

Educating the innovators of the 21st century



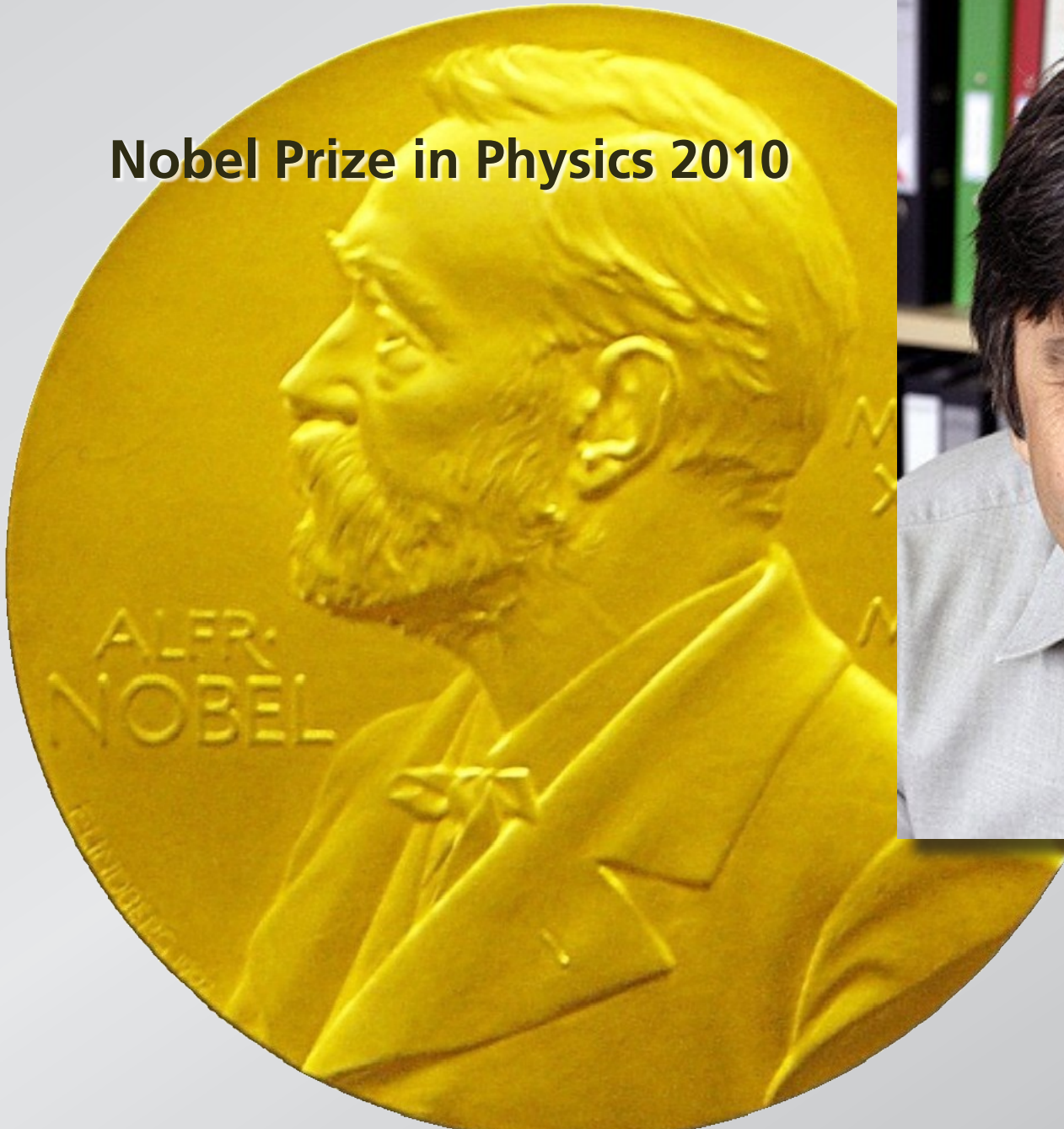
@eric_mazur

The University of Hong Kong
Hong Kong, China, 28 March 2017



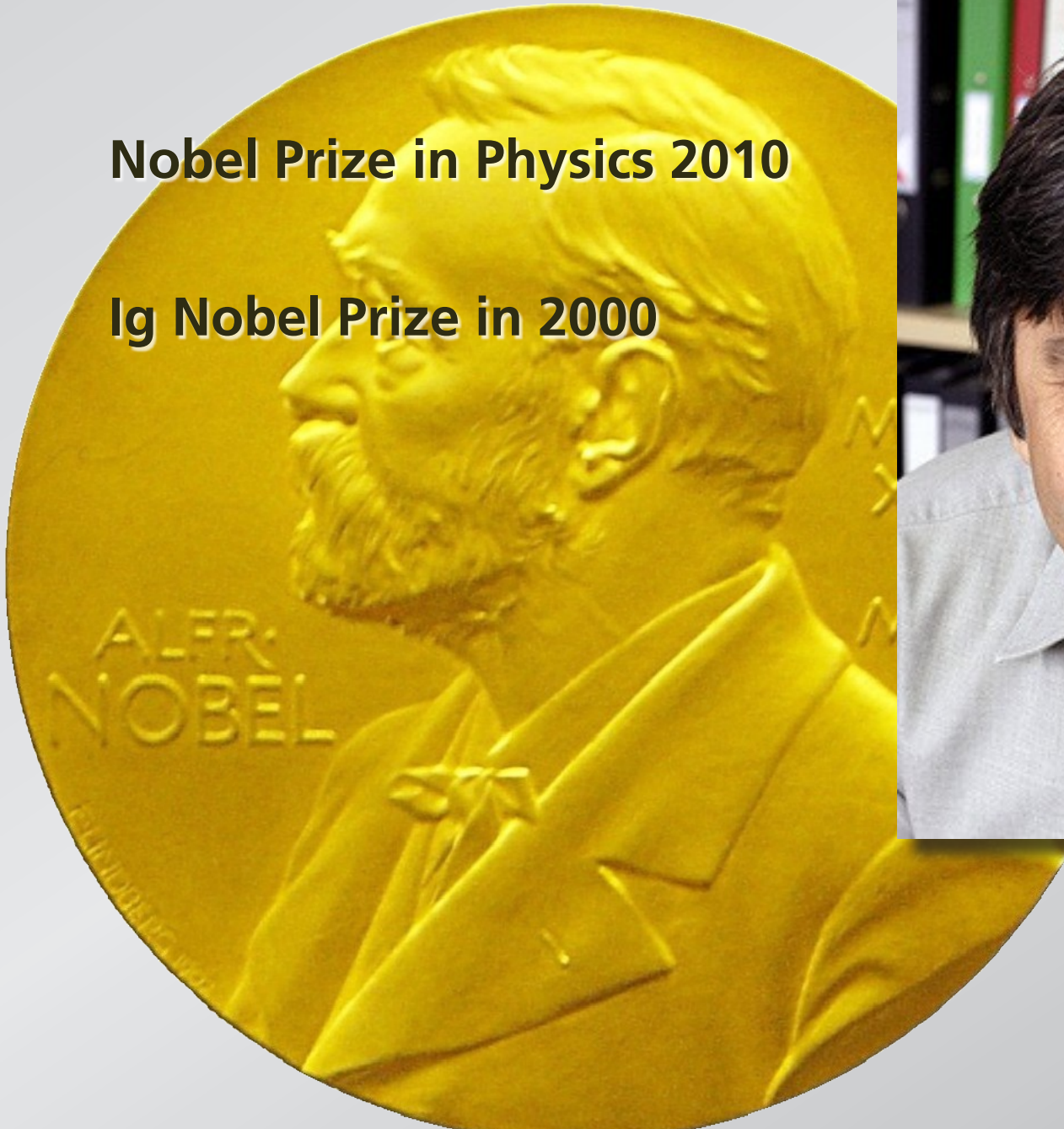
