1. Join network “Harvard Guest”

2. Go to learningcatalytics.com/demo

3. Enter info, click “Start”

4. Join session 123456789

Educating the innovators of the 21st century

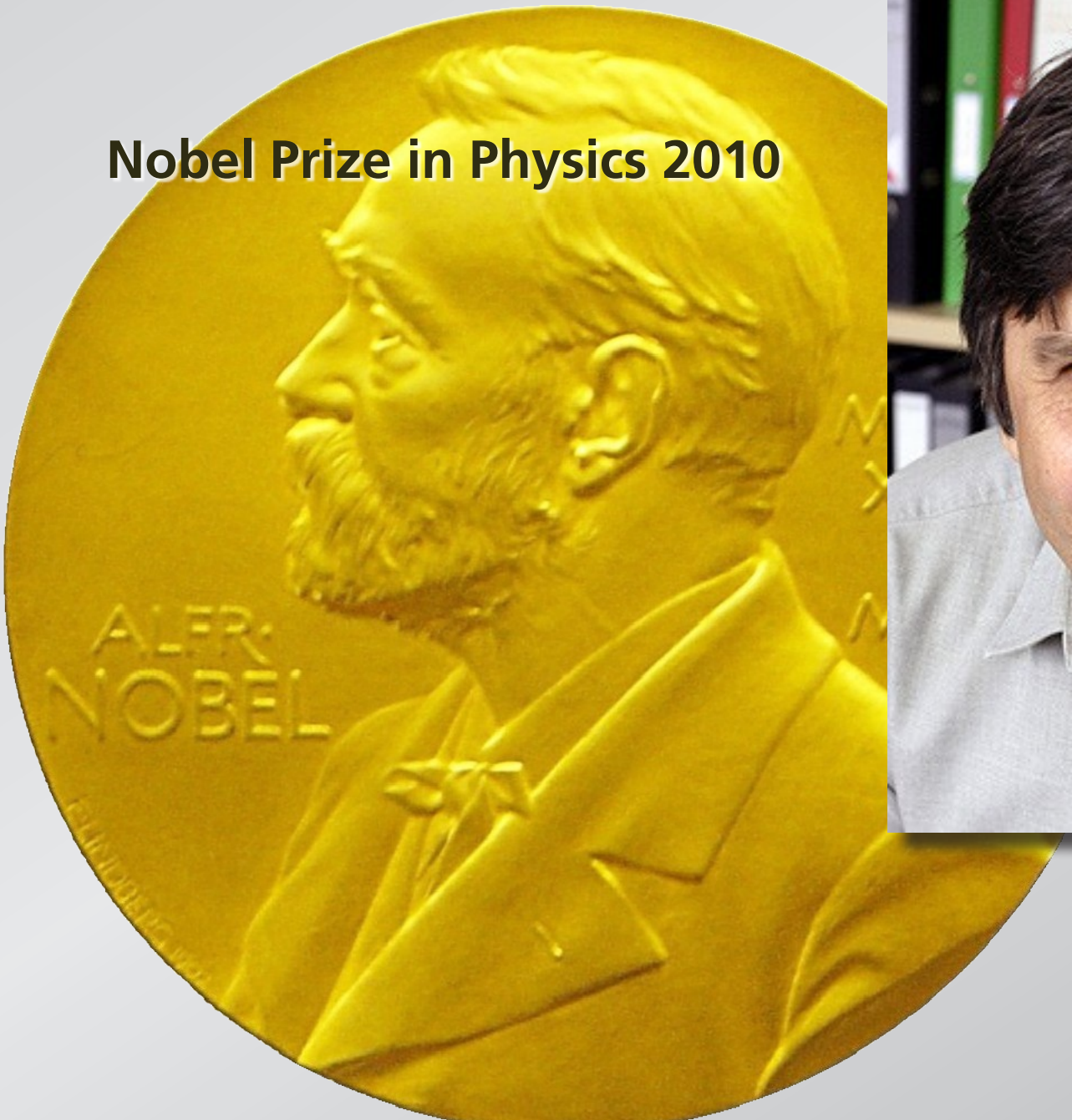
Harvard University
Cambridge, MA, 7 April 2014

Educating the innovators of the 21st century

Harvard University
Cambridge, MA, 7 April 2014

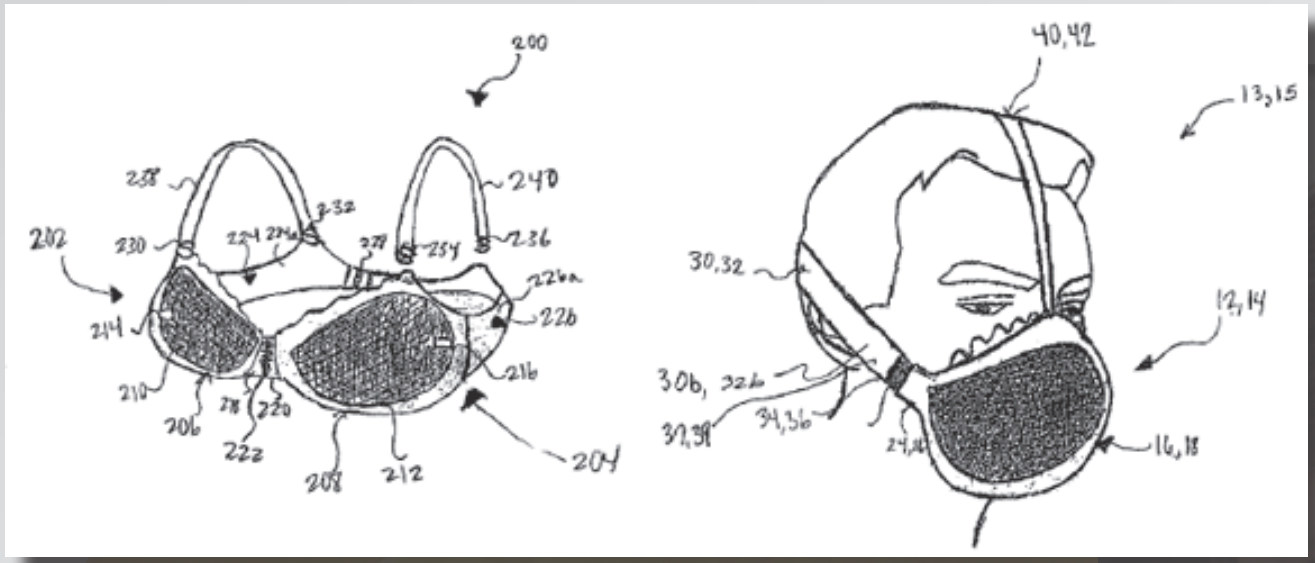
Innovation

Nobel Prize in Physics 2010



Nobel Prize in Physics 2010

Ig Nobel Prize in 2000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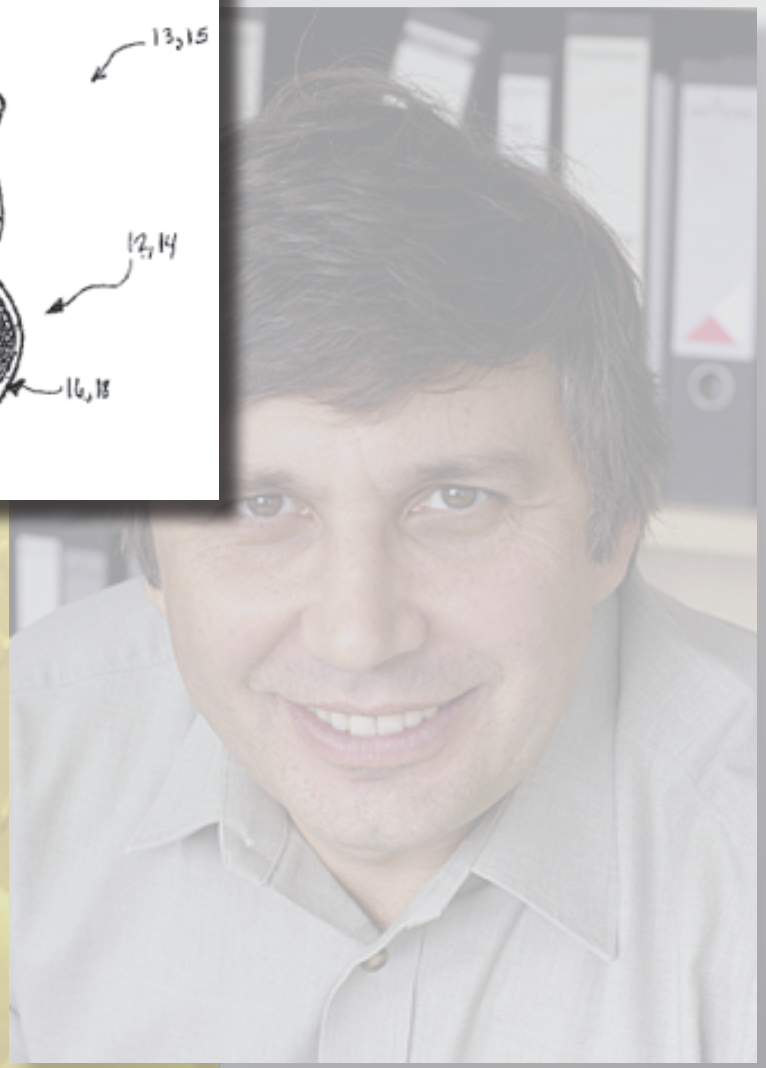
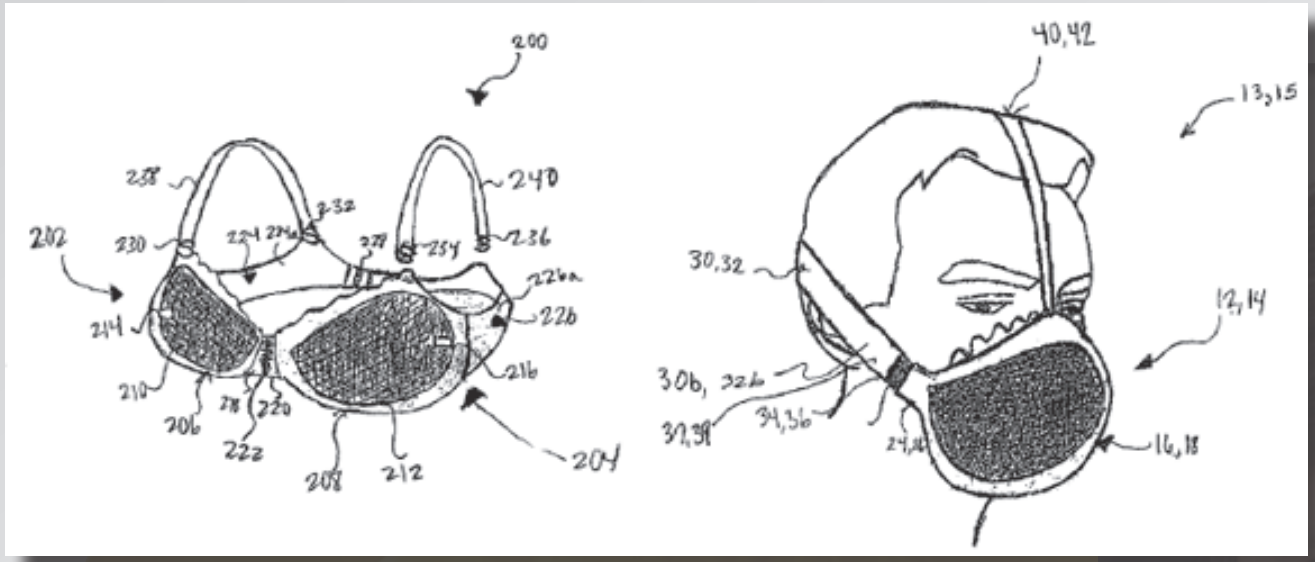
NOBEL

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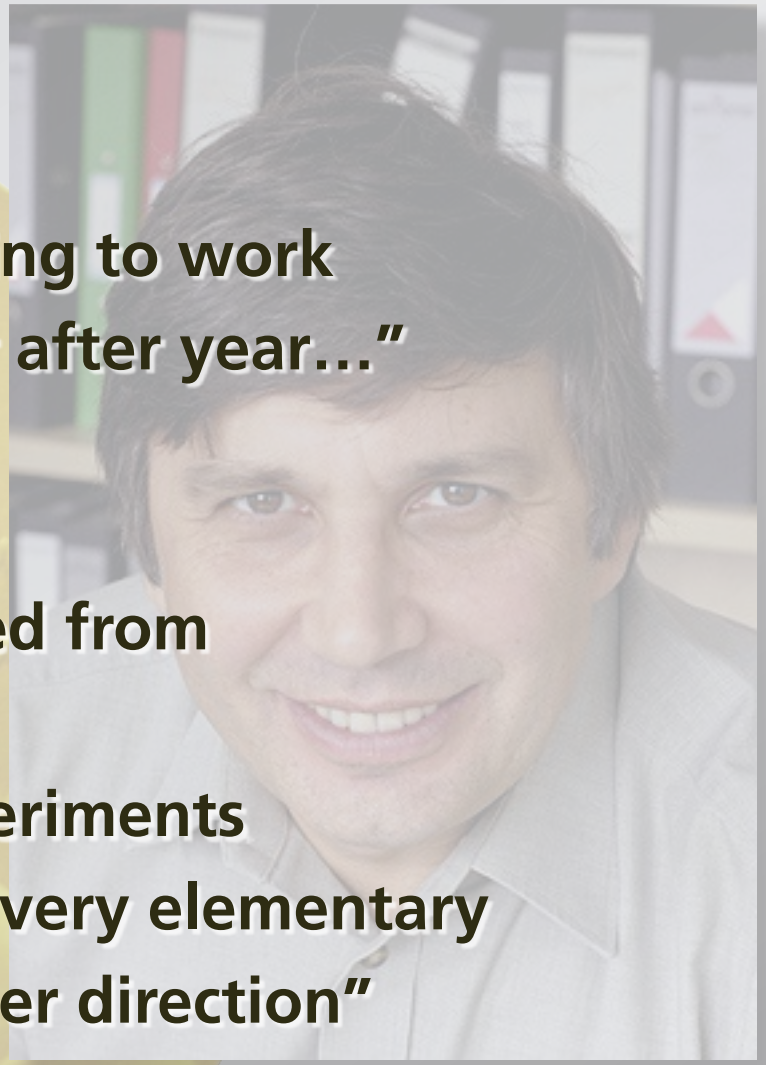
Nobel Prize in Physics 2010

Ig Nobel Prize in 2000

“For me it’s very boring to work on the same thing year after year…”

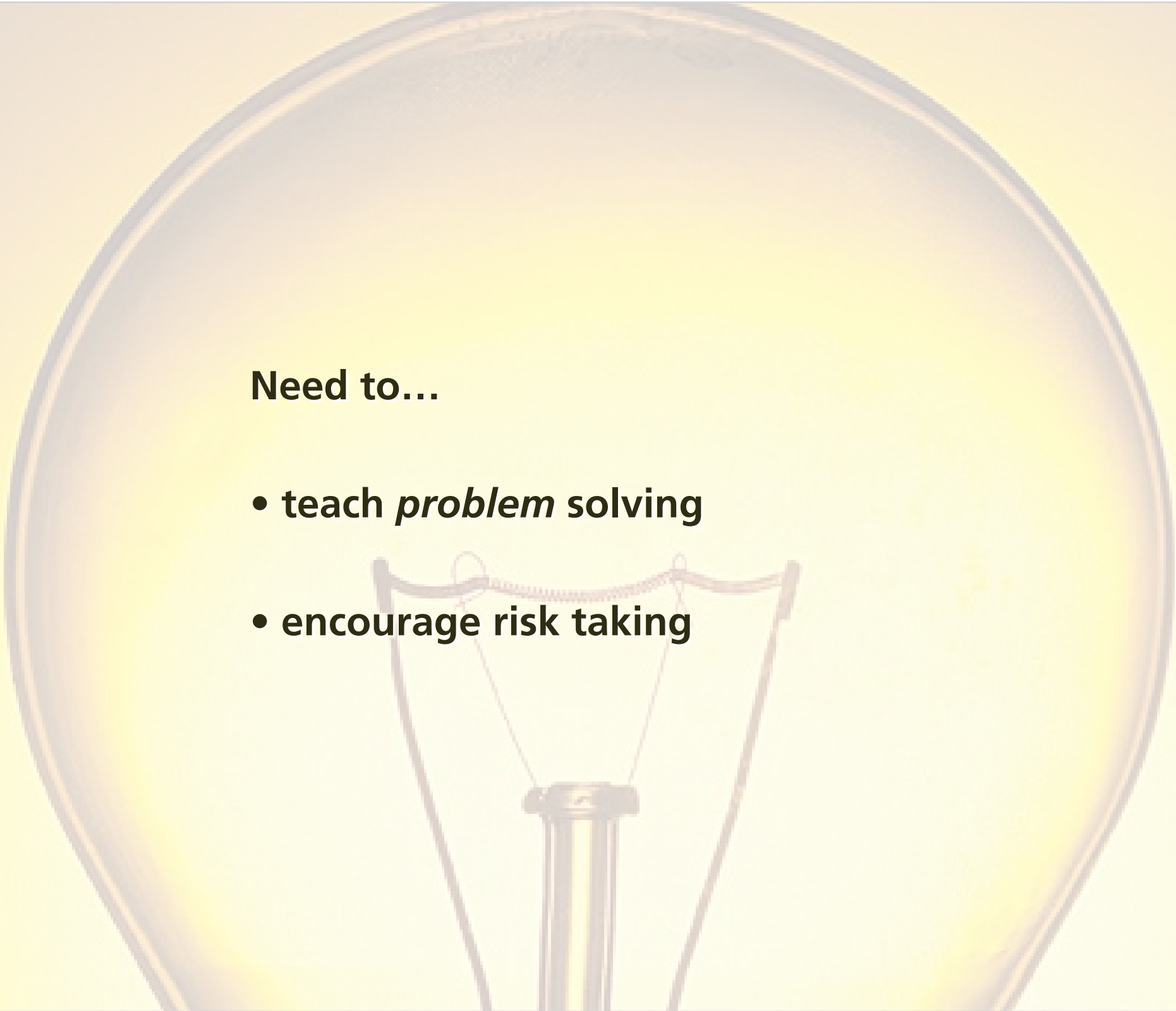


“For me it’s very boring to work
on the same thing year after year…”

graphene resulted from

“Friday night experiments
where you try something very elementary
and try to go in another direction”

how can we foster/teach innovation?



Need to…

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

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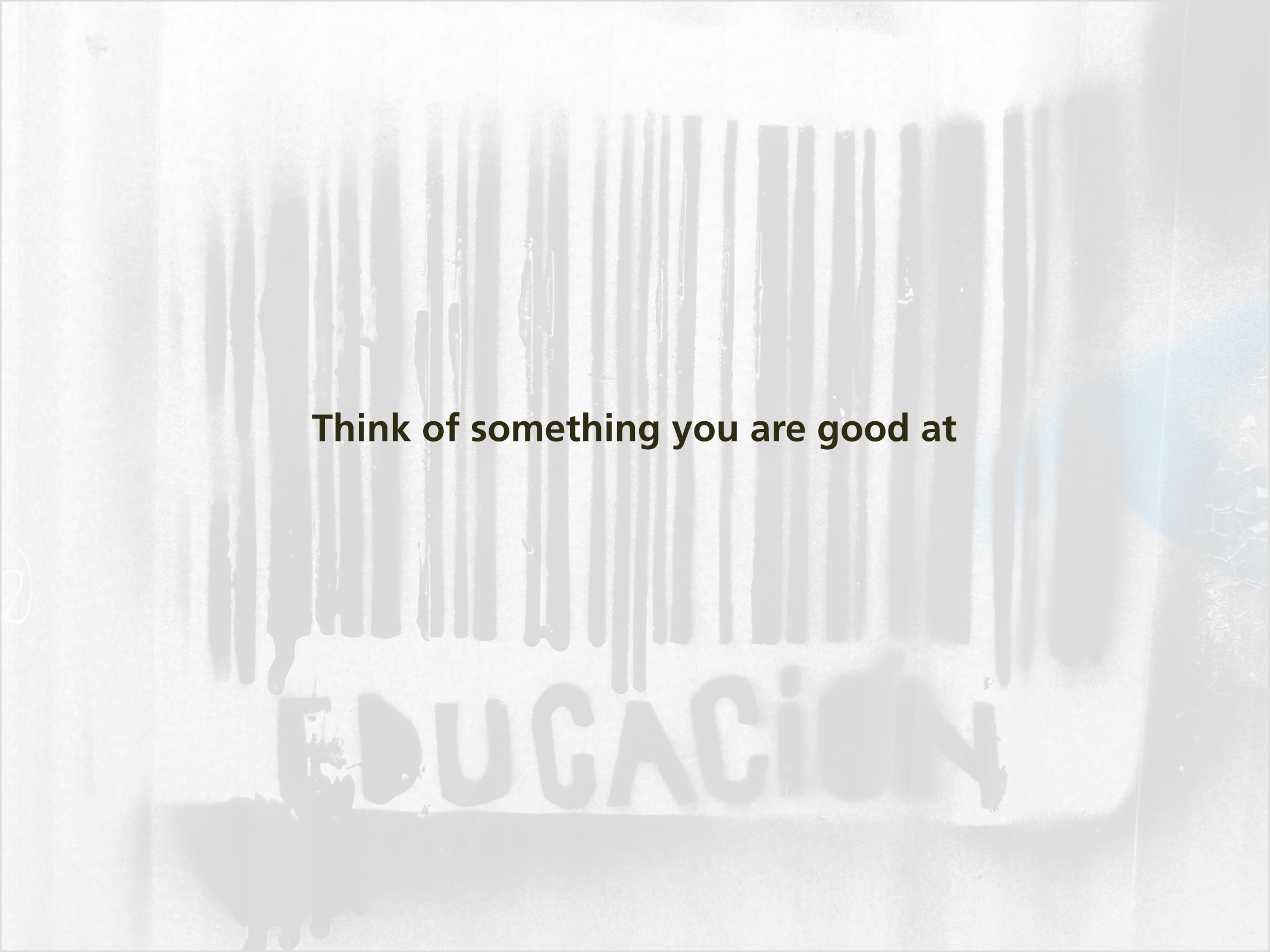
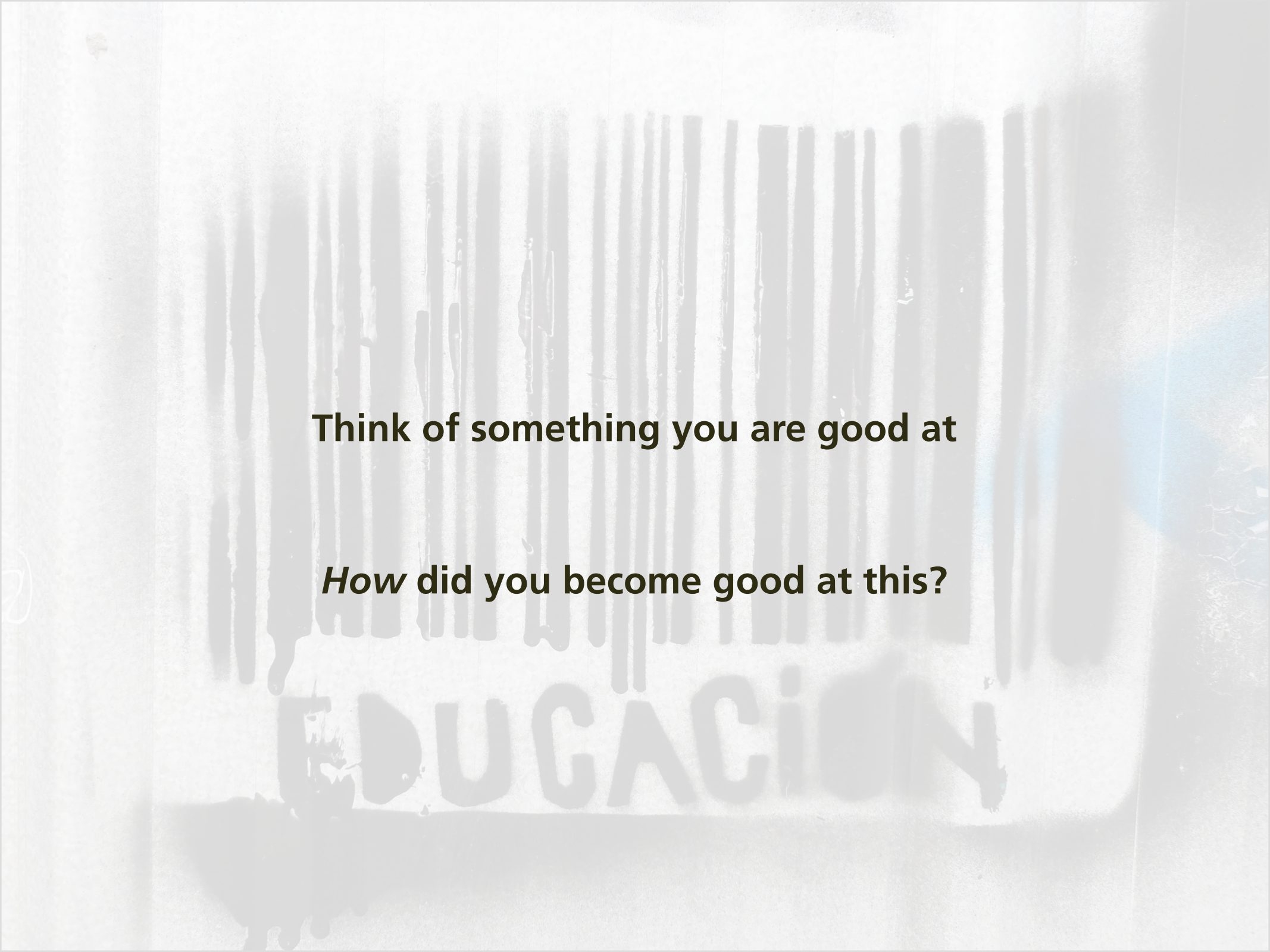
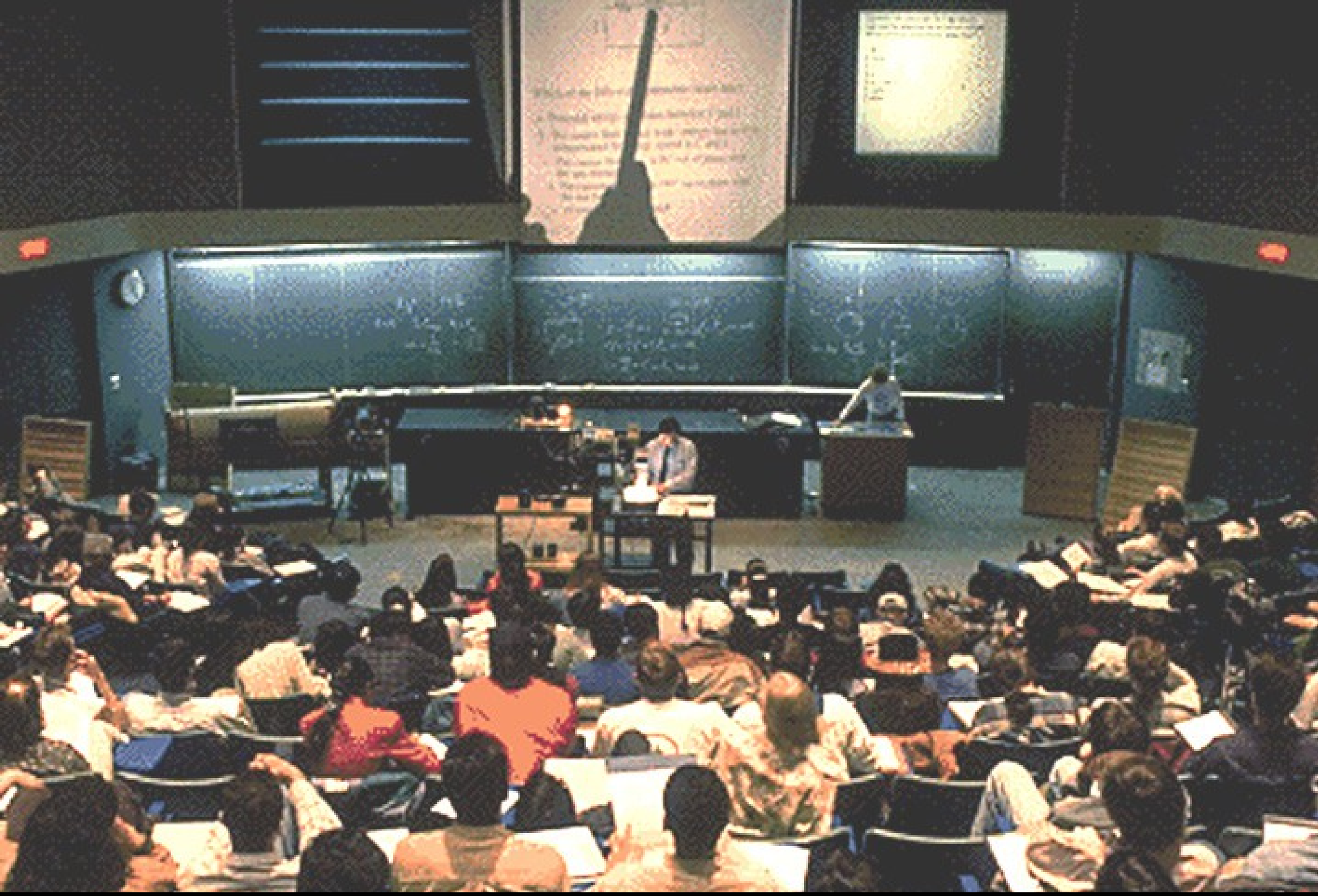

