

# From questions to concepts



Turning Technologies User Conference  
Trinity College  
Dublin, Ireland, 4 November 2013



**Turning Technologies, LLC**  
turning ideas into solutions



# From questions to concepts



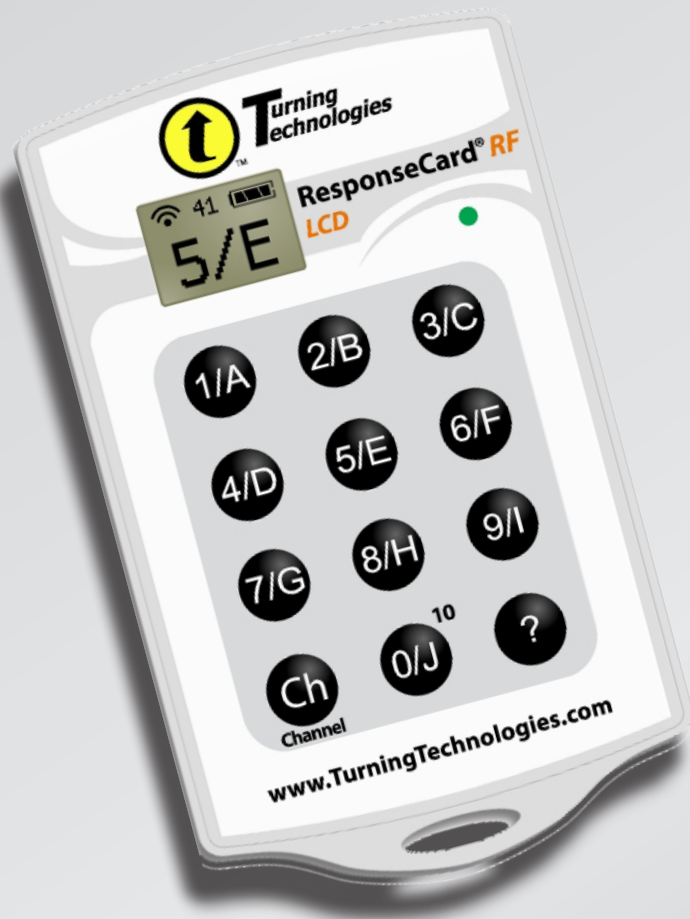
@eric\_mazur

Turning Technologies User Conference  
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**Turning Technologies, LLC**  
turning ideas into solutions

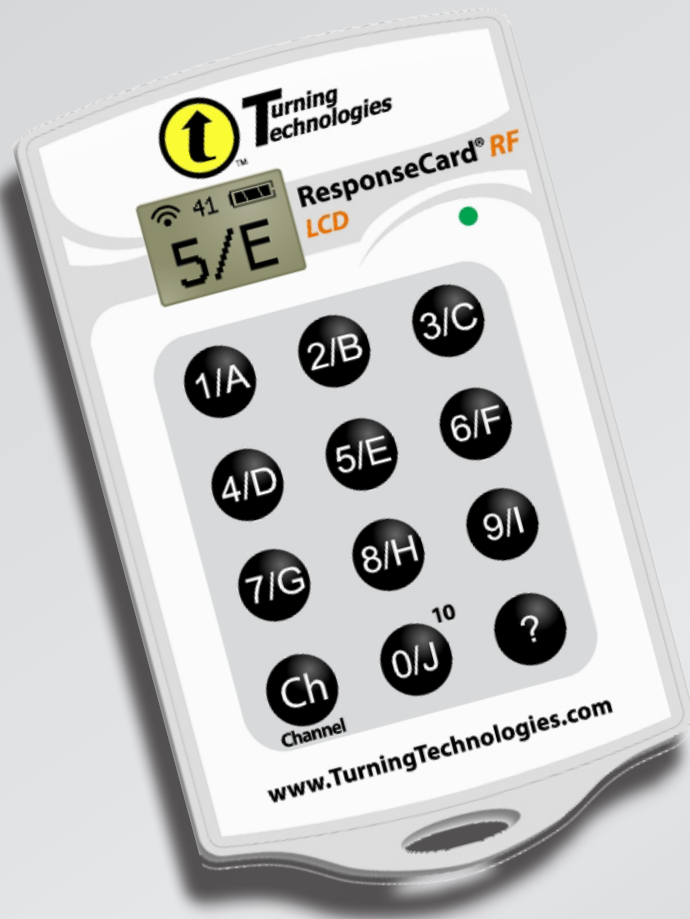




- no ON/OFF button
- only last “click” counts
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**Think of something you are good at — something that you know you do well.**



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

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

**Became good at it by:**

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





What are the following...  
1. Personal...  
2. The...  
3. The...  
4. The...  
5. The...

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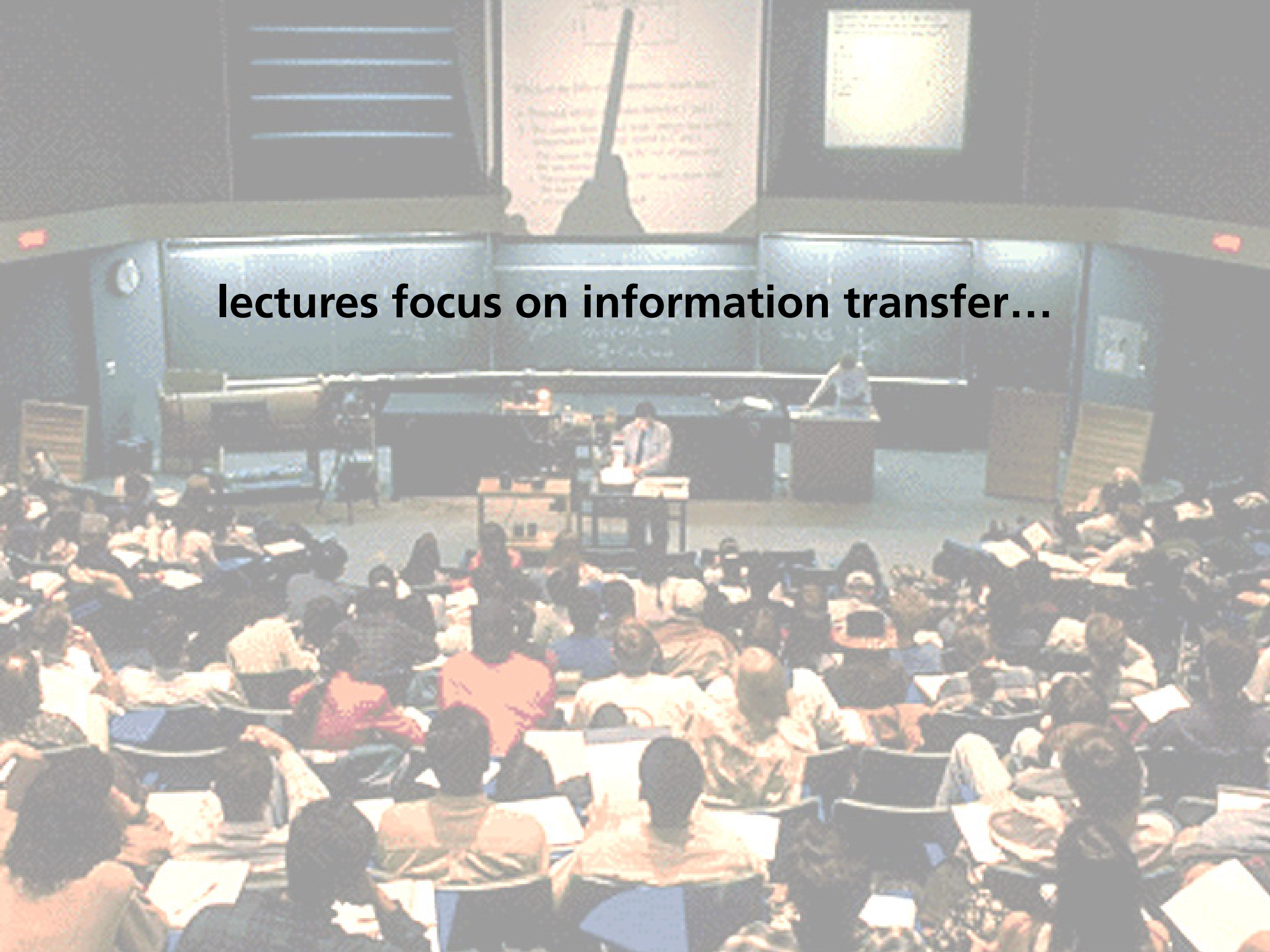
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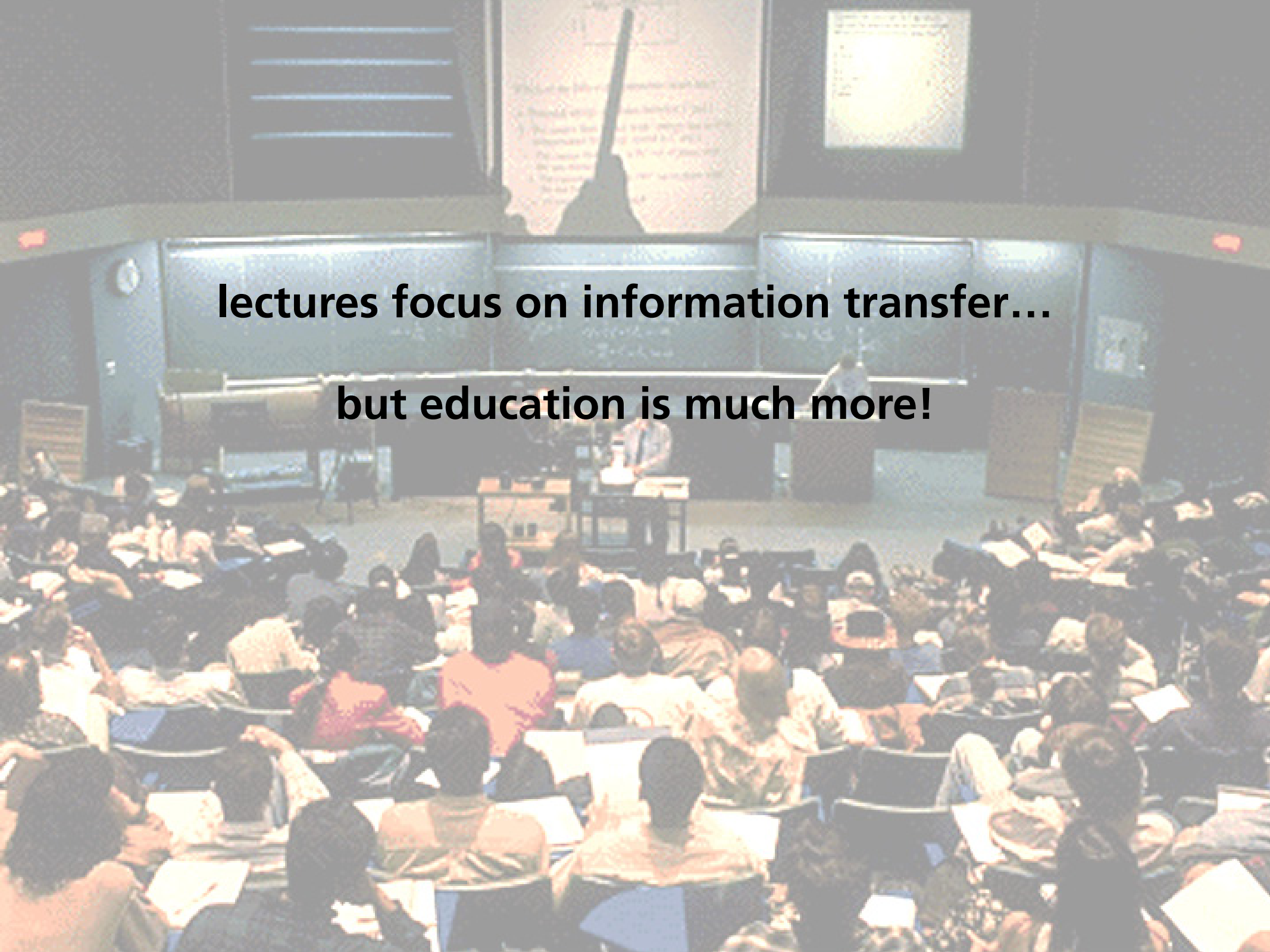
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**lectures focus on information transfer...**

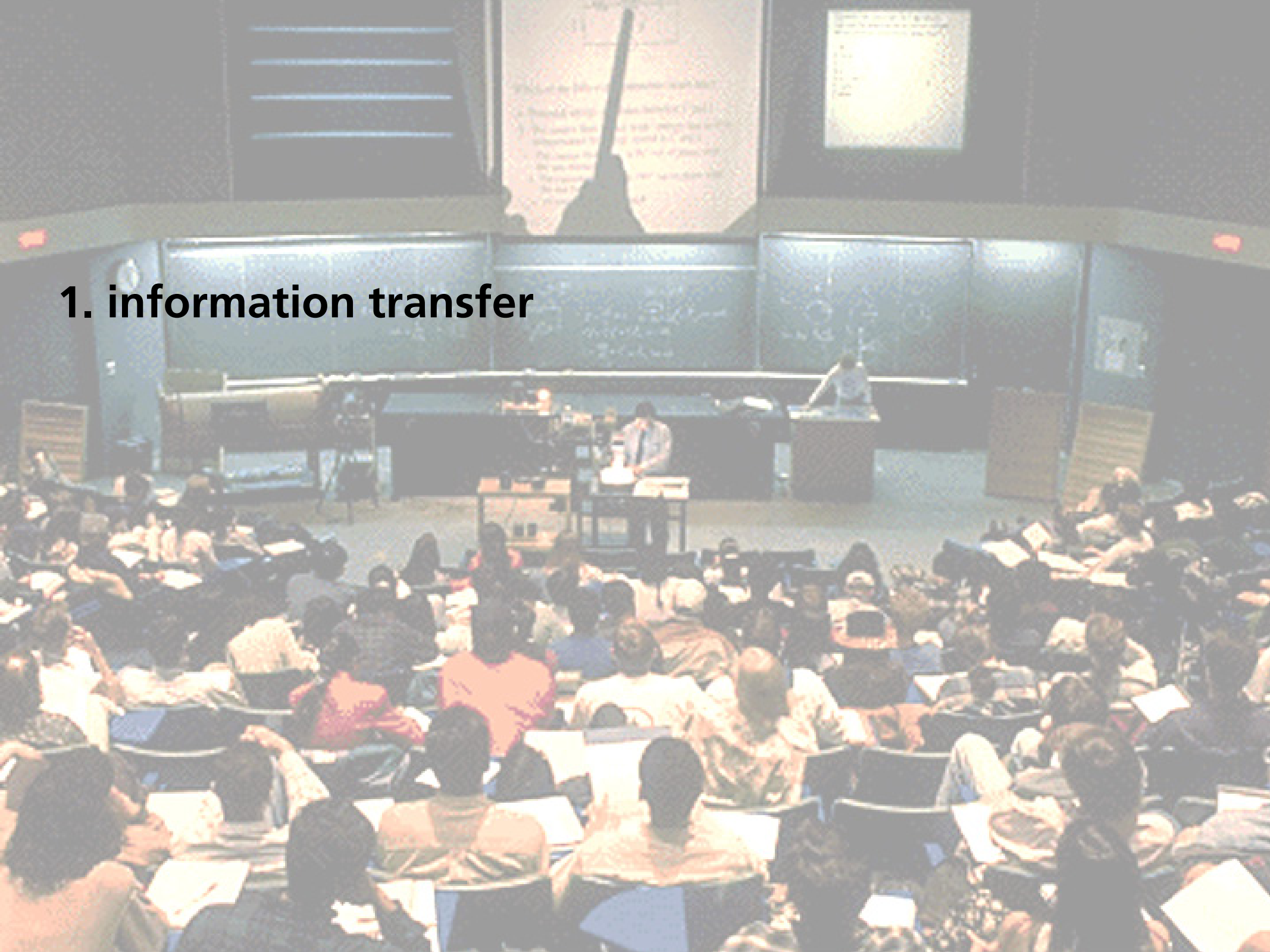




A photograph of a large lecture hall. A professor is standing at a podium on the stage, addressing a large audience of students seated at desks. The room is dimly lit, with the stage area being the primary light source. A large screen or projection is visible at the front of the room, displaying some text. The students are mostly seen from behind, looking towards the front of the hall.

