### **Educating innovators for the 21st century**





### **Nobel Prize in Physics 2010**



### **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"



#### innovation requires whole-brain thinking:

- right-brain imagination and creativity
- left-brain logic and planning



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



Need to...

- teach problem solving
- encourage risk taking

## "Clickers"



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

#### www.TurningTechnologies.com

# Get your clickers ready!



#### www.TurningTechnologies.com

# Get your clickers ready!



#### unique ID on back of clicker

www.TurningTechnologies.com

## How do we learn?

Think of something you are good at — something that you know you do well.

## How do we learn?

Think of something you are good at — something that you know you do well.

How did you become good at this?

## How do we learn?

Became good at it by:

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

# How we teach...



# Learning spaces



# Learning spaces



# Learning spaces





# • Education

# Outline

• Education

Peer Instruction

# Outline

• Education

Peer Instruction

Results



## Some people talk in their sleep.

### Some people talk in their sleep.

### Lecturers talk while other people are sleeping.

**Albert Camus** 



## lectures focus on information transfer...

#### education is not just information transfer



#### education is not just information transfer



#### education is not just information transfer





#### Give students more responsibility for gathering information...

### Give students more responsibility for gathering information... so we can better help them assimilate it.

Includes Class-Tested, Ready-to-Use Resources

FRIC MALUA

A User's Manual

#### Main features:

- pre-class reading
- in-class: depth, not 'coverage'
- ConcepTests

#### ConcepTest:

- 1. Question
- 2. Thinking
- 3. Individual answer
- 4. Peer discussion
- 5. Revised/Group answer
- 6. Explanation
brief presentation























# thermal expansion

Strange St

Section 2

When metals heat up, they expand because all atoms get farther away from each other.



When metals heat up, they expand because all atoms get farther away from each other.



When metals heat up, they expand because all atoms get farther away from each other.

ľ

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 the ted, the diameter of the hole

sa

ecreases.



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.

























is it any good?

#### first year of implementing PI



#### first year of implementing PI



#### first year of implementing PI





#### what about problem solving?









# So better understanding leads to better problem solving!



# So better understanding leads to better problem solving!

(but "good" problem solving doesn't always indicate understanding!)


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

- teaches real problem solving
- encourages risk taking

## Funding:

## **National Science Foundation**

for a copy of this presentation:

## http://mazur.harvard.edu