Think of something you are good at



Think of something you are good at

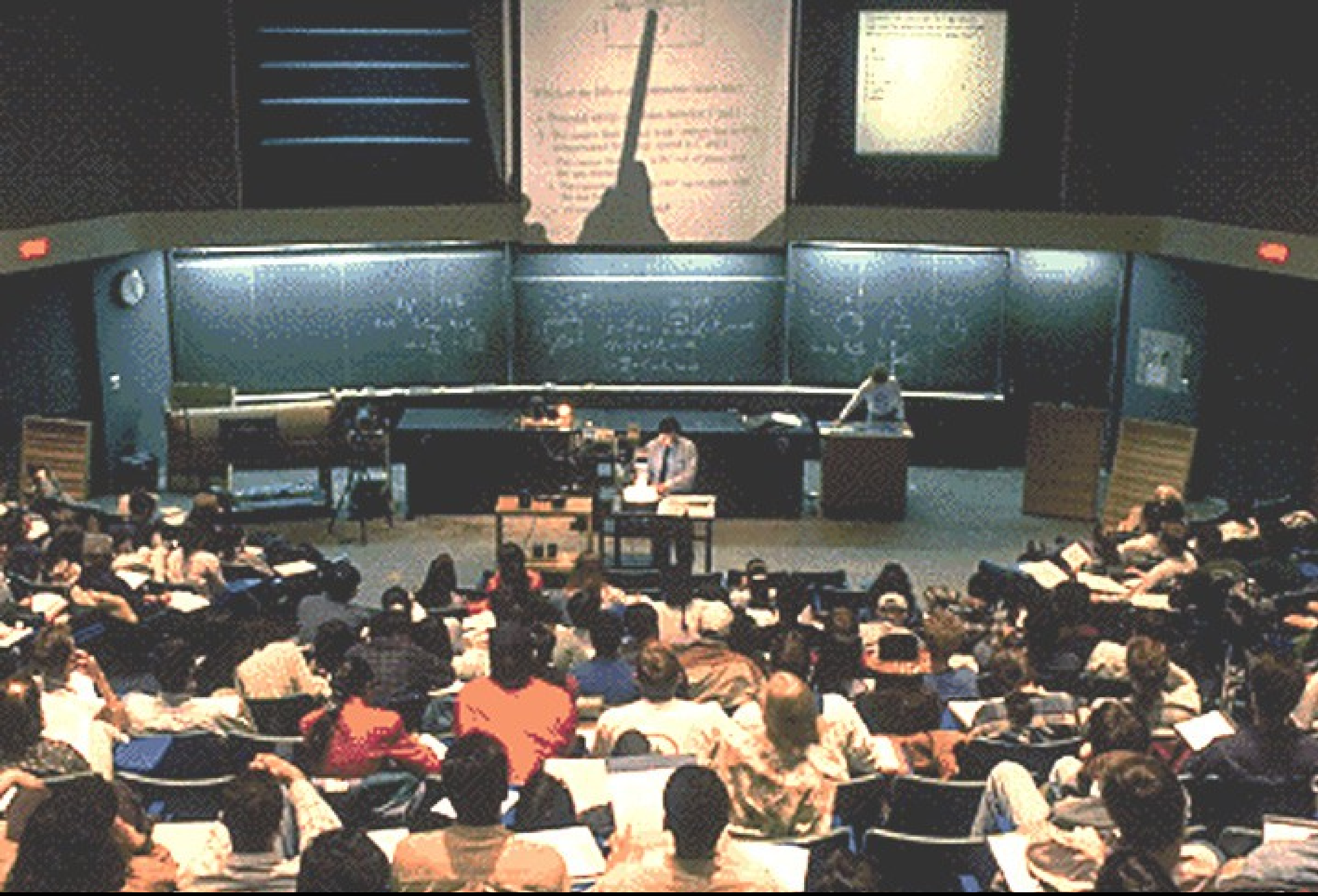
***How* did you become good at this?**



1 education

1 education

2 PI



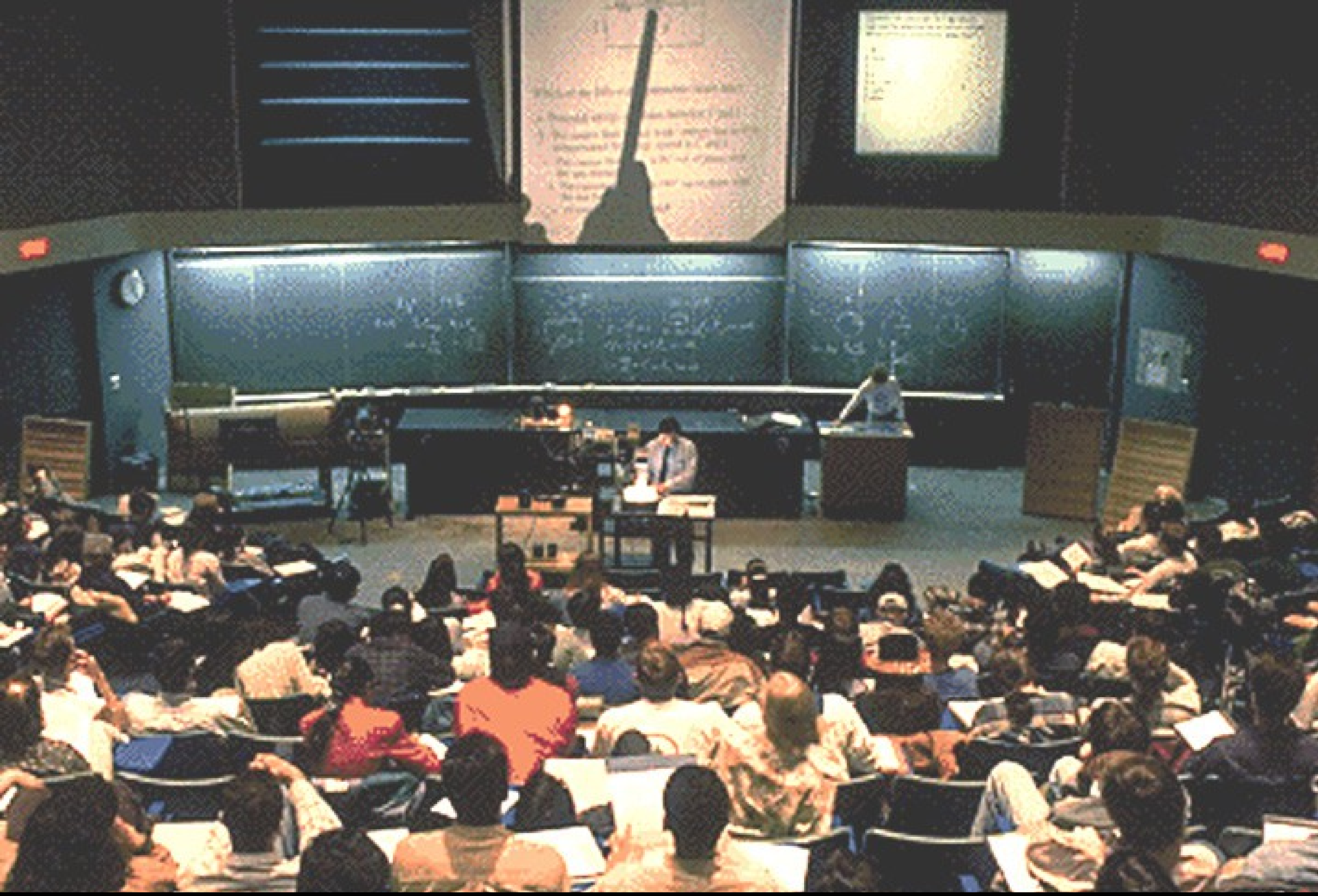
1 education

2 PI

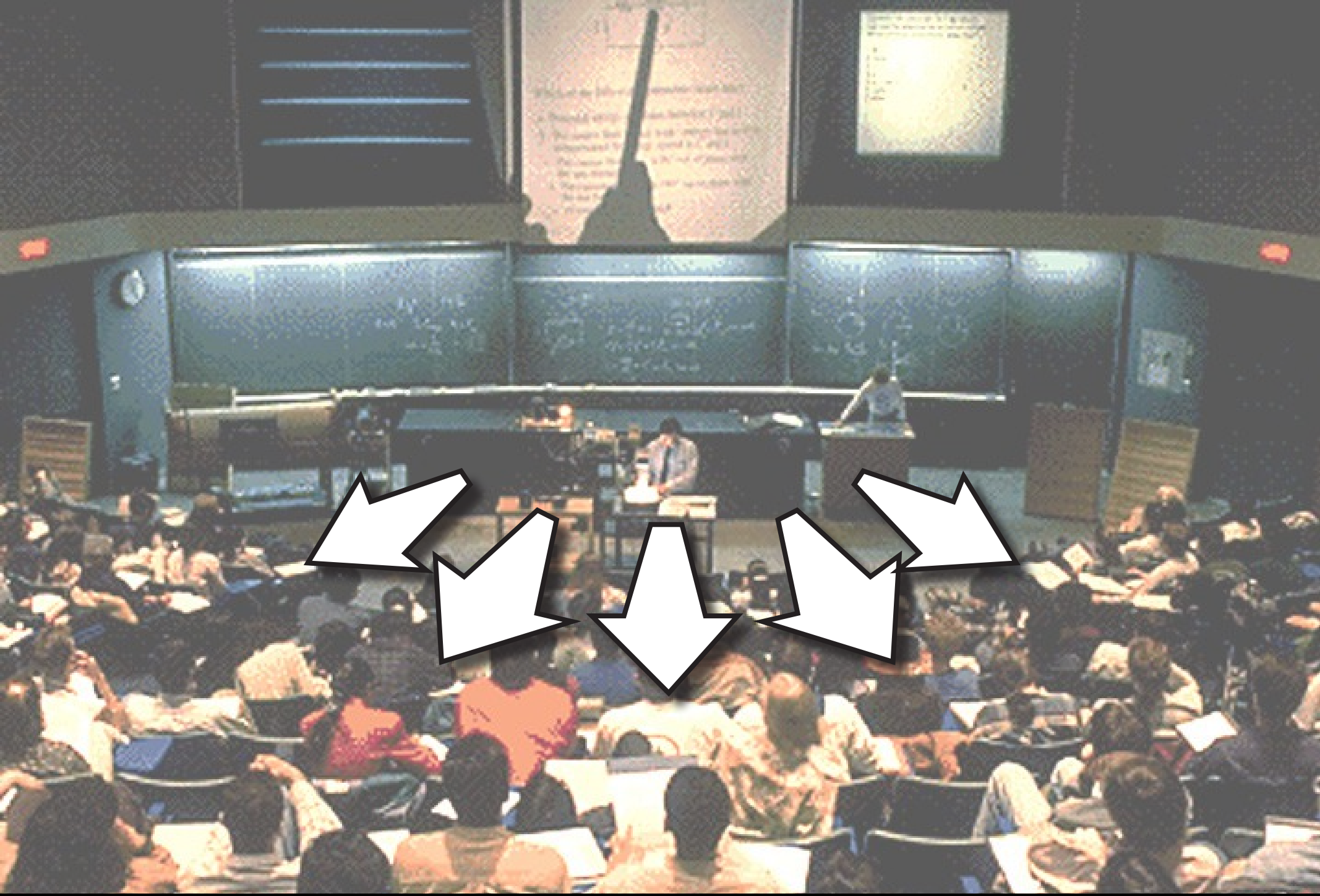
3 test

1 education 2 PI 3 test

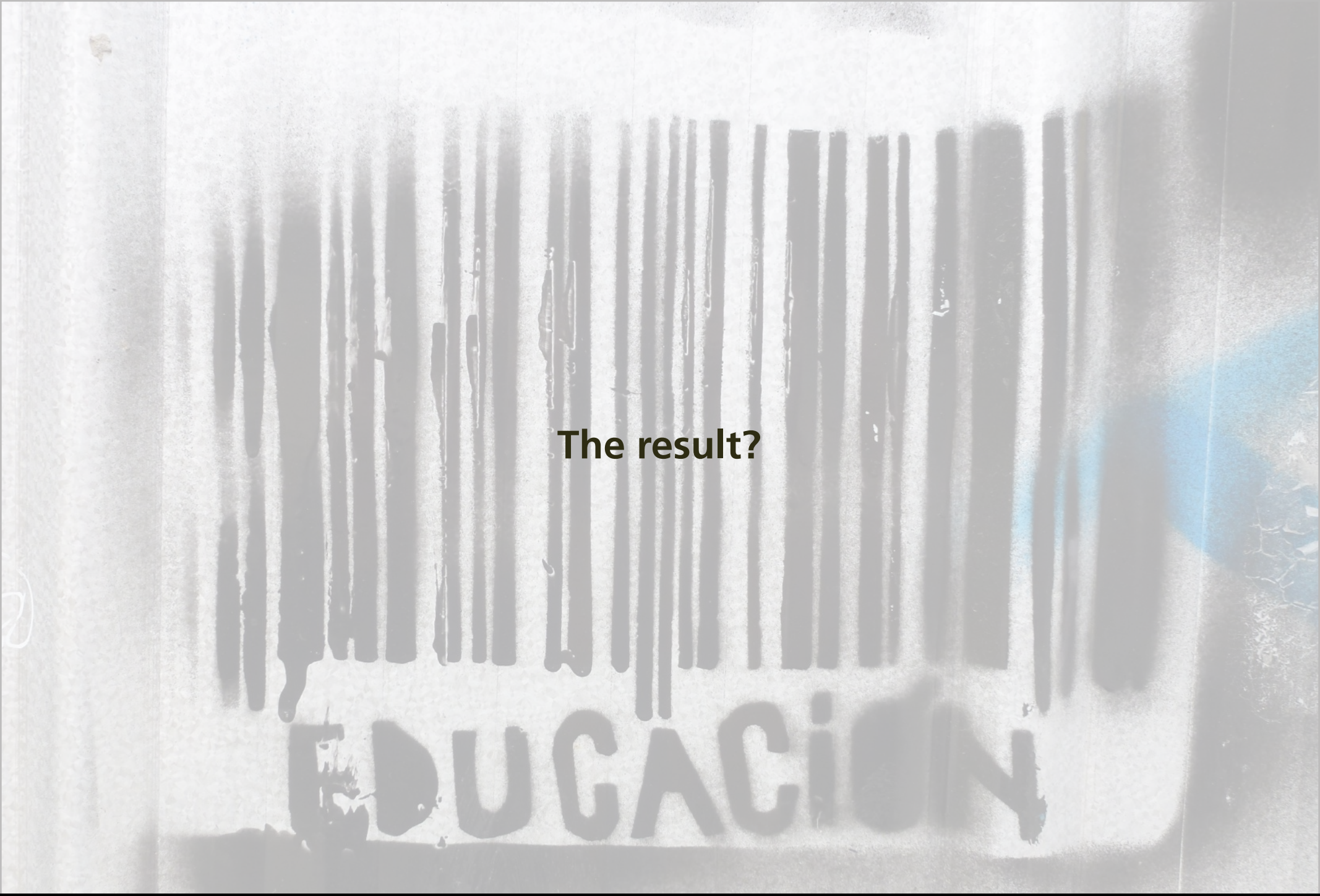
What happens
in a lecture?