**lectures focus on information transfer...  
but education is much more!**

# 1. information transfer





A large lecture hall with a professor at a podium and students seated at desks. The room features a large screen at the front displaying text and diagrams, and a chalkboard with handwritten notes. The students are seated in rows, facing the front of the room.

**1. information transfer**

**2. assimilation of information**

A large lecture hall with a professor at a podium and students seated at desks. The professor is standing at a podium on the stage, facing the audience. The students are seated at desks, many with papers and laptops. The room is dimly lit, with the stage area being brighter. There are large screens or posters on the wall behind the professor.

**1. information transfer (easy)**

**2. assimilation of information (hard and left to student)**



**1** Peer Instruction





**1** Peer Instruction

**2** let's try it!



**1** Peer Instruction

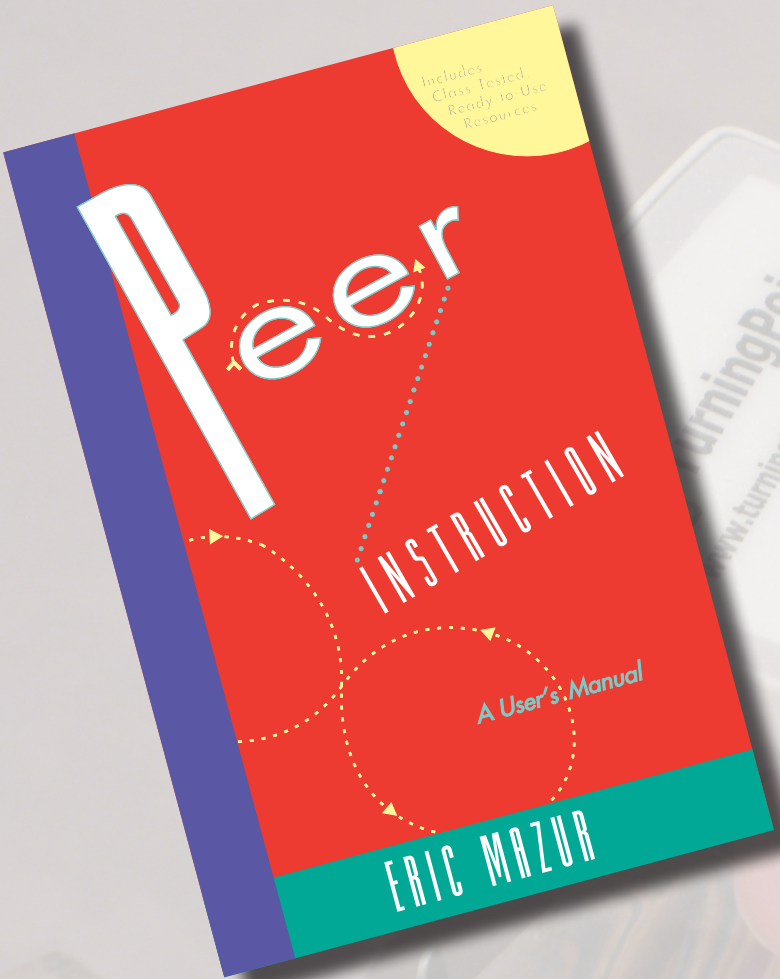
**2** let's try it!

**3** results



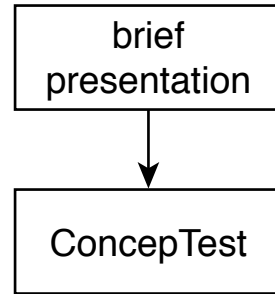
**move information transfer  
out of classroom**

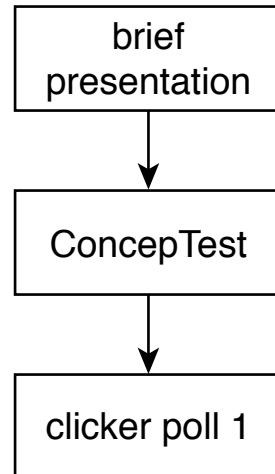
- **assign reading**
- **teach by questioning**



