



1 what

2 how

3 when

**what is the meaning/definition of...?**

**EDUCACION**



**inauthentic problem solving**

**EDUCACION**

**problem**

**EDUCACION**

**1** what

**problem**

**outcome**

**EDUCACION**

**problem**

**outcome**

**KNOWN**

**EDUCACION**

problem

solution

outcome

**KNOWN**

EDUCACION

problem

solution

outcome

UNKNOWN

KNOWN

EDUCACION

problem

solution

outcome

UNKNOWN → KNOWN

problem

problem

solution

outcome

UNKNOWN

KNOWN

problem

procedure

KNOWN



problem

solution

outcome

UNKNOWN

KNOWN

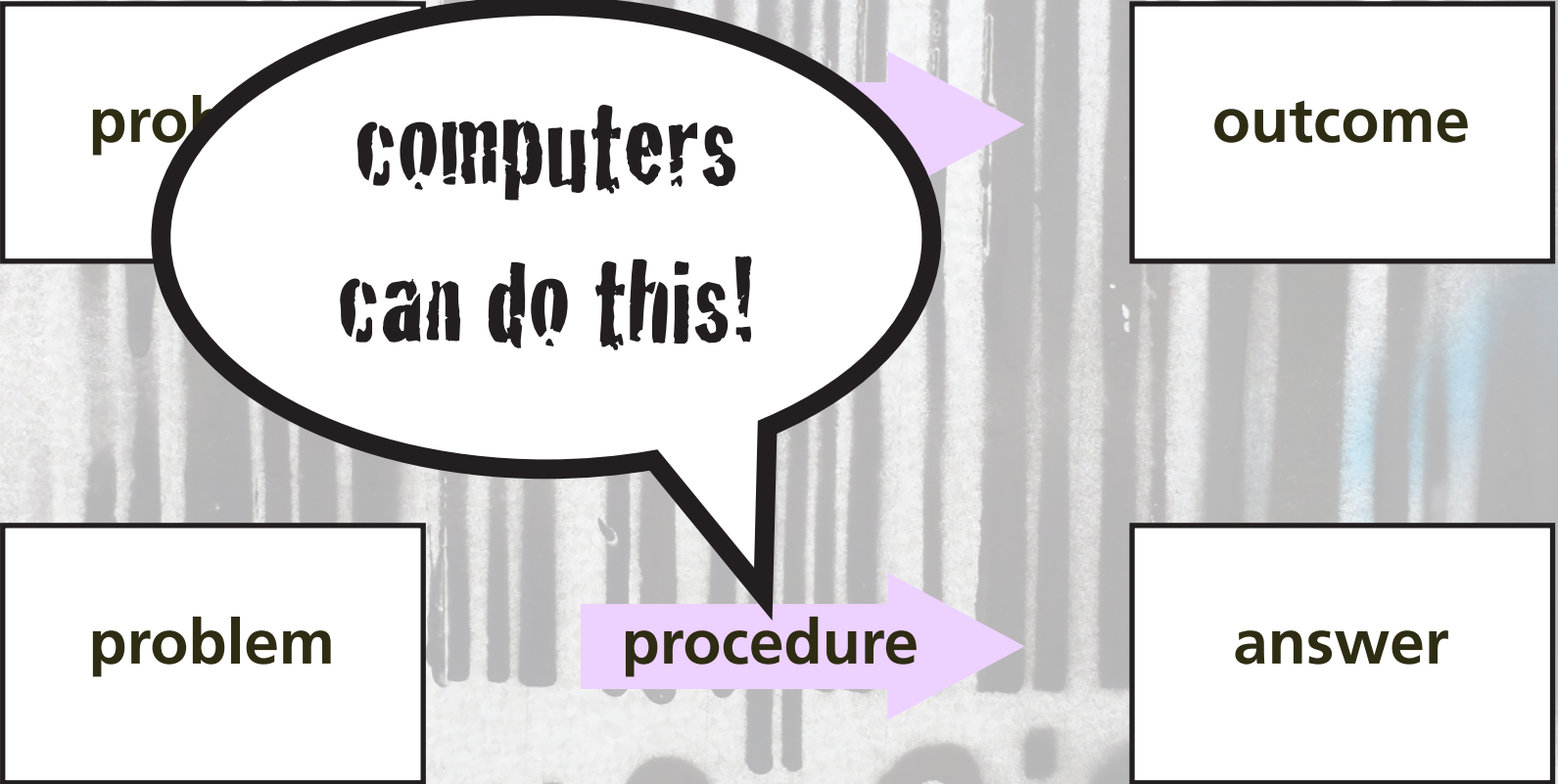
problem

procedure

answer

KNOWN

UNKNOWN







1 what

problem

solution

outcome

problem

pre... ver

**REAL**  
**problem solving**

**problem**

**approach 1**

**approach 3**

**approach 2**

**outcome**

**EDUCACION**

**problem**

**approach 1**

**approach 3**

**approach 2**

**outcome**

**grading incompatible with real problem solving**



1 what

2 how





# isolation

1 what

2 how



# open-book exam

**1** what

**2** how

Google™

1 what

2 how



1 what

2 how

④ We will use spherical coordinates:

$0 \leq \rho \leq 4$ ,  $0 \leq \theta \leq 2\pi$ ,  $0 \leq \varphi \leq \pi$ . The integral is thus:

$$\int_{\rho=0}^4 \int_{\theta=0}^{2\pi} \int_{\varphi=0}^{\pi} (\rho \cos \varphi) (\rho^2 \sin \varphi) d\varphi d\theta d\rho$$

$$= \left\{ \int_{\rho=0}^4 \rho^3 d\rho \right\} \left\{ \int_{\theta=0}^{2\pi} d\theta \right\} \left\{ \int_{\varphi=0}^{\pi} \sin(2\varphi) d\varphi \right\} = \boxed{0}$$

Since the third integral equals 0.

⑤ Direction vectors for the plane are

$$(1) \quad (1) \quad (0) \quad (0) \quad (1) \quad (-1)$$

1 what

2 how

3 when

# high-stakes examinations promote cramming



**1** what

**2** how

**3** when



**information stored in short-term memory**



**1 what**

**2 how**

**3 when**

A person is sleeping at a desk with a laptop and a cup of coffee. The scene is dimly lit, suggesting a late night or early morning. The person's head is resting on their hand, and they appear to be in a state of deep sleep. The background is a soft, out-of-focus light.

**no retention**

information stored in short-term memory

**no transfer**

An analog clock is visible in the lower-left corner of the image. The clock face is white with black numbers and hands. The time shown is approximately 10:10.

**1 what**

**2 how**

**3 when**



④ We will use spherical coordinates:

$0 \leq \rho \leq 4$ ,  $0 \leq \theta \leq 2\pi$ ,  $0 \leq \phi \leq \pi$ . The integral is thus:

$$\int_{\rho=0}^4 \int_{\theta=0}^{2\pi} \int_{\phi=0}^{\pi} (\rho \cos \phi) (\rho^2 \sin \phi) d\phi d\theta d\rho$$

**high-stakes assessment:**

**the silent killer of educational innovation**

$$= \left\{ \int_{\rho=0}^4 \rho^3 d\rho \right\} \left\{ \int_{\theta=0}^{2\pi} d\theta \right\} \left\{ \frac{1}{2} \int_{\phi=0}^{\pi} \sin(2\phi) d\phi \right\} = \boxed{0}$$

Since the third integral equals 0.