Innovation

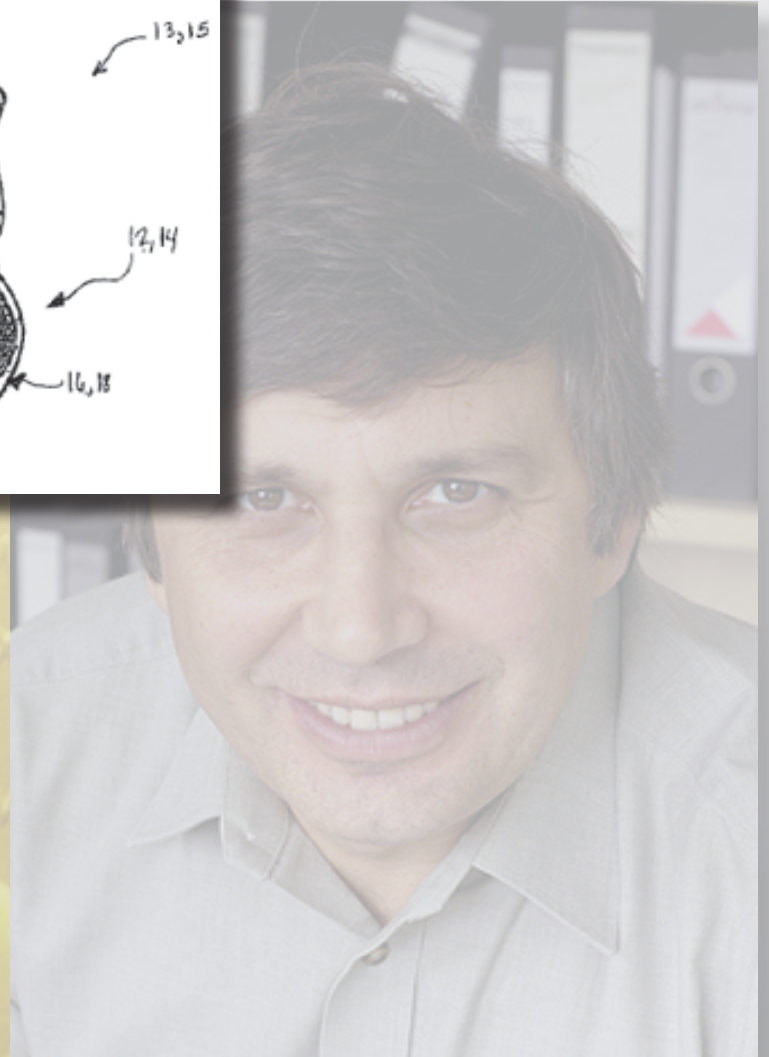
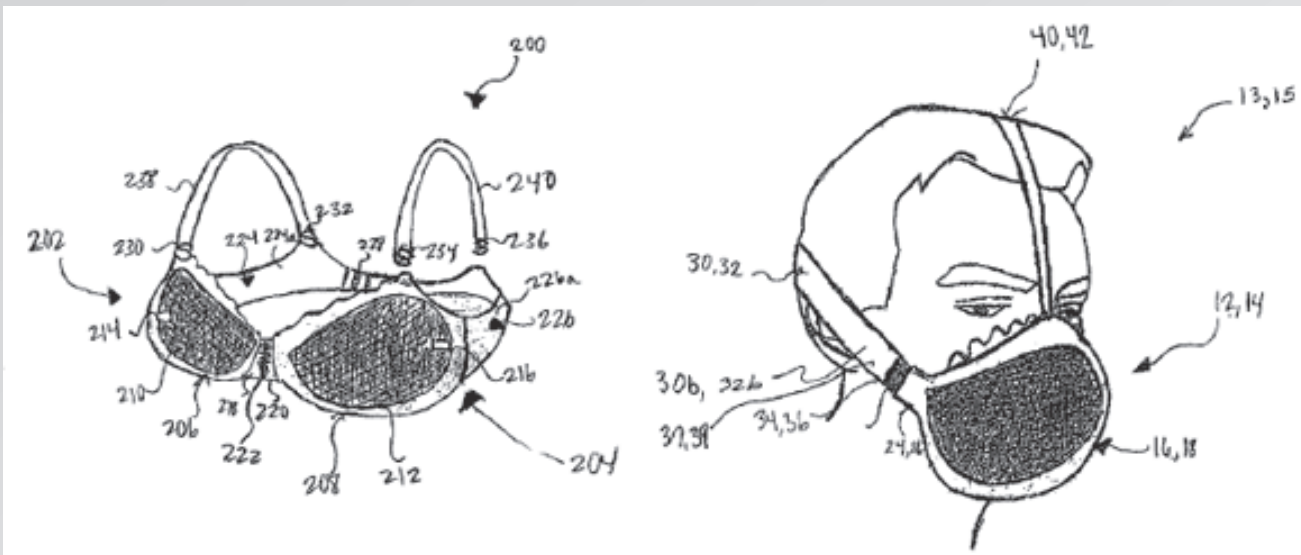
Nobel Prize in Physics 2010

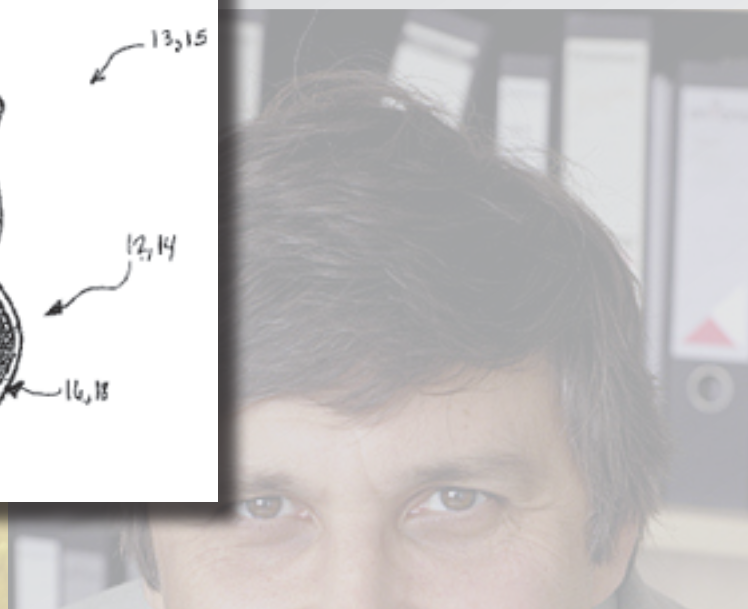
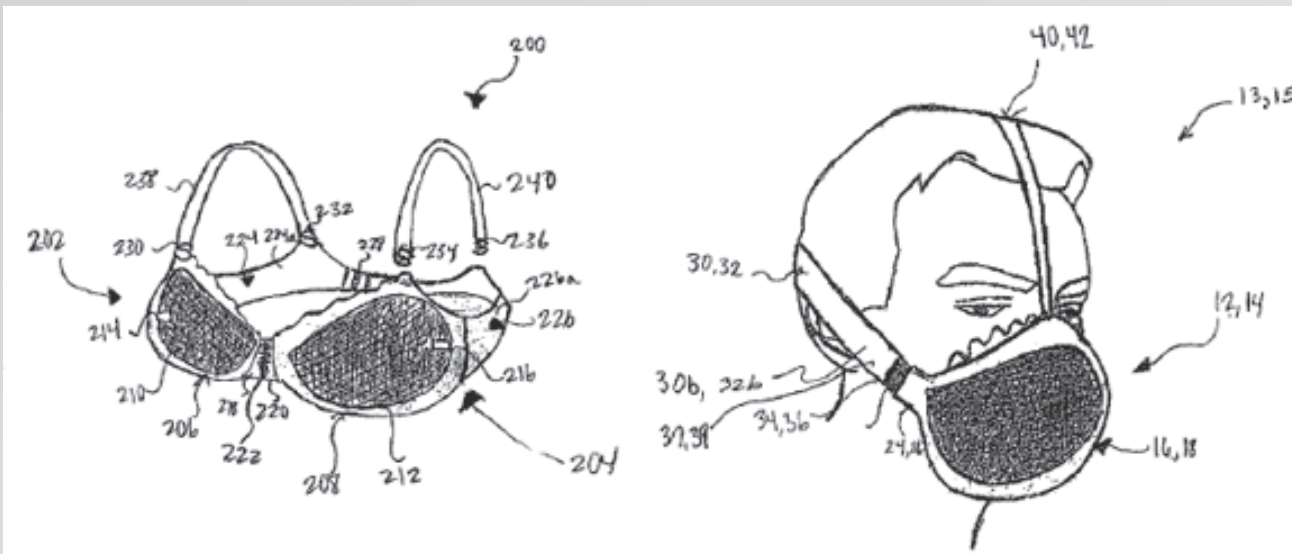