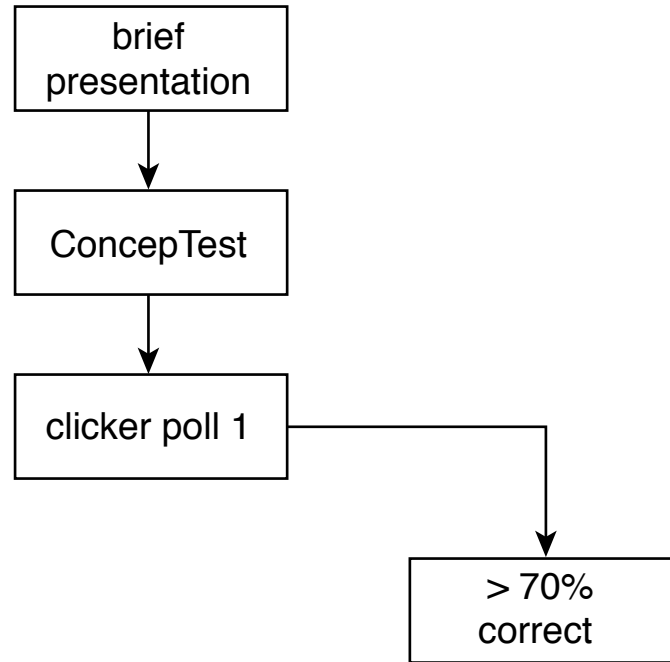


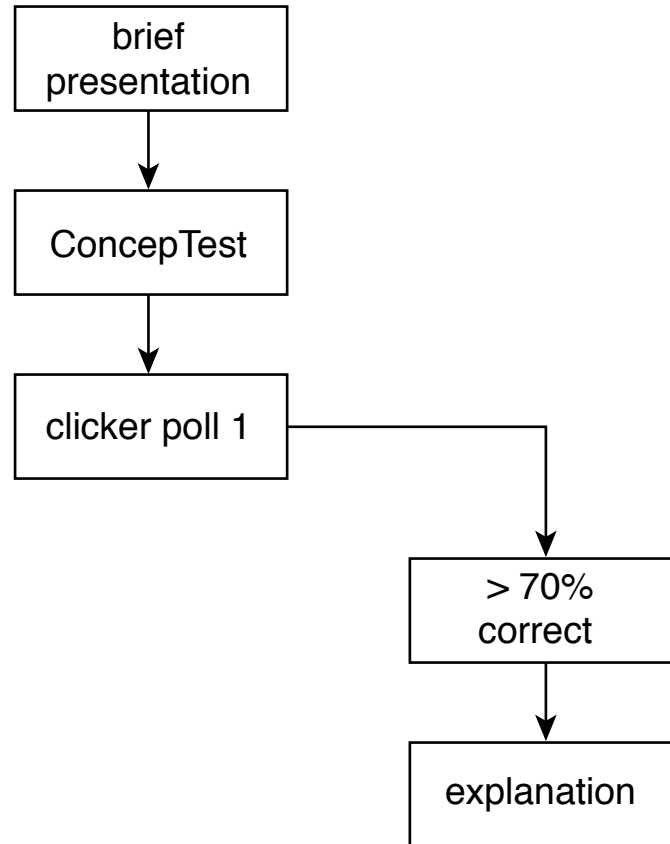
brief  
presentation

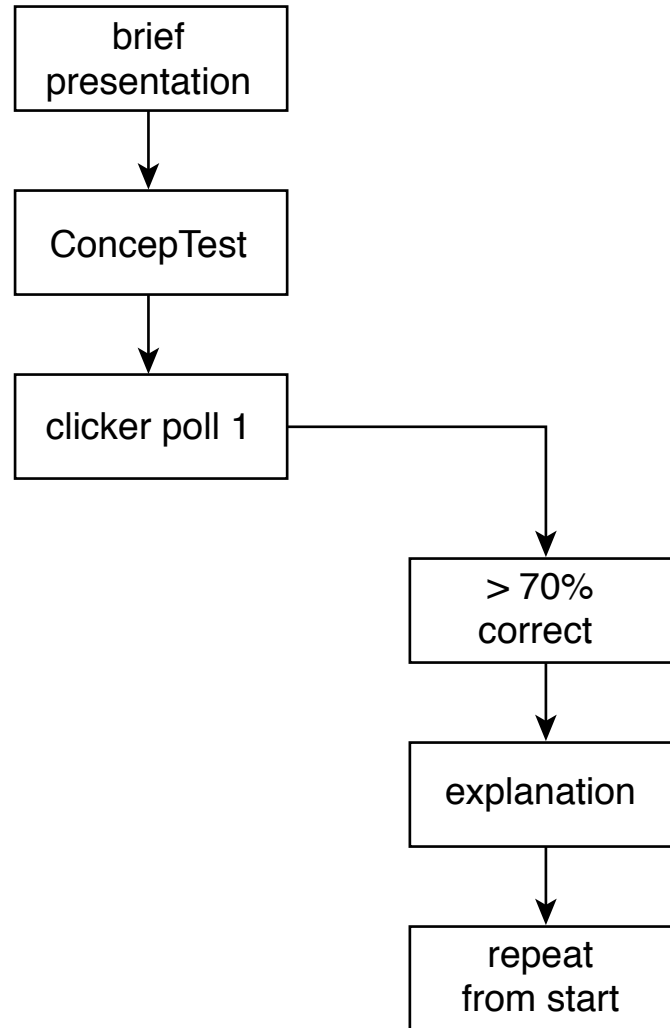




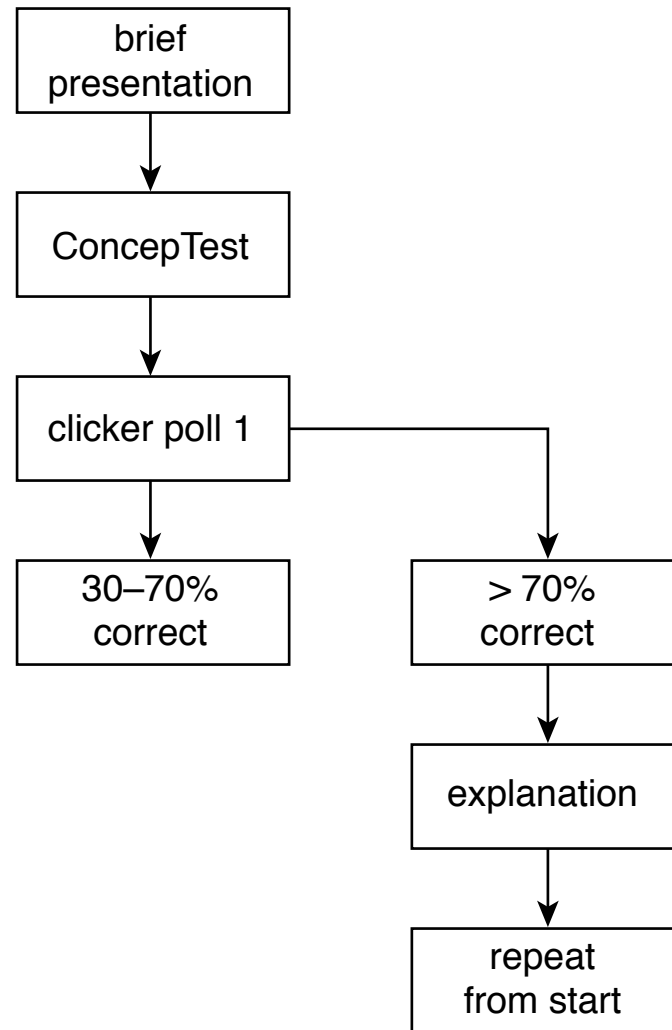


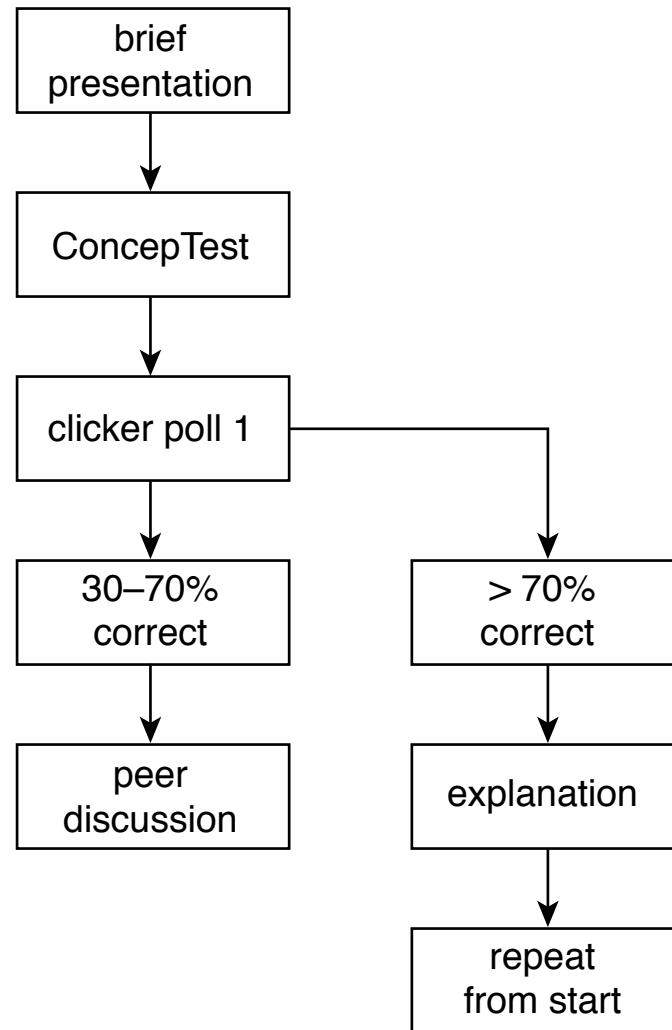


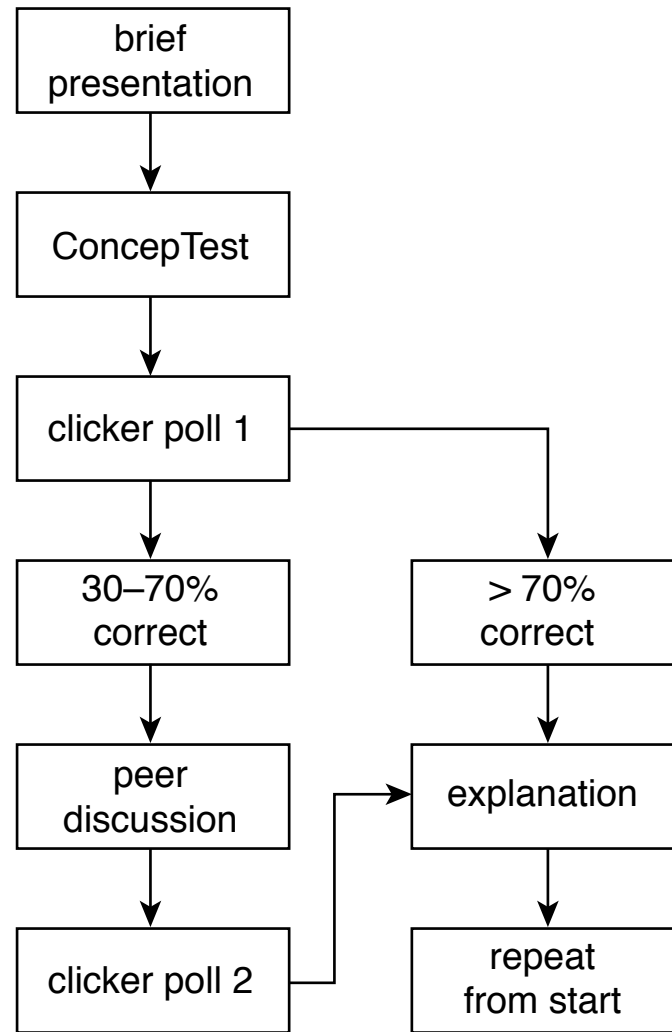


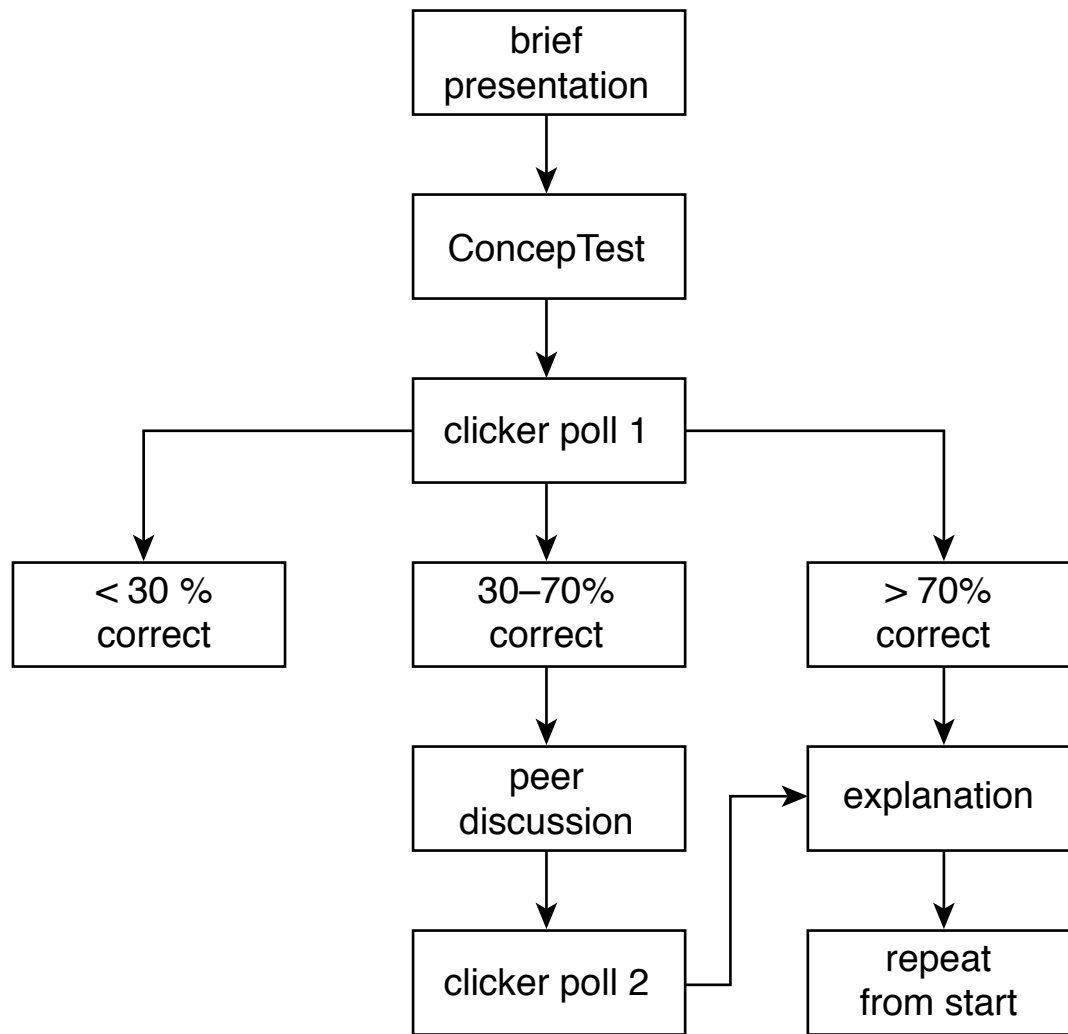




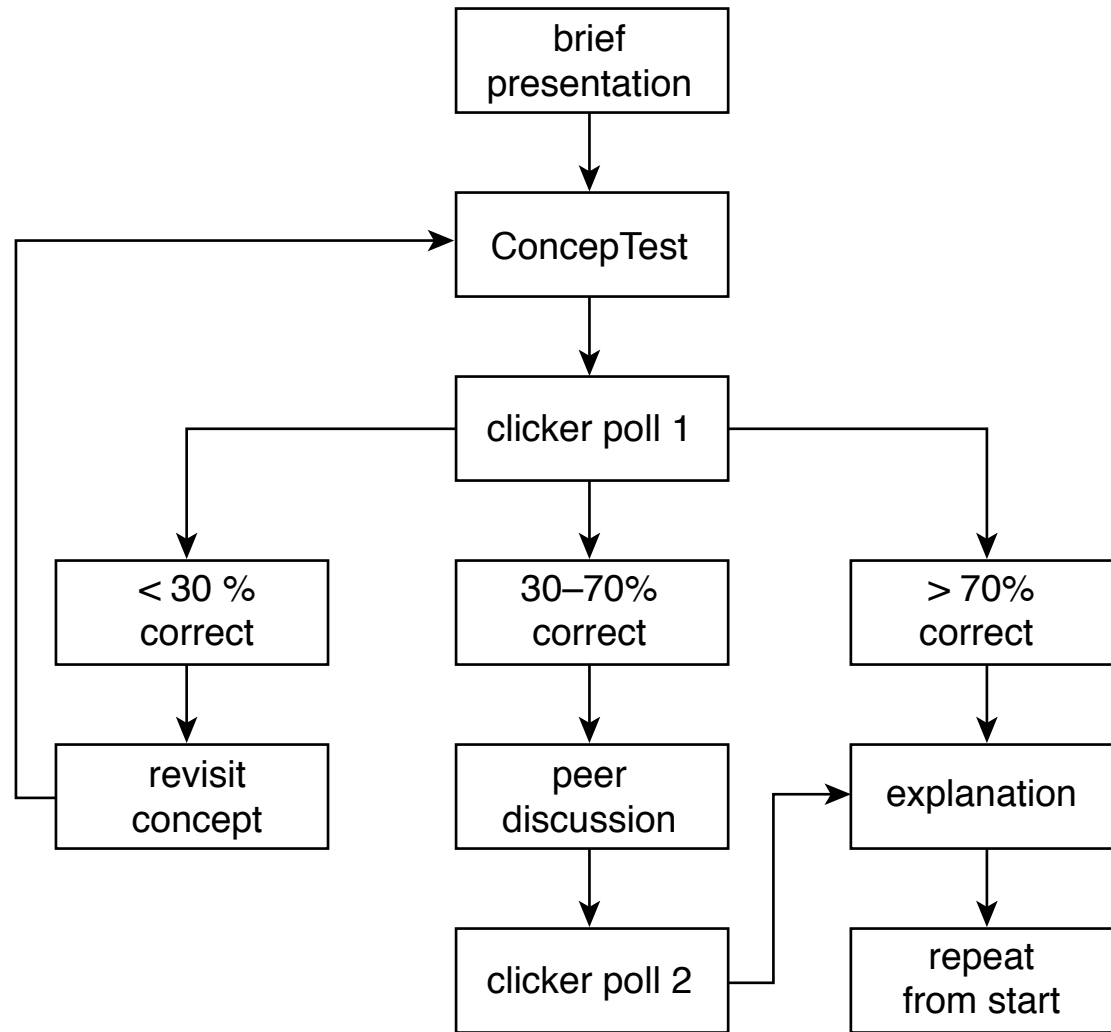


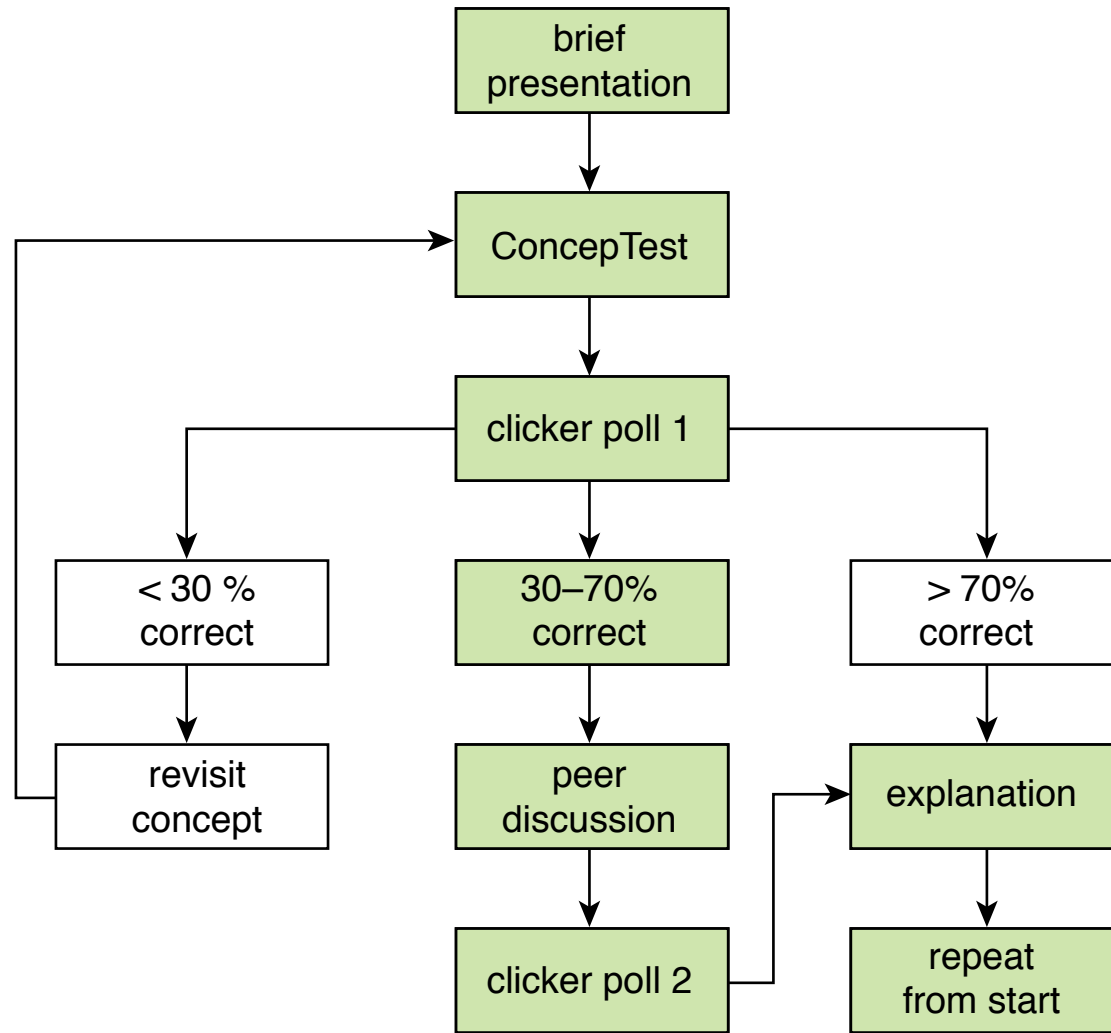












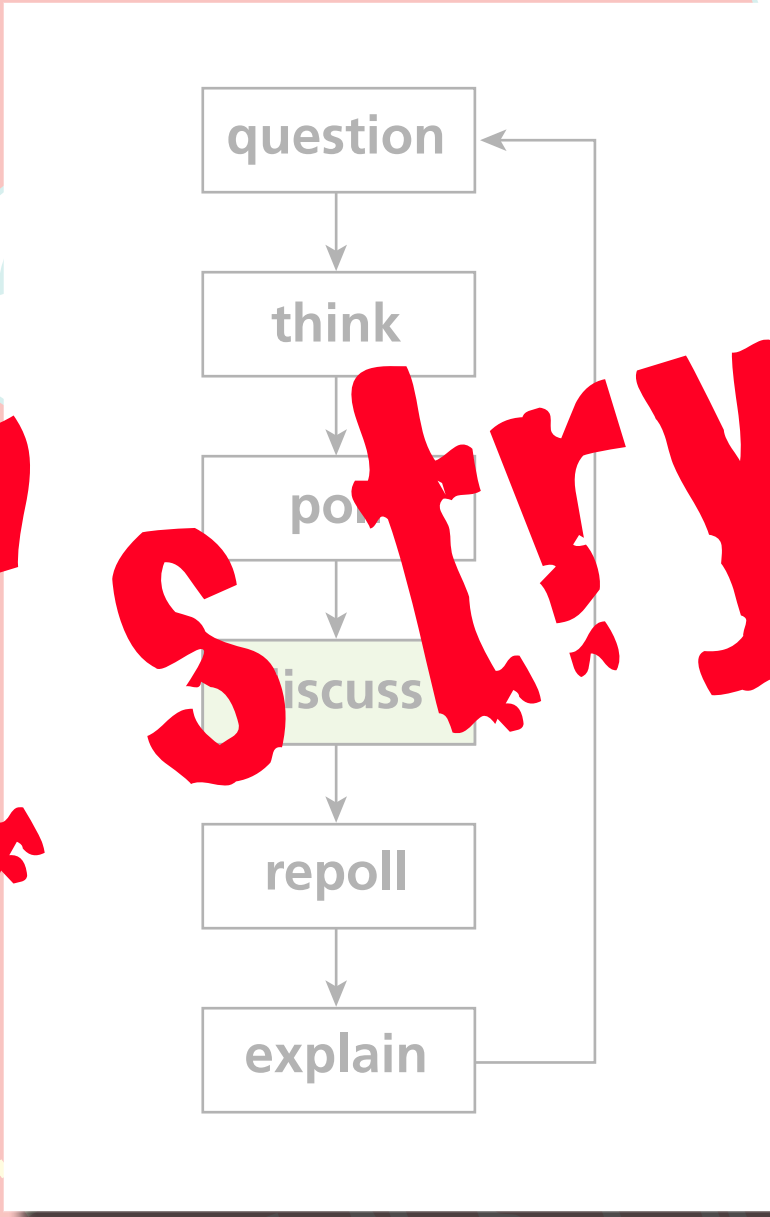


Let's try it!