---

⑤ Direction vectors for the plane are

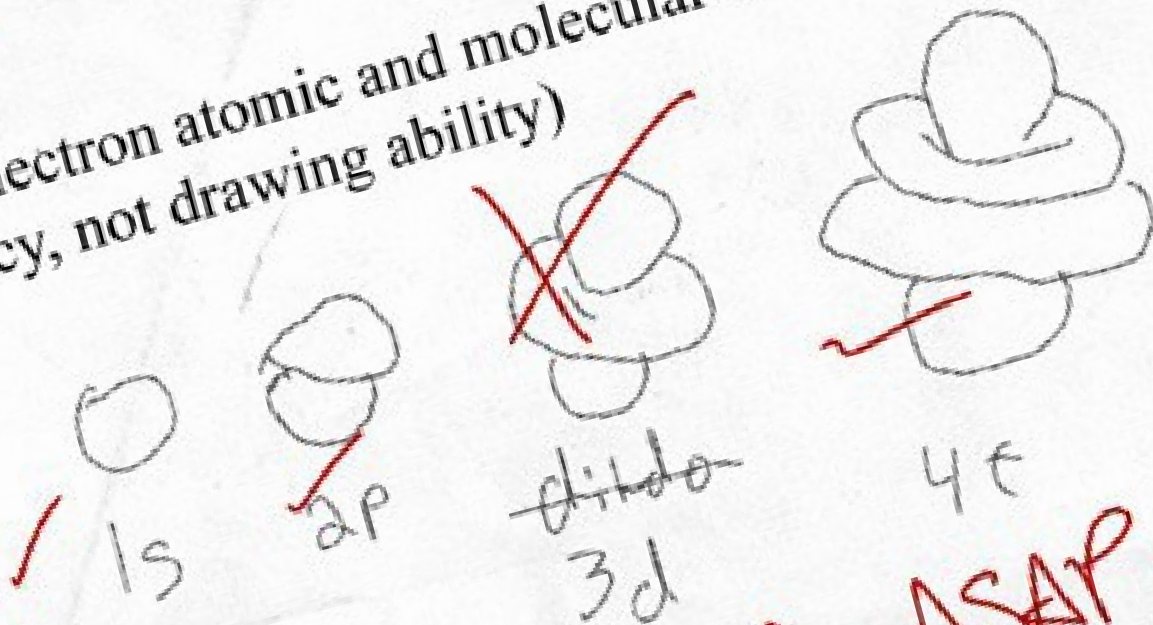
$$\begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}$$

chemical (DIA)  
unrelated, I saw my T.A., Jimmy, kissing  
chemical reaction does one of two things to involved substance

Increases or decreases the  
energy of the substance  
the form of heat or light

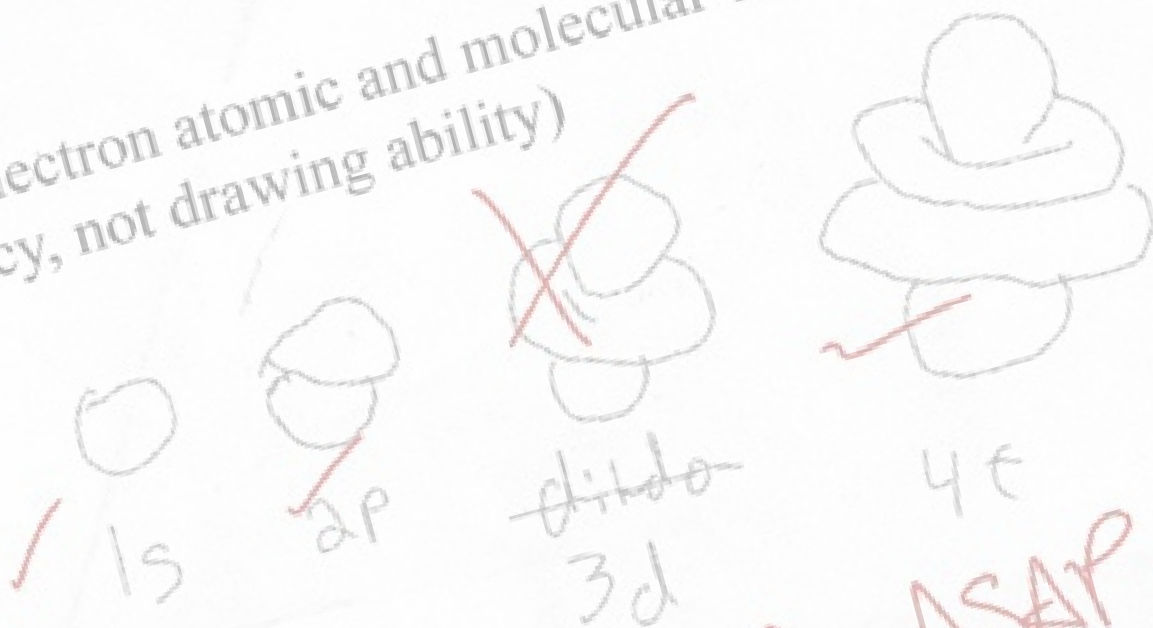
MICK IN FRONT OF  
UNWEAVING A WHITE  
VICTORIAN SECRET  
A CREDIT  
inappropriate thing

a representation of electron atomic and molecular orbitals 1s, 2p, 3d and 4f.  
are not based on accuracy, not drawing ability)



soo me  
ASAP

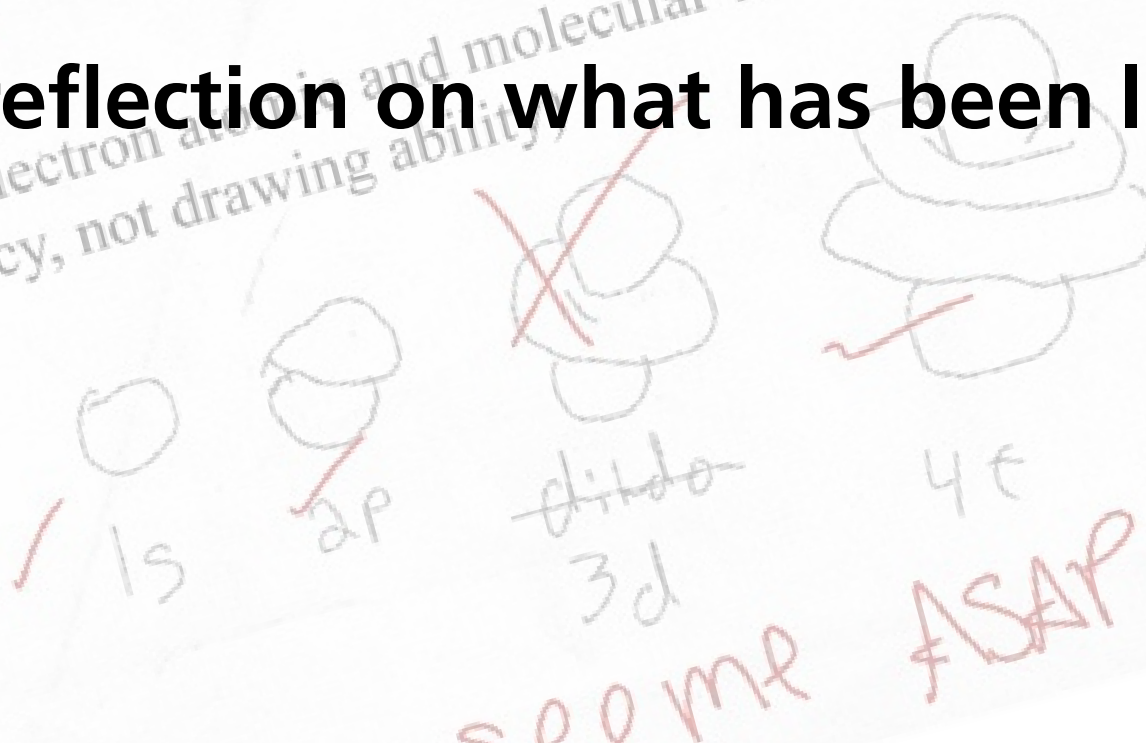
**grades: measure of standing relative to others**