1 education

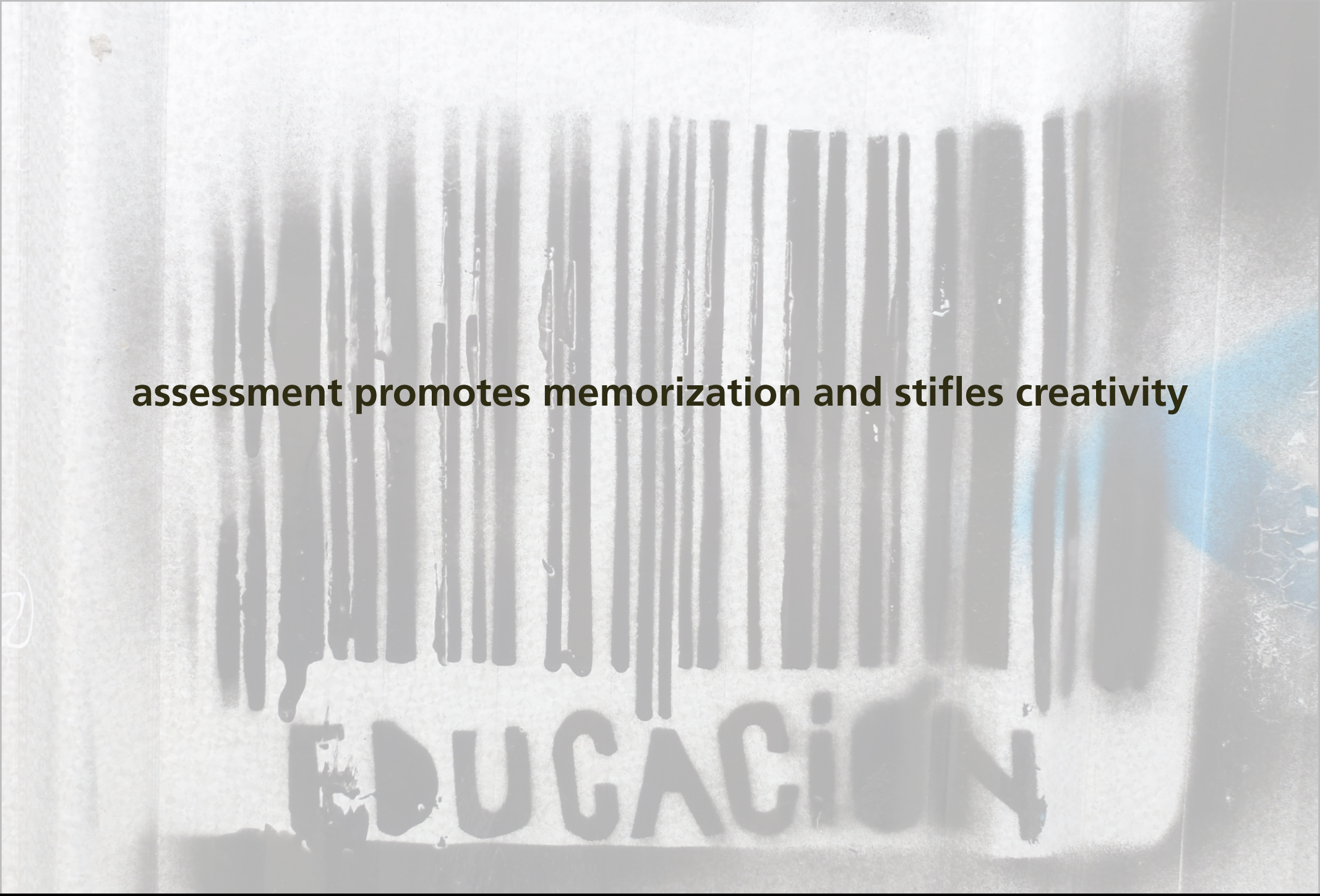


1 education

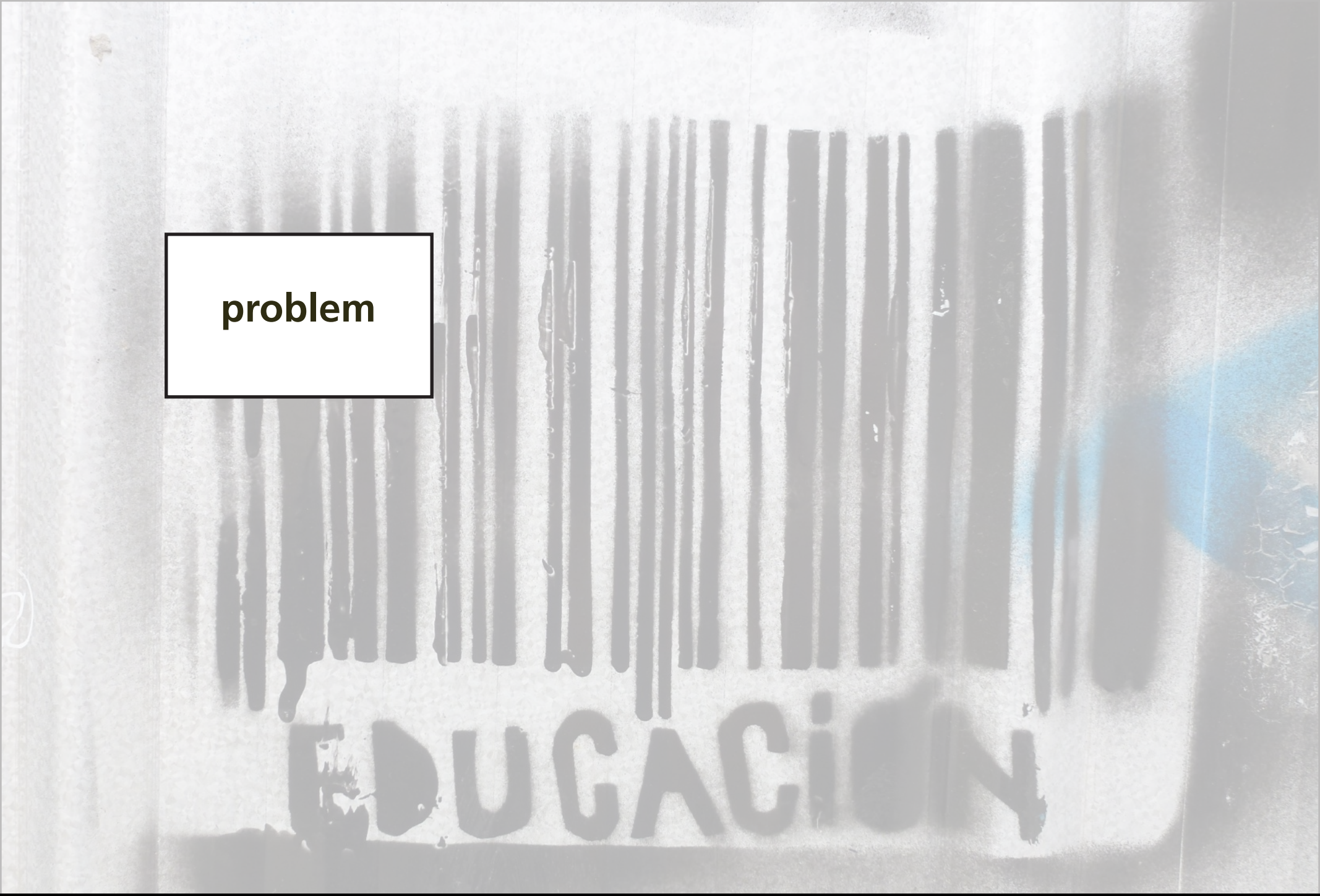

The result?
EDUCACION

1 education

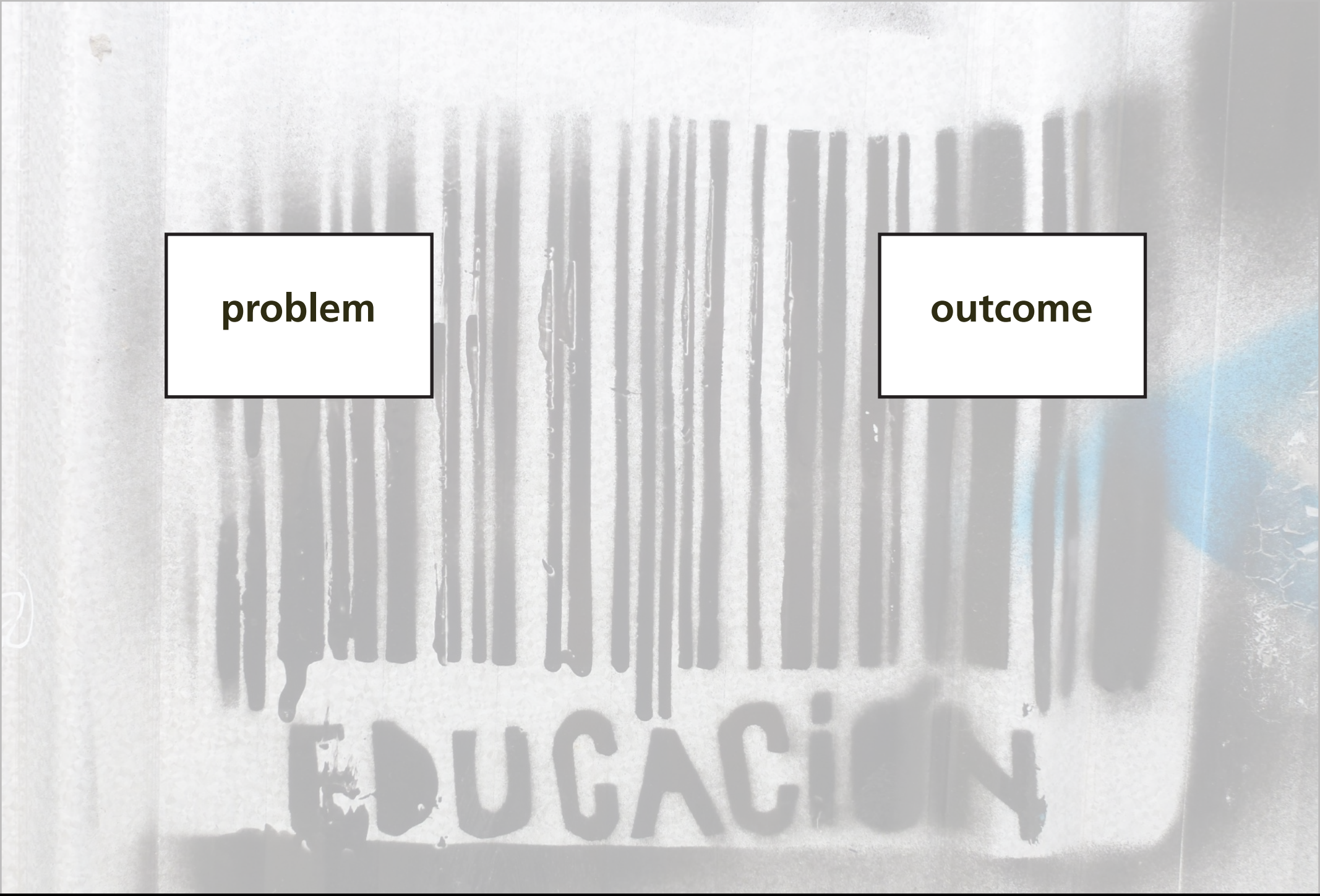
1 education



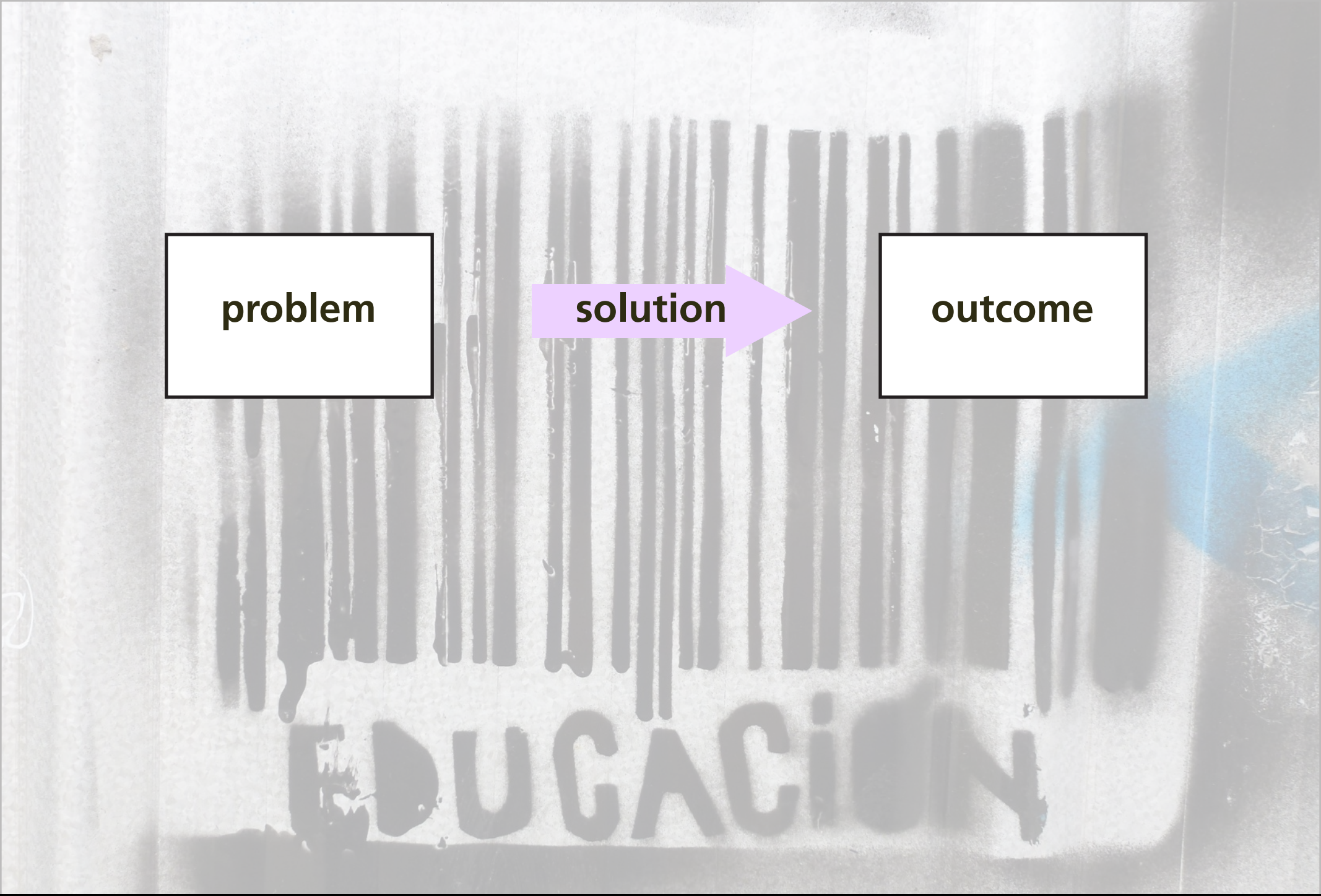
assessment promotes memorization and stifles creativity



1 education



1 education



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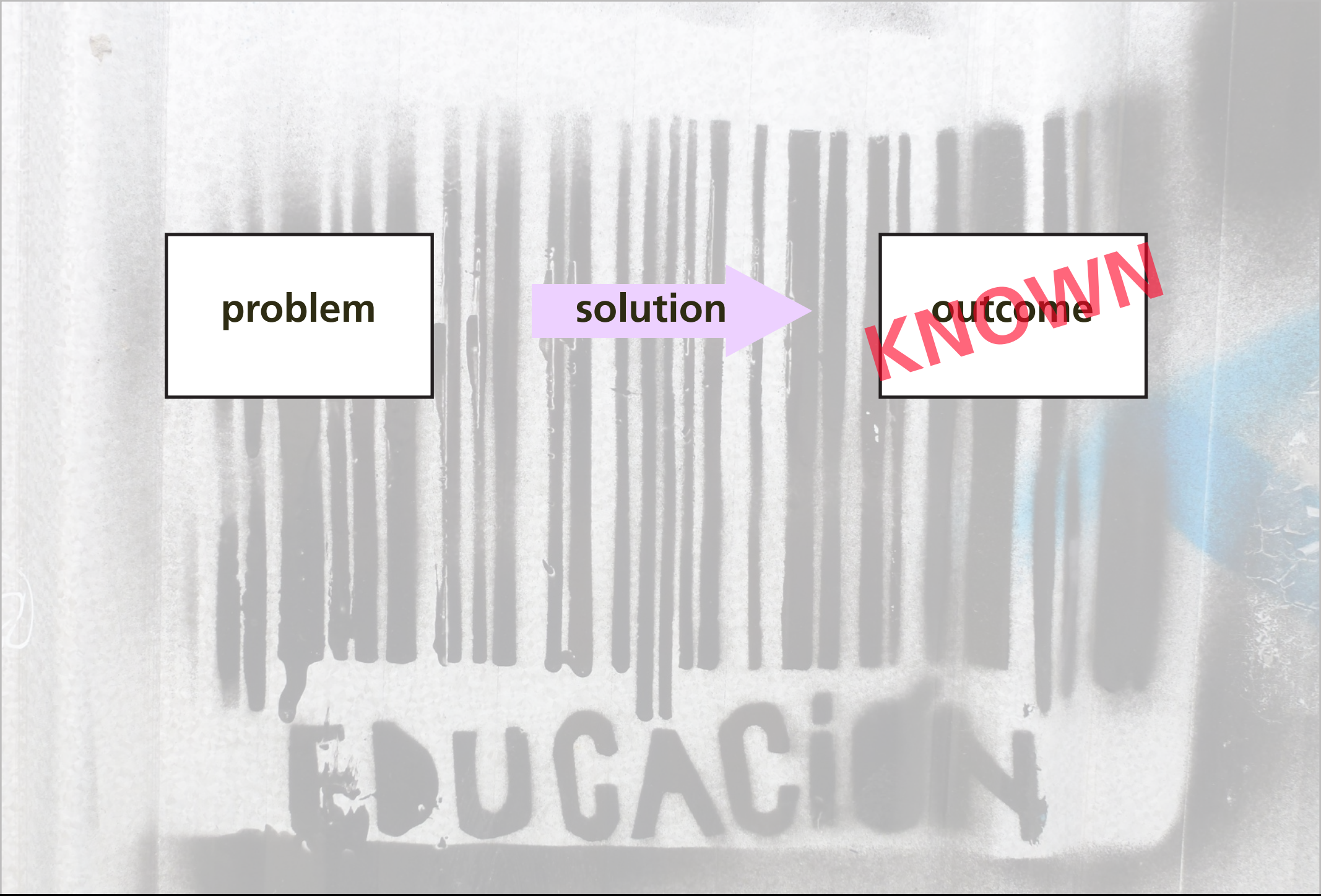

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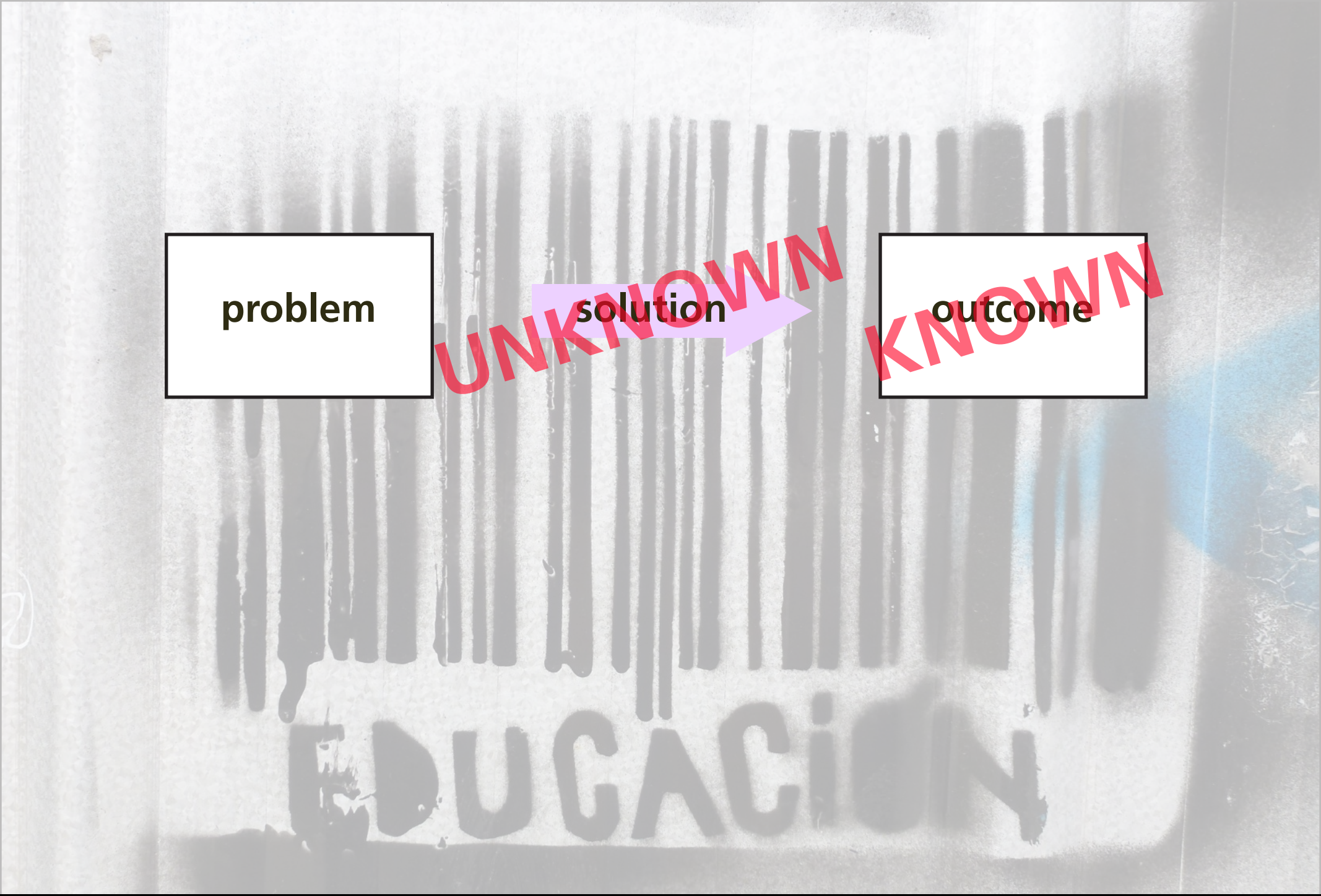
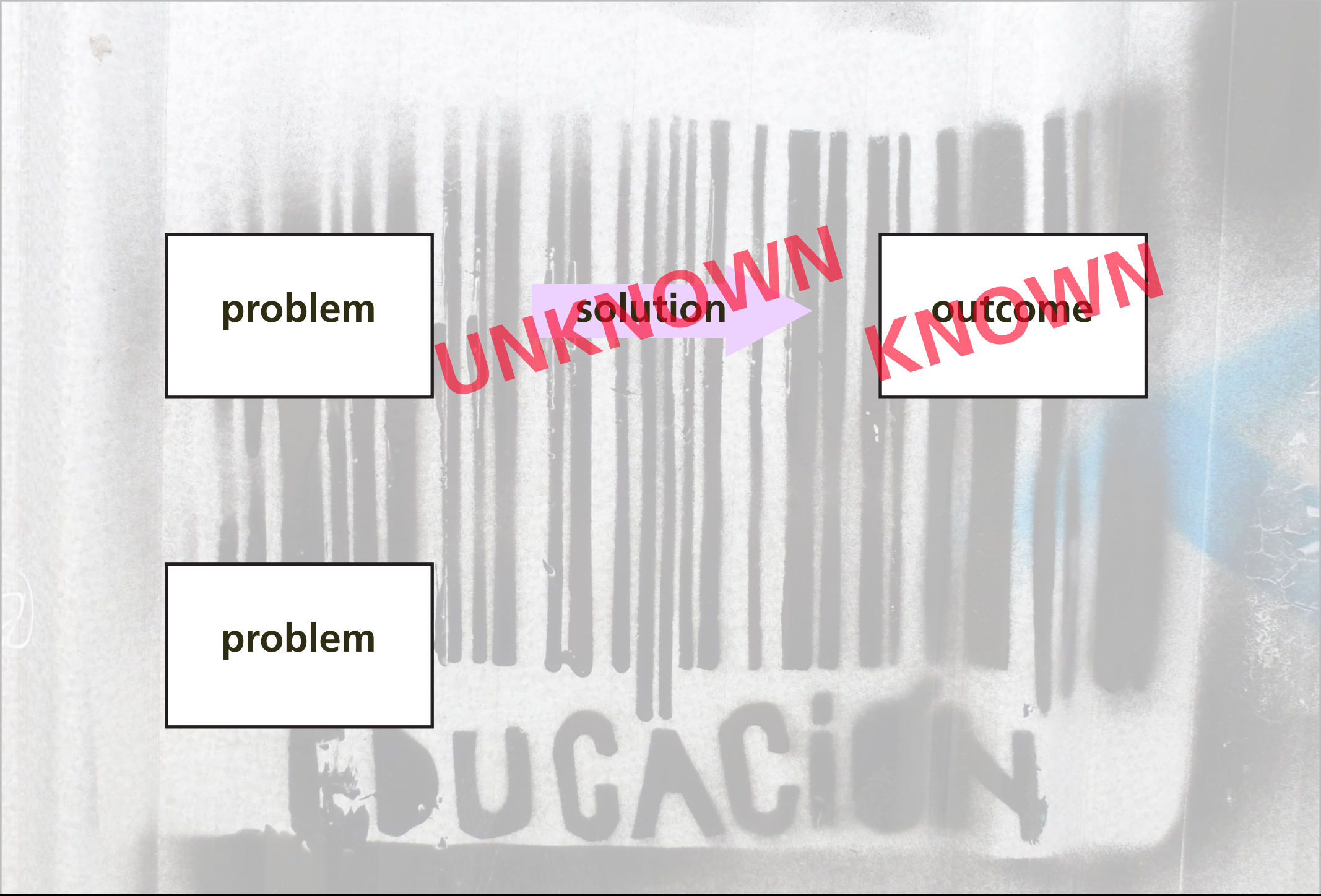