QUESTION

Let's try it!

ACTION



1 Peer Instruction

2 let's try it!

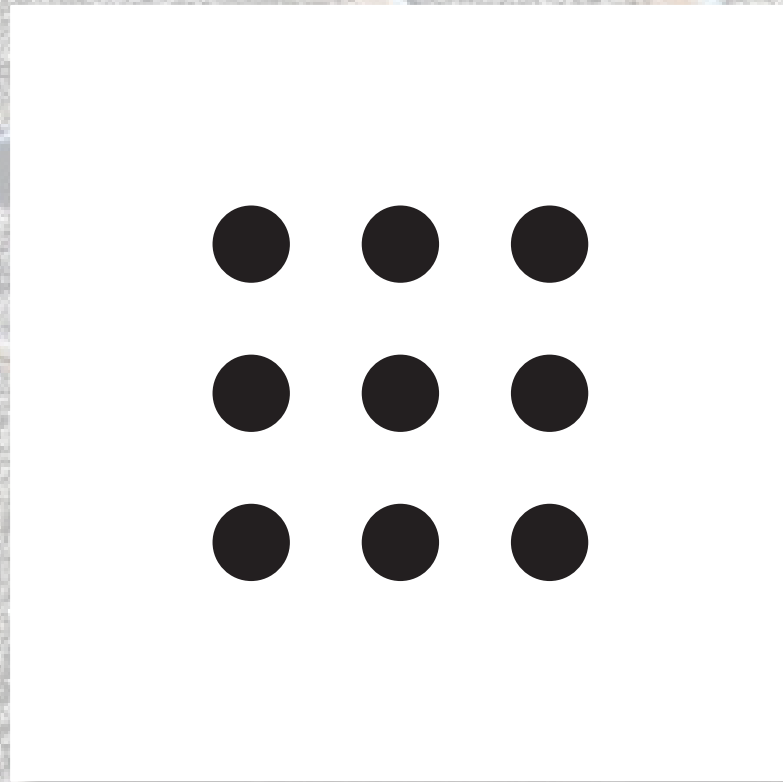




**thermal expansion**

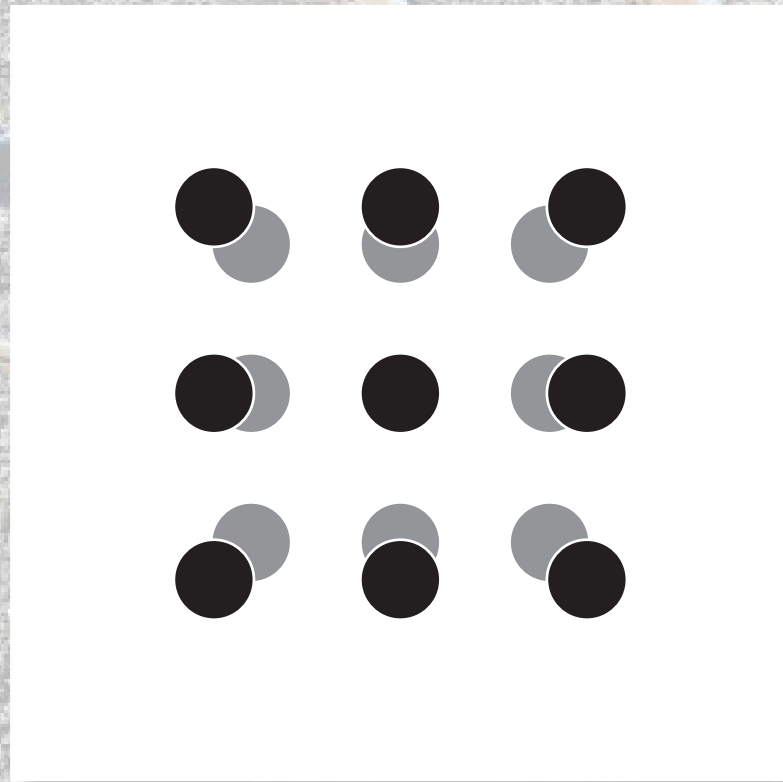
**1 Peer Instruction**

**2 let's try it!**



**1** Peer Instruction

**2** let's try it!



**1** Peer Instruction

**2** let's try it!

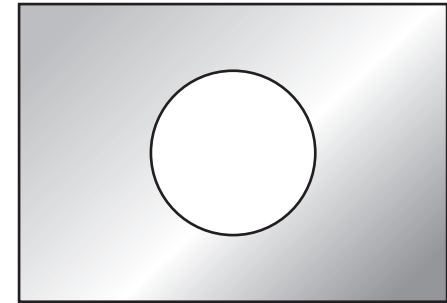
**all of them!**

**1 Peer Instruction**

**2 let's try it!**



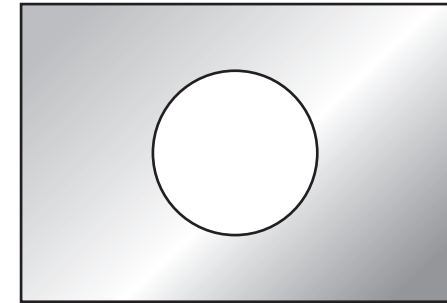
**Consider a rectangular metal plate  
with a circular hole in it.**



**1 Peer Instruction**

**2 let's try it!**

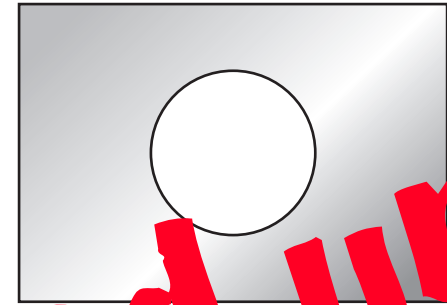
**Consider a rectangular metal plate with a circular hole in it.**



**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.

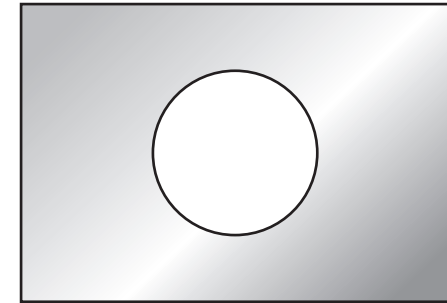


When the plate is uniformly heated, the diameter of the hole

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...**

**1 Peer Instruction**

**2 let's try it!**



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

**1 Peer Instruction**

**2 let's try it!**

**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**

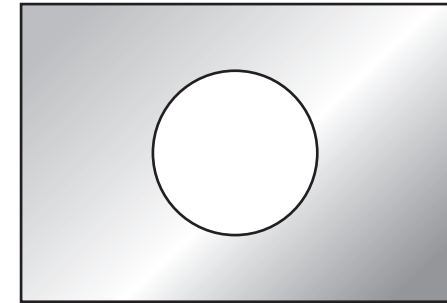


**Before I tell you the answer, let's analyze what happened.**

**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**

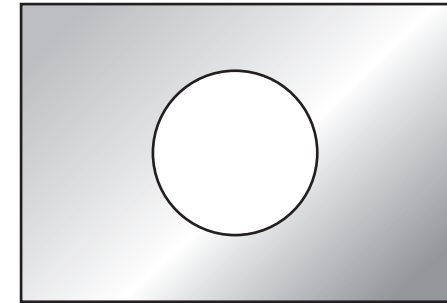
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**When the plate is uniformly heated, the diameter of the hole**

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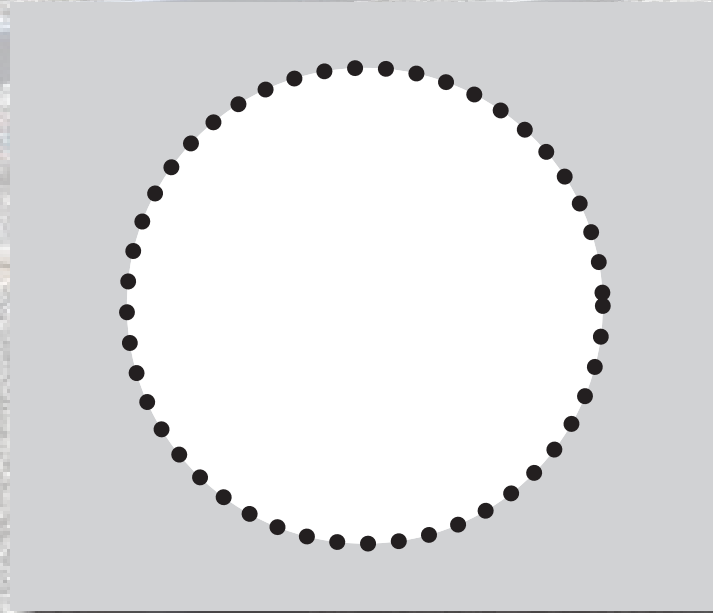
Consider a rectangular metal plate with a circular hole in it.



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

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

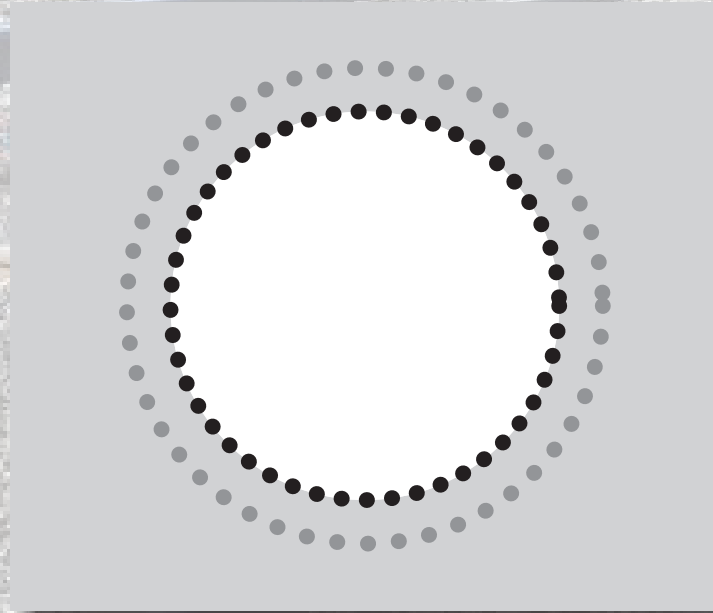
consider atoms at rim of hole



**1** Peer Instruction

**2** let's try it!

consider atoms at rim of hole

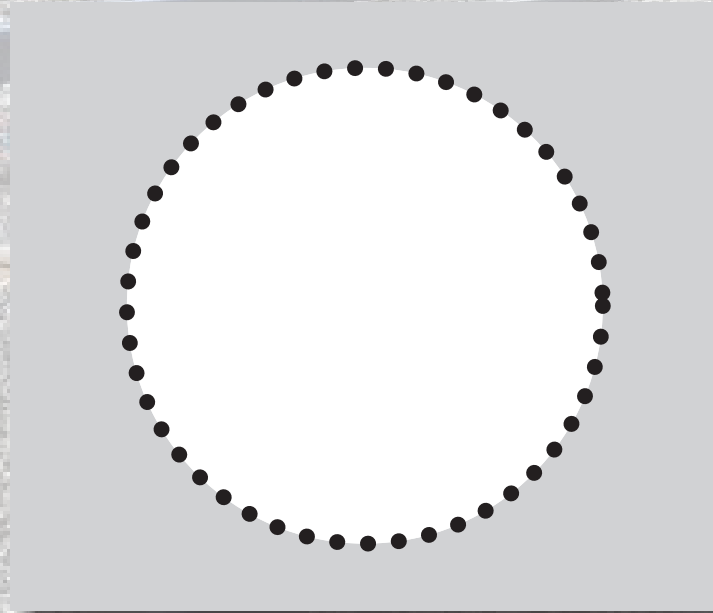


**1** Peer Instruction

**2** let's try it!



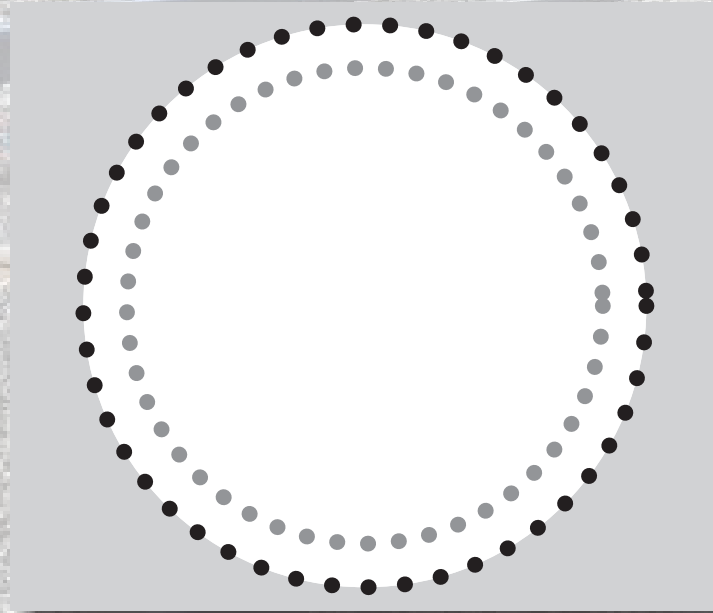
consider atoms at rim of hole



**1** Peer Instruction

**2** let's try it!

consider atoms at rim of hole



**1** Peer Instruction

**2** let's try it!

consider atoms at rim of hole

**you won't forget this**



**1** Peer Instruction

**2** let's try it!

Peer

back to pi

INSTRUCTION

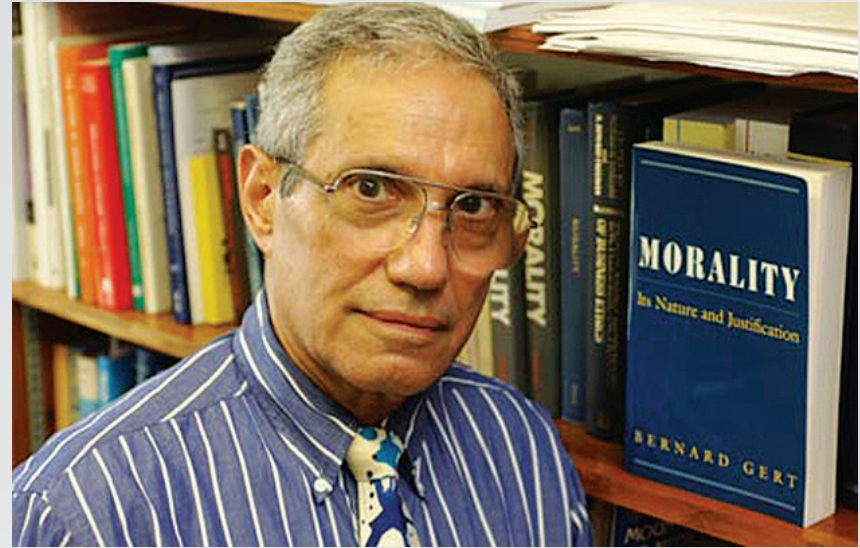
1 Peer Instruction

2 let's try it!