soo me ASAP

**grades: measure of standing relative to others**

**feedback: reflection on what has been learnt**

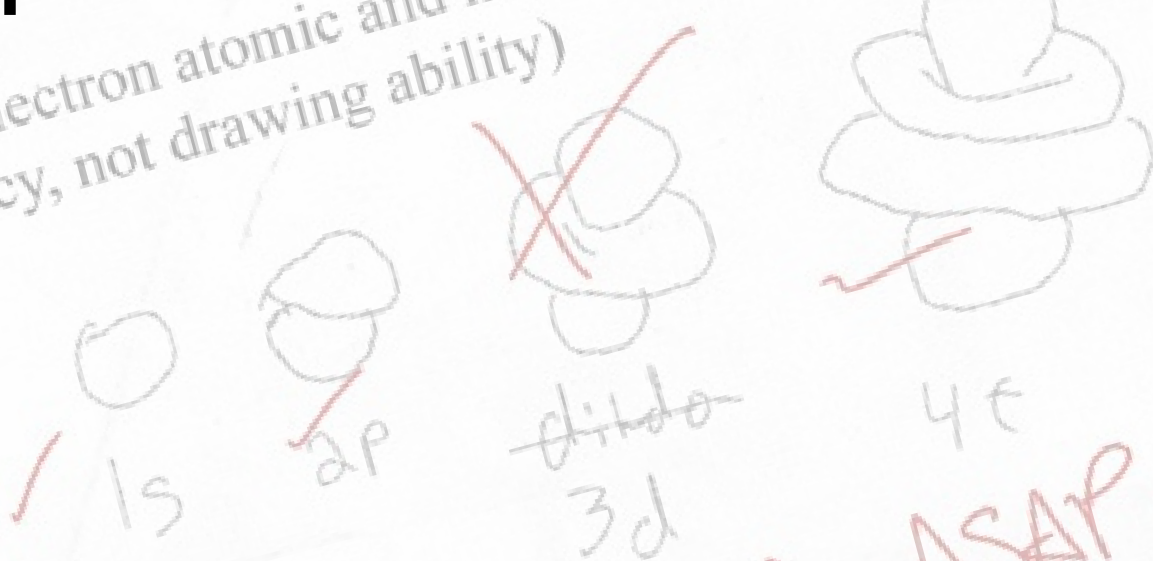


**1** what

**2** how

**3** when

# peer- and self-assessment



1 what

2 how

3 when



A large, empty classroom with rows of desks and chairs. The room has a light blue floor with yellow and red lines. The walls are light-colored wood paneling. In the background, there are bleachers and a whiteboard. The text "rethink assessment" is overlaid in the center of the image in a large, bold, black font with a blue outline.

**rethink  
assessment**

A large, empty classroom with rows of desks and chairs. The room has a light blue floor with yellow and red lines. The walls are light-colored wood paneling. There are several doors in the background. The text "...so it supports learning" is overlaid in the center of the image.

**...so it supports learning**





**...so it supports learning**

- focus on skills, not content**

A large, empty classroom with rows of desks and chairs. The room has a light blue floor with yellow and red lines. The walls are light-colored wood paneling. There are several doors in the background. The text is overlaid on the image.

**...so it supports learning**

- focus on skills, not content**
- change assessment environment**

A large, empty classroom with rows of desks and chairs, suggesting a focus on learning environment. The room has a blue floor with yellow and red lines, and a whiteboard in the background.

**...so it supports learning**

- focus on skills, not content**
- change assessment environment**
- encourage ownership of learning**



**feedback**

**1** lecture

**2** PI

**3** PI 2.0



1991



1 lecture

2 PI

3 PI 2.0



1993

A black handheld remote control with a numeric keypad. The keypad has buttons for numbers 1-9, 0, and a red button. A green logo with the letters 'FRS' is visible on the bottom right. 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?

Use intelligent algorithms and data analytics to...

- 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?
- $Assets = Liabilities + Owners' equity$
  - $Liabilities = Assets + Owners' equity$
  - $Owner's equity = Assets + Liabilities$
  - $Revenue = Assets - Liabilities$
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
- 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

**Think of something you are good at**

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

**EDUCACION**



**Became good at it by:**

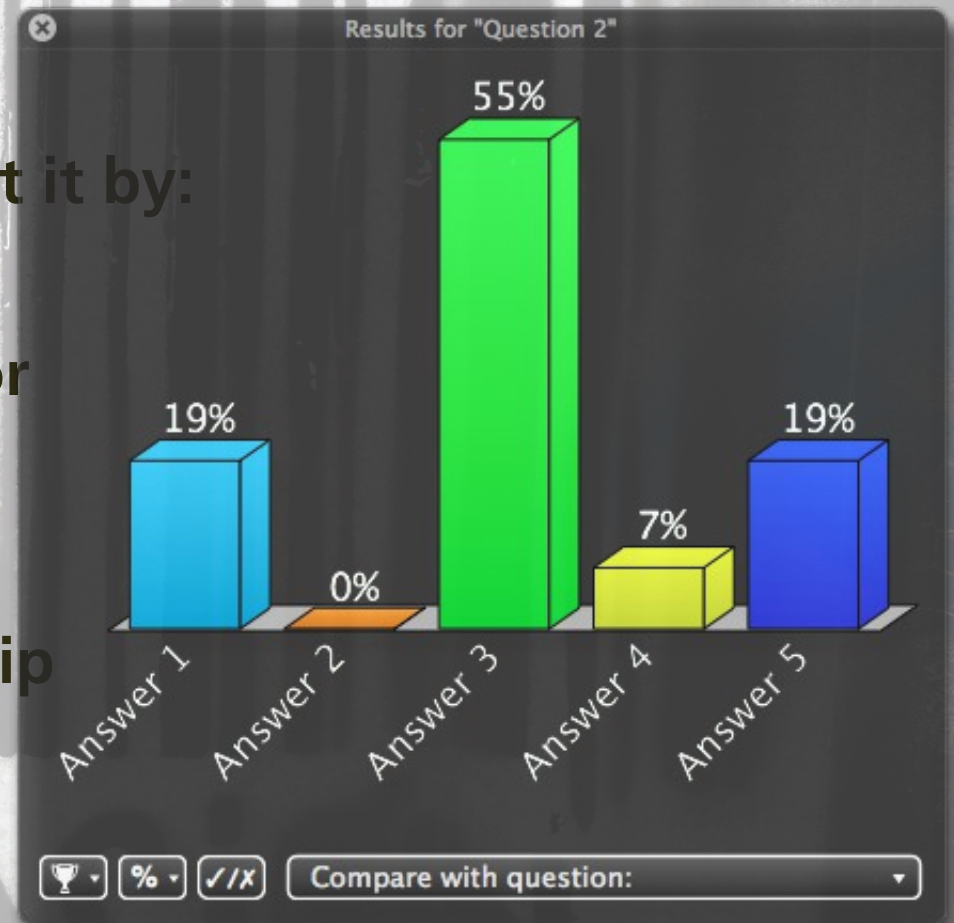
- 1. trial and error**
- 2. lectures**
- 3. practicing**
- 4. apprenticeship**
- 5. other**

**EDUCACION**



Became good at it by:

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





Carrier



10:24 PM



Leave

session 123456

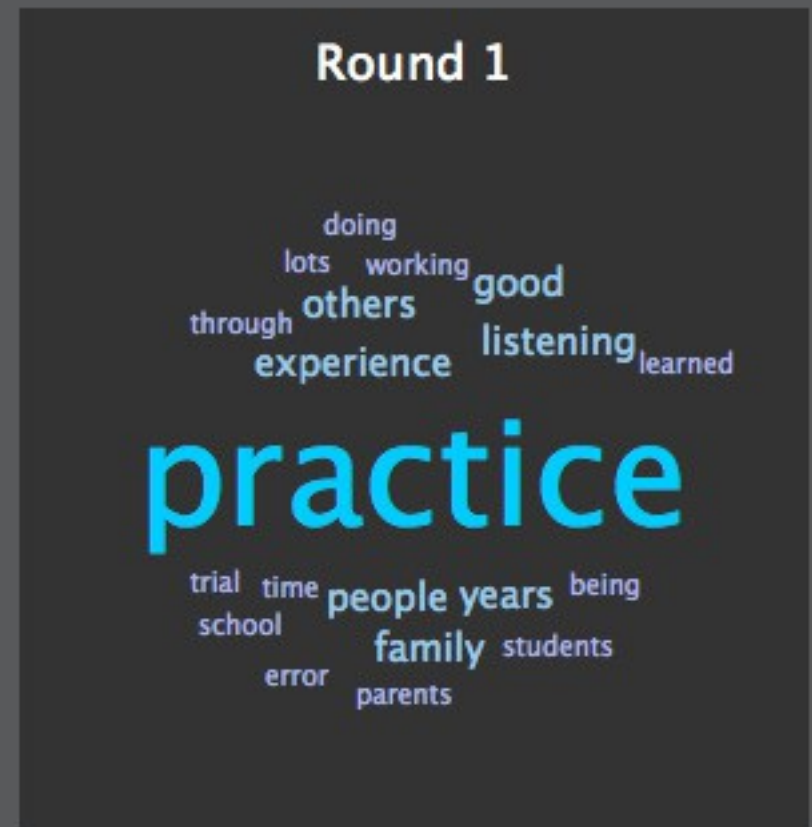
Logout

Now describe in a couple of words how you became good at whatever it is you entered in the previous question.

Submit response

## Class session: 123456

Now describe in a couple of words how you became good at whatever it is you entered in the previous question.





**1** education

**2** PI

**3** PI 2.0

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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

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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

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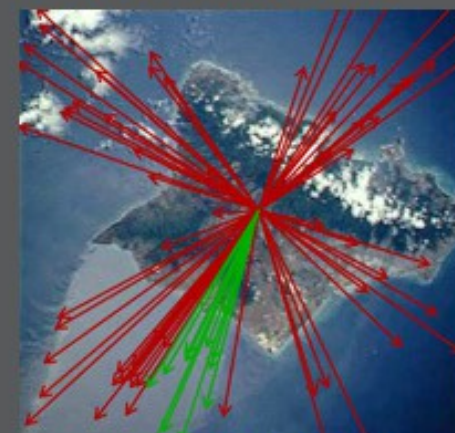
4. direction  
prevailing

...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





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optics i

current session: **766079** | 69 students

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Jump to ▾

1

2

3

4

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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 education

2 PI

3 PI 2.0

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current session: **766079** | 69 students

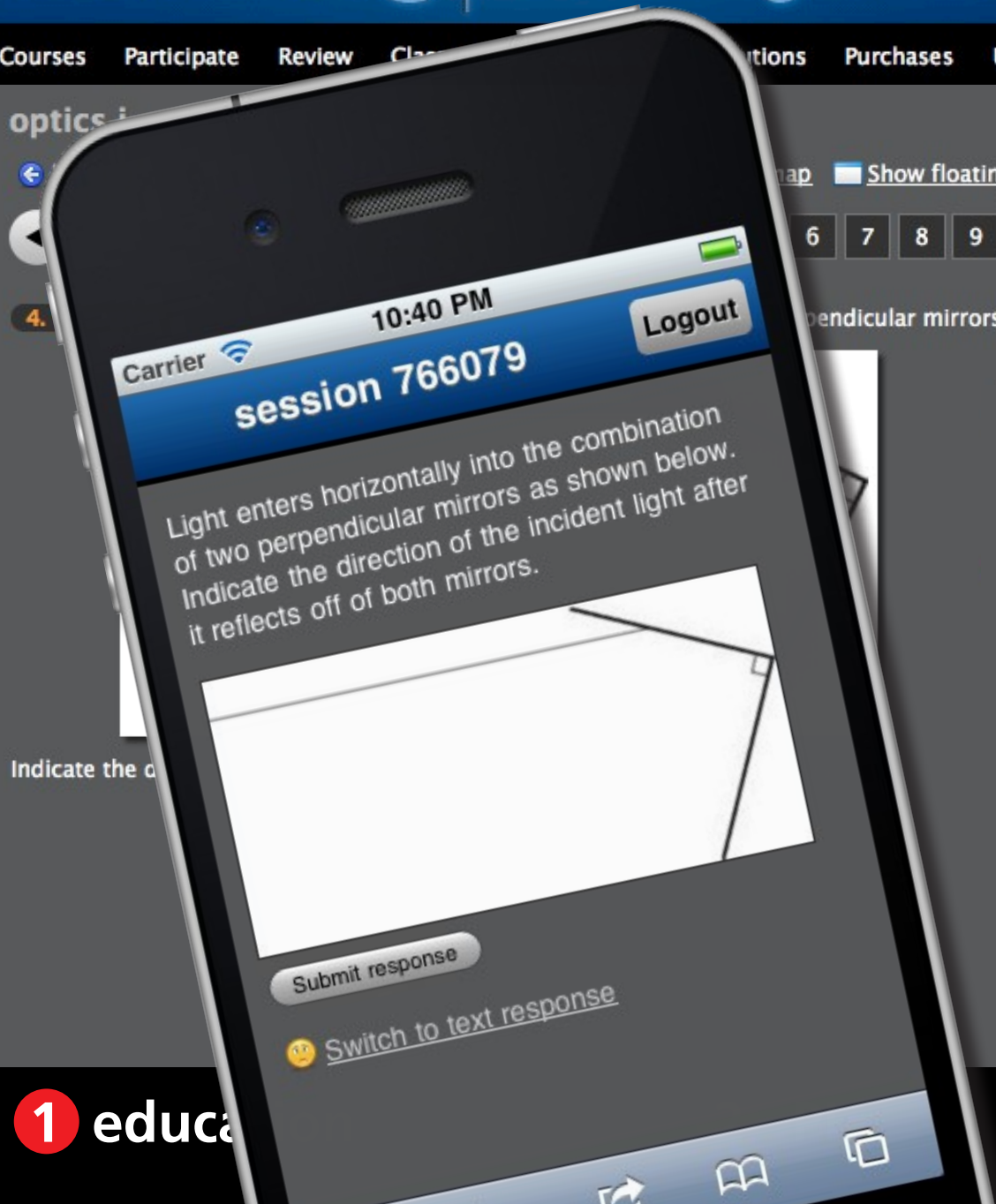
[Map](#) [Show floating session ID](#) [Edit](#) [Delete](#)

6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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current session: **766079** | 69 students