Nobel Prize in Physics 2010

Ig Nobel Prize in 2000



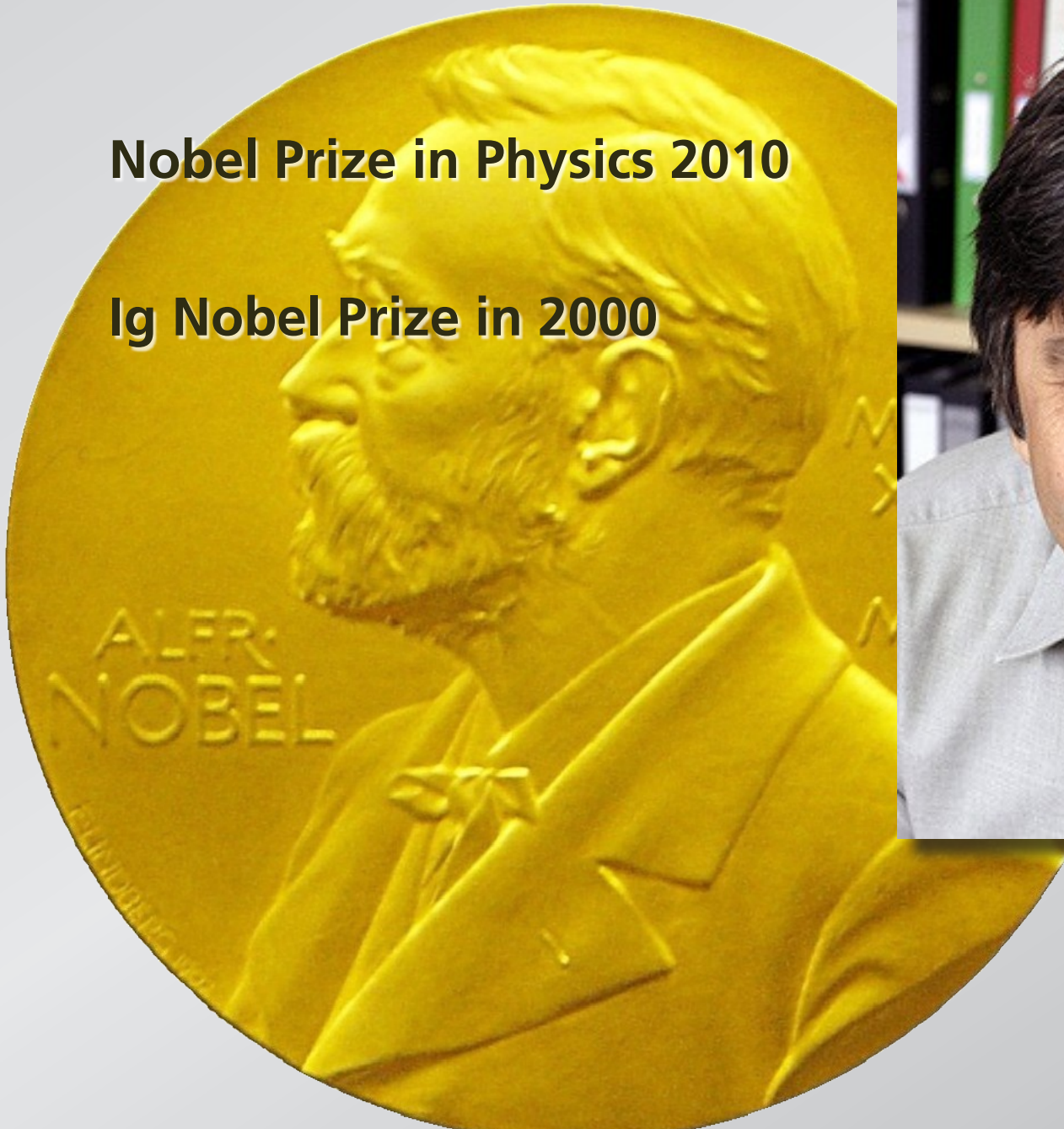




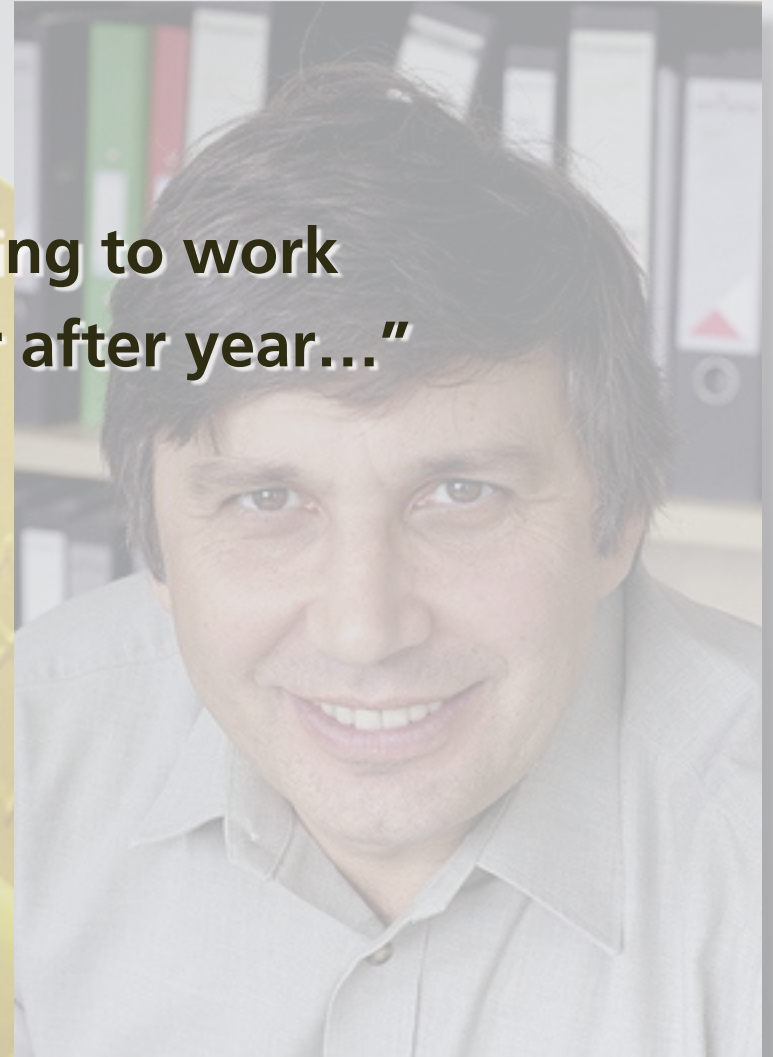


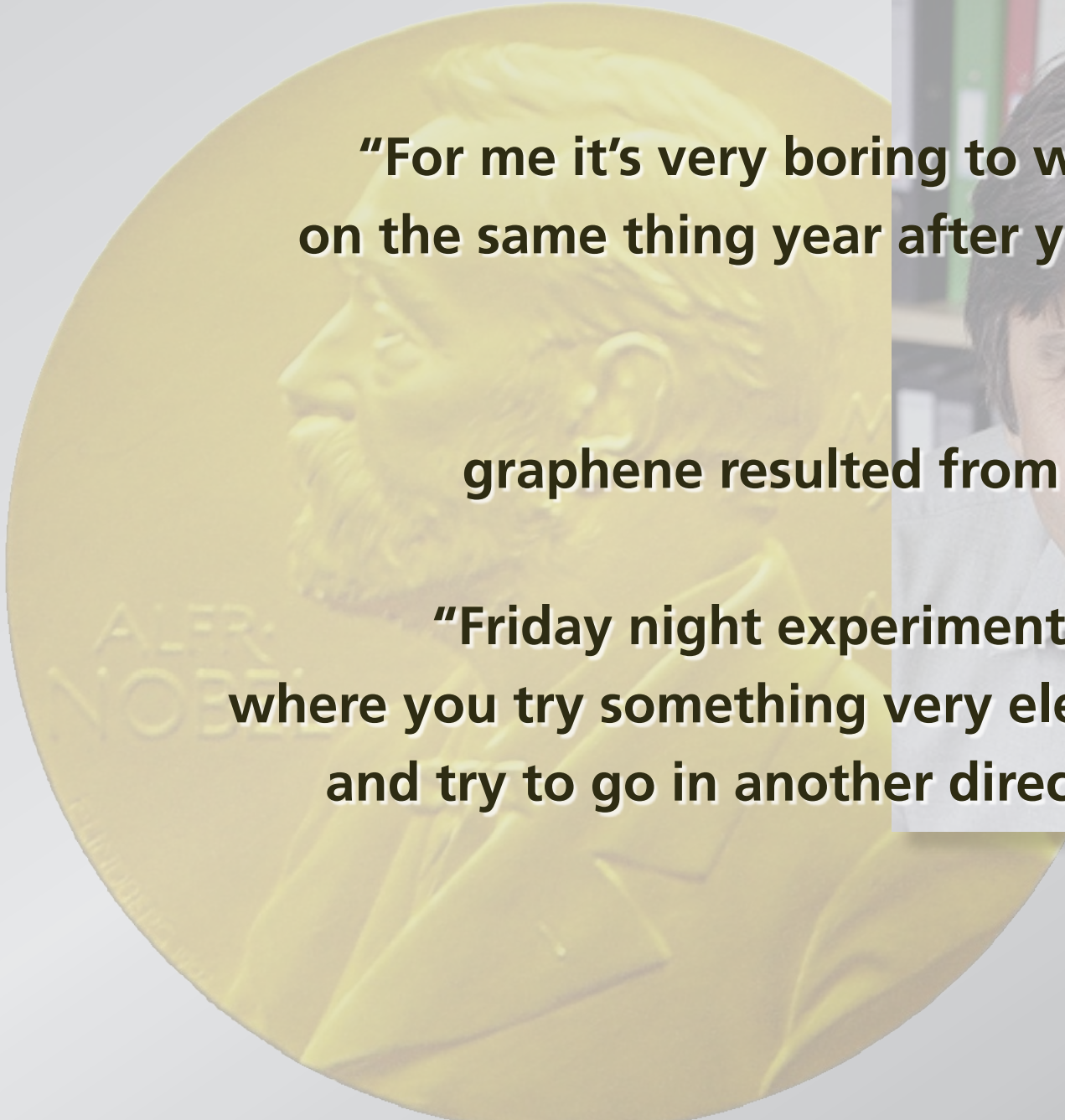
Nobel Prize in Physics 2010

Ig Nobel Prize in 2000



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

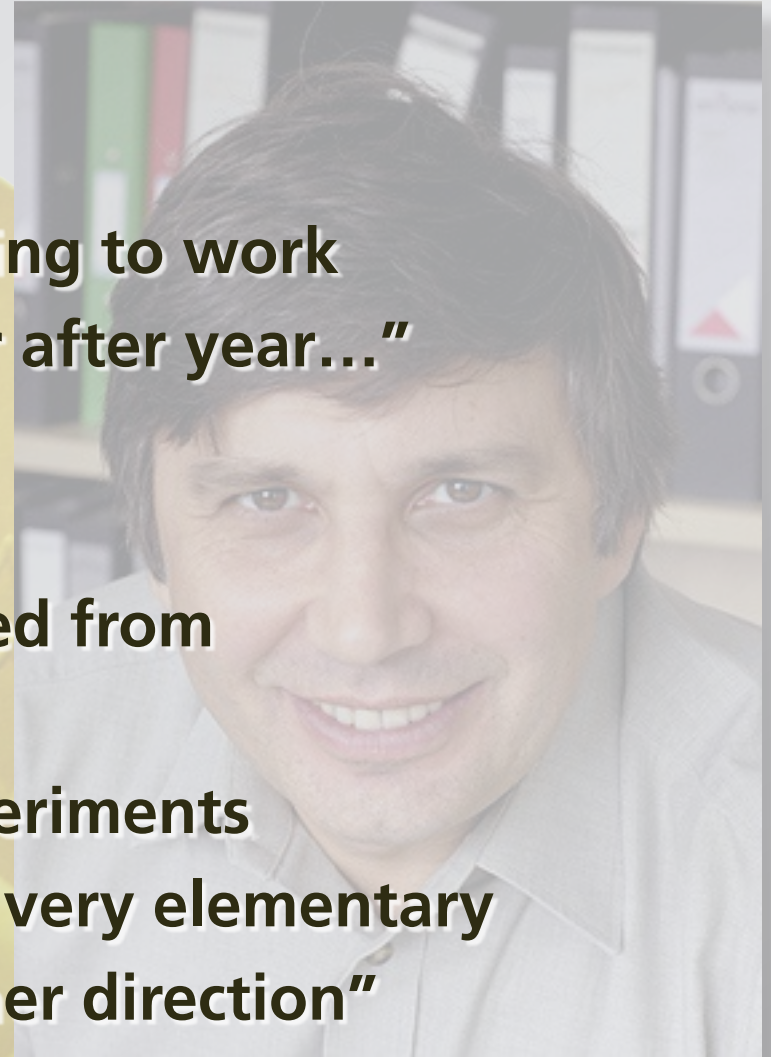




**“For me it’s very boring to work
on the same thing year after year...”**

graphene resulted from

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



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**



What are the factors that determine the quality of a product? (10 marks)

- 1. The quality of the raw materials used
- 2. The quality of the manufacturing process
- 3. The quality of the design
- 4. The quality of the customer service
- 5. The quality of the packaging