**Bernard Gert (1934 – 2011)**

**Moral philosopher**

**Professor at Dartmouth**



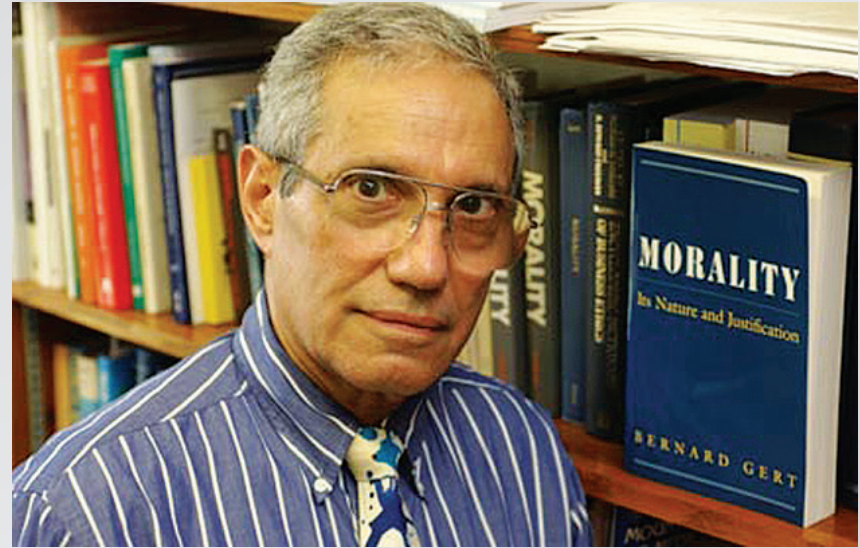
**1 Peer Instruction**

**2 let's try it!**



**Bernard Gert (1934 – 2011)**

**Moral philosopher  
Professor at Dartmouth**



**“Morality is an informal public system applying to all rational persons, governing behavior that affects others, and includes what are commonly known as the moral rules, ideals, and virtues and has the lessening of evil or harm as its goal.”**

**1 Peer Instruction**

**2 let's try it!**

## **Bernard Gert's moral system created by 10 rules:**

- 1. Do not kill**
- 2. Do not cause pain**
- 3. Do not disable**
- 4. Do not deprive of freedom**
- 5. Do not deprive of pleasure**
- 6. Do not deceive**
- 7. Keep your promises**
- 8. Do not cheat**
- 9. Obey the law**
- 10. Do your duty (as required by job, circumstances).**

Heinz's wife was near death, and her only hope was a drug that had been discovered by a pharmacist who was selling it for an exorbitant price. The drug cost \$20,000 to make, and the pharmacist was selling it for \$200,000. Heinz could only raise \$50,000 and insurance wouldn't make up the difference. He offered what he had to the pharmacist, and when his offer was rejected, Heinz said he would pay the rest later. Still the pharmacist refused. In desperation, Heinz broke into the store and stole the drug.

**1** Peer Instruction

**2** let's try it!

Heinz's wife was near death, and her only hope was a drug that had been discovered by a pharmacist who was selling it for an exorbitant price. The drug cost \$20,000 to make, and the pharmacist was selling it for \$200,000. Heinz could only raise \$50,000 and insurance wouldn't make up the difference. He offered what he had to the pharmacist, and when his offer was rejected, Heinz said he would pay the rest later. Still the pharmacist refused. In desperation, Heinz broke into the store and stole the drug.

Should Heinz have broken into the store to steal the drug for his wife?

**1** Peer Instruction

**2** let's try it!

## **Bernard Gert's moral system created by 10 rules:**

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9. Obey the law
10. Do your duty (as required by job, circumstances).

**Should Heinz have broken into the store to steal the drug for his wife?**

- 1. Yes**
- 2. No**



**1 Peer Instruction**

**2 let's try it!**



Bernard Gert's moral system created by 10 rules:

1. Do not kill
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4. Do not deprive of freedom
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10. Do your duty (as required by job, circumstances).

Should Heinz have broken into the store to steal the drug for his wife?