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

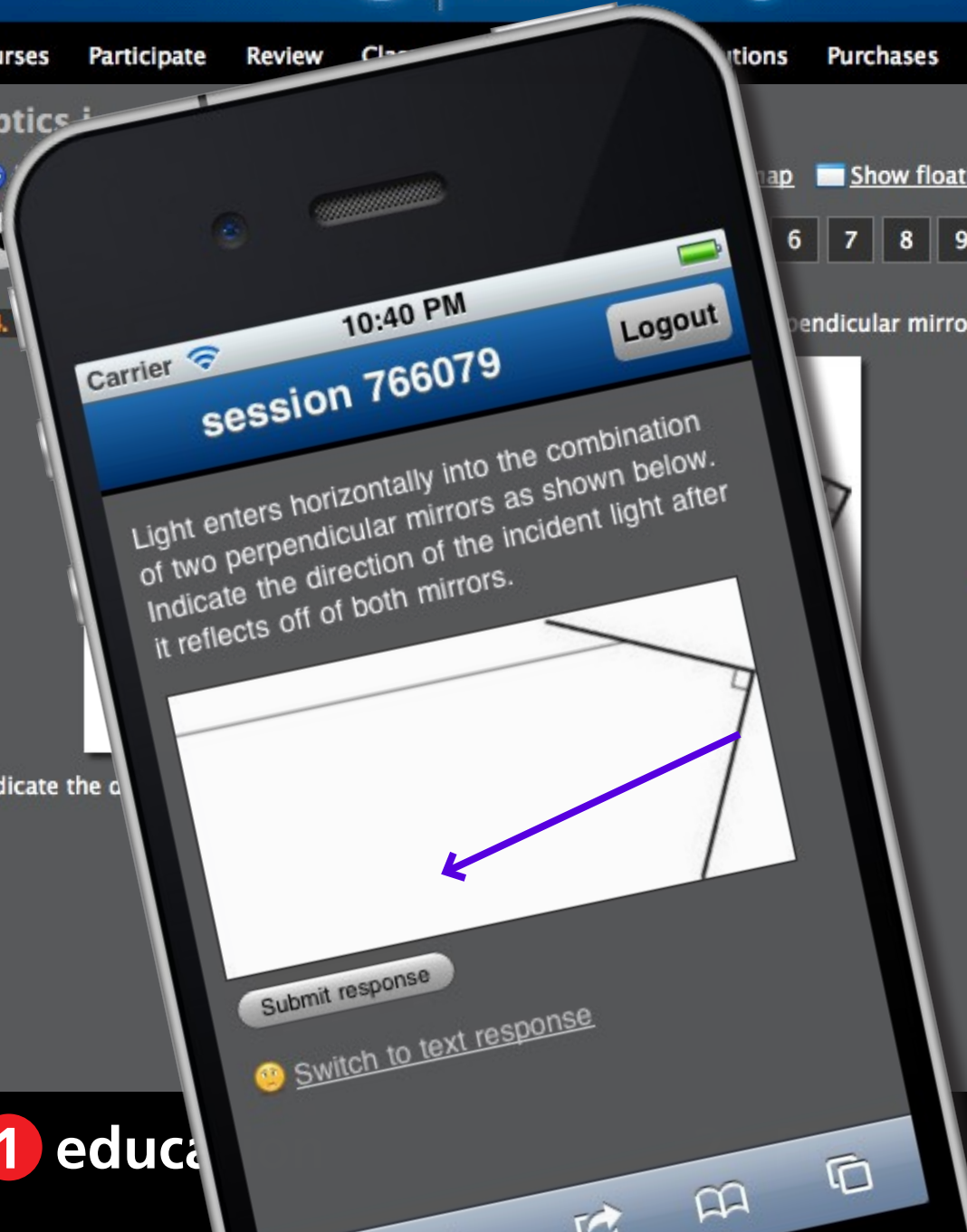
6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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Indicate the d



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

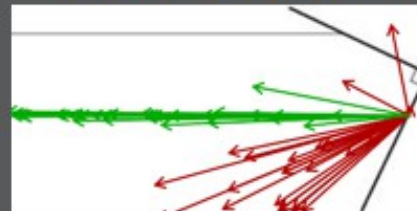
6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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

Round 1 ✖  

57 responses, 58% correct



 [feedback & support](#)



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current session: **766079** | 69 students

Map  Show floating session ID  Edit  Delete

6 7 8 9 10 11 12 13 14 15

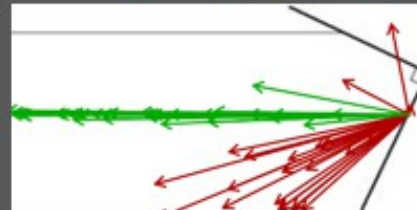


perpendicular mirrors as shown below.

Deliver  Show all results

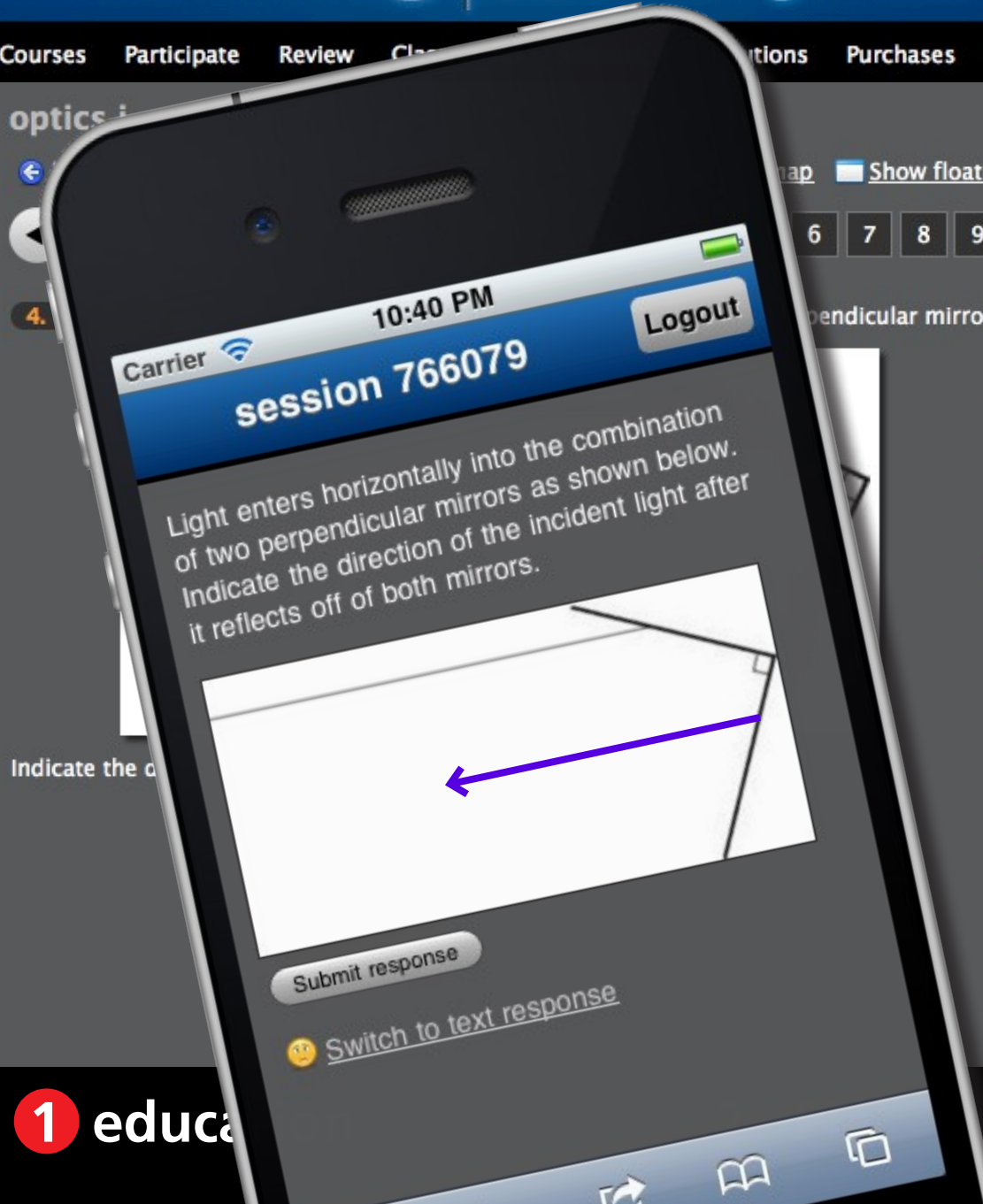
Round 1     
● 57 responses, 58% correct