Year	2010	2011	2012	2013	2014
Revenue	100	110	120	130	140
Profit	20	22	24	26	28

1. The quality of the raw materials used

2. The quality of the manufacturing process

3. The quality of the design

4. The quality of the customer service

5. The quality of the packaging







1 education

2 PI


3 test



1 education

2 PI

3 test

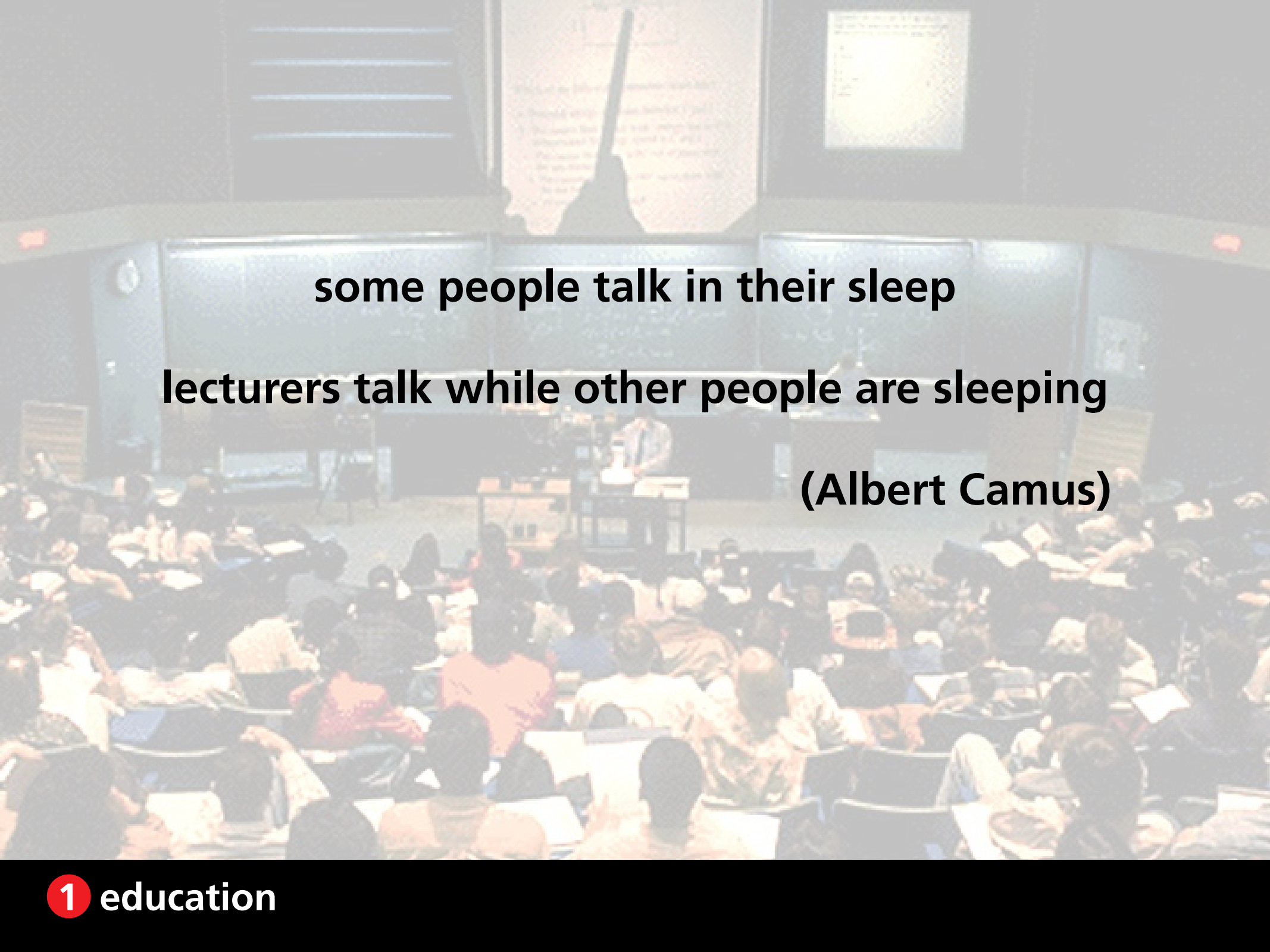


**What happens
in a lecture?**



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 front wall with a large chalkboard and a projection screen above it. A lecturer is visible at a podium in the center of the front stage. The overall atmosphere is one of a lecture where many students are disengaged or tired.