1 education



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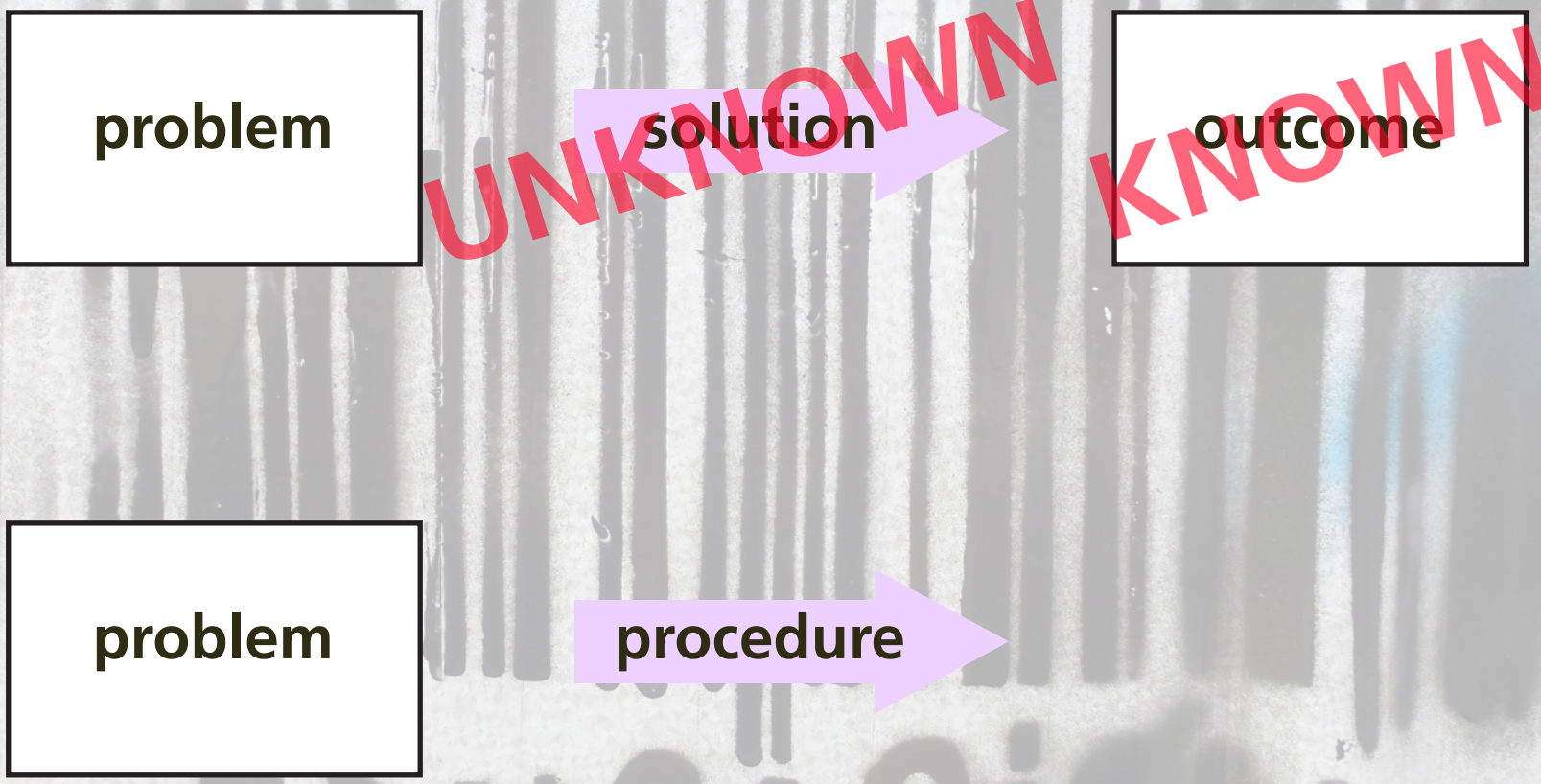
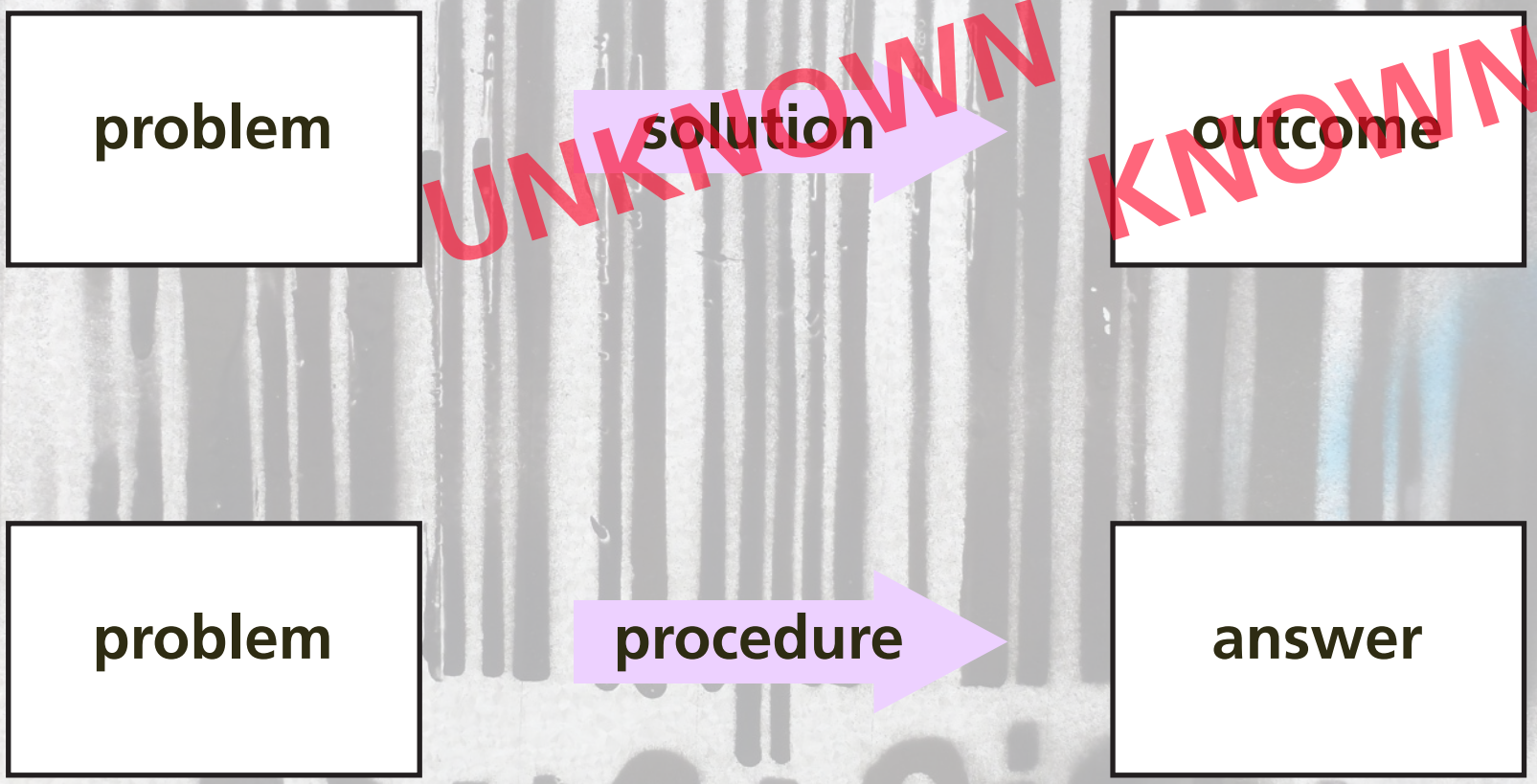
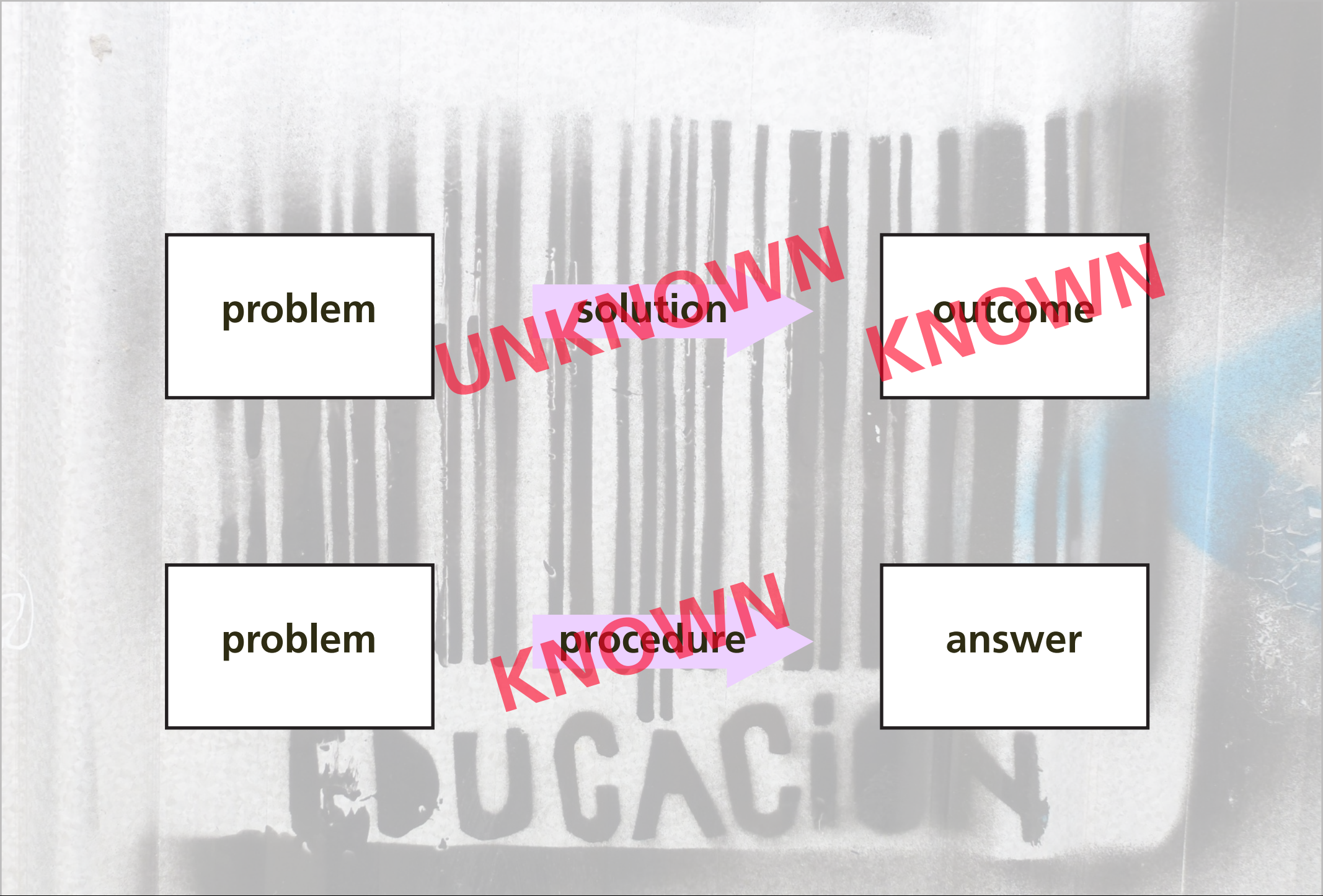

problem
solution
outcome
UNKNOWN
KNOWN
problem
procedure


problem
solution
outcome
UNKNOWN
KNOWN
problem
procedure
answer

1 education


problem
solution
outcome
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problem
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answer
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problem
solution
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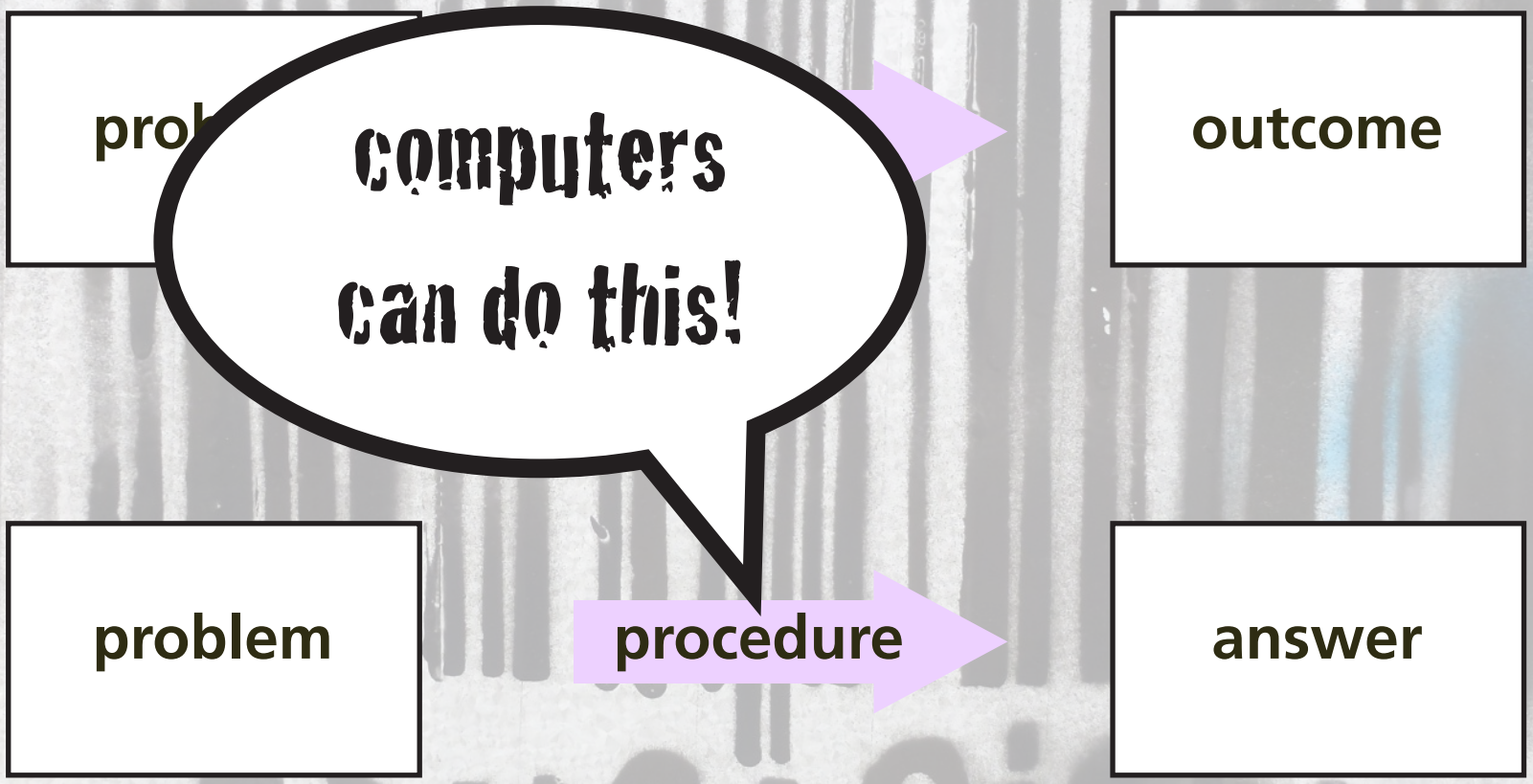
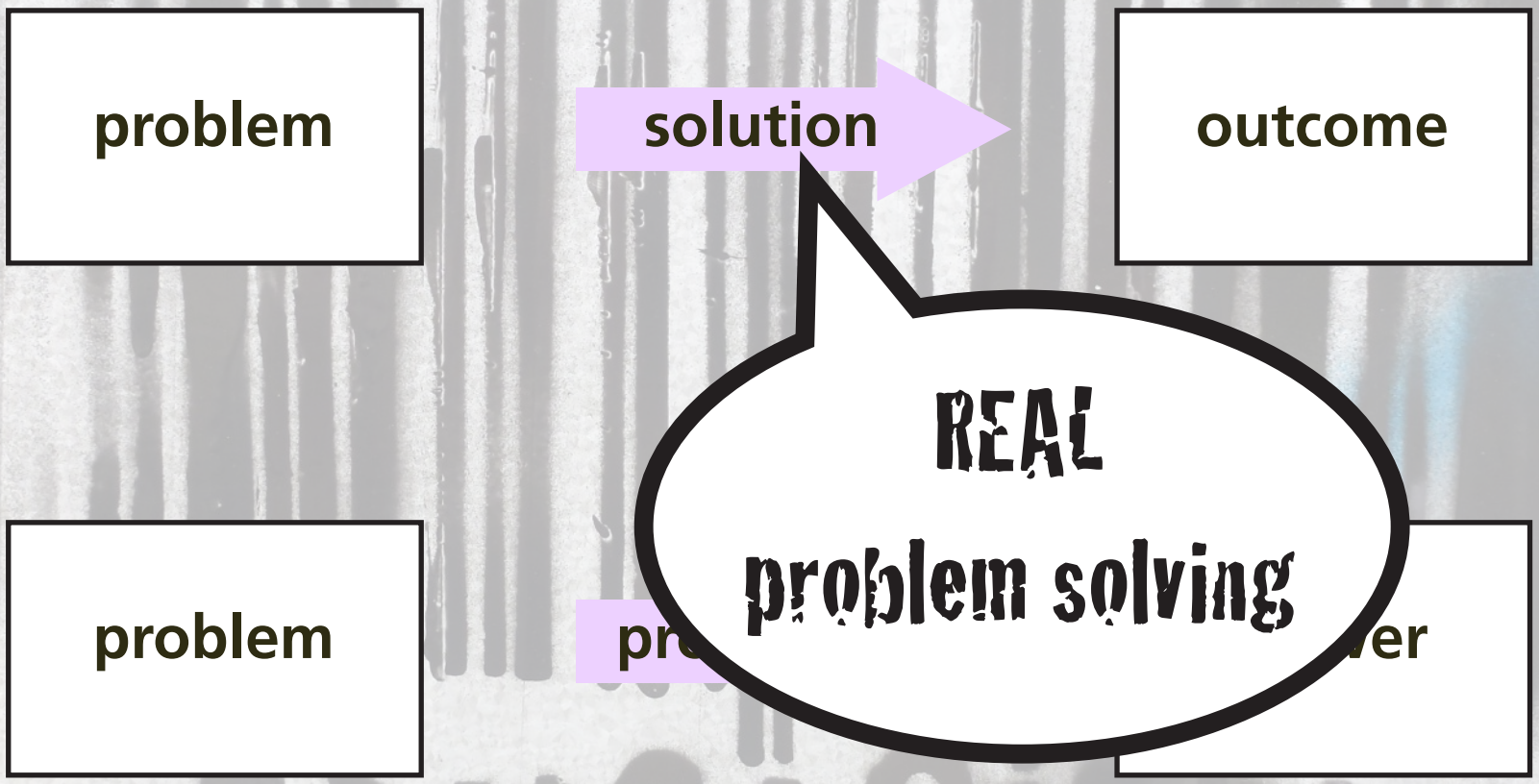
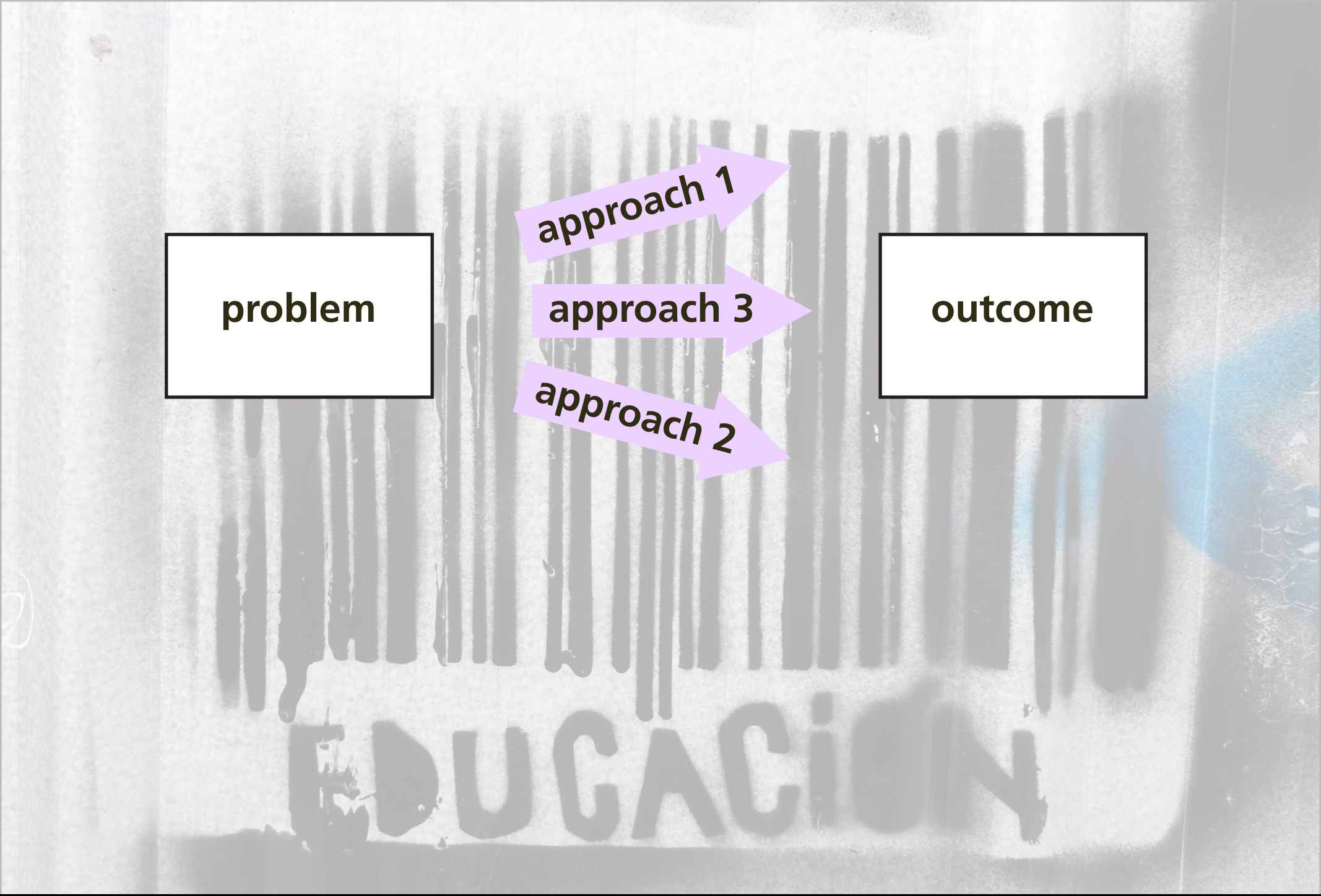
KNOWN
UNKNOWN