Round 2     
● 51 responses, 73% correct



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

feedback & support



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arlington school district

current session: **48222** | 24 students

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Jump to ▾ **1** 2 3 4 **5**



**5.** region Where is Tanzania?

[✖ Stop delivery](#) [🔄 Deliver again](#) [👥 Assign groups](#) [📊 Show all results](#)



[feedback & support](#)

**1** education

**2** PI

**3** PI 2.0

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arlington school district

current session: **48222** | 24 students

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Jump to 1 2 3 4 5

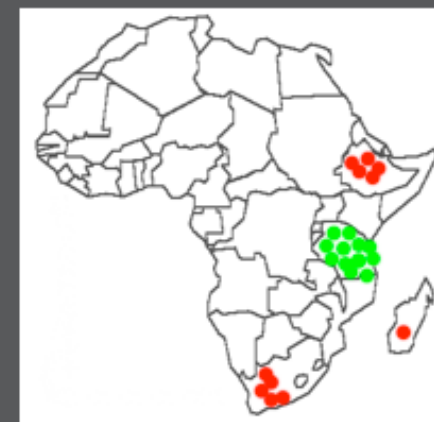


5. region Where is Tanzania?

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



Round 1 ✕   
● 24 responses, 75% correct



feedback & support

1 education

2 PI

3 PI 2.0

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## transformations of parabolas

current session: **773885** | 9 students

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1

2

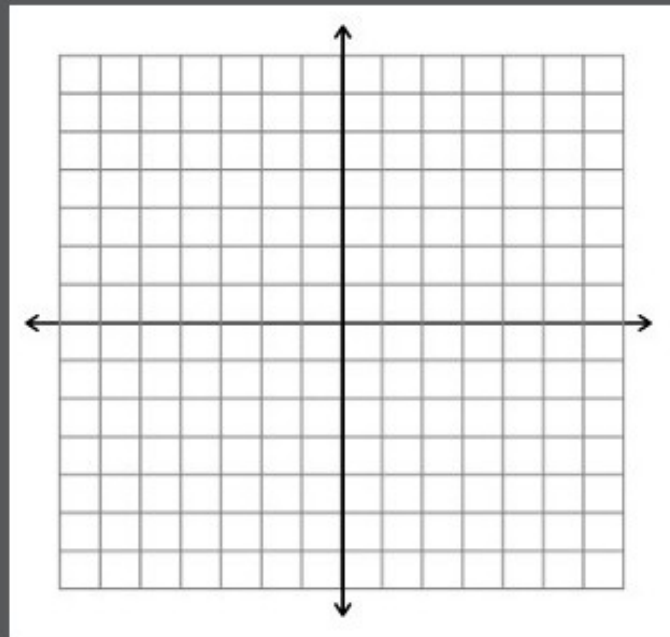
3

4



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

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1 education

2 PI

3 PI 2.0



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## transformations of parabolas

current session: **773885** | 9 students

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Jump to ▾

1

2

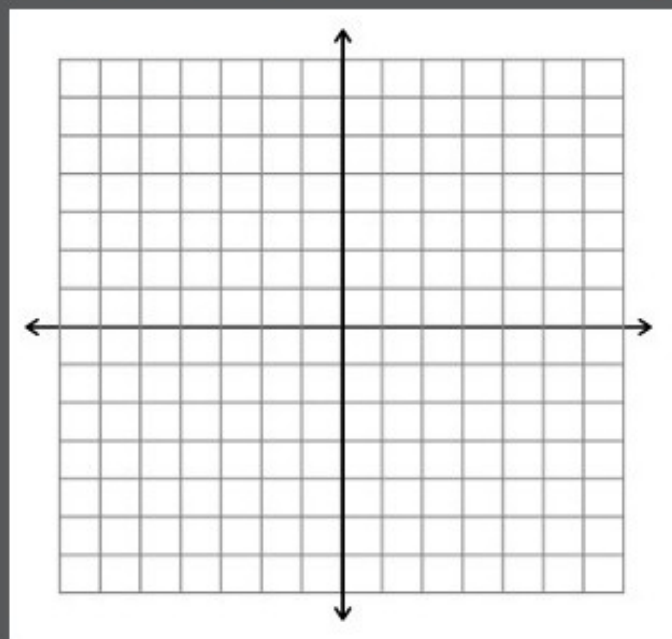
3

4



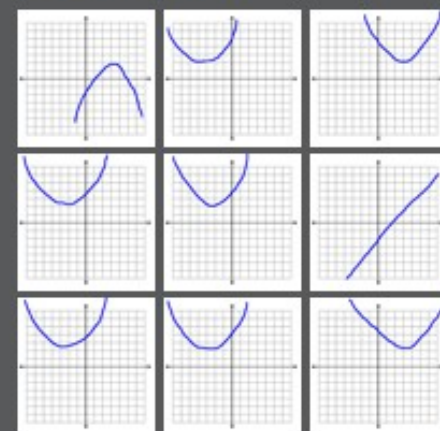
4. sketch Sketch a graph of the function  $f(x) = (x - 3)^2 + 2$ .