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

not transfer but assimilation of information is key





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

problem

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answer

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problem

UNKNOWN

solution

outcome

KNOWN

problem

KNOWN

procedure

answer

problem

solution

outcome

problem

procedure

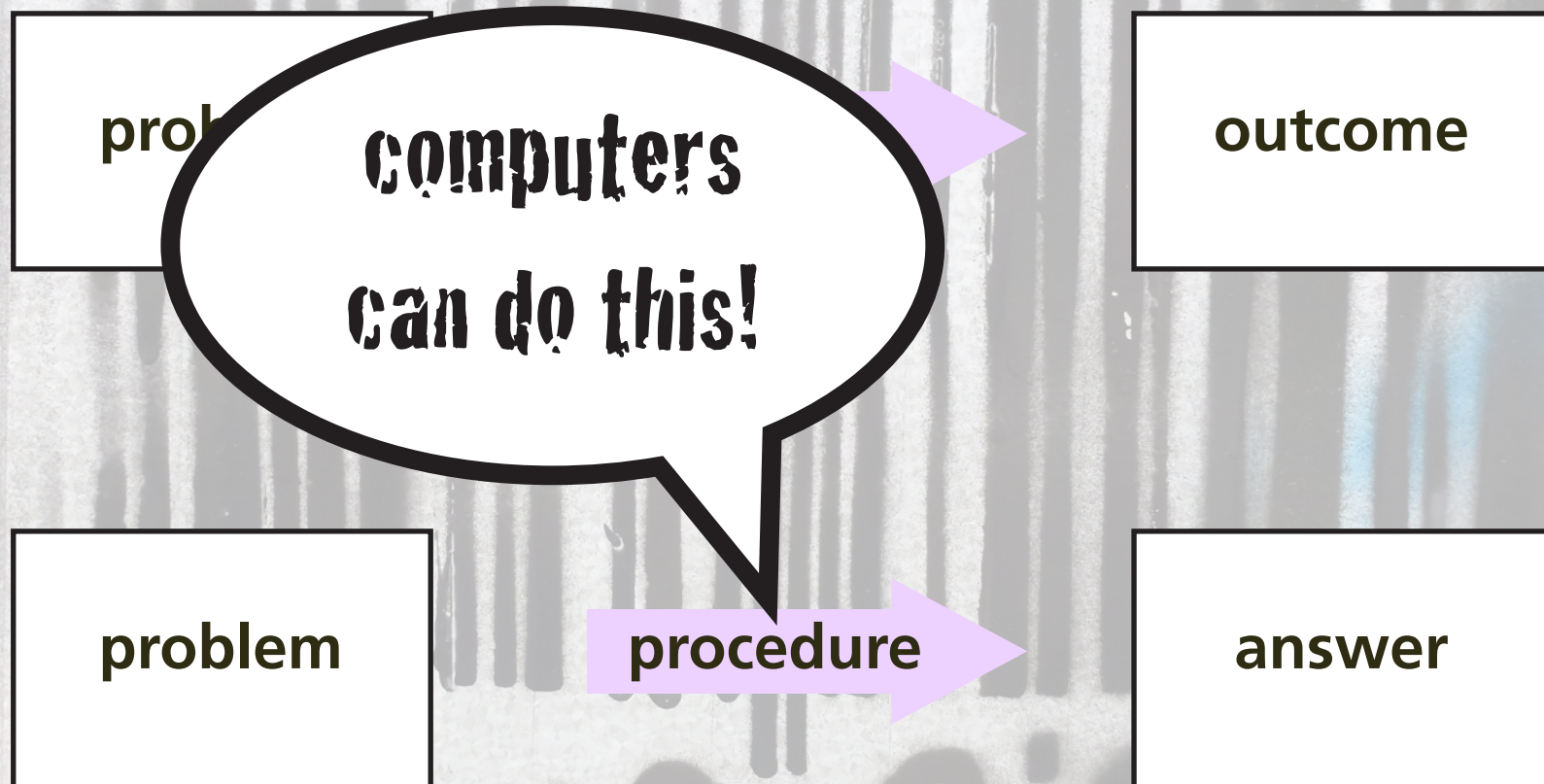
answer

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



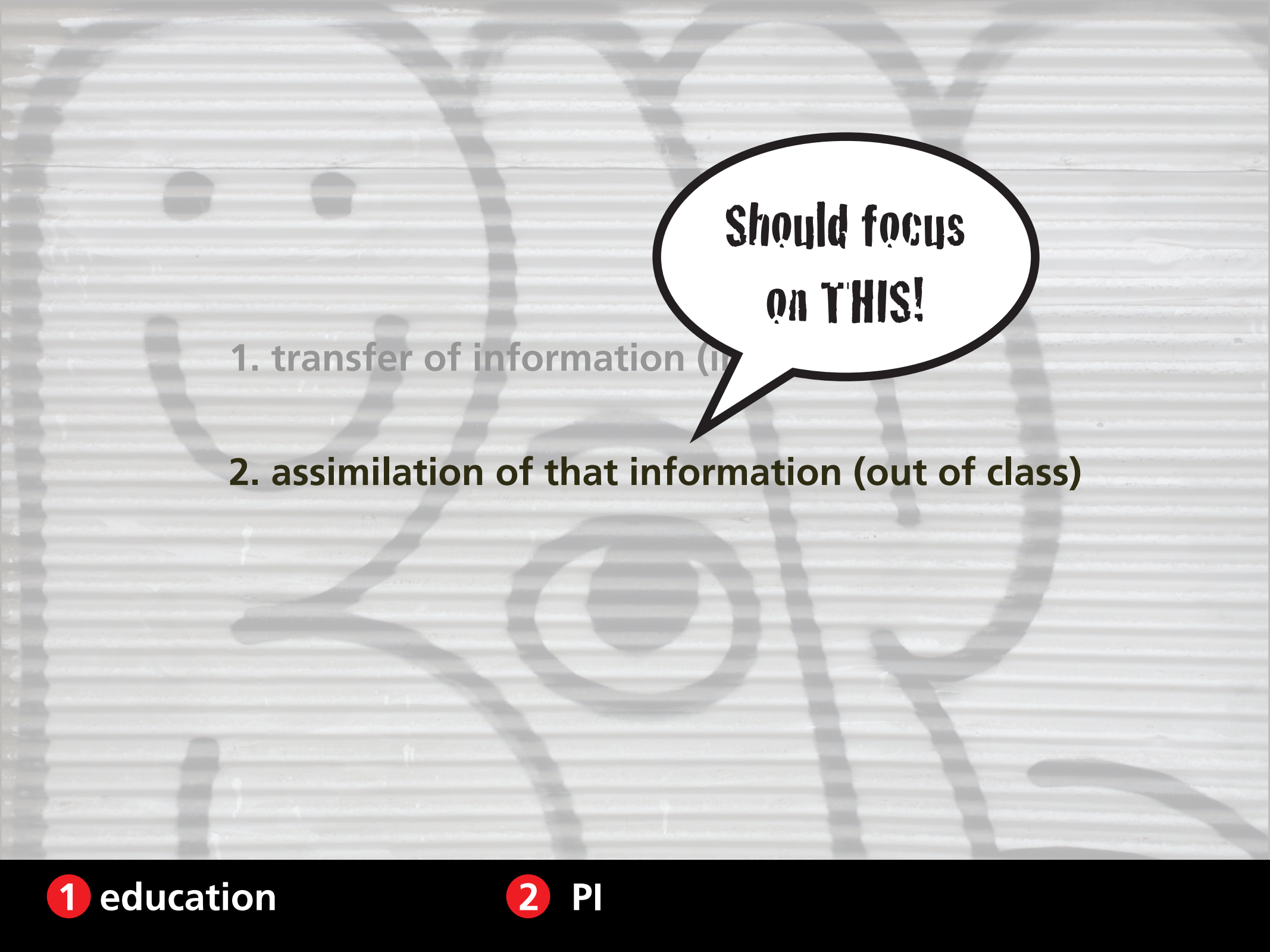
1. transfer of information (in class)

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



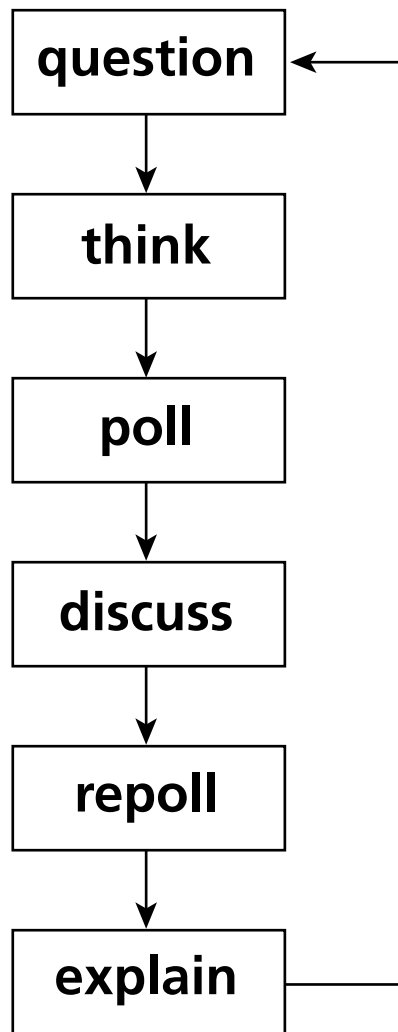
discuss

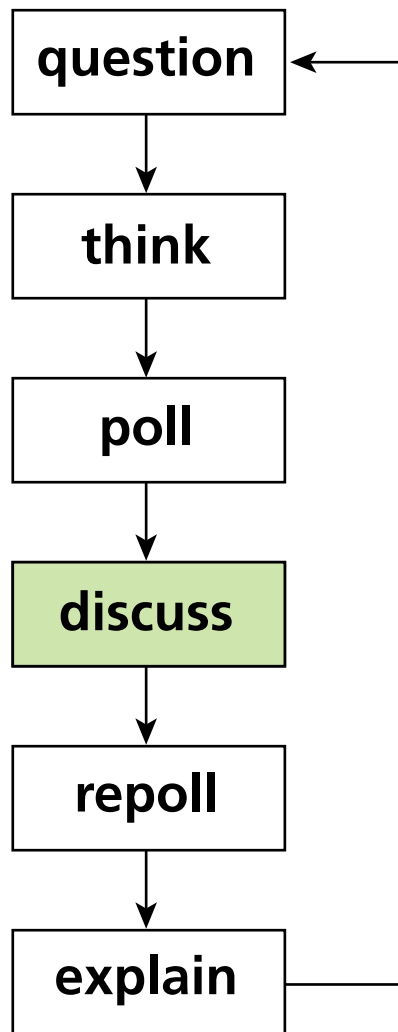


repoll



explain





Let's try it!