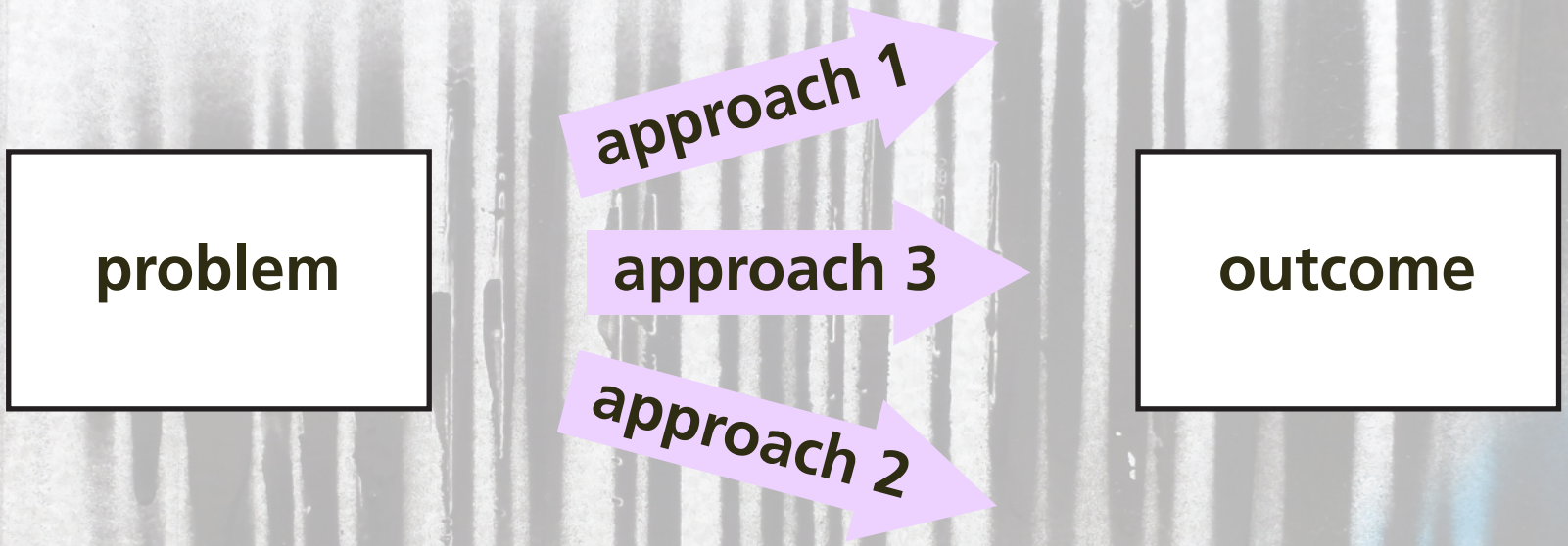
1 education


prob
computers
can do this!
outcome
problem
procedure
answer


problem
solution
outcome
REAL
problem solving
problem



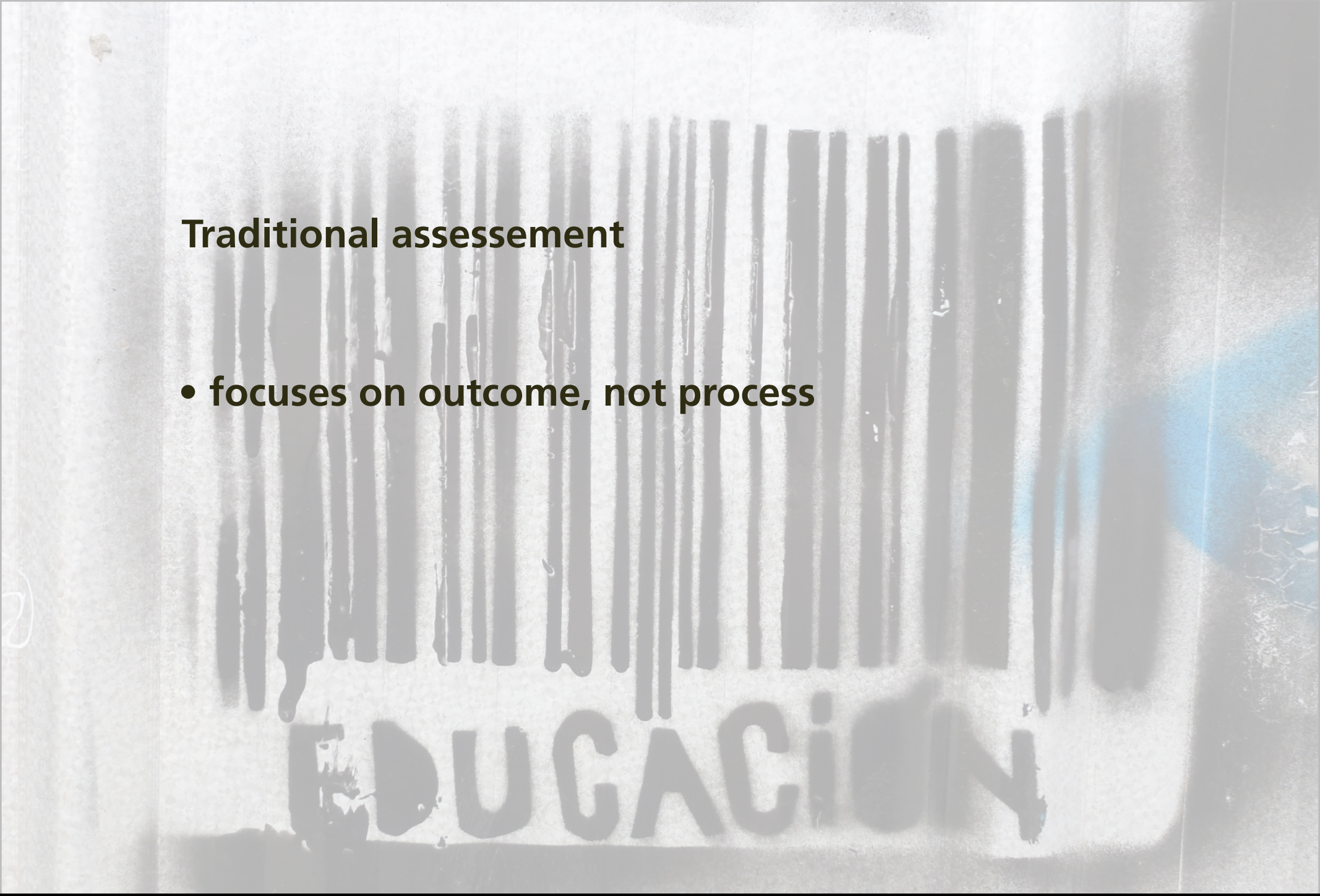
1 education



assessment incompatible with real problem solving

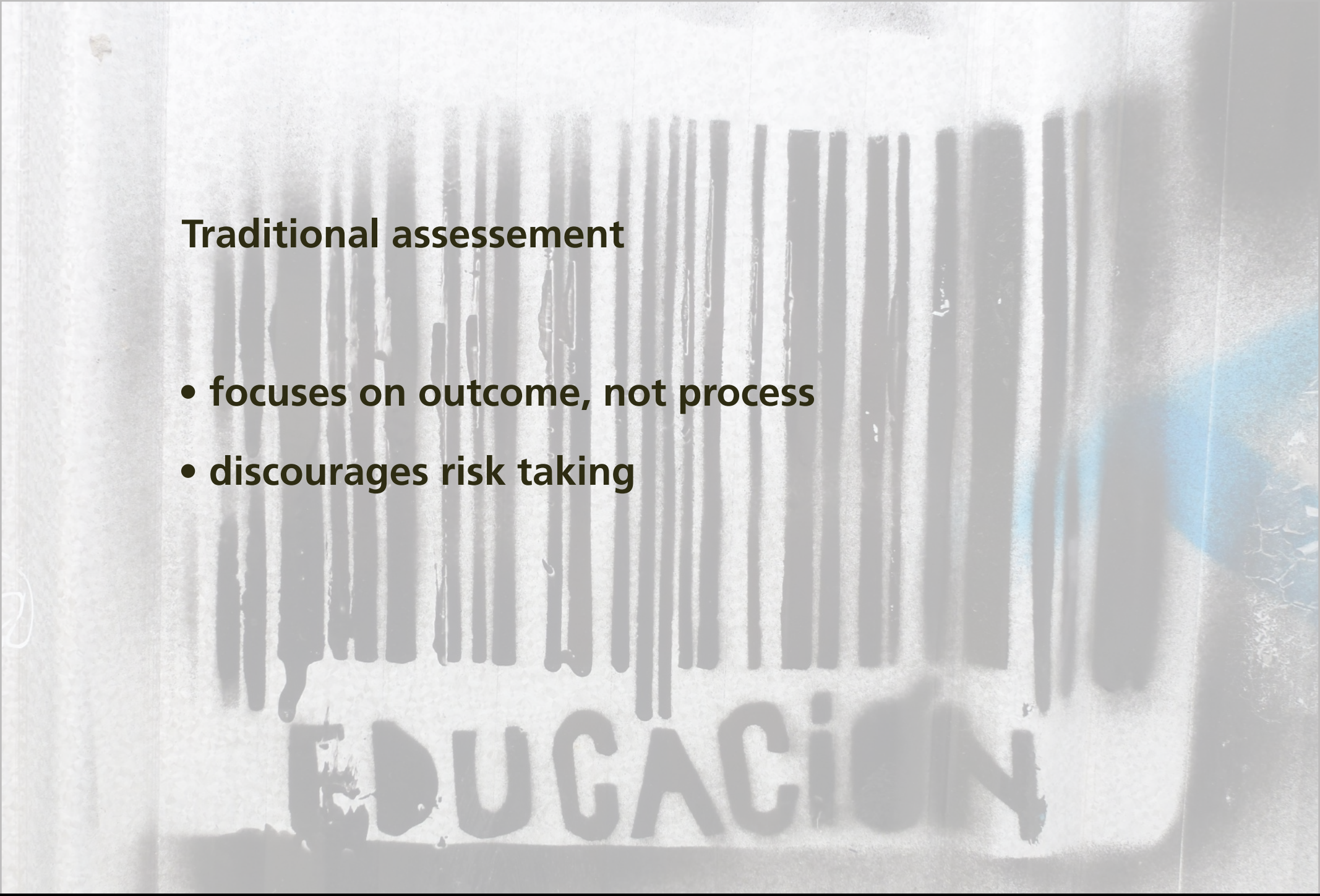
Traditional assessement

- focuses on outcome, not process



Traditional assessement

- focuses on outcome, not process
- discourages risk taking



Traditional assessement

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

Traditional assessement

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

1 education

2 PI

1. transfer of information

1. transfer of information

2. assimilation of that information

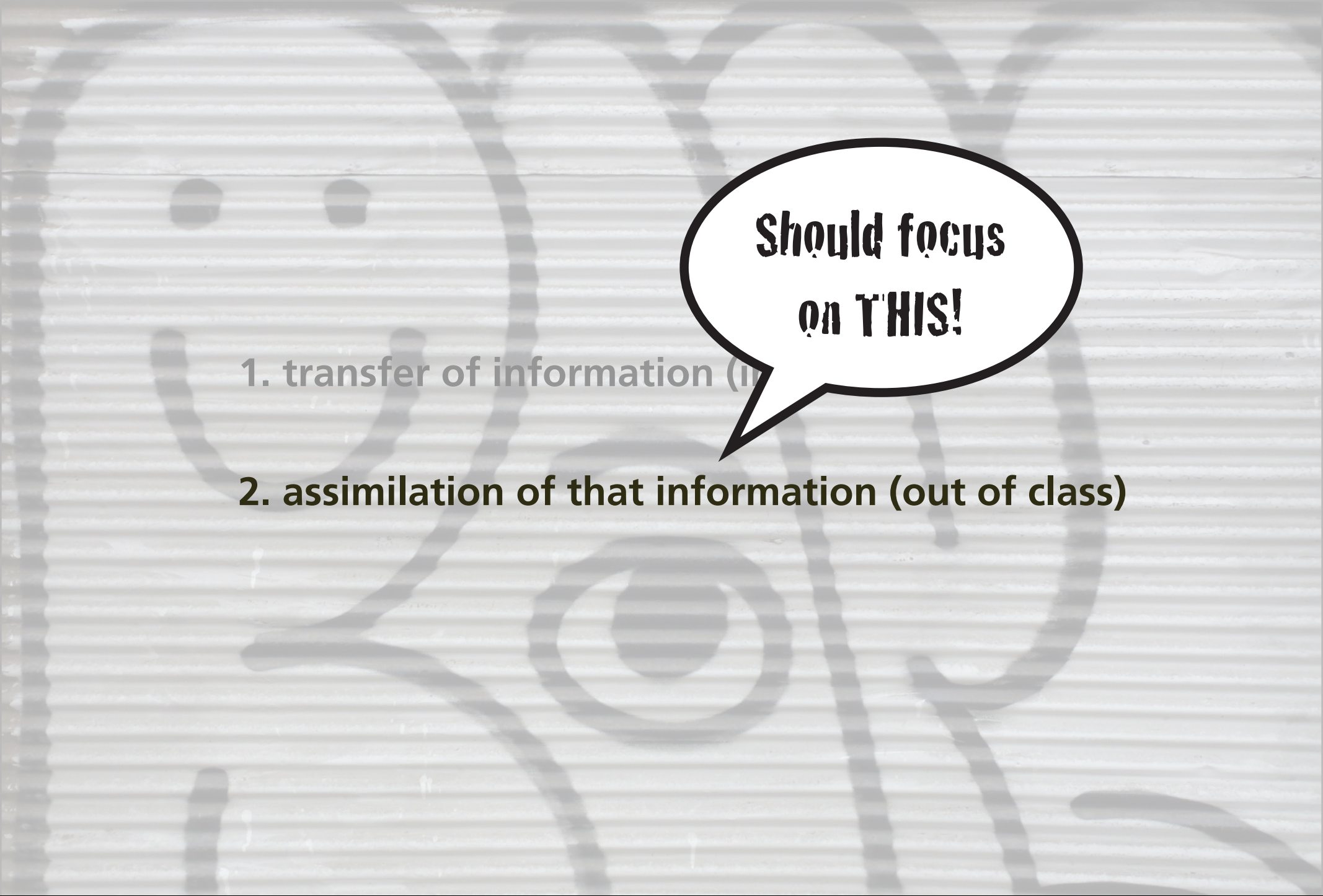
1 education 2 PI

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)



1 education 2 PI

1. transfer of information (in class)

2. assimilation of that information (out of class)

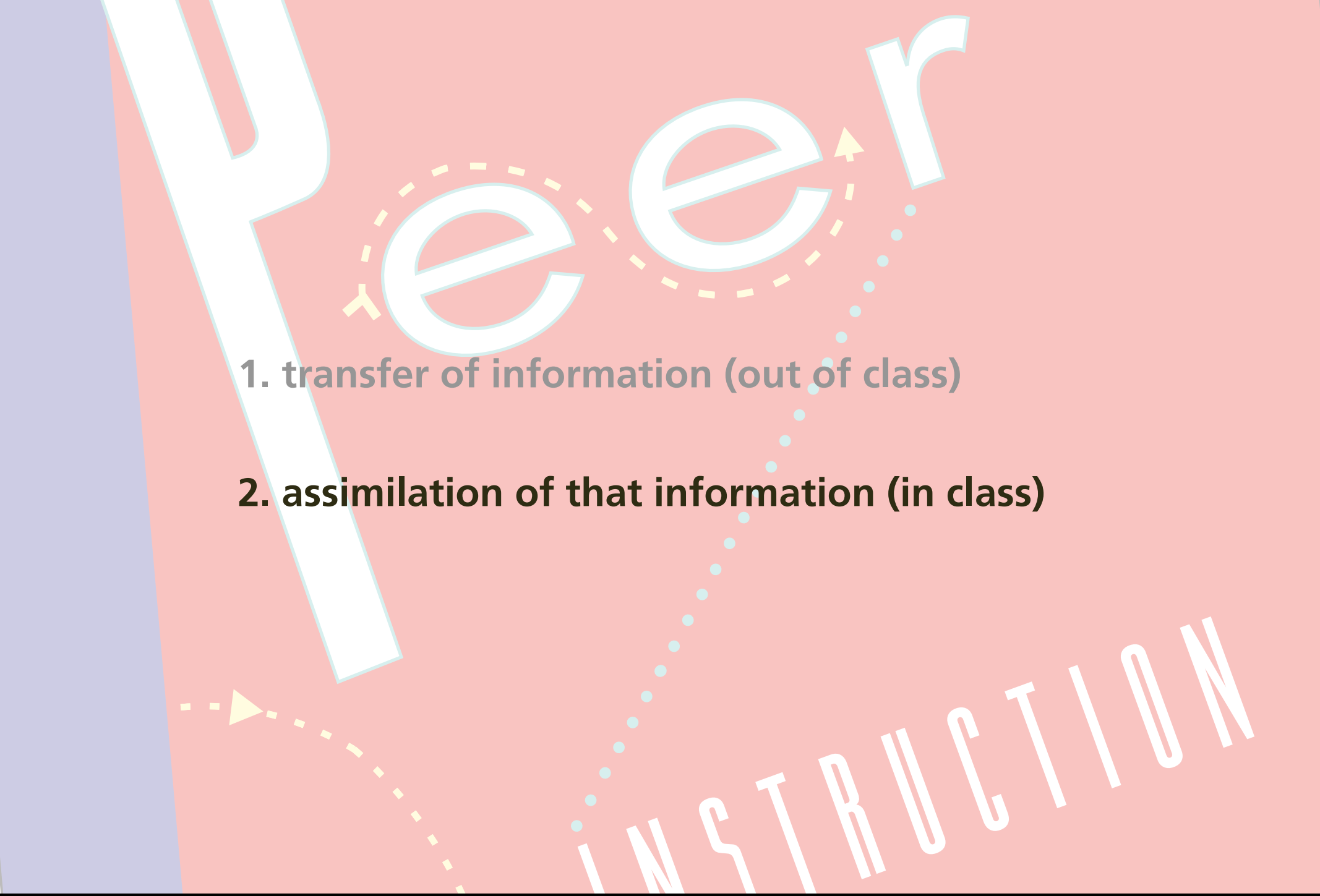
1 education

2 PI

1. transfer of information (out of class)

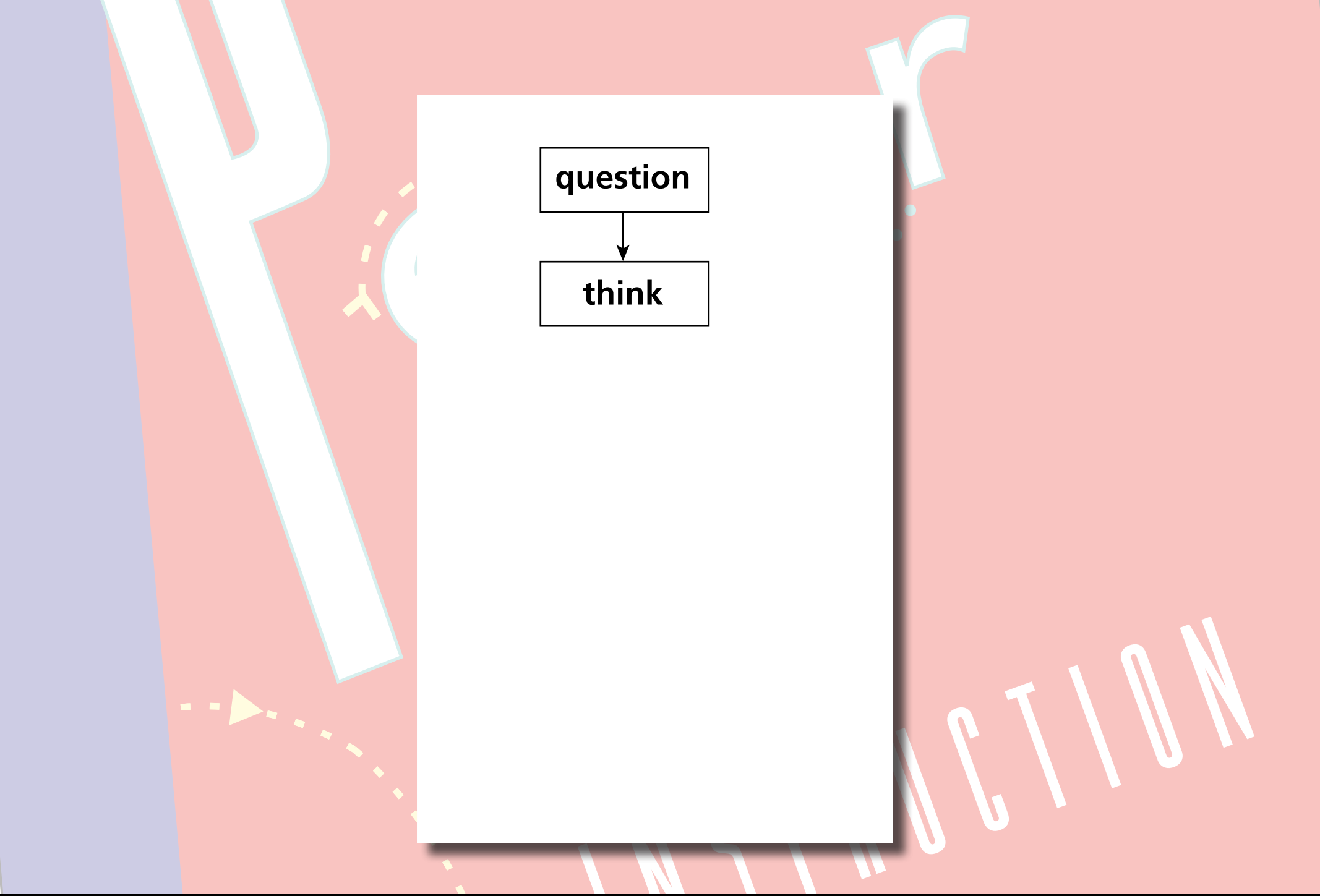
2. assimilation of that information (in class)