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



Round 1

9 responses



1 education

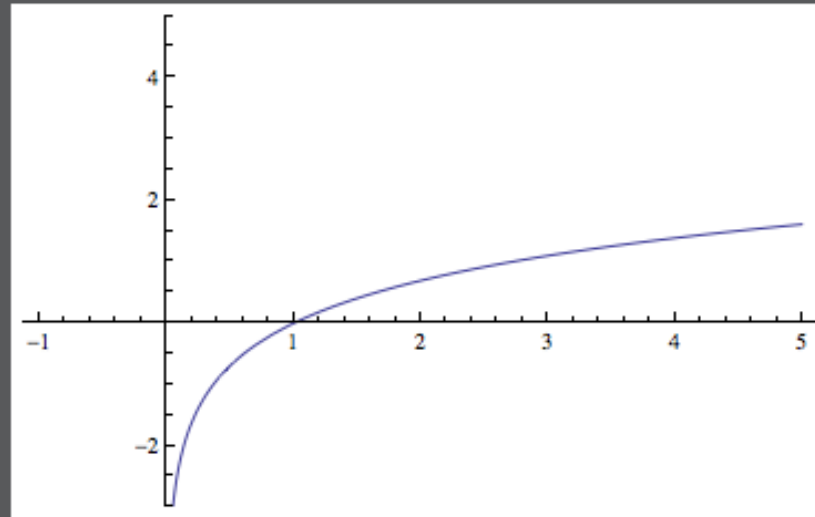
2 PI

3 PI 2.0

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



1 education

2 PI

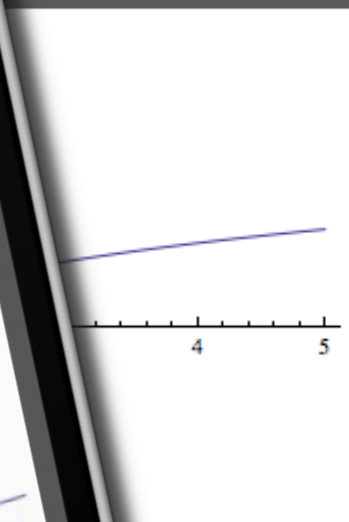
3 PI 2.0

# learning | catalytics

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



**1** education

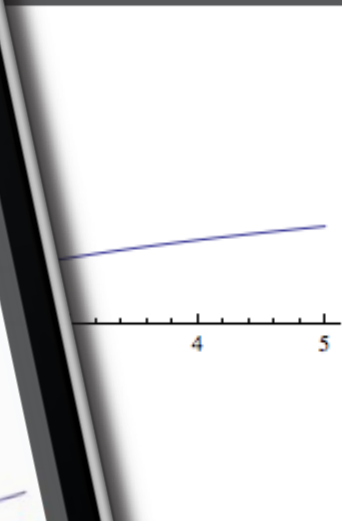
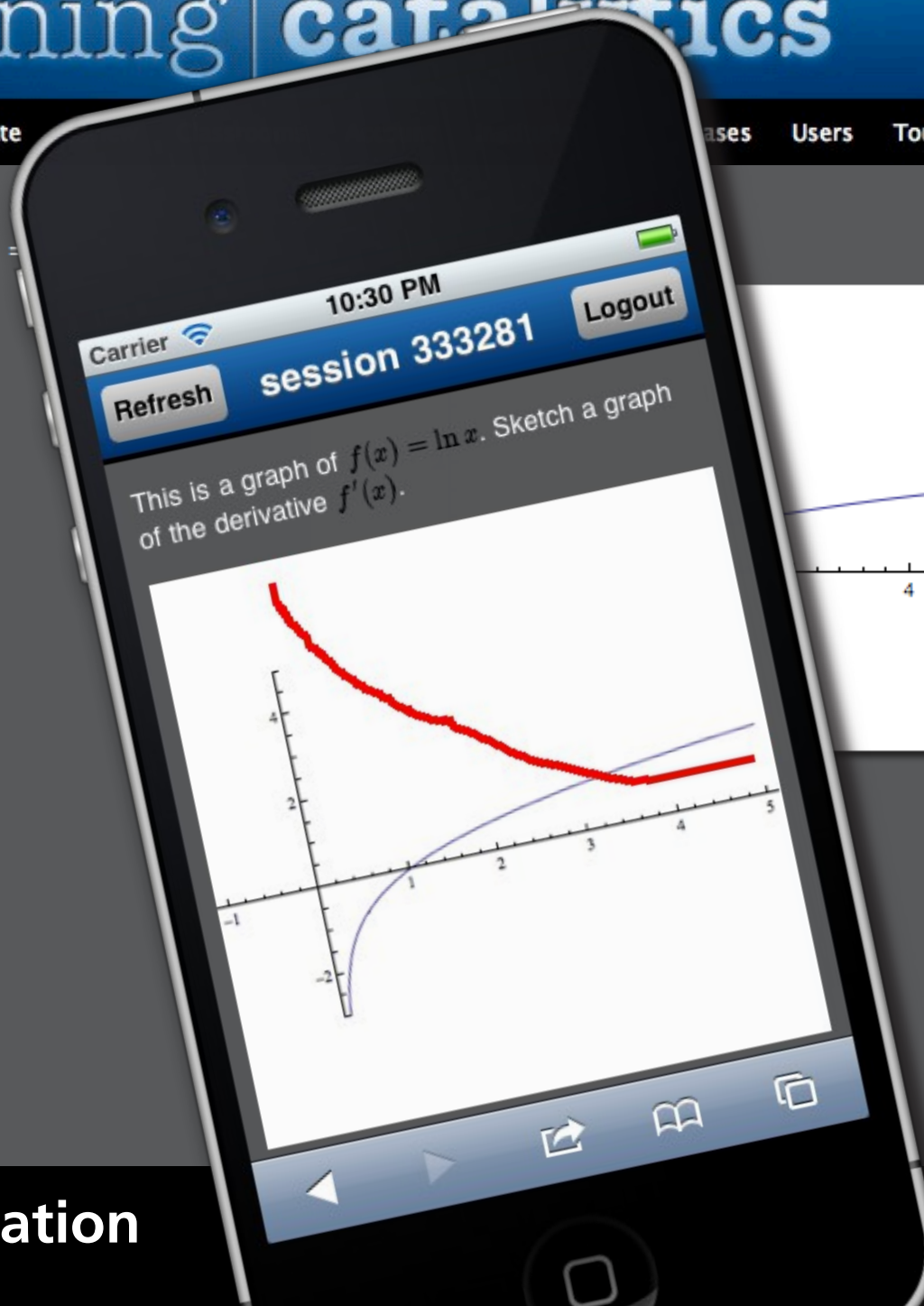
**3** PI 2.0

# learning | catalytics

Courses Participate

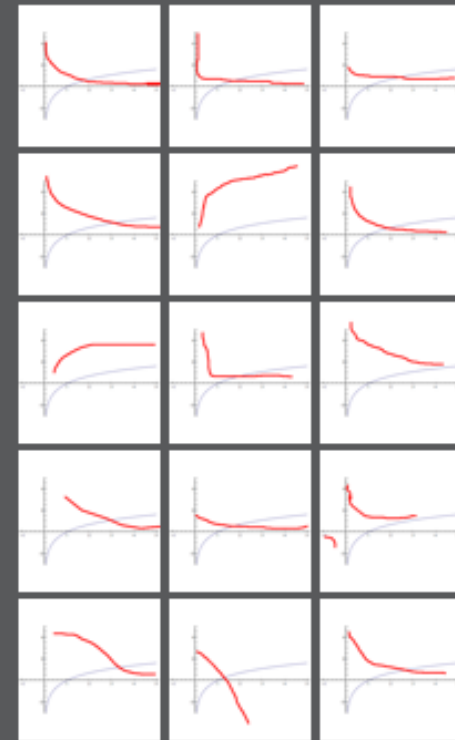
ases Users Tour Help

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



Round 1

15 responses



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

1 education

3 PI 2.0

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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 education

2 PI

3 PI 2.0

# learning | catalytics

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1. highlighting  
sonnet?

this Shakespeare

[Stop delivery](#)

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1 educa

3 PI 2.0

# learning | catalytics

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1. highlighting  
sonnet?

[his 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,

## 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

**data analytics**





1 lecture

2 PI

3 PI 2.0



# human interaction

1 lecture

2 PI

3 PI 2.0

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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 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