QUESTION

think

poll

discuss

repoll

explain

ACTION

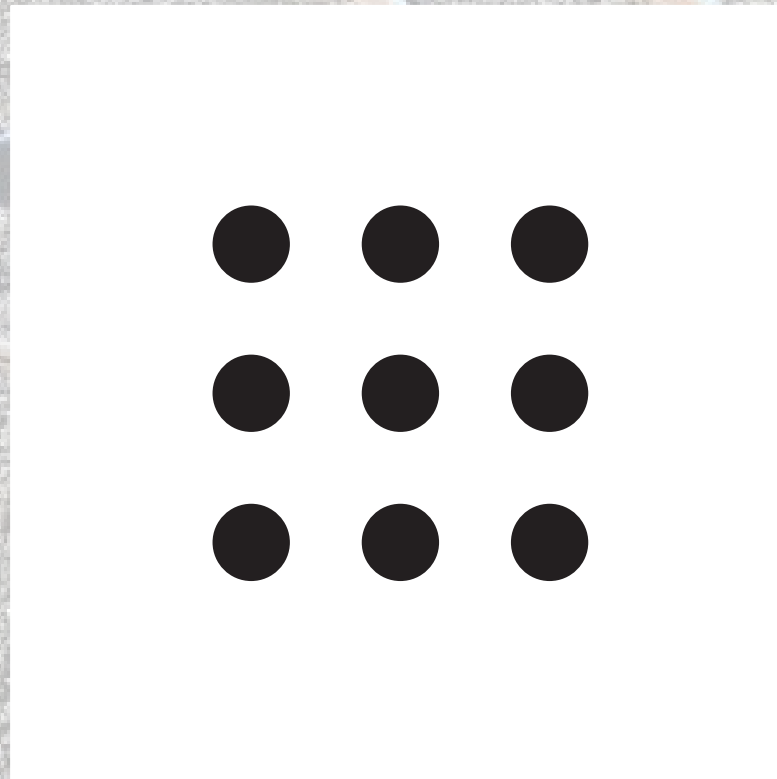


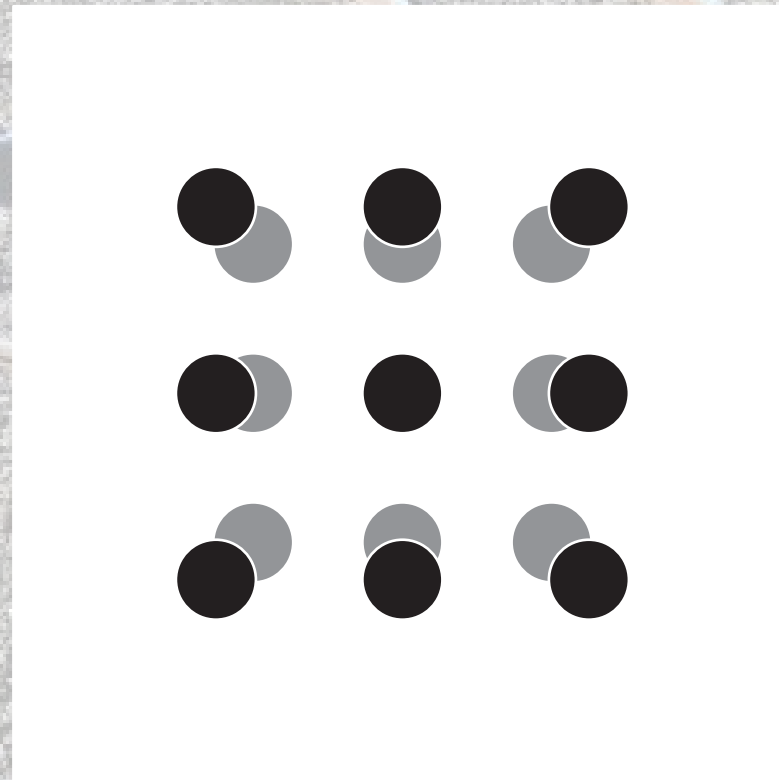
1 education

2 PI



thermal expansion





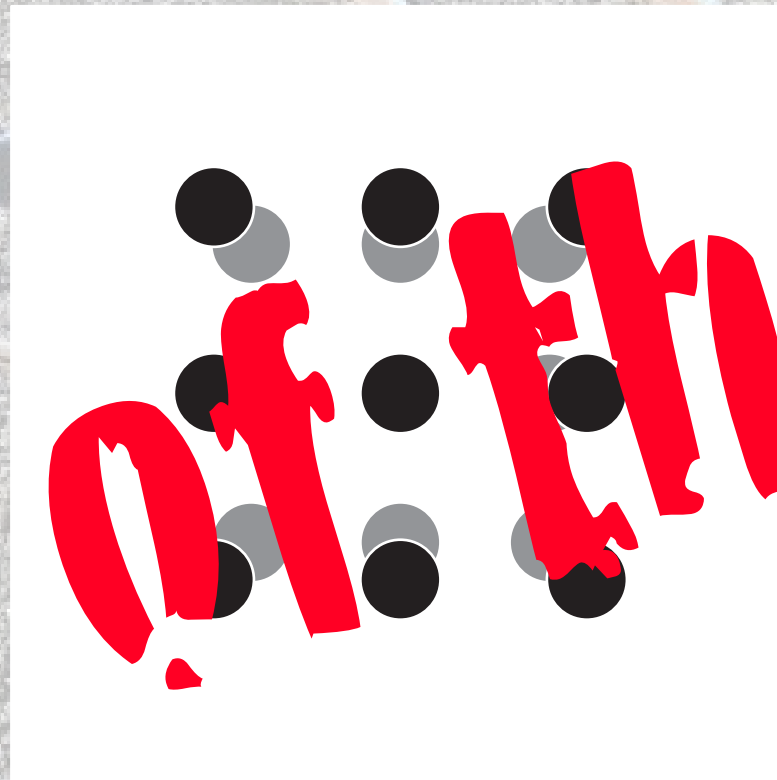
all of them



1 education

2 PI

all of them

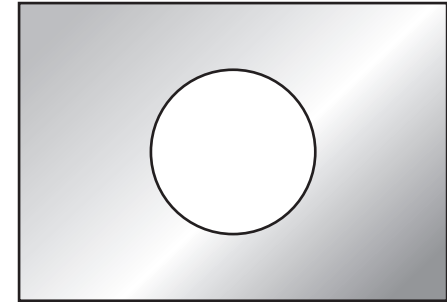


1 education

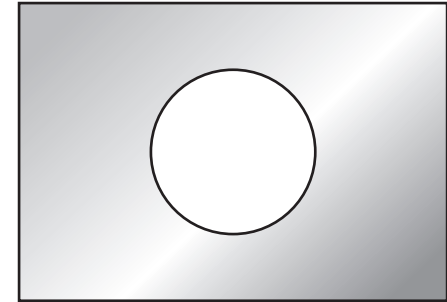
2 PI

3 test?

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



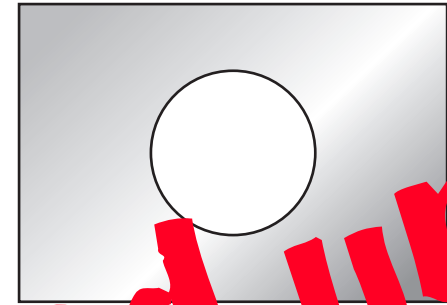
Consider a rectangular metal plate with a circular hole in it.