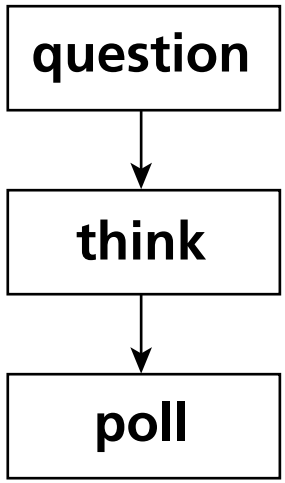
1 education 2 PI

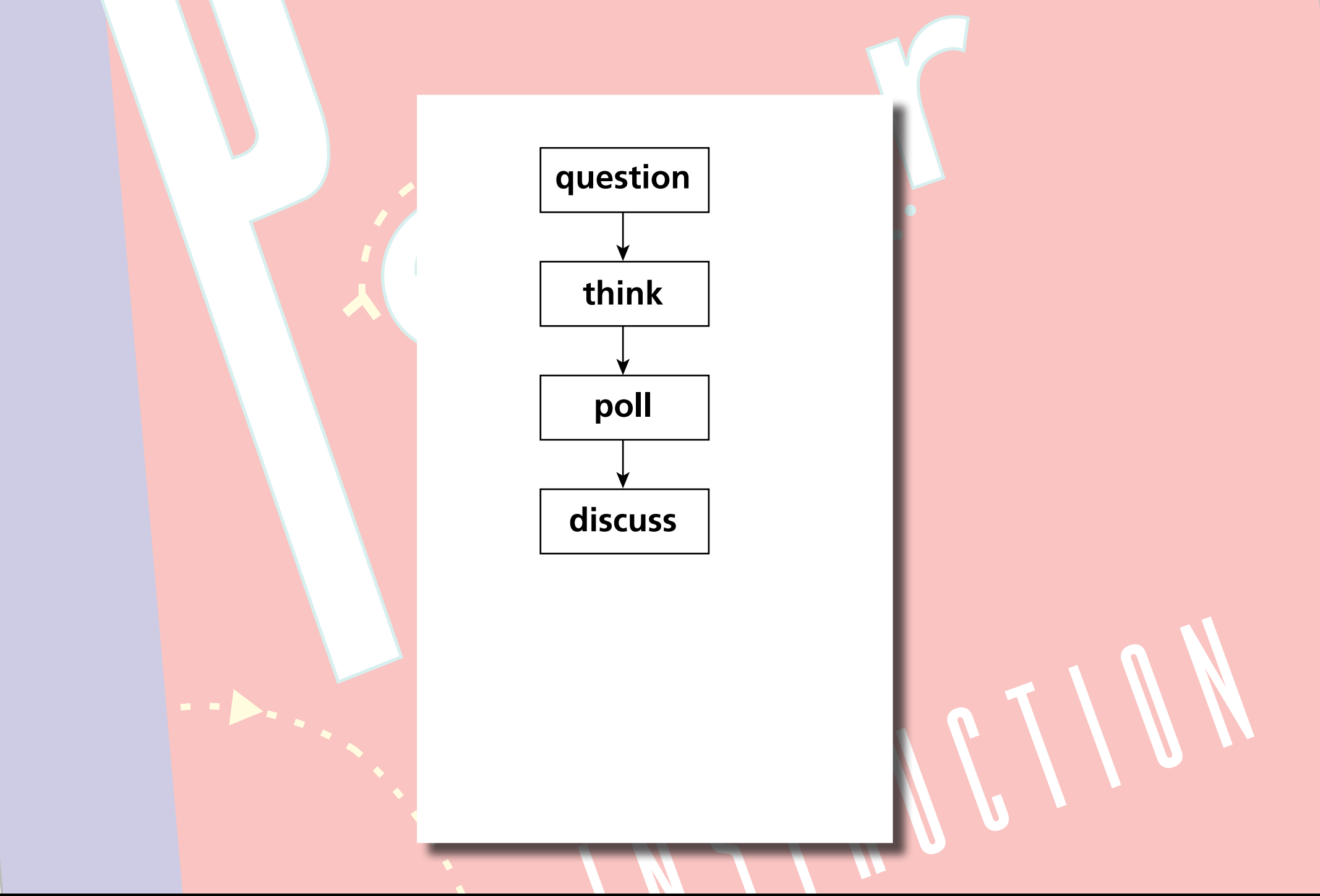


1 education 2 PI

1 education 2 PI

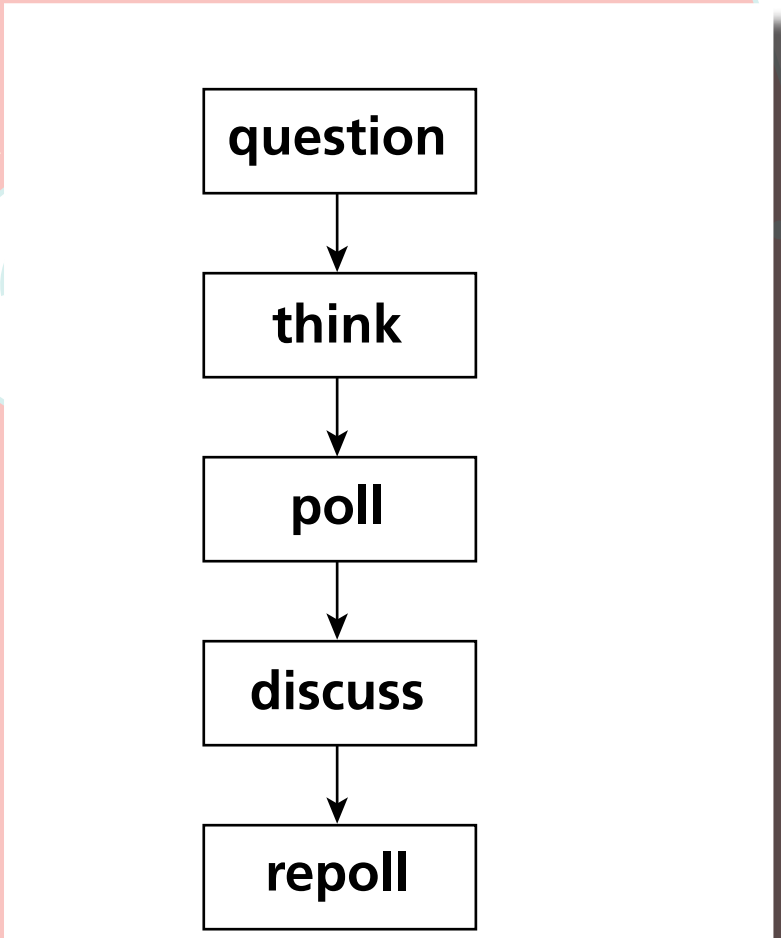

question
think

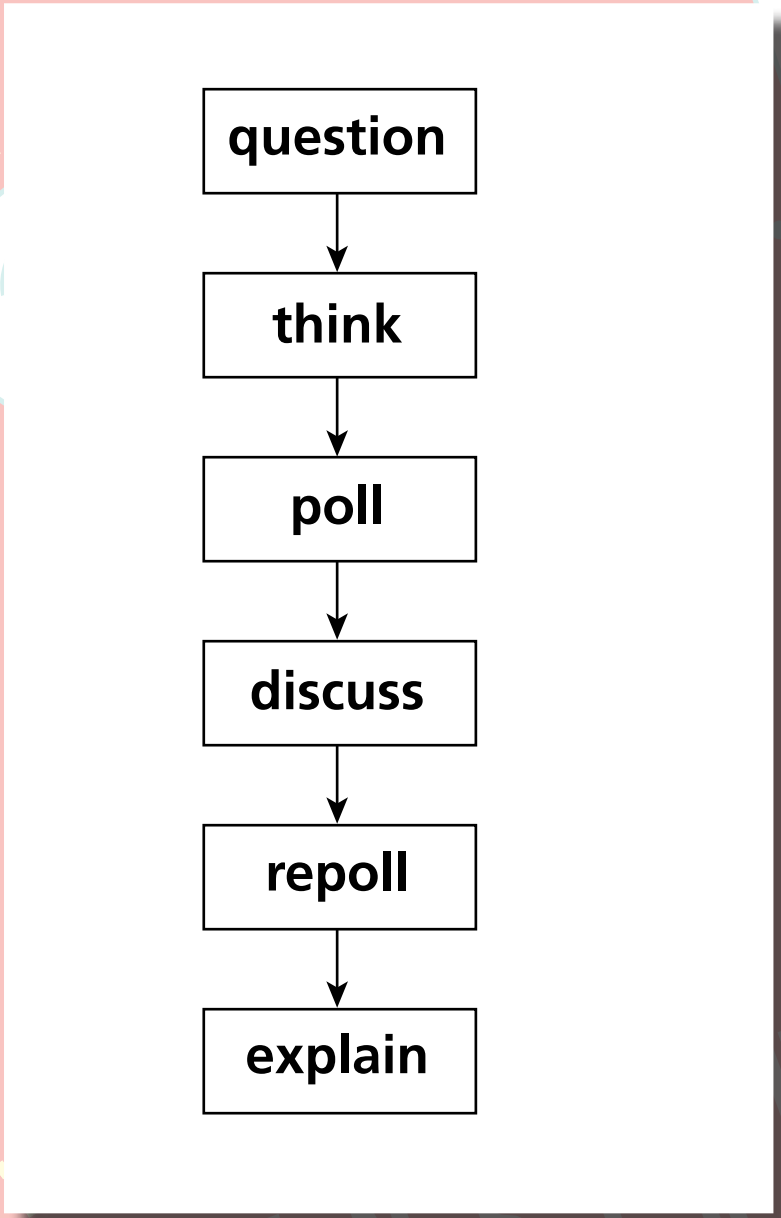

question
think
poll

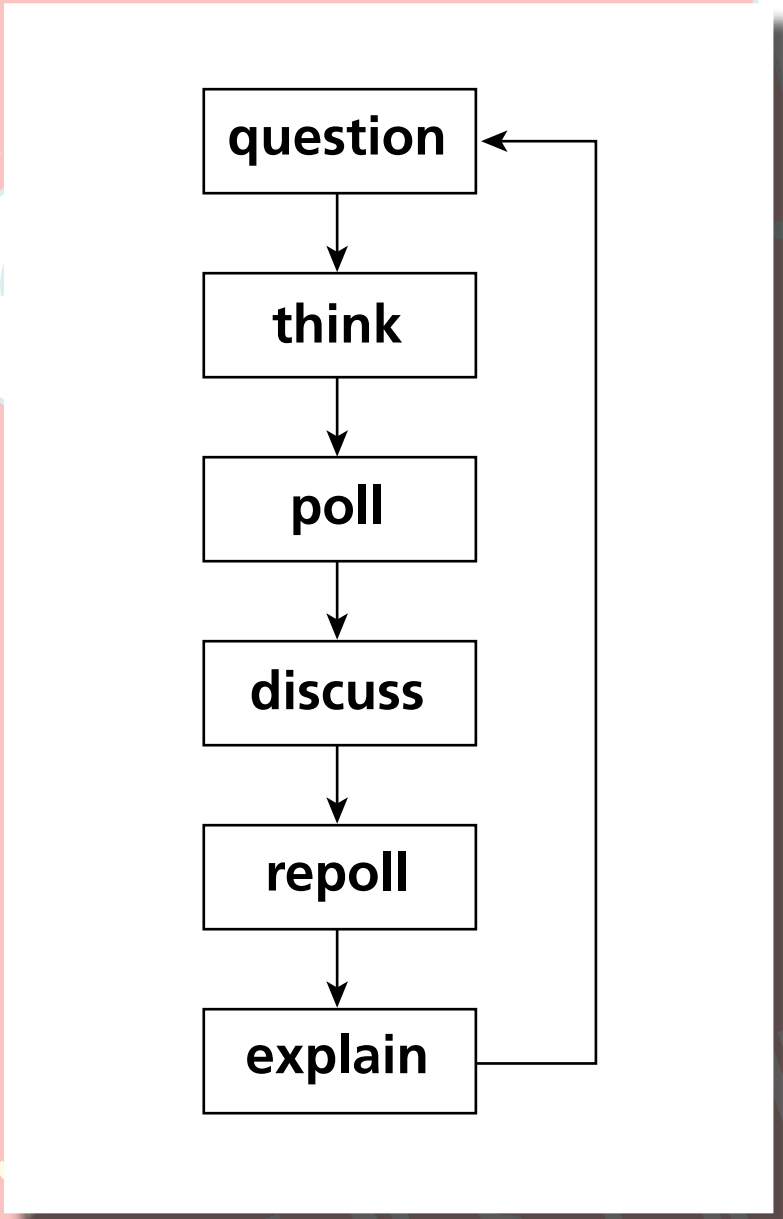


1 education

2 PI


question
think
poll
discuss
repoll


question
think
poll
discuss
repoll
explain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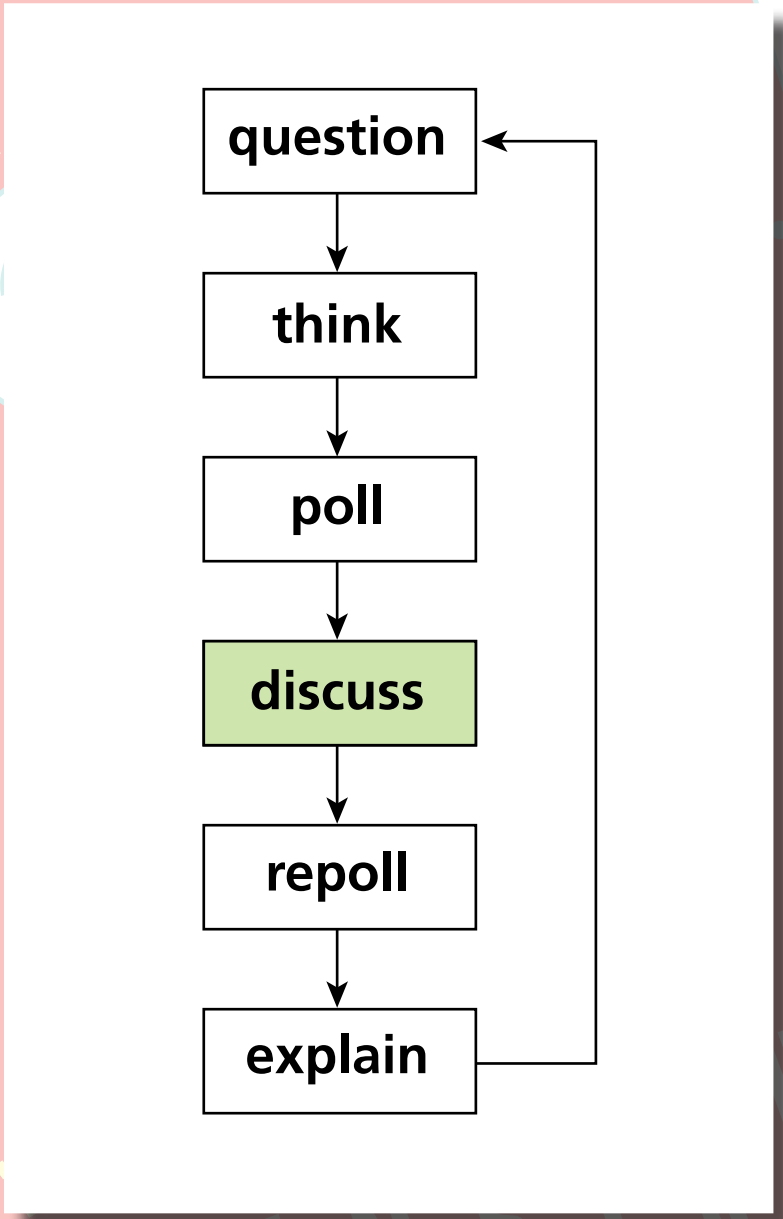
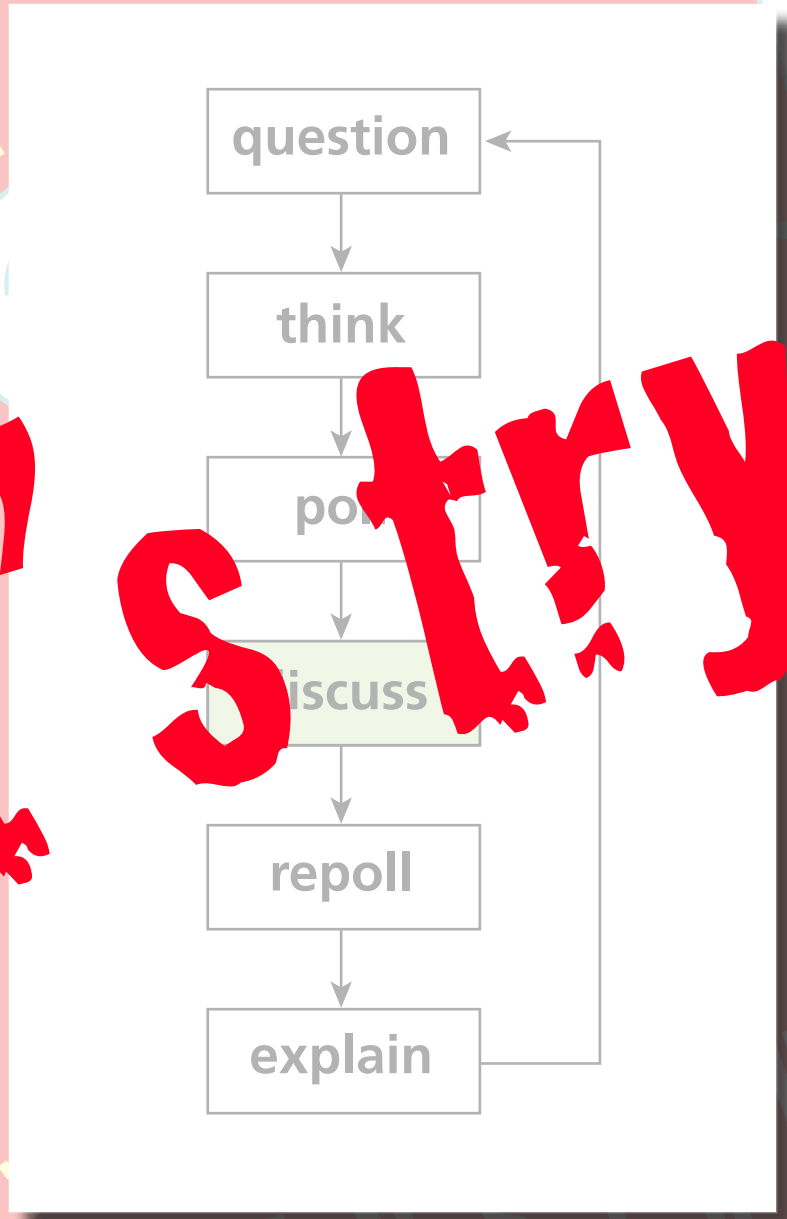


1 education

2 PI

1. lecture
2. PI



Let's try it!

1 education

2 PI

Archimedes' Principle

An object submerged either fully or partially in a fluid experiences an upward buoyant force the magnitude of which is equal to the magnitude of the force of gravity exerted on the fluid displaced by the object.

1 education 2 PI 3 test

An object submerged either fully or partially in a fluid experiences an upward buoyant force the magnitude of which is equal to the magnitude of the force of gravity exerted on the fluid displaced by the object. The volume of displaced fluid is equal to the volume of the submerged portion of the object.

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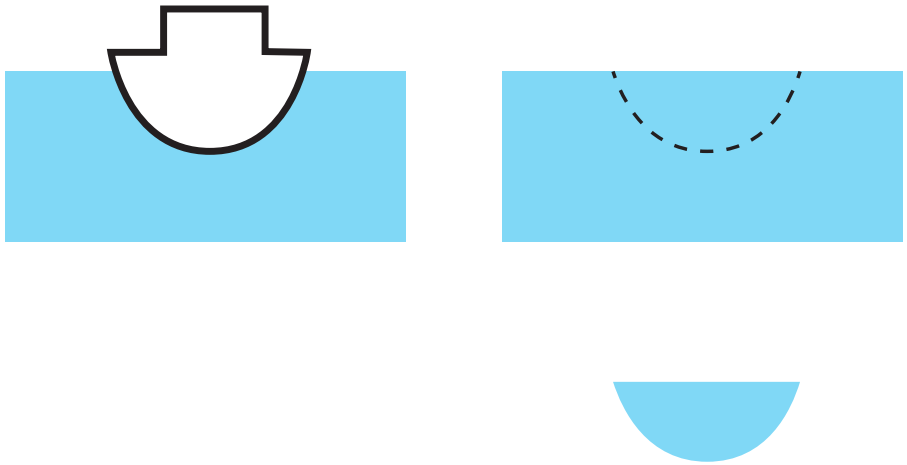
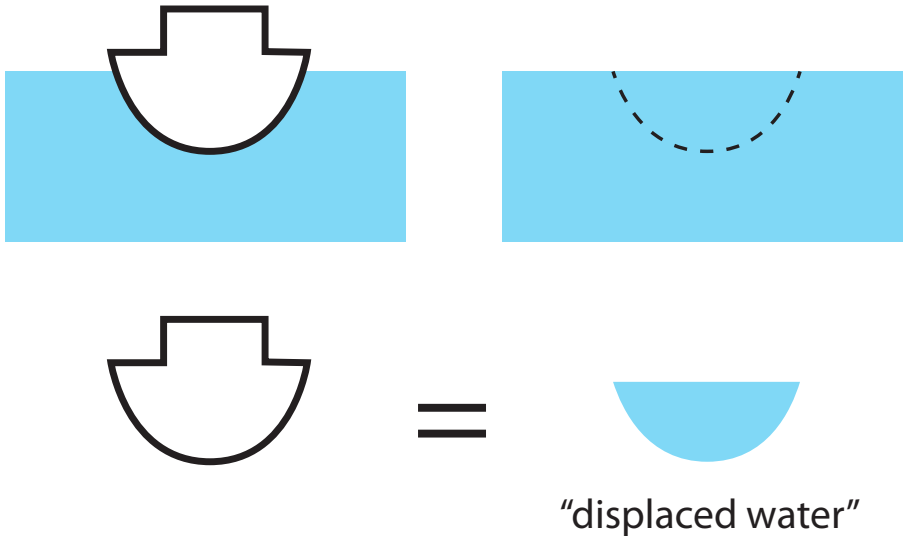


"displaced water"

An object submerged either fully or partially in a fluid experiences an upward buoyant force the magnitude of which is equal to the magnitude of the force of gravity exerted on the fluid displaced by the object. The volume of displaced fluid is equal to the volume of the submerged portion of the object.

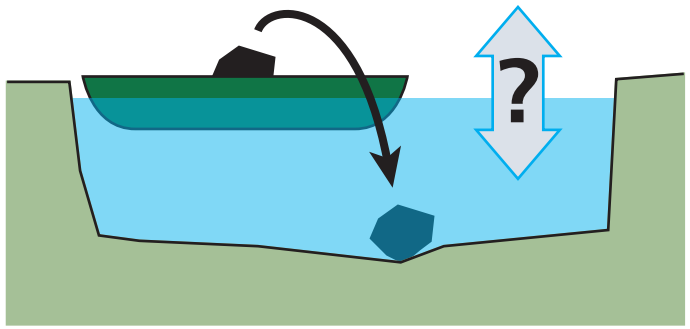


An object submerged either fully or partially in a fluid experiences an upward buoyant force the magnitude of which is equal to the magnitude of the force of gravity exerted on the fluid displaced by the object. The volume of displaced fluid is equal to the volume of the submerged portion of the object.

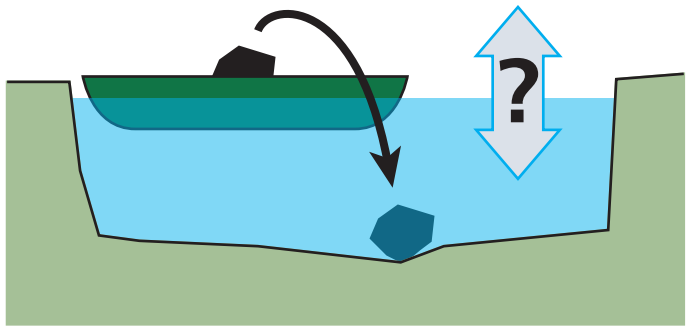
questions!

"displaced water"

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.



A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.

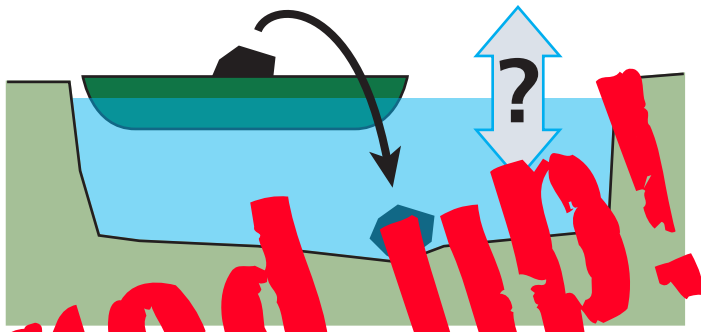


After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than

it was when the boulder was in the boat.

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.



After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
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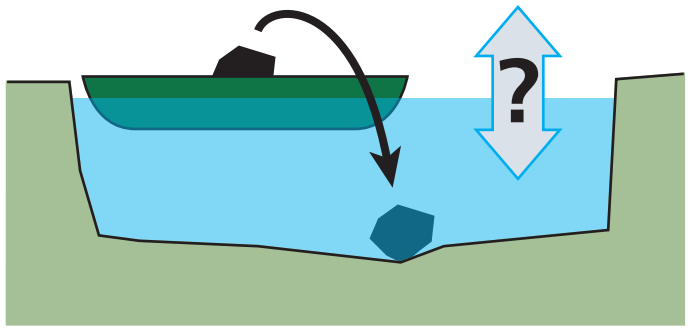
it was when the boulder was in the boat.

you got all fired up!

1 education 2 PI 3 test

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.



After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than

it was when the boulder was in the boat.

Before I tell you the answer…

1 education

2 PI

3 test

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

1 education 2 PI 3 test

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

You…

1 education 2 PI 3 test

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…

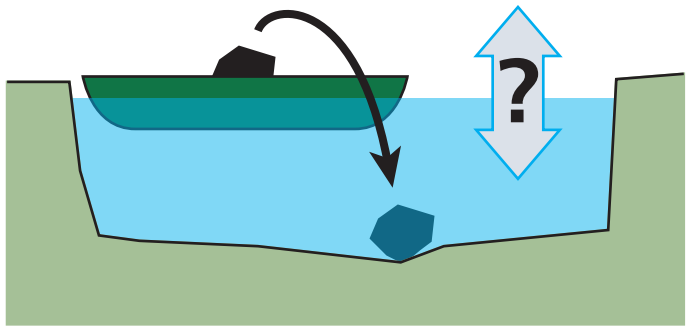
1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning

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

A boat carrying a large boulder is floating on a small pond. The boulder is thrown overboard and sinks to the bottom of the pond.



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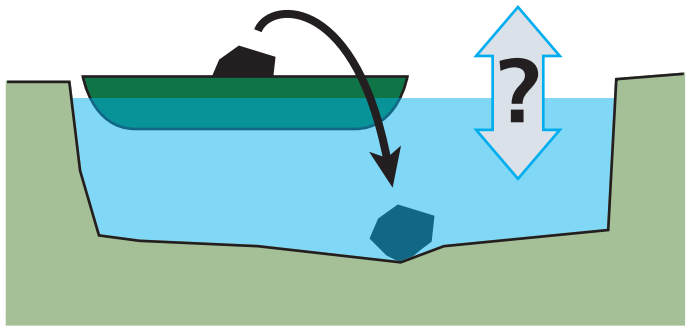


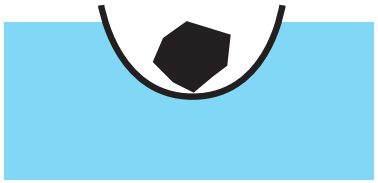
After the boulder sinks to the bottom of the pond, the level of the water in the pond is

1. higher than
2. the same as
3. lower than ✔

it was when the boulder was in the boat.