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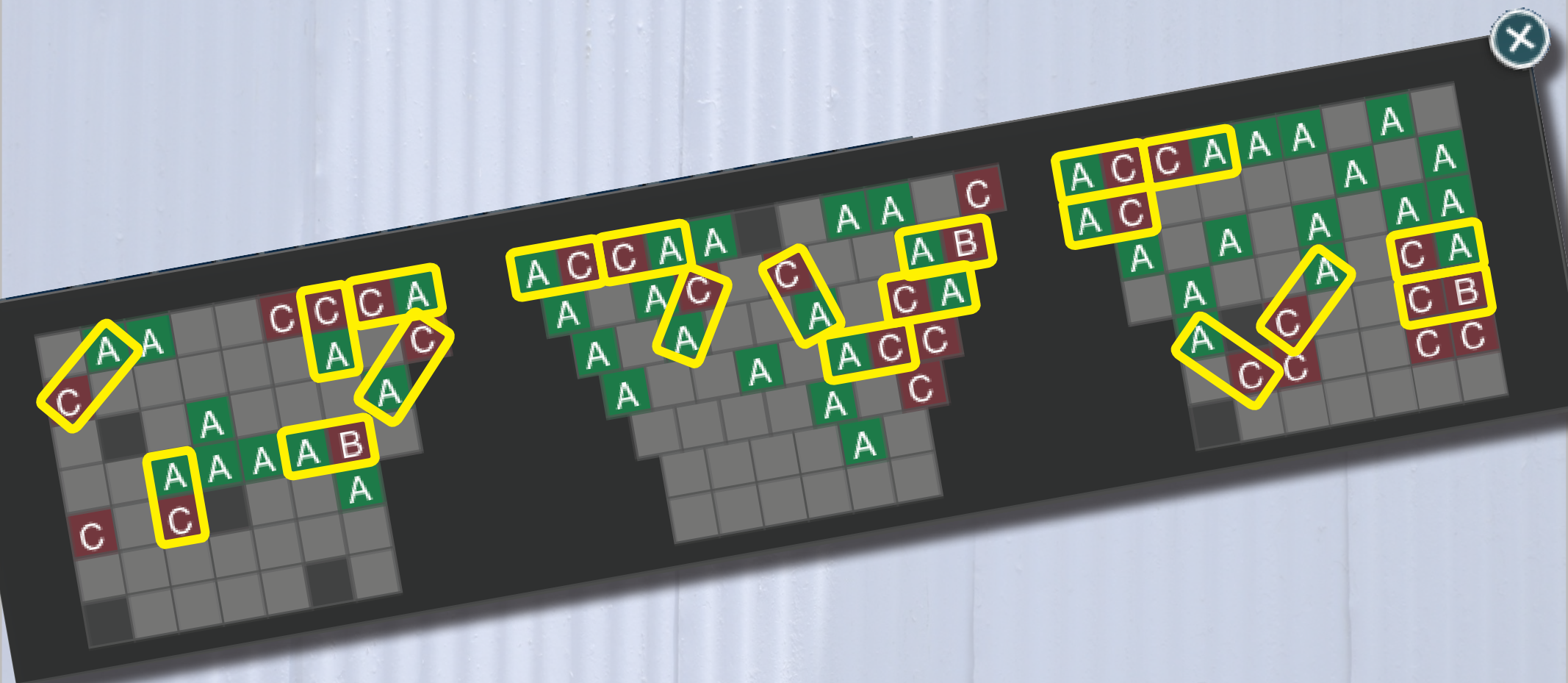
Search: \_\_\_\_\_

1 lecture

2 PI

3 PI 2.0

let system manage pairing



1 lecture

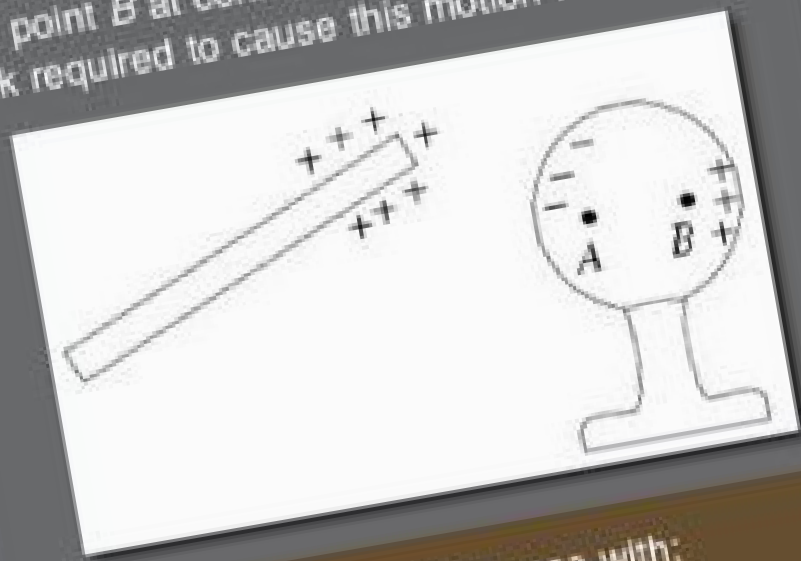
2 PI

3 PI 2.0



Leave

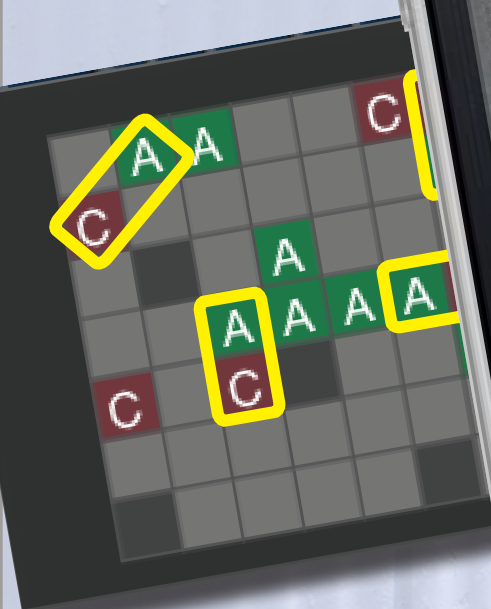
A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B at constant speed. The mechanical work required to cause this motion is



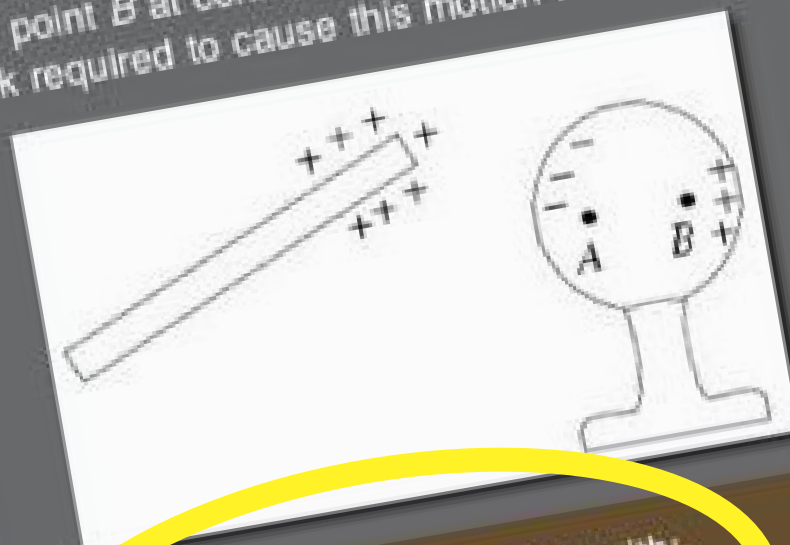
Please discuss your response with:

- Brian Lukoff (to your left)

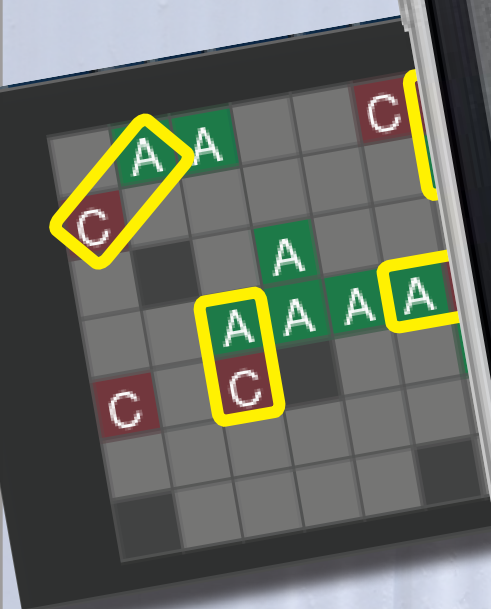
I am talking to this person/people



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Please discuss your response with:  
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