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

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

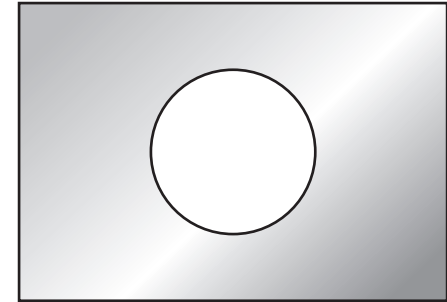
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3. decreases.

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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...

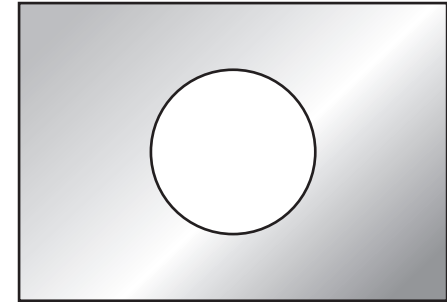
- 1. made a commitment**
- 2. externalized your answer**
- 3. moved from the answer/fact to reasoning**

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**

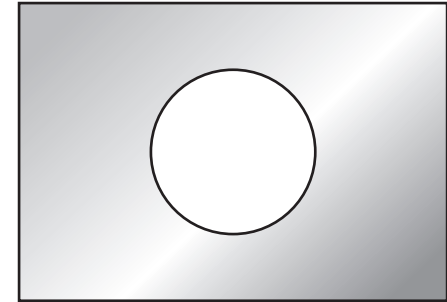
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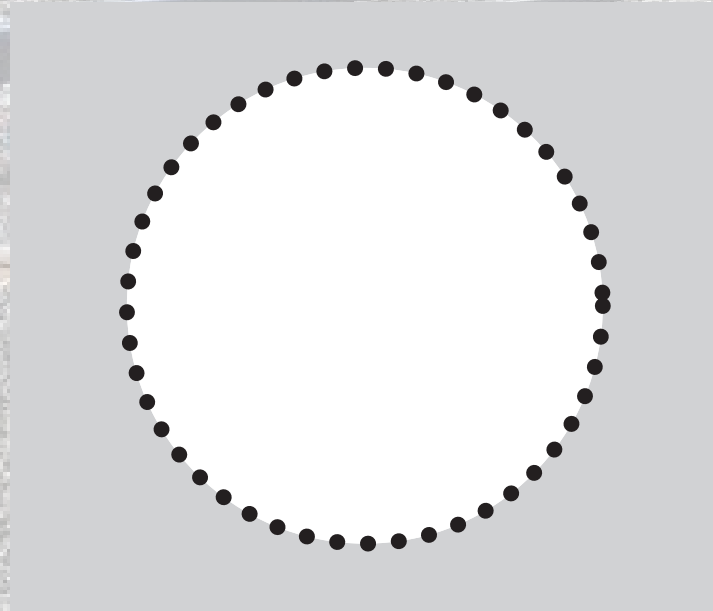
Consider a rectangular metal plate with a circular hole in it.



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

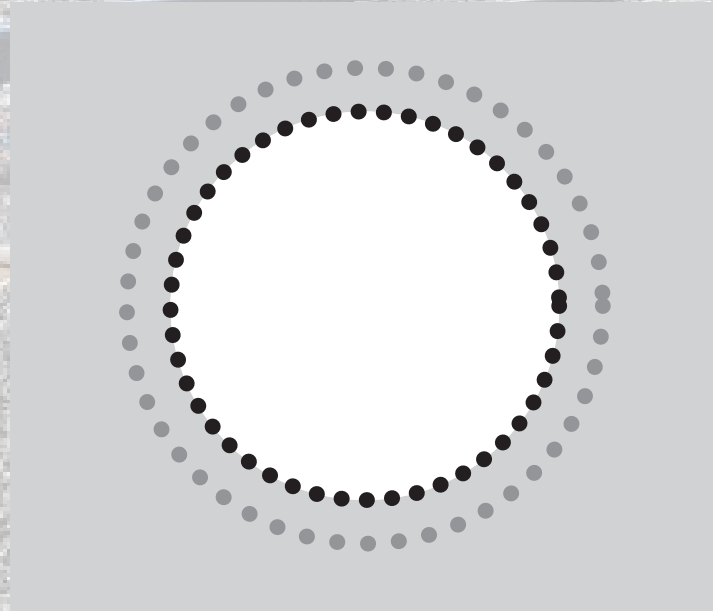


1 education

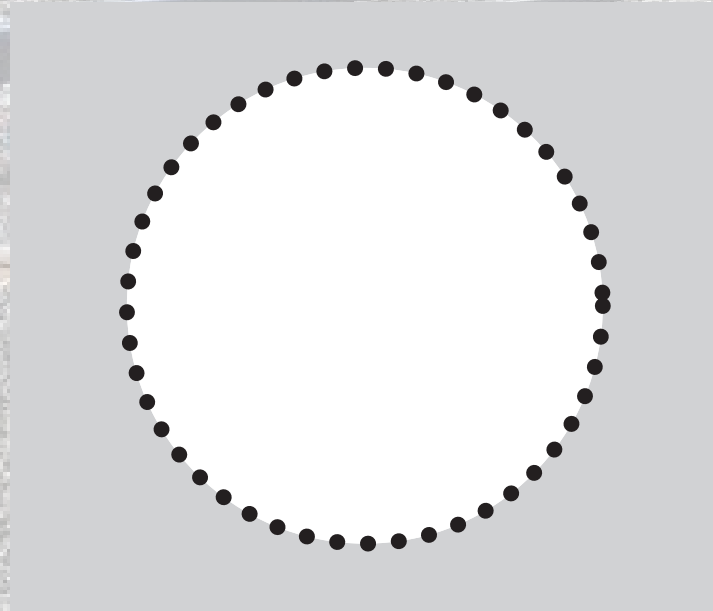
2 PI

3 test

consider atoms at rim of hole



consider atoms at rim of hole

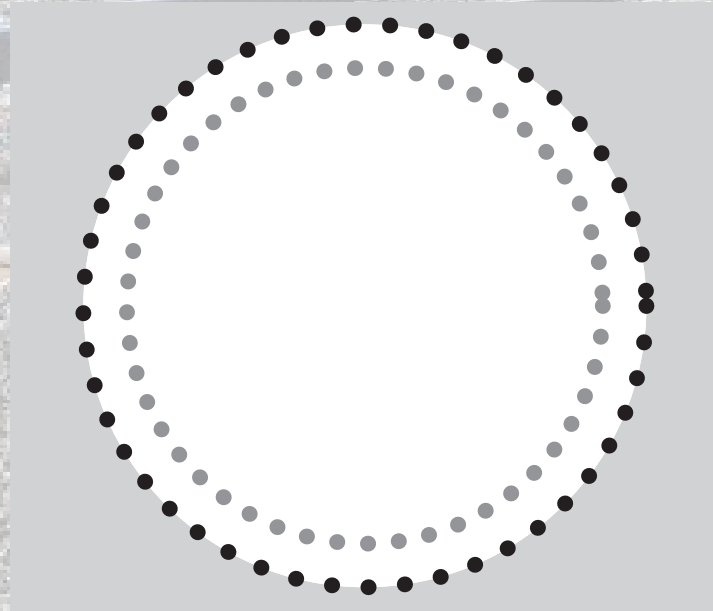


1 education

2 PI

3 test

consider atoms at rim of hole



1 education

2 PI

3 test

consider atoms at rim of hole

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



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, 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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