1. Yes
2. No

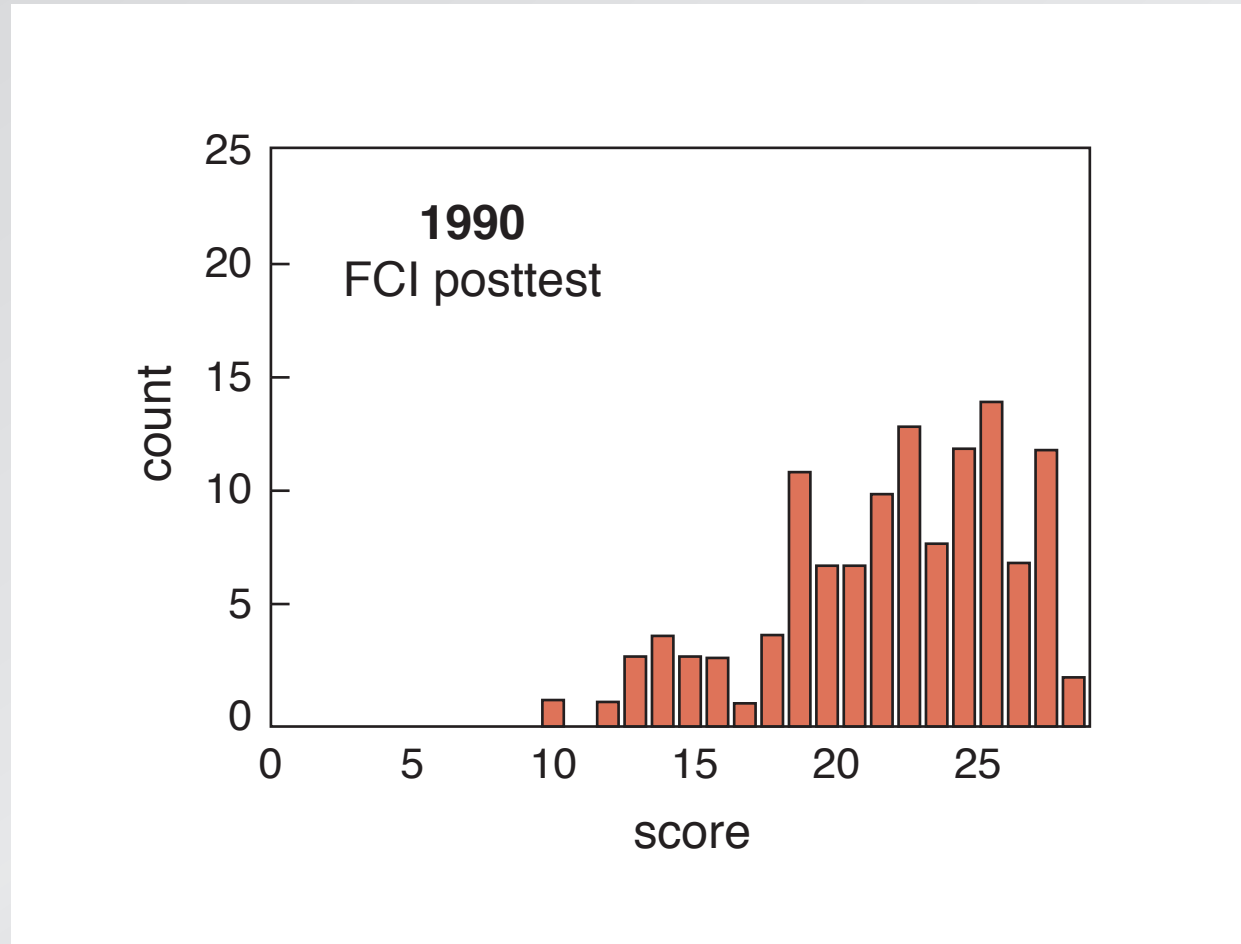
**you got all engaged!**



**1 Peer Instruction**

**2 let's try it!**

## traditional instruction

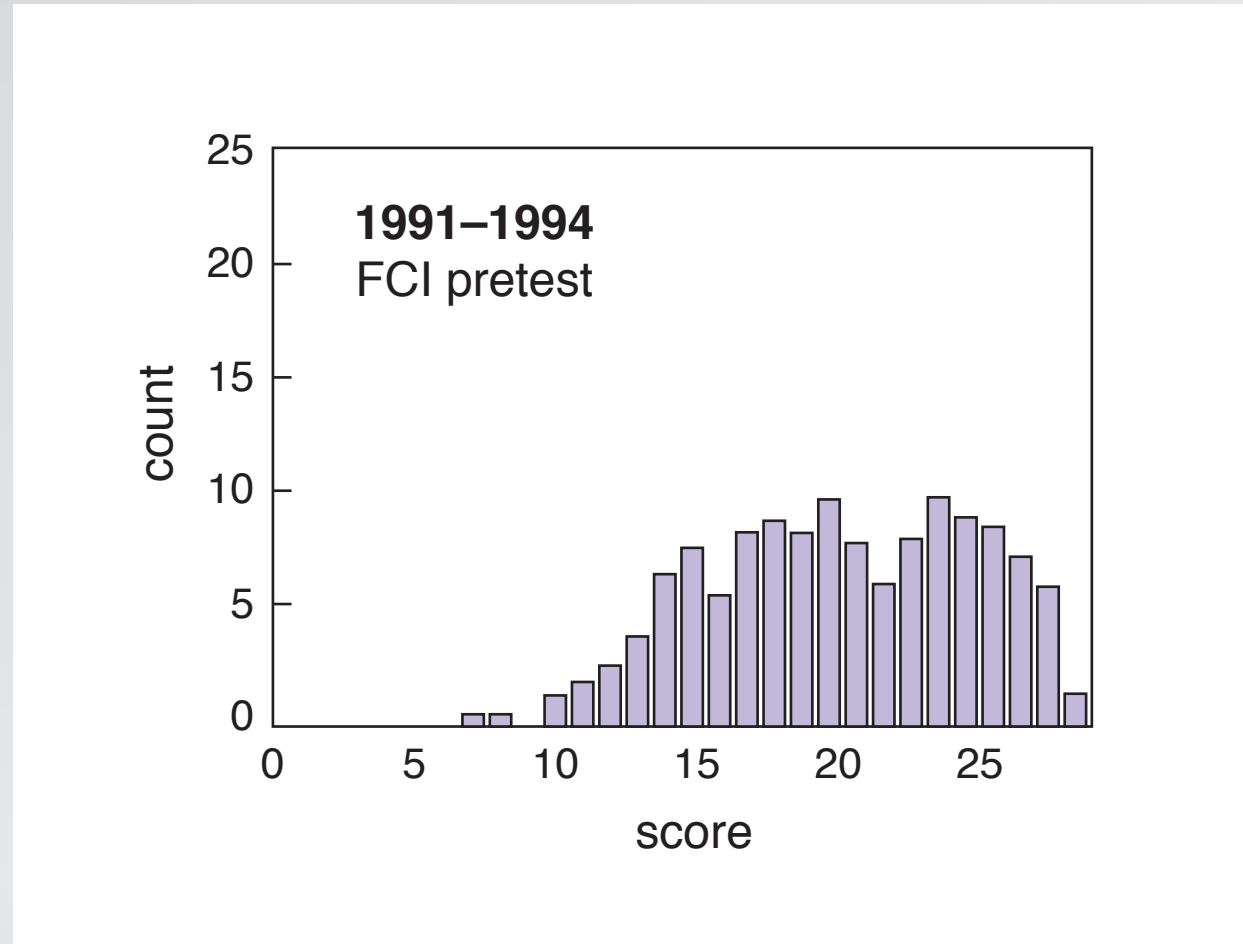


**1** Peer Instruction

**2** let's try it!

**3** results

## traditional instruction

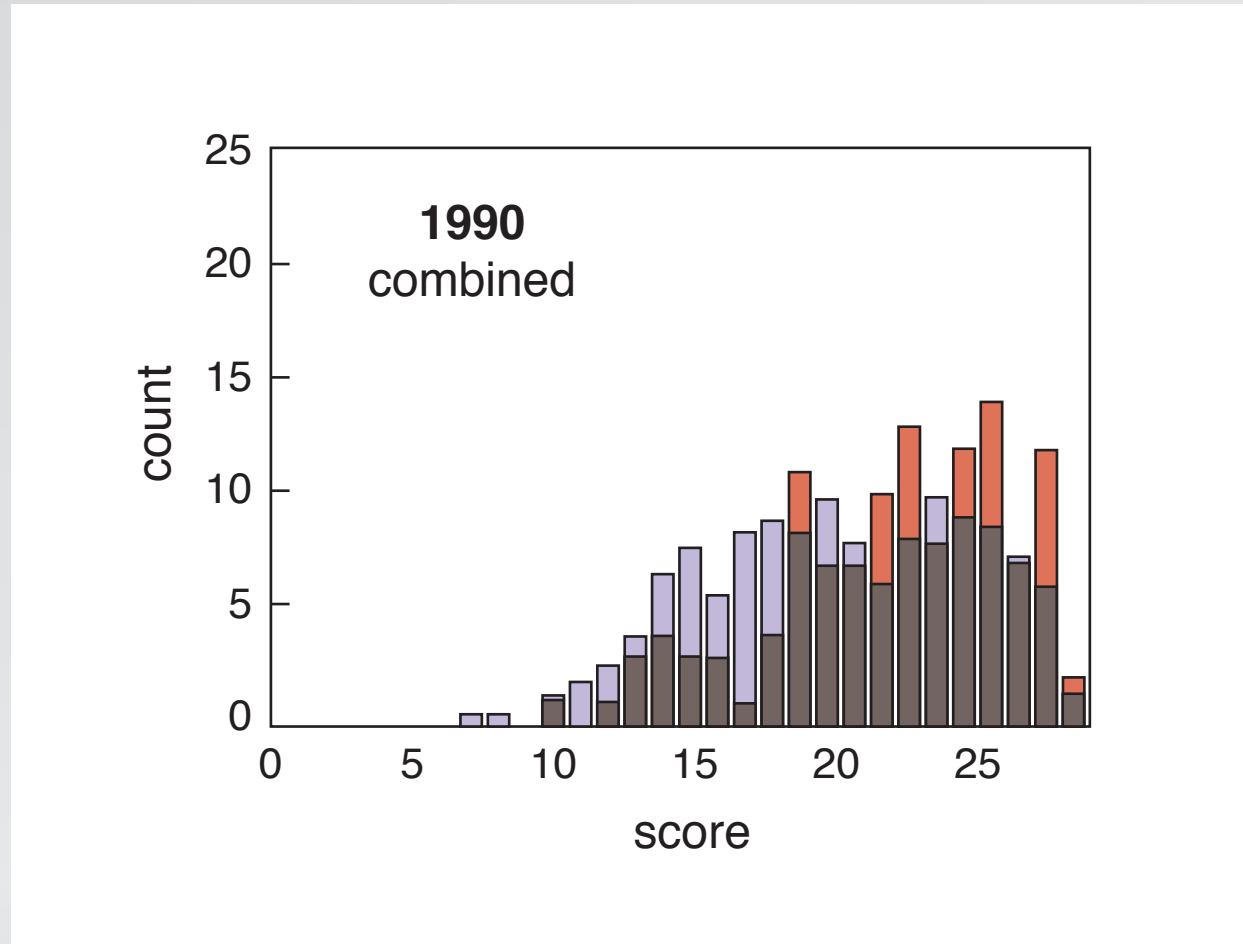


**1** Peer Instruction

**2** let's try it!

**3** results

# traditional instruction

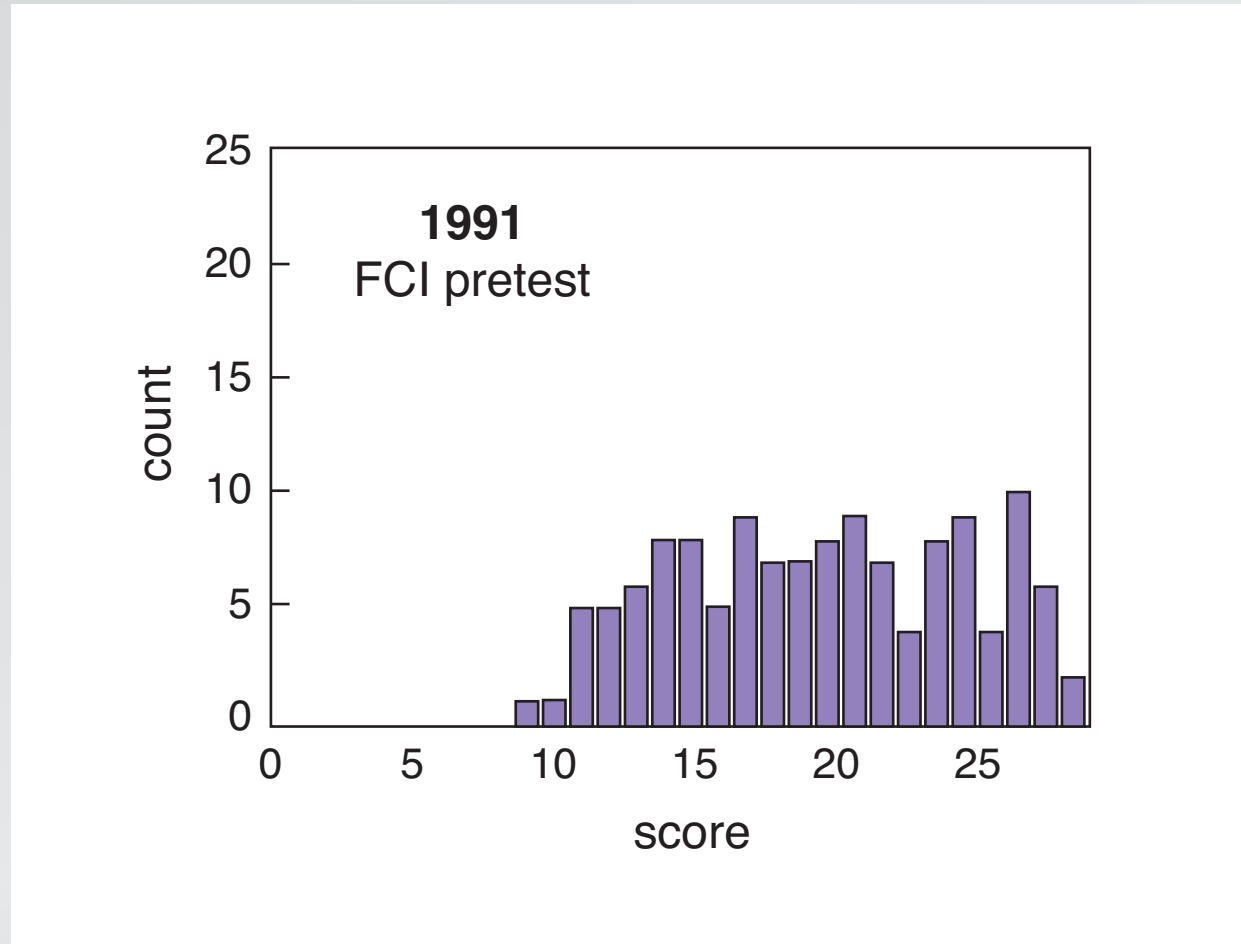


1 Peer Instruction

2 let's try it!

3 results

## first year of implementing PI

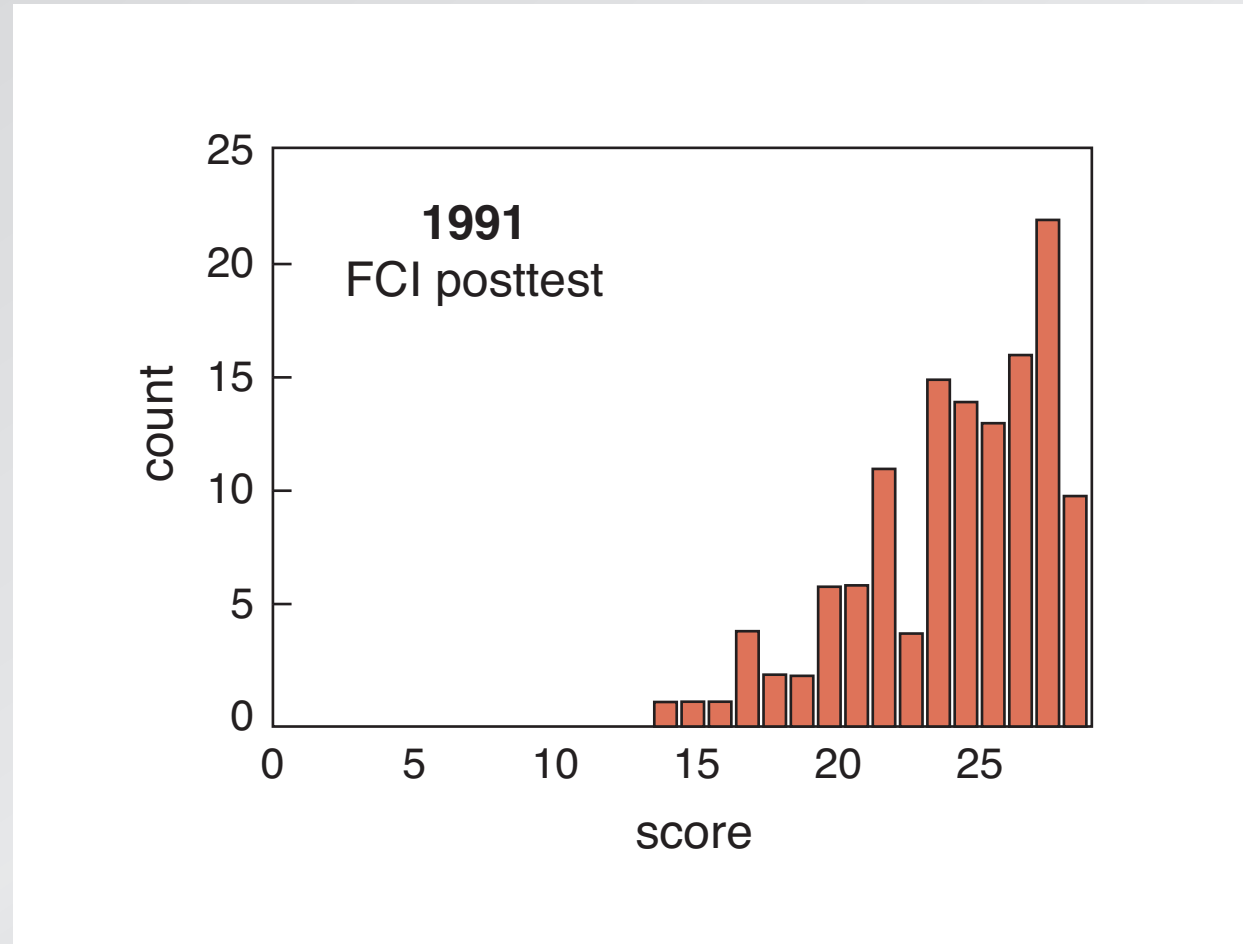


**1** Peer Instruction

**2** let's try it!

**3** results

## first year of implementing PI



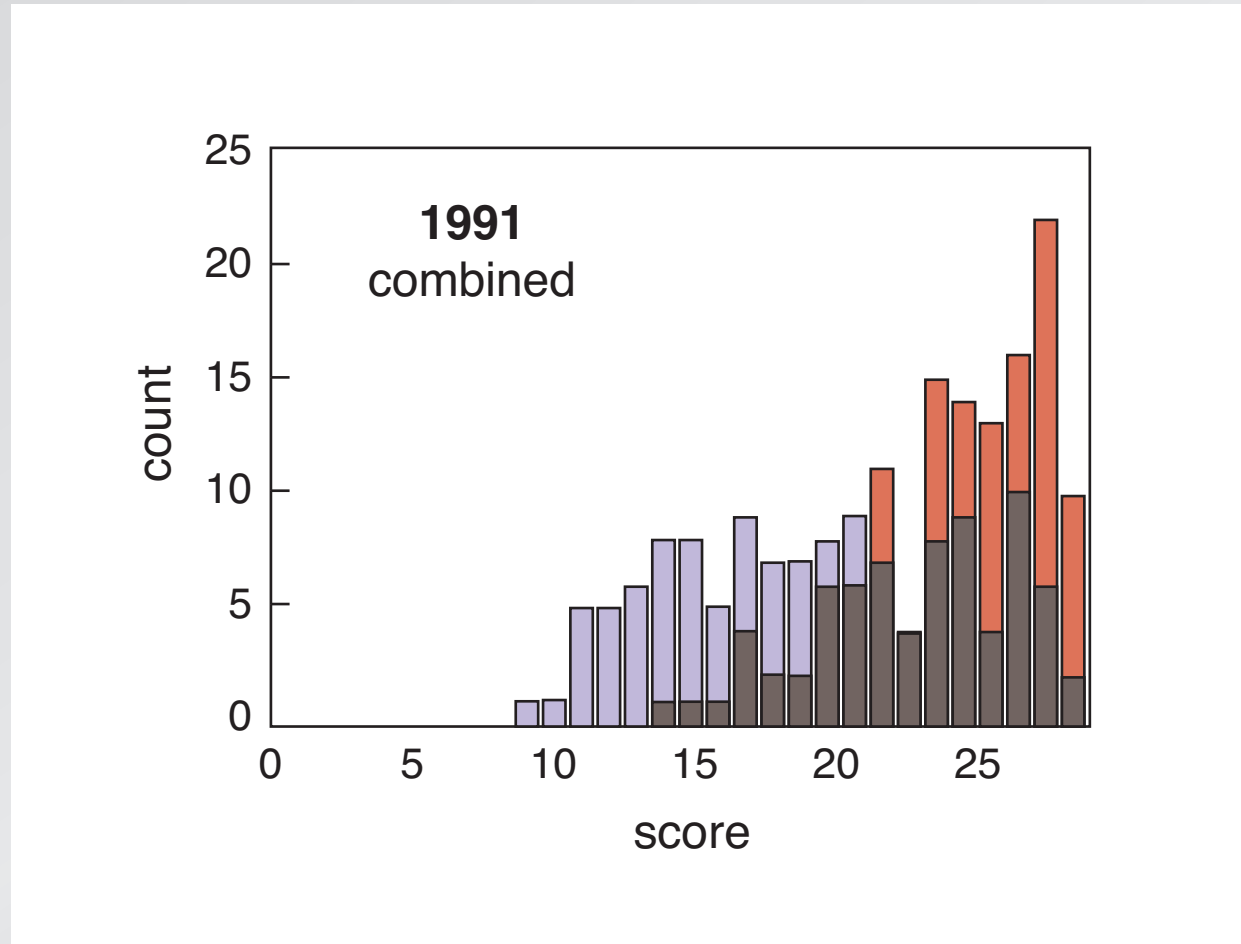
**1** Peer Instruction

**2** let's try it!

**3** results



## first year of implementing PI



1 Peer Instruction

2 let's try it!