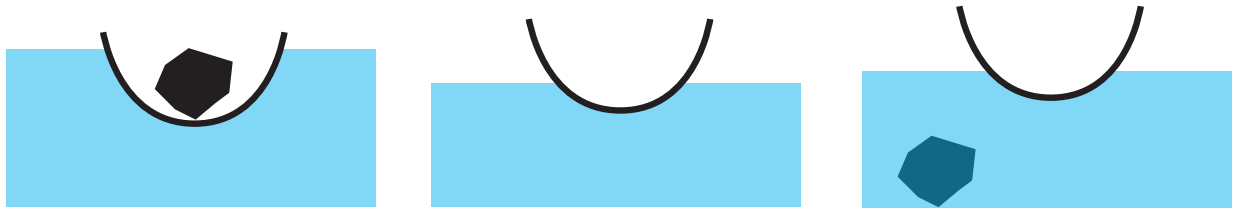
remember: amount of displaced water

remember: amount of displaced water

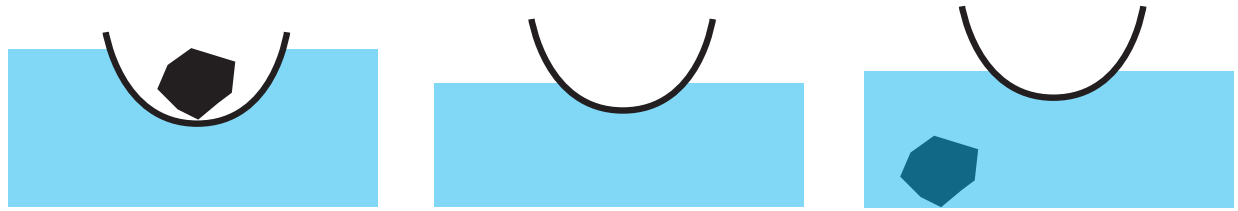


remember: amount of displaced water

remember: amount of displaced water

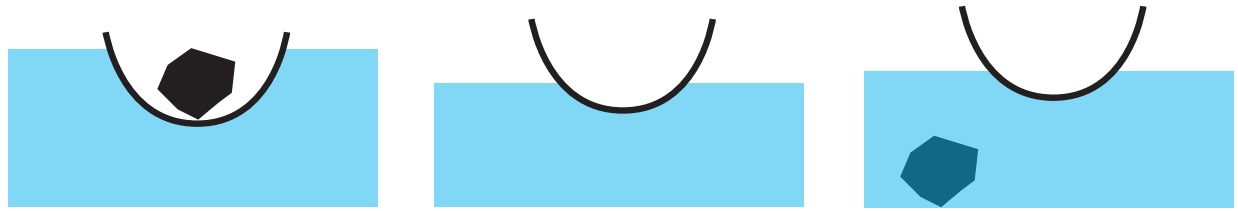


remember: amount of displaced water



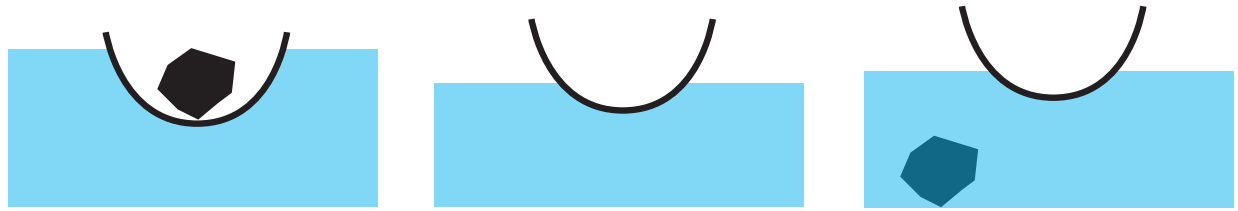
displaced
water

remember: amount of displaced water



displaced water = weight of rock

remember: amount of displaced water



displaced water = weight of rock

= volume of rock

remember: amount of displaced water

you won't forget this

1 education 2 PI 3 test

1 education 2 PI 3 test

Peer
Higher learning gains
INSTRUCTION
1 education
2 PI
3 test

Peer
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

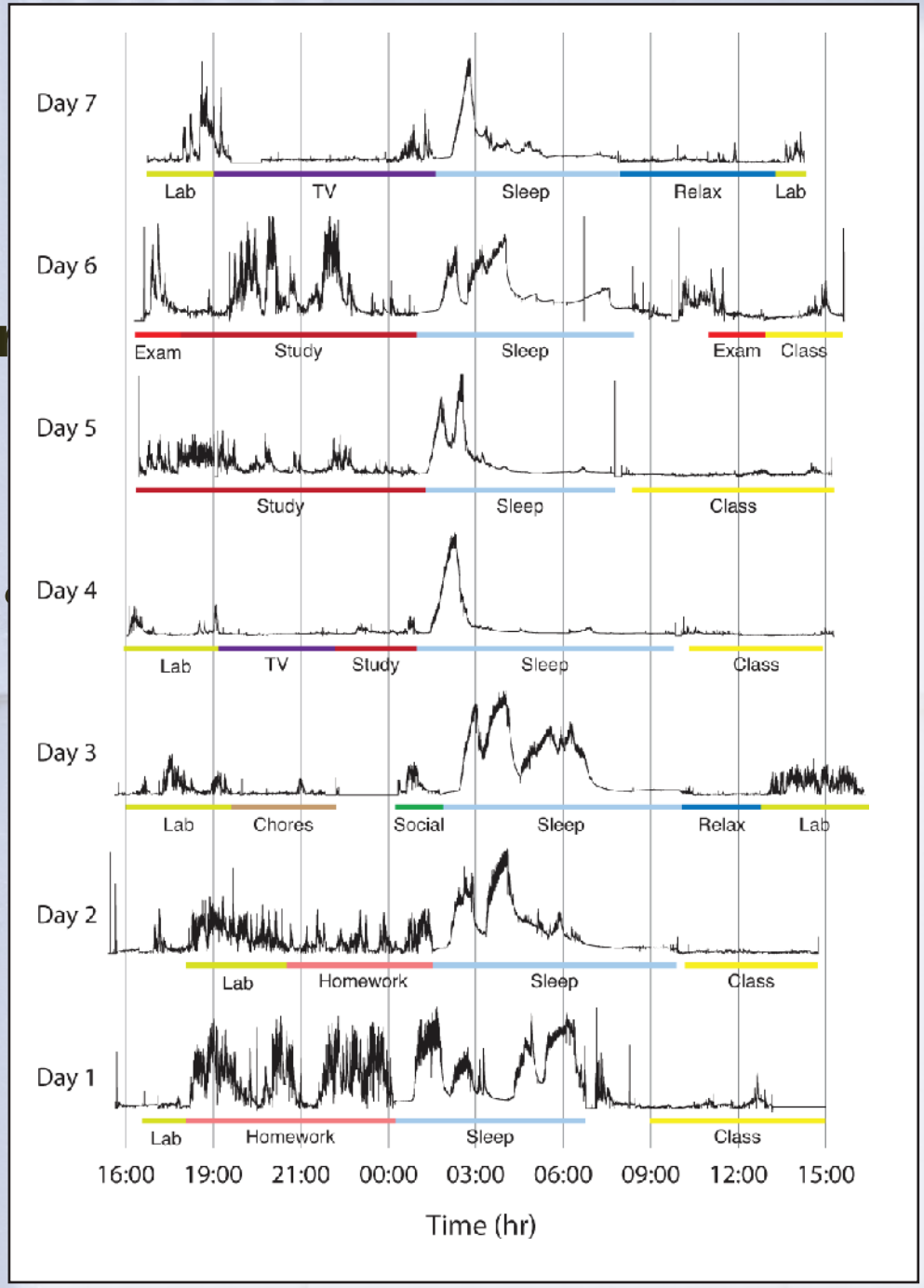
3 test

in a lecture, students…

1. don’t pay utmost attention

in a lectur

1. don’t pay utmost

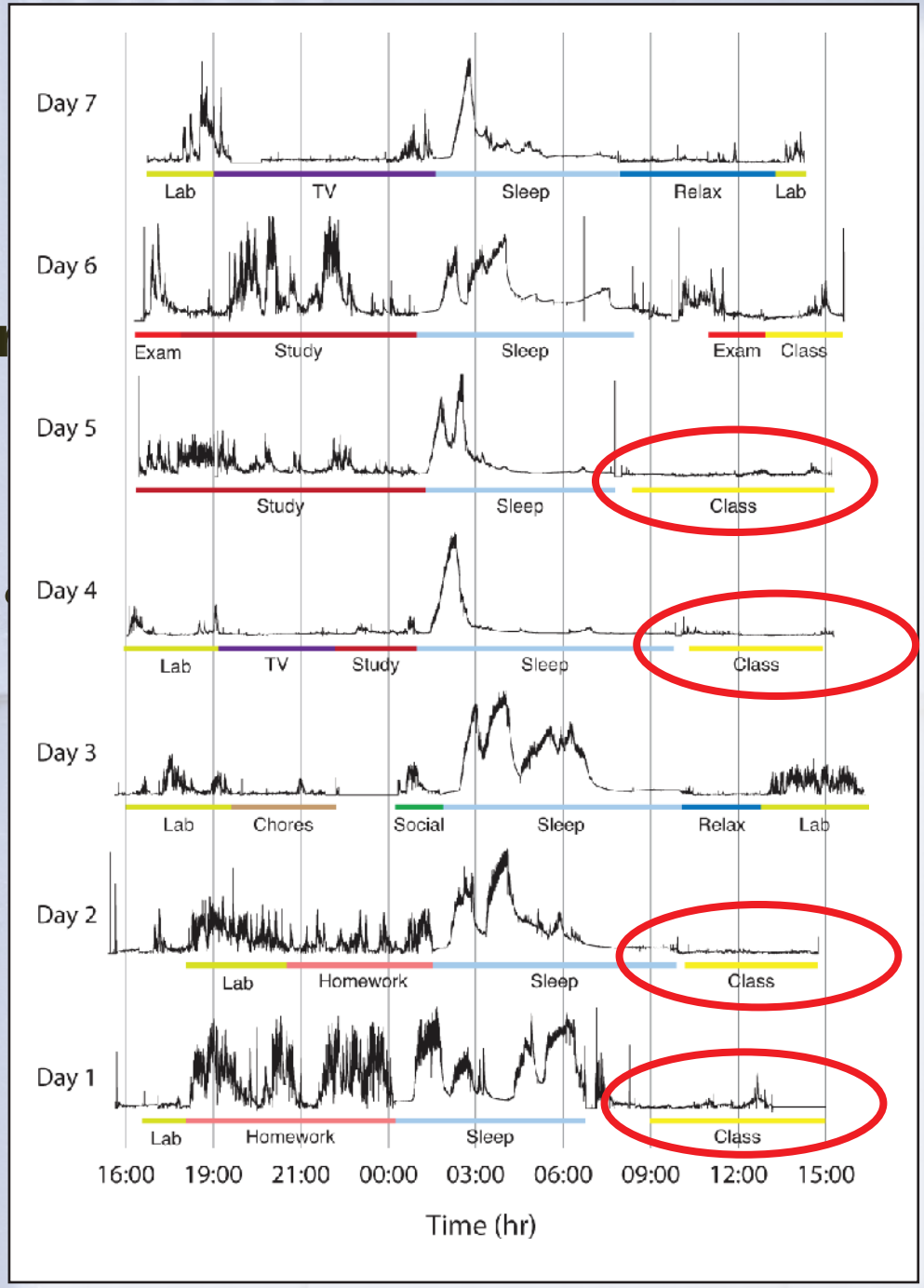


doi: 10.1109/TBME.2009.2038487

1 education 2 PI 3 test

in a lectur

1. don’t pay utmost



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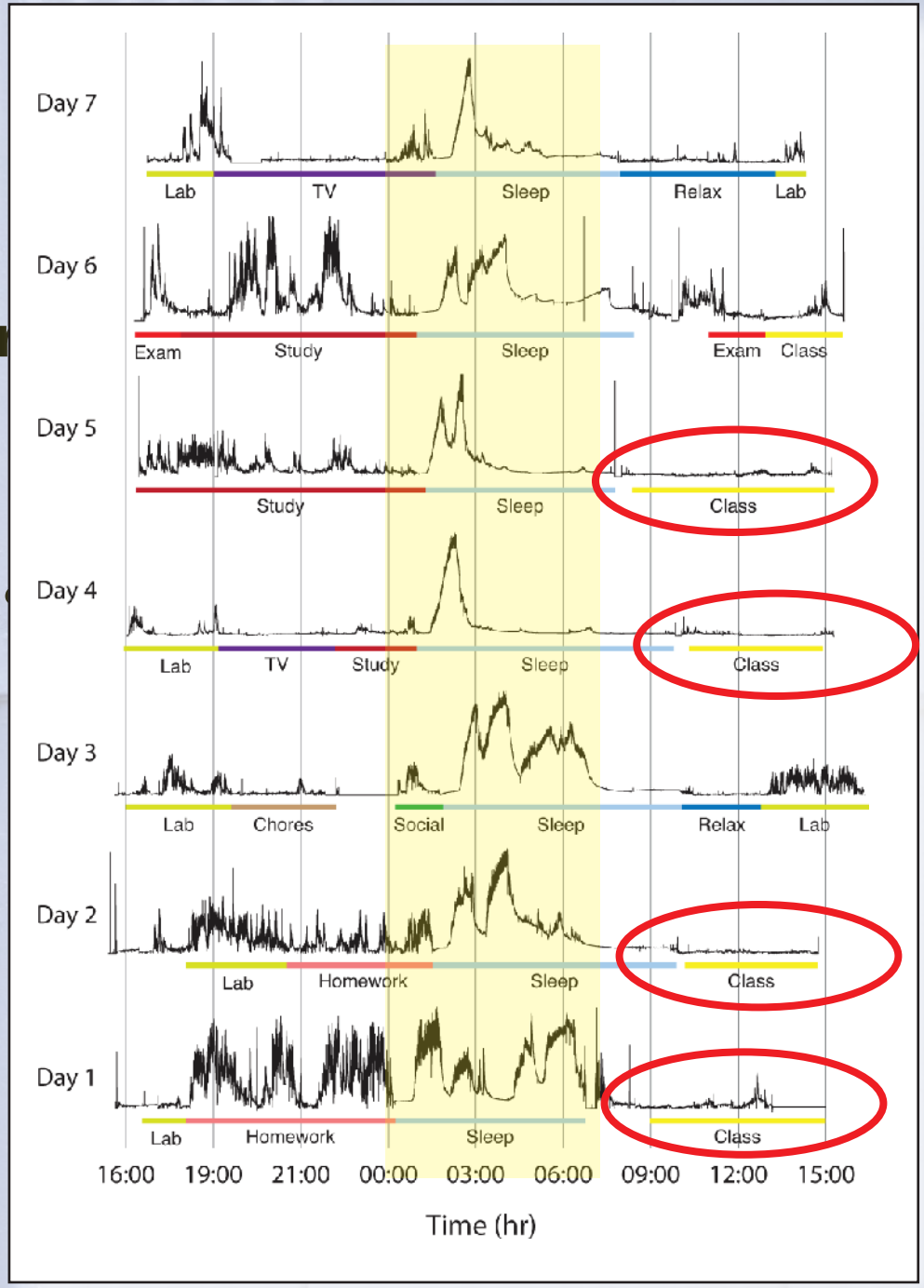
1 education 2 PI 3 test

in a lectur

1. don’t pay utmost



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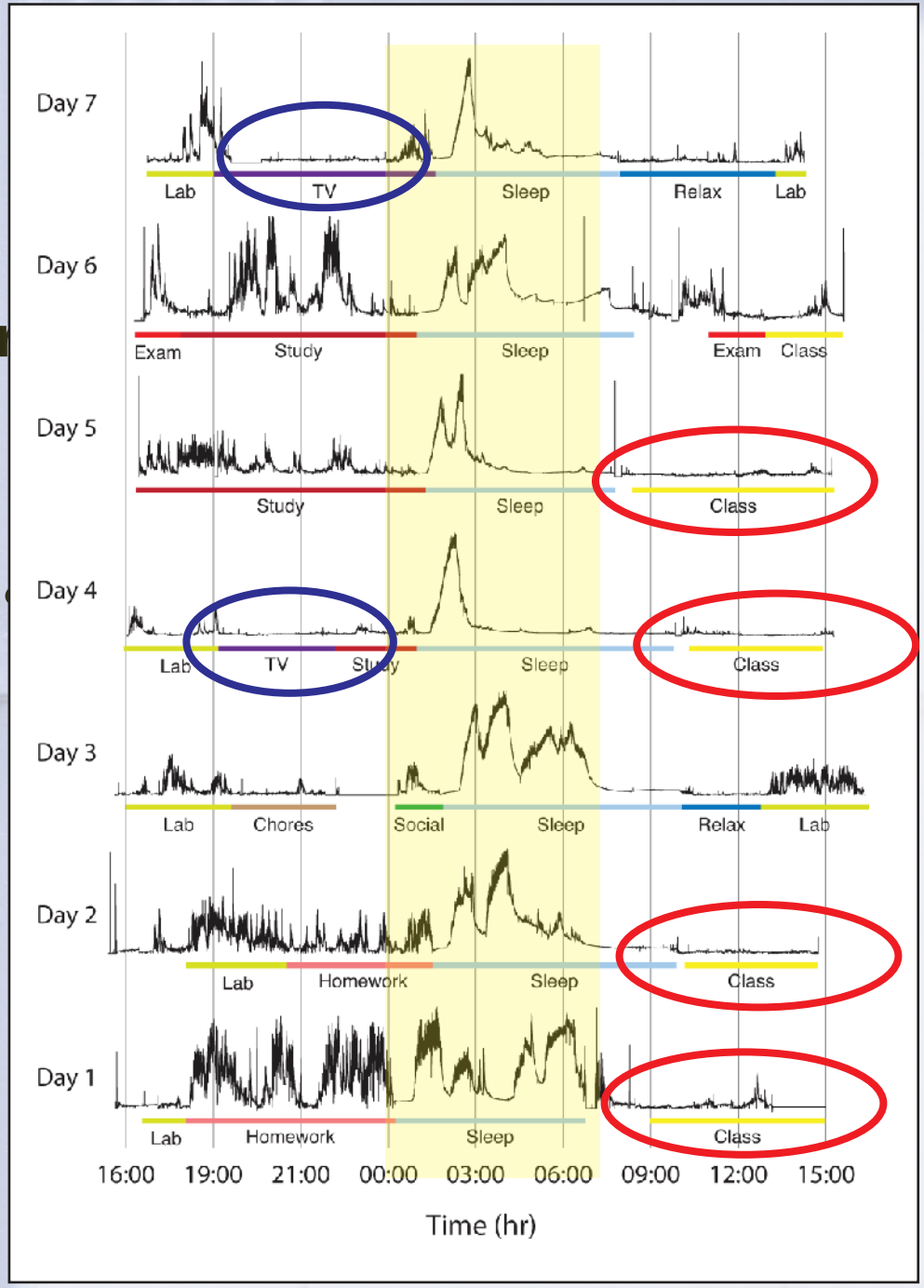
1 education 2 PI 3 test

in a lectur

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

1 education 2 PI 3 test

1991
1 lecture
2 PI
3 PI 2.0

1 lecture

2 PI

3 PI 2.0

1 lecture 2 PI 3 PI 2.0

1 lecture

2 PI

3 PI 2.0

1 lecture 2 PI 3 PI 2.0

How do I…

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

learning | catalytics
1 lecture
2 PI
3 PI 2.0

Use intelligent algorithms and data analytics to…

- improve questioning
- manage discussions
- facilitate time management/flow

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a. A 30-year fixed rate
b. A 15-year fixed rate mortgage at
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 ov
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 would most likely use which

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

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

business model

preciation?

extensible plug-in architecture for question types

1 lecture 2 PI 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

Sample question types:

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4. directi… …tle. The image provides several clues about the direction of prevailing … …n your screen.

Deliver Show all results

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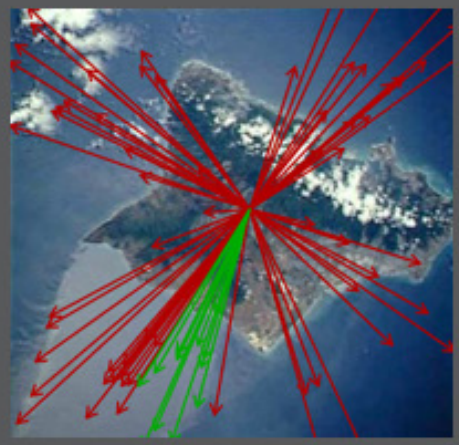
4. directi… prevailing …tle. The image provides several clues about the direction of …n your screen.

Deliver Show all results

Round 1

77 responses, 16% correct



17 get it now

3 still don't get it

1 lecture

3 PI 2.0

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current session: 766079 | 69 students

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◀ Jump to ▼ 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 ▶

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

Deliver | Show all results

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

feedback & support

1 lecture 2 PI 3 PI 2.0

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optics i

current session: 766079 | 69 students

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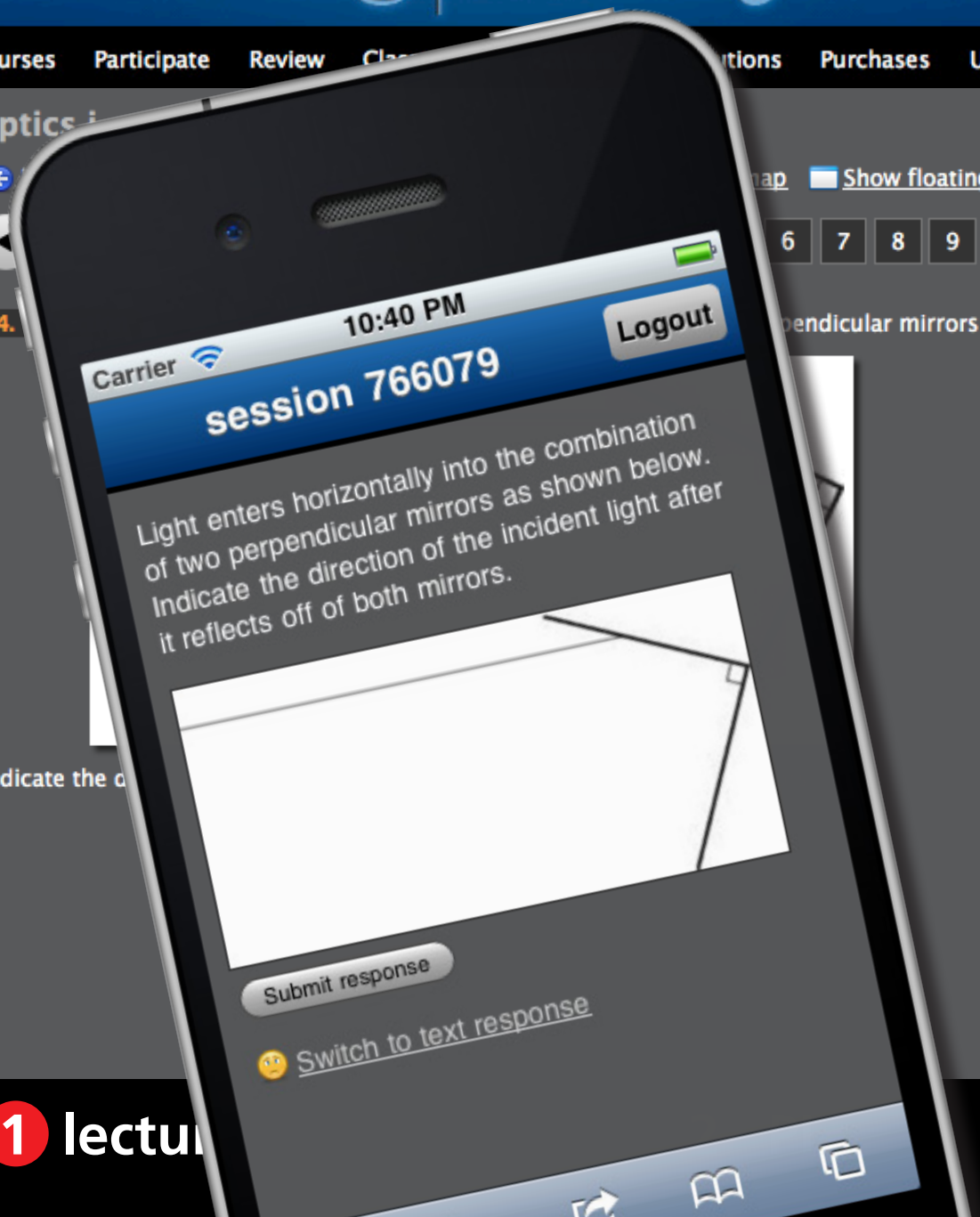
6 7 8 9 10 11 12 13 14 15

4. endicular mirrors as shown below.

Deliver Show all results

Indicate the d

feedback & support



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6 7 8 9 10 11 12 13 14 15

4.

endicular mirrors as shown below.

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Indicate the d

feedback & support

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optics i

current session: 766079 | 69 students

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6 7 8 9 10 11 12 13 14 15

4.

endicular mirrors as shown below.

Deliver Show all results

Round 1

57 responses, 58% correct

Indicate the d

feedback & support

1 lectu

3 PI 2.0

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Courses Participate Review Cla tions Purchases Users Tour Help

optics i

current session: 766079 | 69 students

ap Show floating session ID Edit Delete

6 7 8 9 10 11 12 13 14 15

4.

endicular 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

Indicate the d

feedback & support

1 lectu

3 PI 2.0

Sample question types:

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

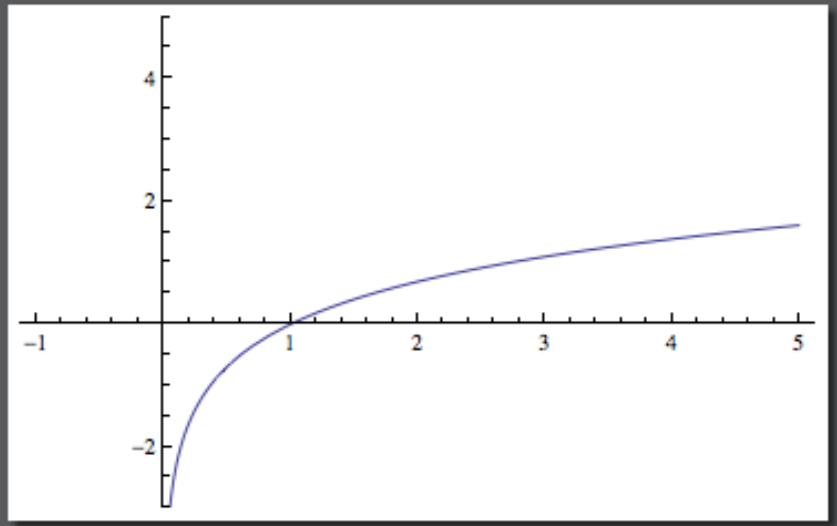
If $2x - y = 4$, then $x =$

1 lecture 2 PI 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

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



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

1 lecture

3 PI 2.0

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This is a graph of $f(x)$ =
Carrier
10:30 PM
Logout
Refresh
session 333281
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

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

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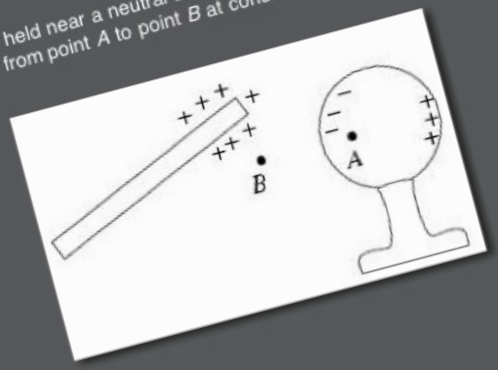
A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point *A* to point *B* at constant speed. The potential difference from *A* to *B* is



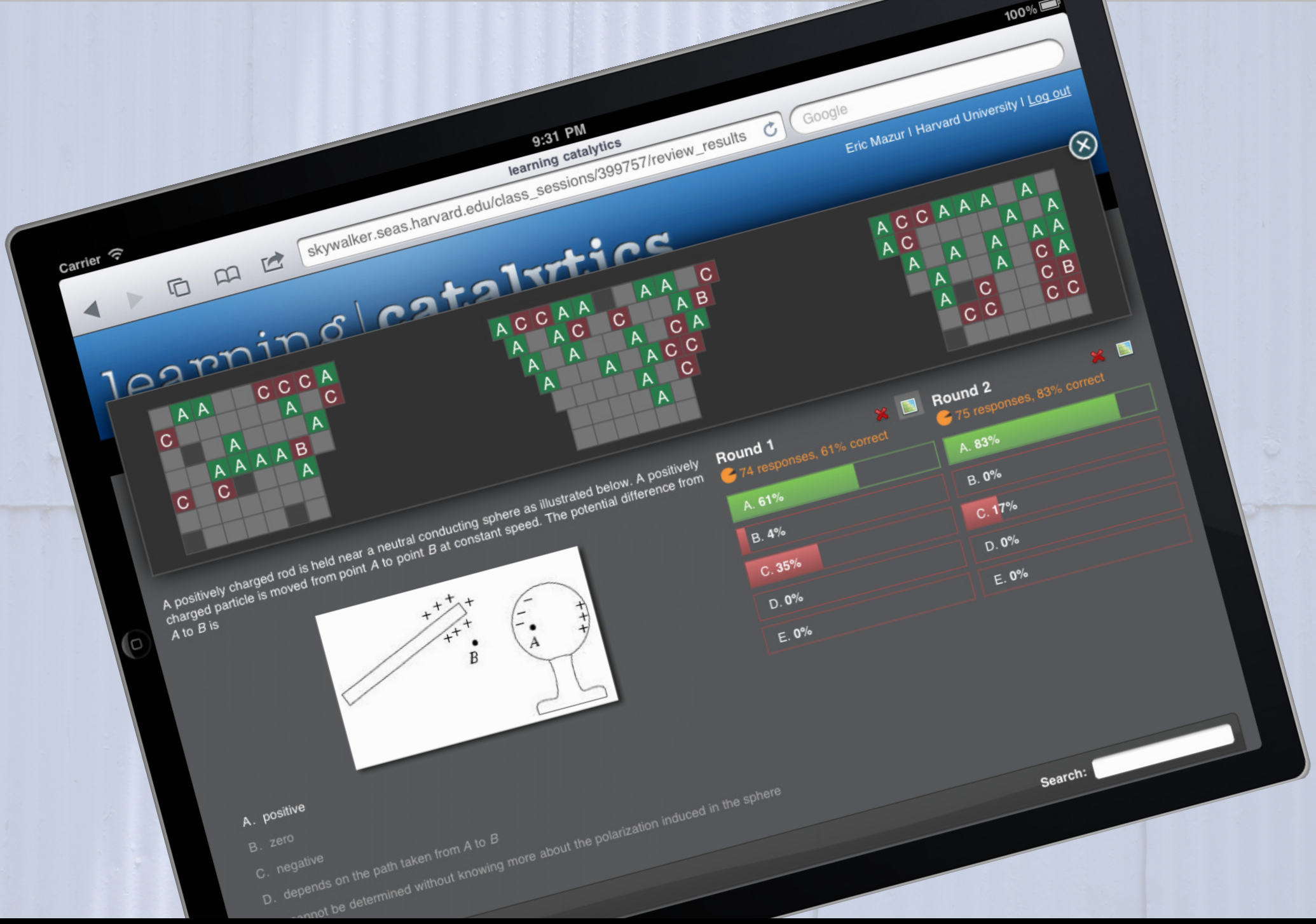
A. positive
B. zero
C. negative
D. depends on the path taken from *A* to *B*
cannot be determined without knowing more about the polarization induced in the sphere

Round 1
74 responses, 61% correct
A. 61%
B. 4%
C. 35%
D. 0%
E. 0%

Round 2
75 responses, 83% correct
A. 83%
B. 0%
C. 17%
D. 0%
E. 0%

Search:

1 lecture 2 PI 3 PI 2.0



1 lecture

2 PI

3 PI 2.0

Carrier 9:31 PM 100%

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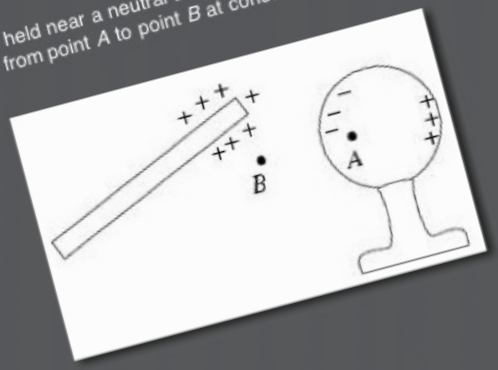

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B. zero
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E. cannot be determined without knowing more about the polarization induced in the sphere

Round 1
74 responses, 61% correct
A. 61%
B. 4%
C. 35%
D. 0%
E. 0%

Round 2
75 responses, 83% correct
A. 83%
B. 0%
C. 17%
D. 0%
E. 0%

Search:

1 lecture 2 PI 3 PI 2.0

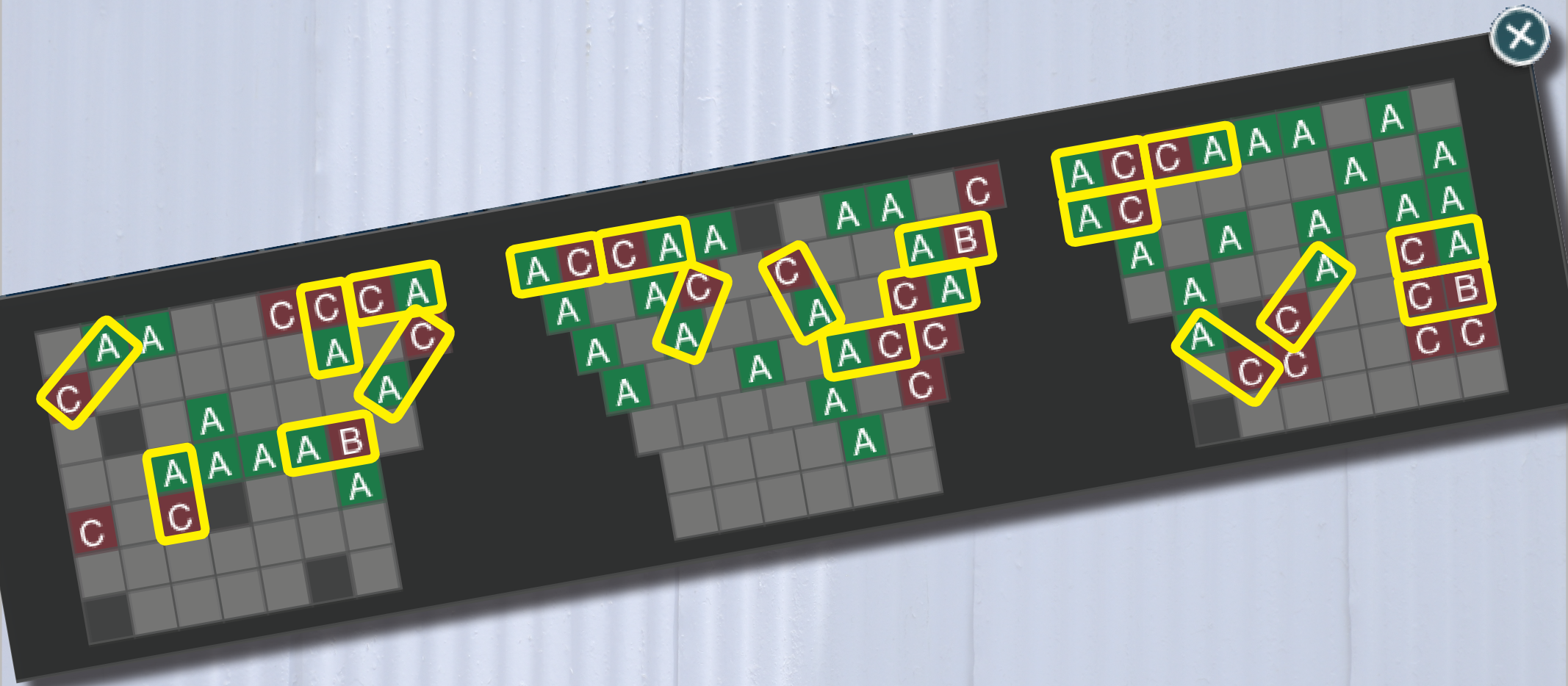
1 lecture

2 PI

3 PI 2.0

let system manage pairing

1 lecture 2 PI 3 PI 2.0



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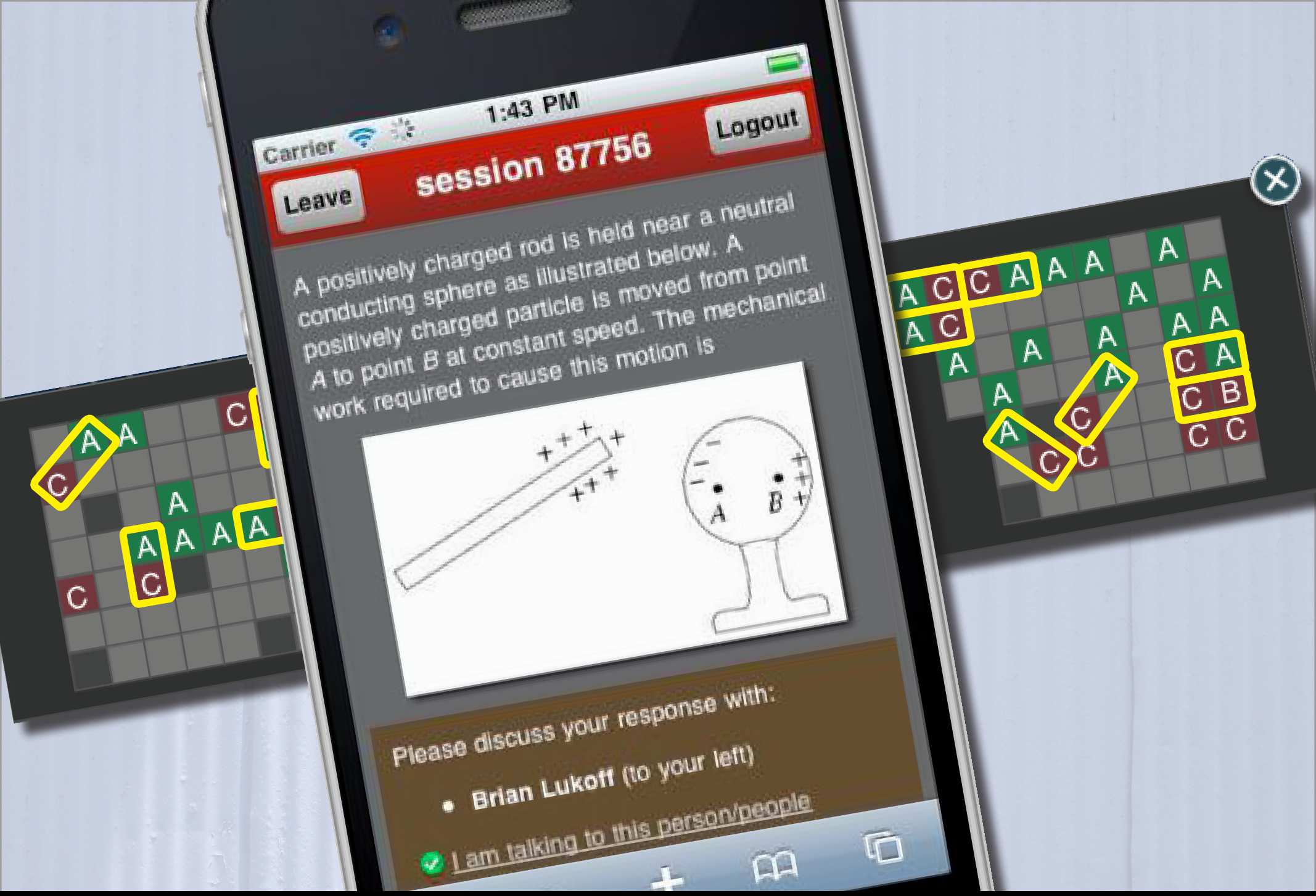
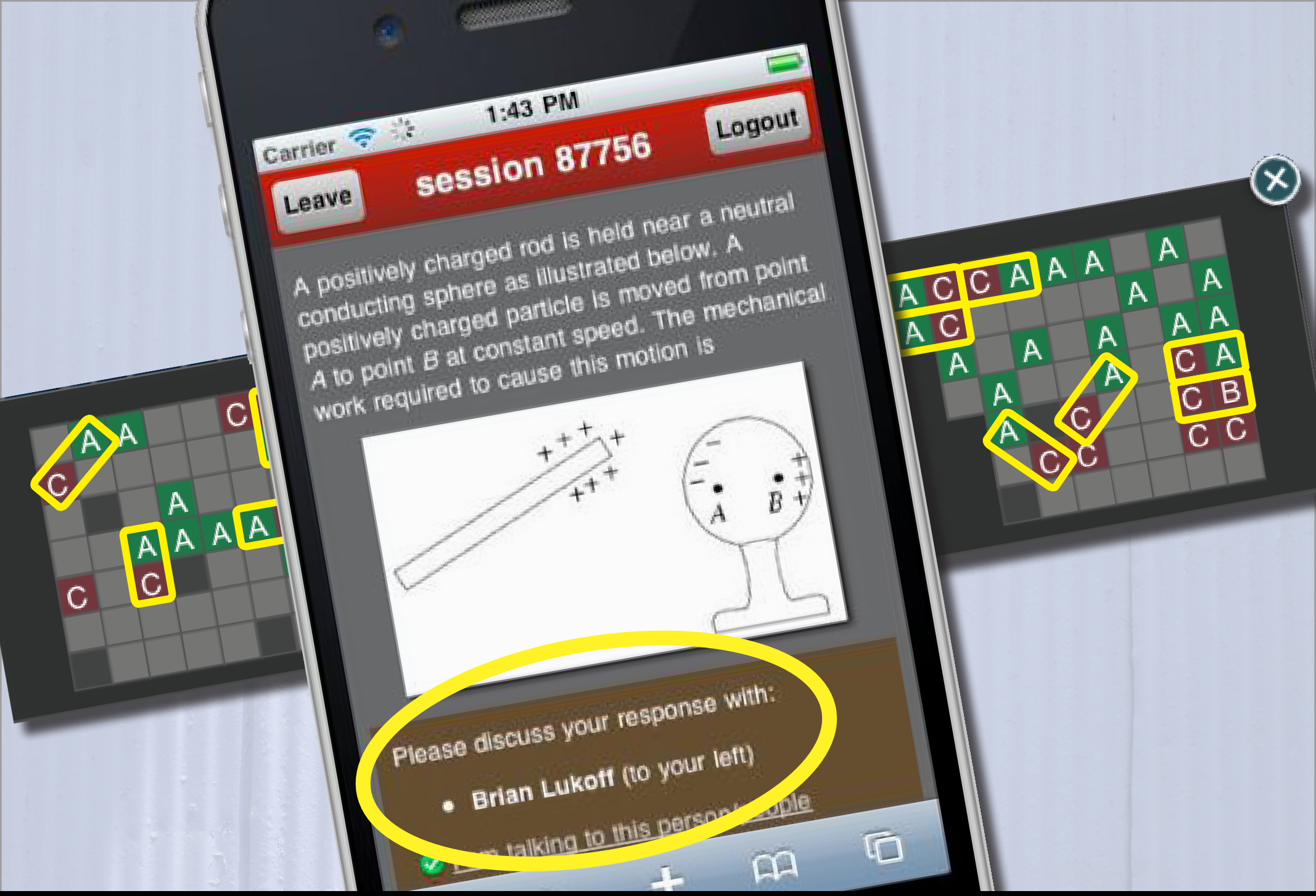


1 lecture

2 PI

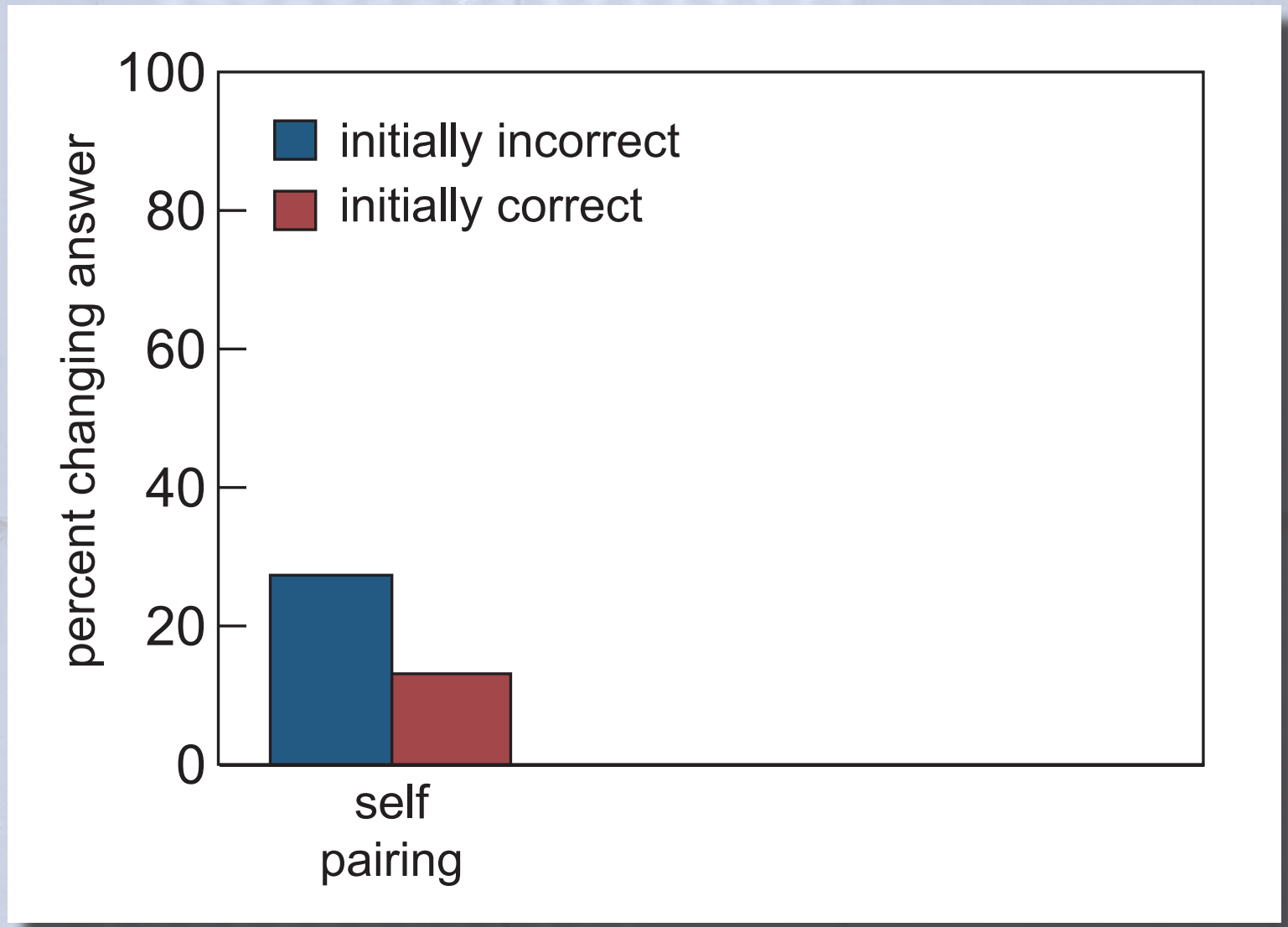
3 PI 2.0

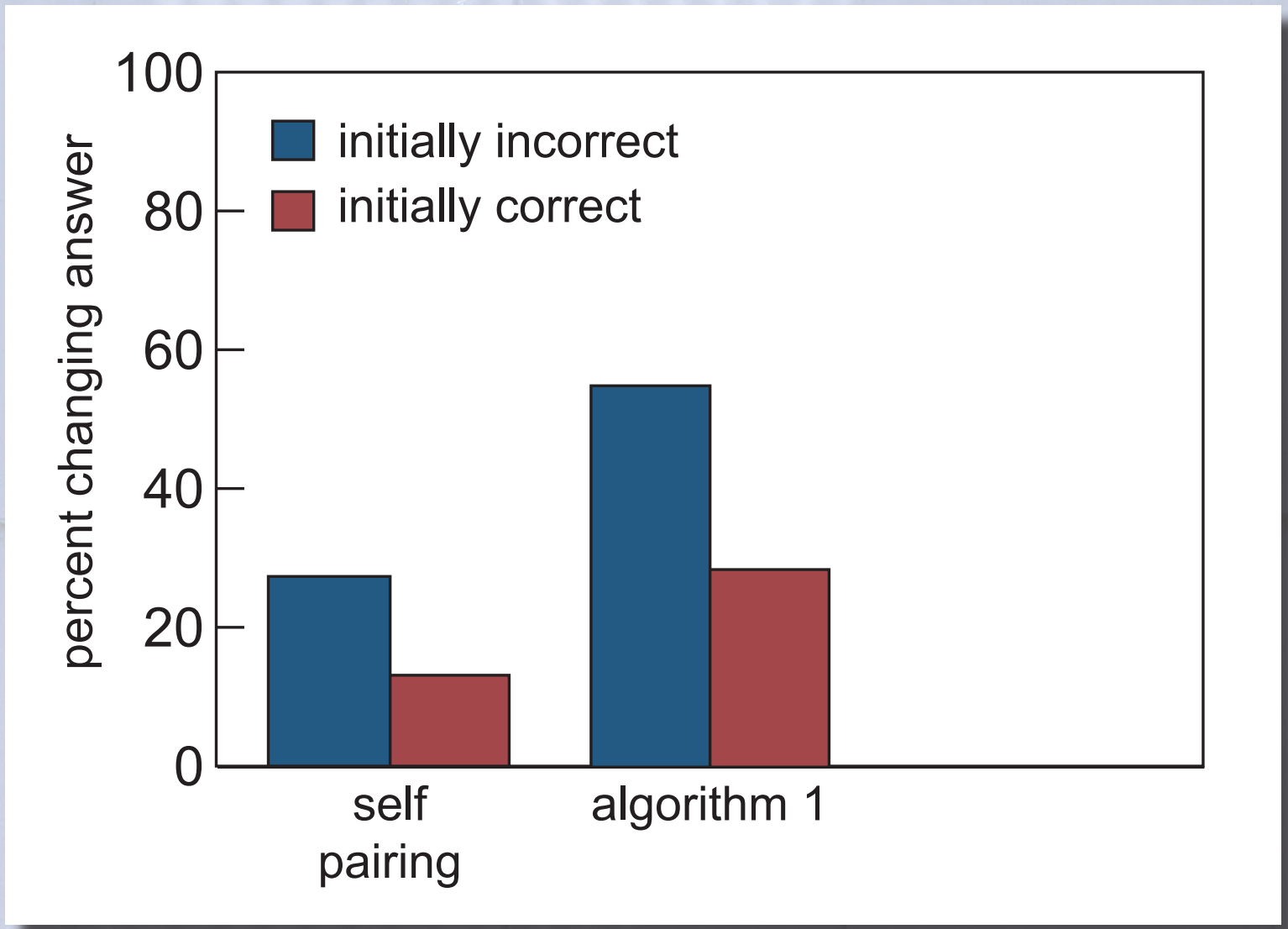


1 lecture

2 PI

3 PI 2.0


100
80
60
40
20
0
percent changing answer
initially incorrect
initially correct
self
pairing


100
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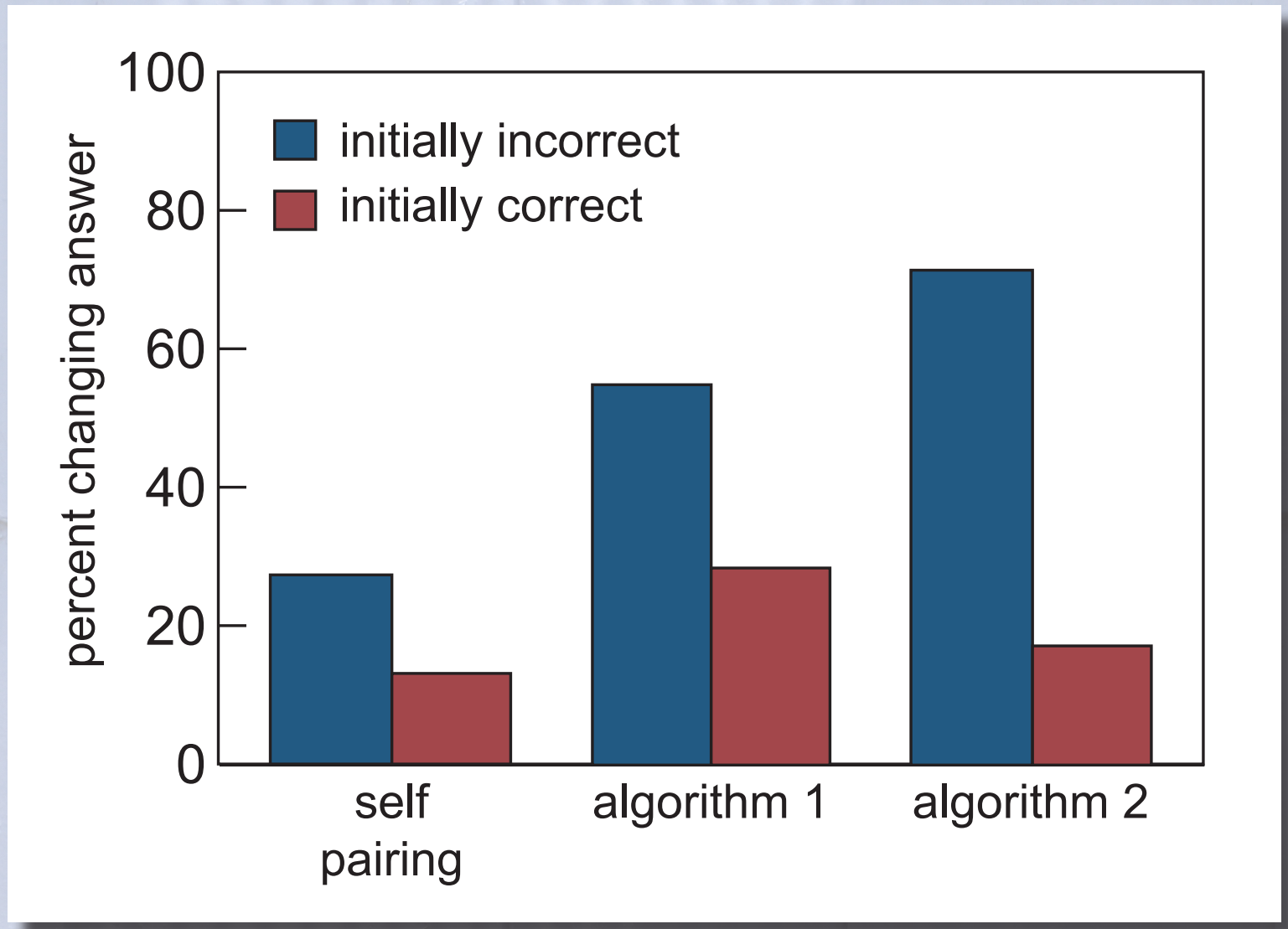
60
40
20
0
percent changing answer
initially incorrect
initially correct
self pairing
algorithm 1


100
80
60
40
20
0
percent changing answer
initially incorrect
initially correct
self pairing
algorithm 1
algorithm 2

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:

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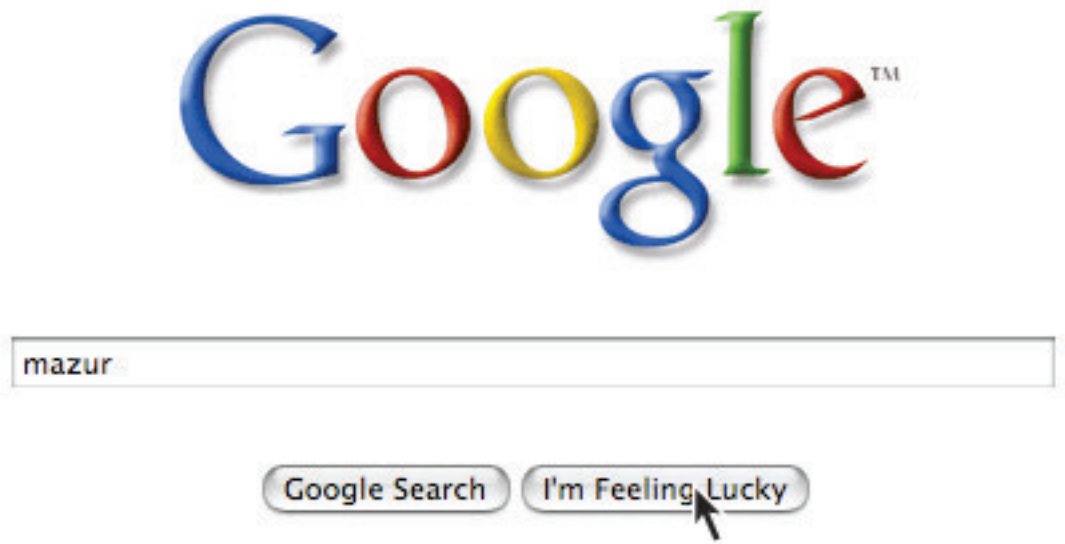
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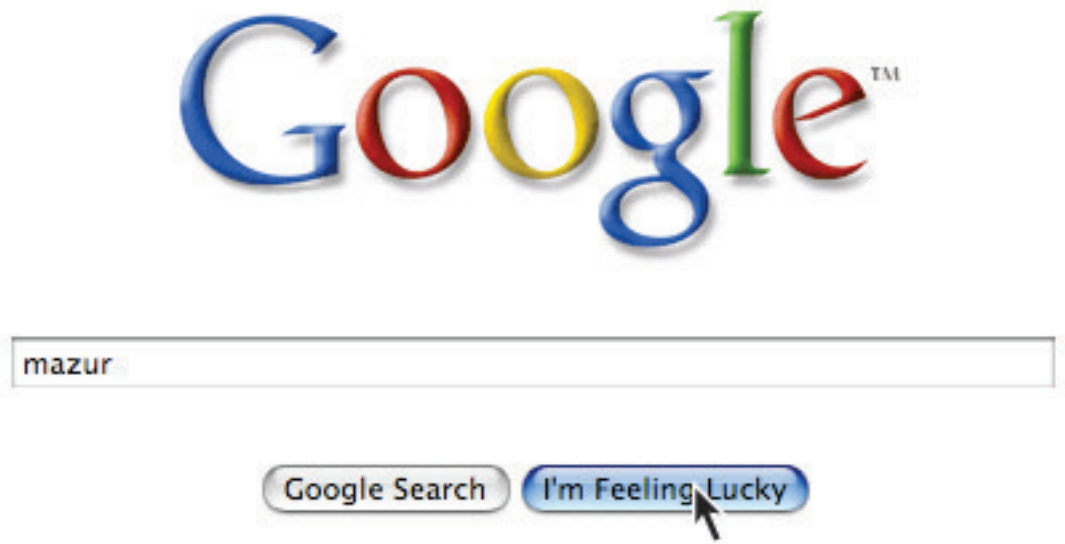
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