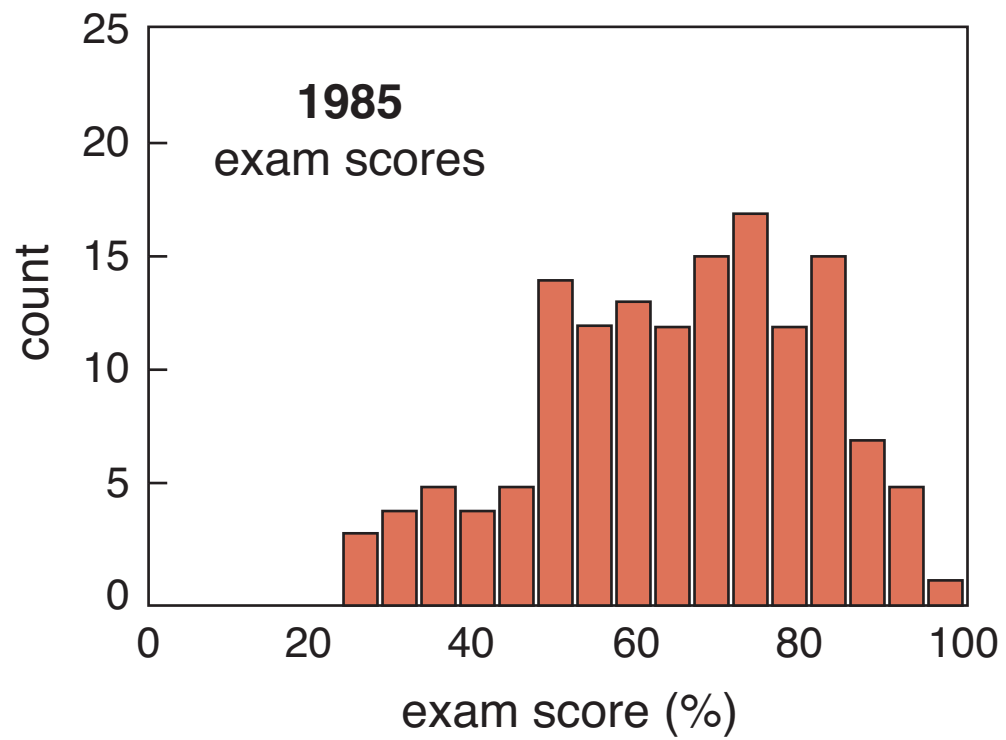
3 results

**what about problem solving?**

**1 Peer Instruction**

**2 let's try it!**

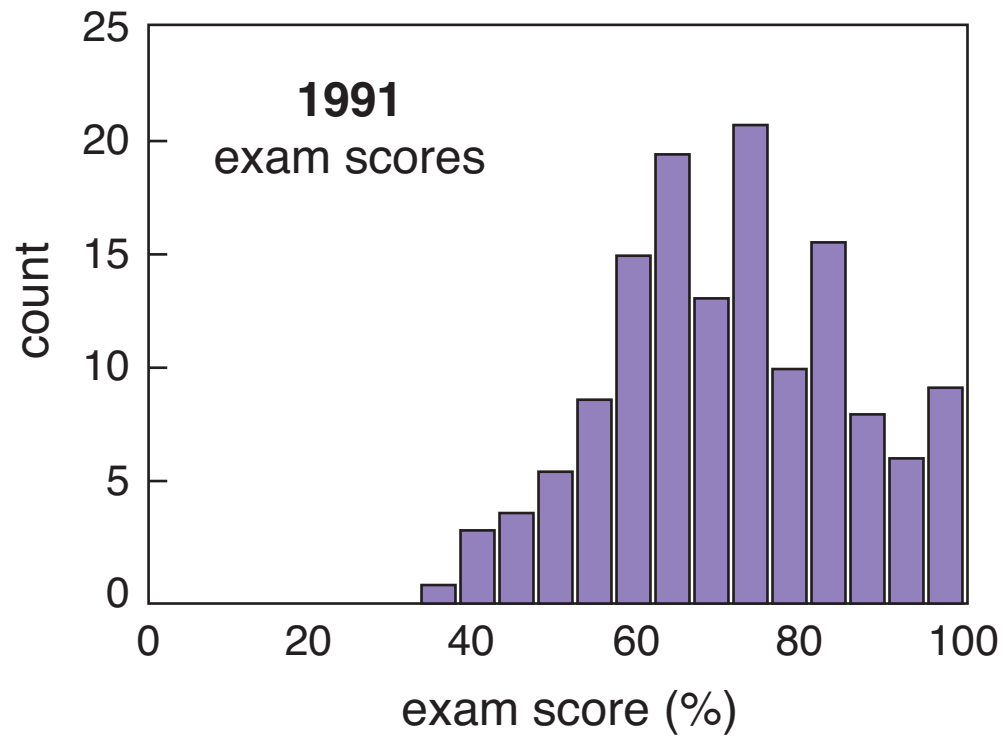
**3 results**



**1** Peer Instruction

**2** let's try it!

**3** results

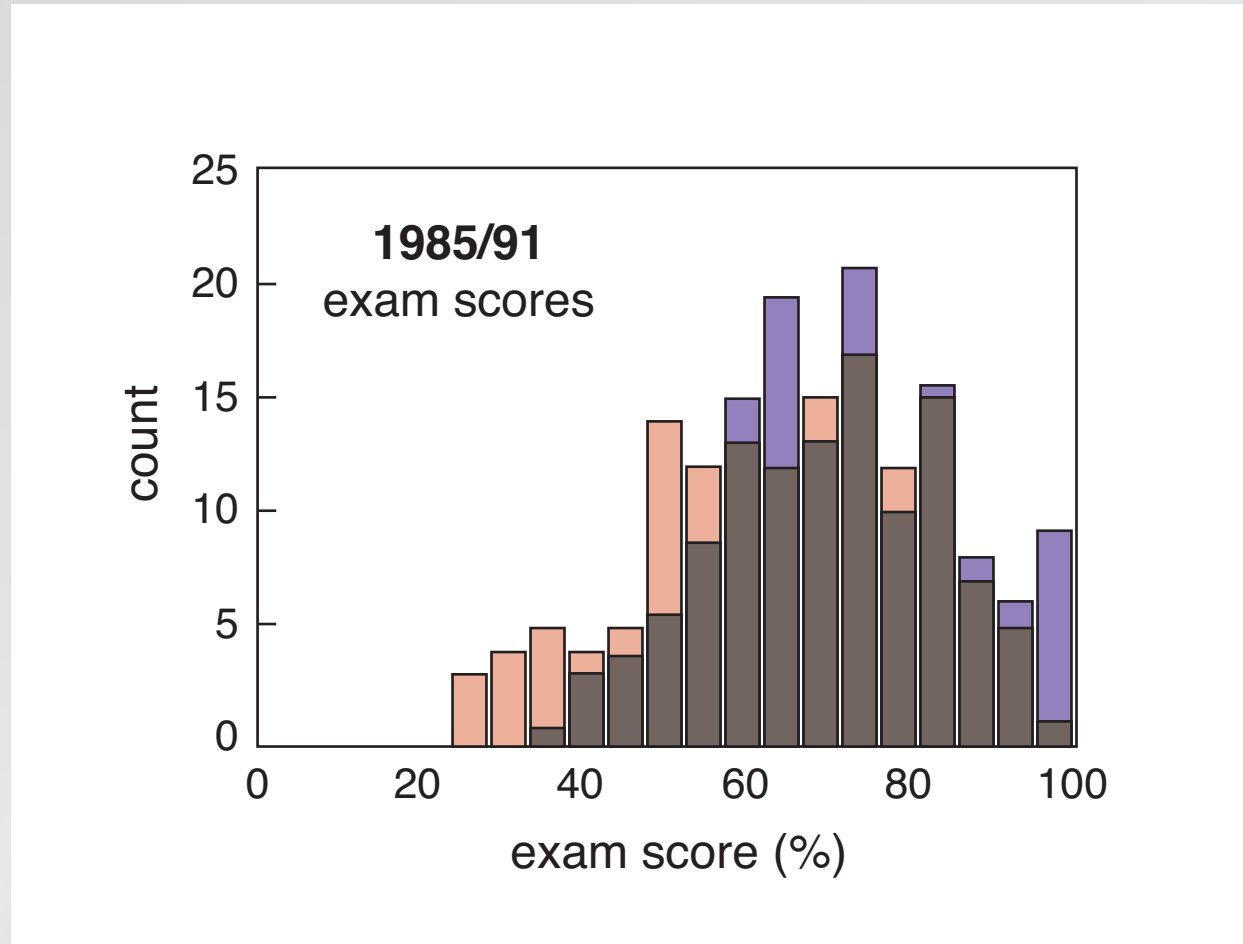


**1** Peer Instruction

**2** let's try it!

**3** results

# better understanding leads to better problem solving



1 Peer Instruction

2 let's try it!

3 results





**1** Peer Instruction

**2** let's try it!

**3** results



in a lecture, students...

**1** Peer Instruction

**2** let's try it!

**3** results



**in a lecture, students...**

**1. don't pay utmost attention**

**1 Peer Instruction**

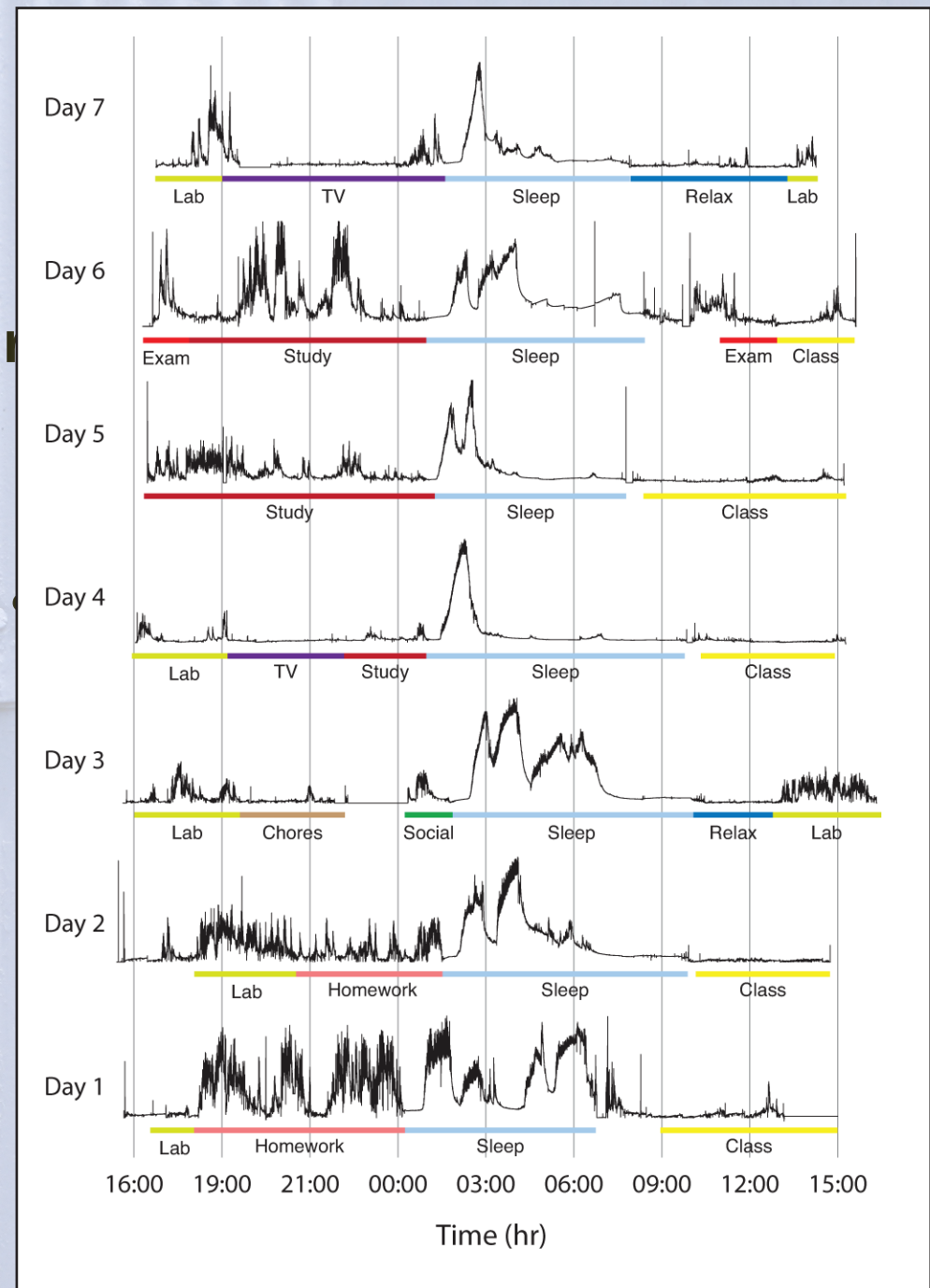
**2 let's try it!**

**3 results**



in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

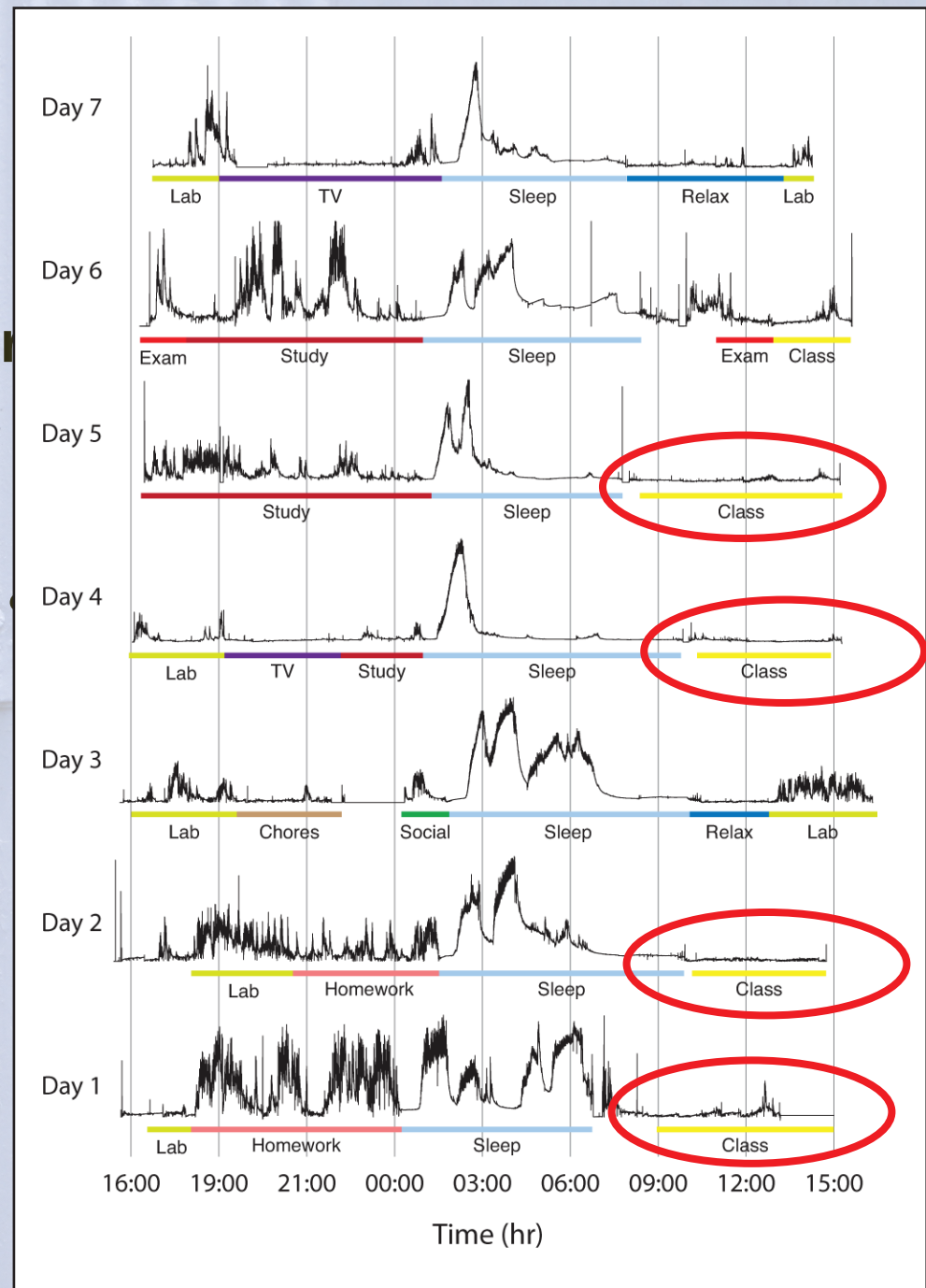
1 Peer Instruction

2 let's try it!

3 results

in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 Peer Instruction

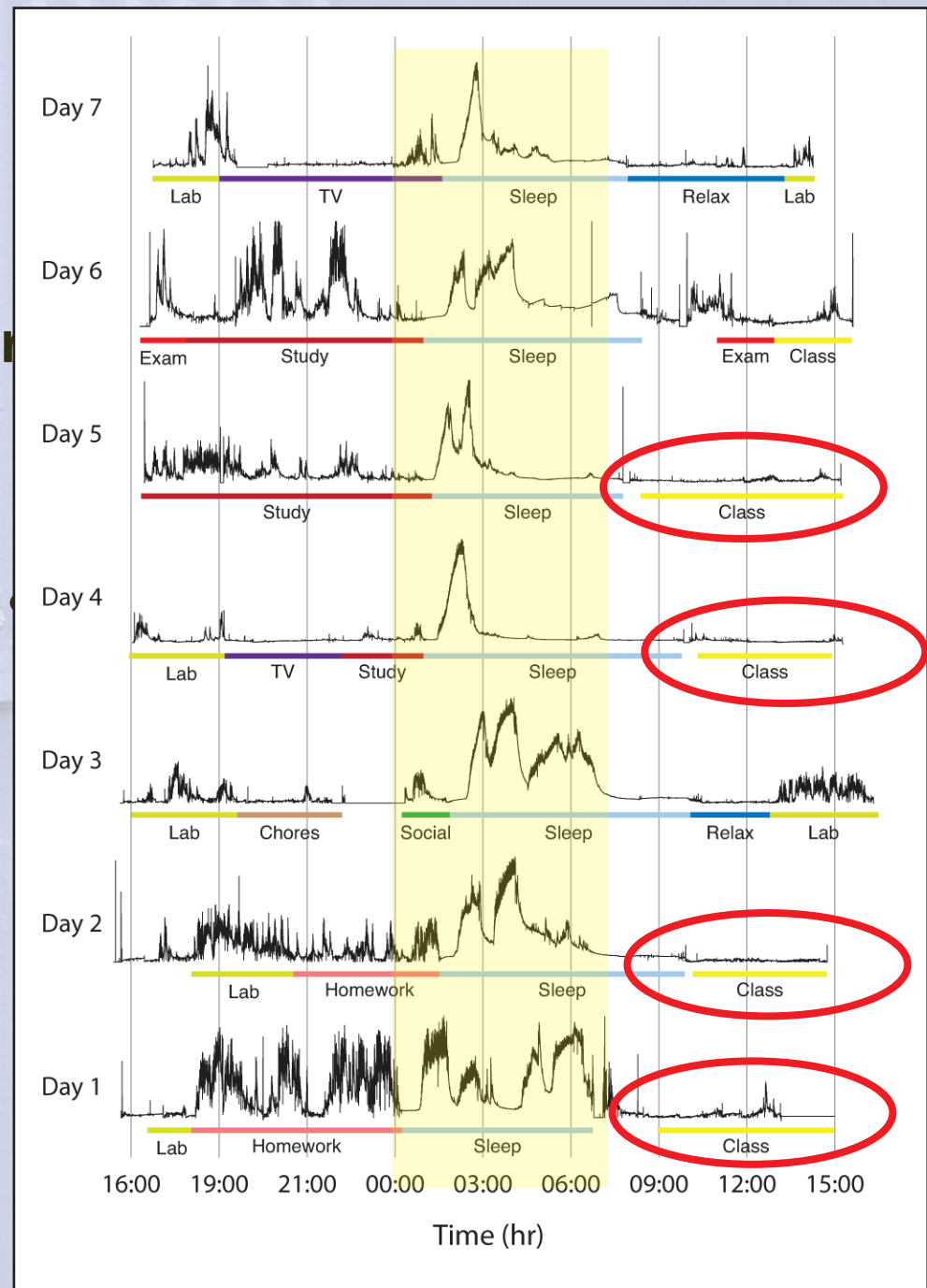
2 let's try it!

3 results



in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

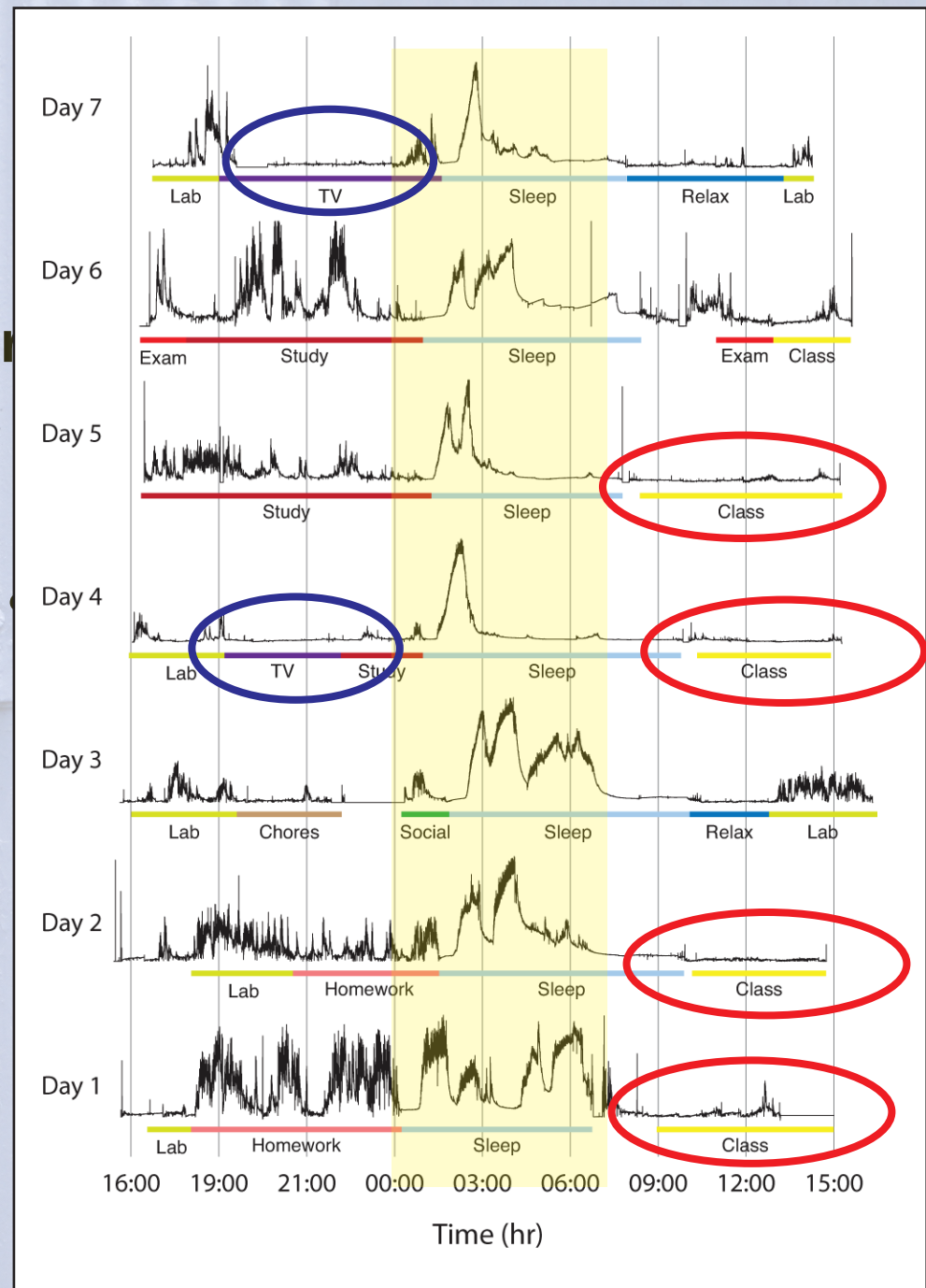
1 Peer Instruction

2 let's try it!

3 results

in a lecture

1. don't pay utmost



doi: 10.1109/TBME.2009.2038487

1 Peer Instruction

2 let's try it!

3 results



**in a lecture, students...**

**1. don't pay utmost attention**

**2. think they know it**





<http://www.babble.com>

**1** Peer Instruction

**2** let's try it!

**3** results



A close-up photograph of a calico cat's face, showing its green eyes and orange, white, and black fur. The image is slightly blurred and has a semi-transparent white overlay.

**2 short video lectures on calico cats, same content**

doi: [10.3758/s13423-013-0442-z](https://doi.org/10.3758/s13423-013-0442-z)

**1** Peer Instruction

**2** let's try it!

**3** results

**2 short video lectures on calico cats, same content**

**fluent video**



**speaks fluidly w/o notes**

**upright**

**maintains eye contact**

doi: 10.3758/s13423-013-0442-z

**1 Peer Instruction**

**2 let's try it!**

**3 results**



## 2 short video lectures on calico cats, same content

**fluent video**



**speaks fluidly w/o notes  
upright  
maintains eye contact**

**disfluent video**



**speaks haltingly from notes  
slumped  
looks away**

doi: 10.3758/s13423-013-0442-z

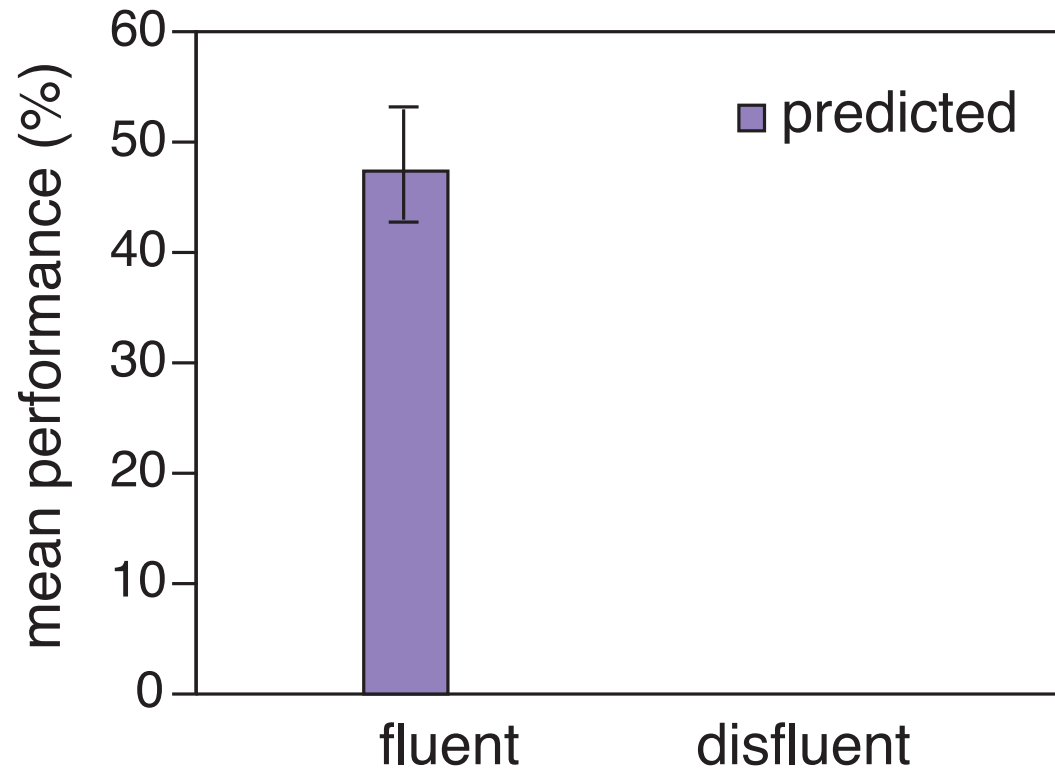
**1 Peer Instruction**

**2 let's try it!**

**3 results**



## judgement of learning



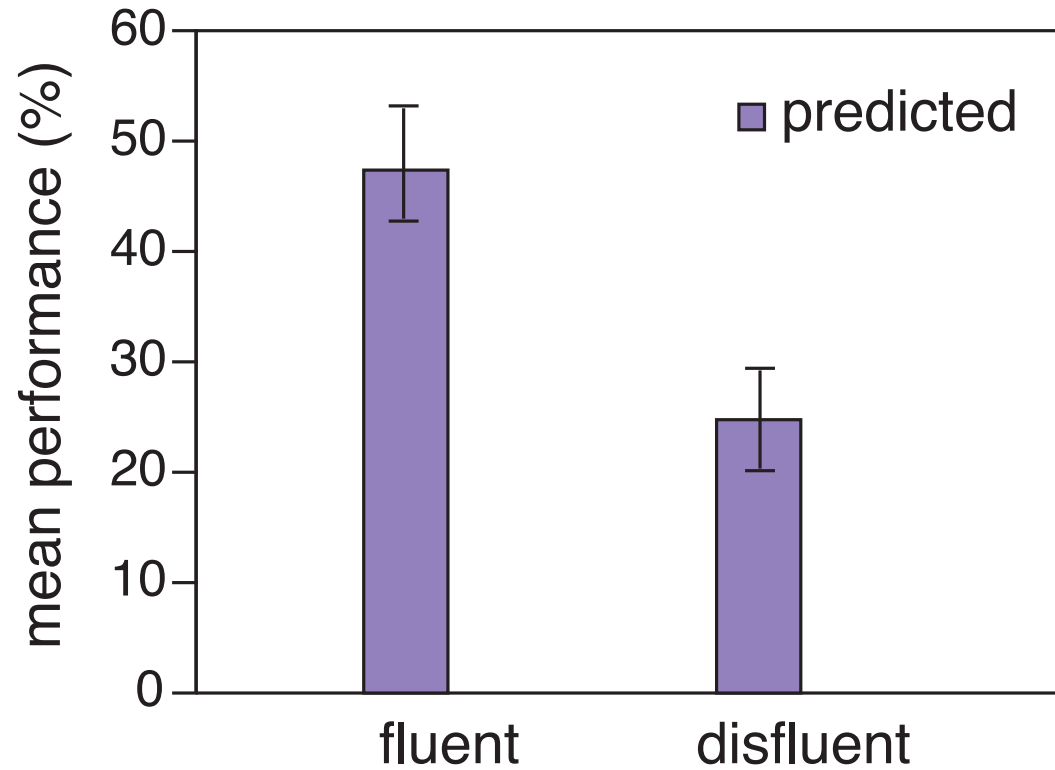
doi: 10.3758/s13423-013-0442-z

**1** Peer Instruction

**2** let's try it!

**3** results

## judgement of learning



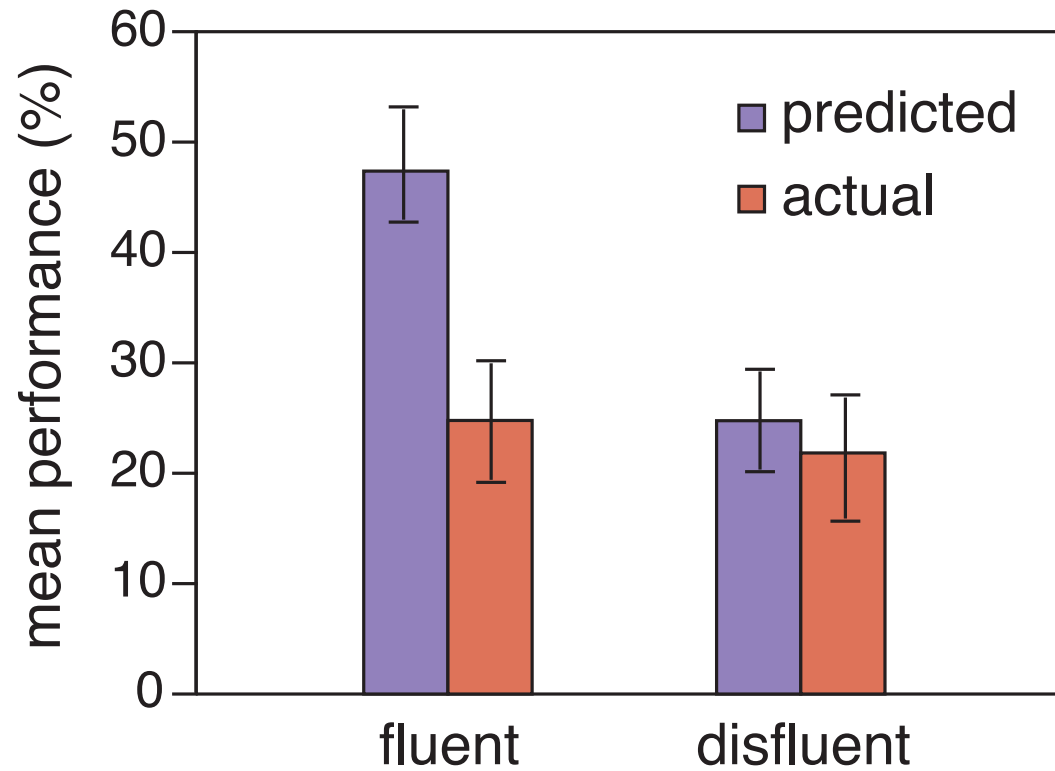
doi: 10.3758/s13423-013-0442-z

**1** Peer Instruction

**2** let's try it!

**3** results

## judgement of learning



doi: 10.3758/s13423-013-0442-z

**1** Peer Instruction

**2** let's try it!

**3** results



**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** Peer Instruction

**2** let's try it!

**3** results





**1** Peer Instruction

**2** let's try it!

**3** results





**an illusion. . .**

**1 Peer Instruction**

**2 let's try it!**

**3 results**





**Education is not just about:**

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

**1 Peer Instruction**

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**Education is not just about:**

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

**active participation a must!**

**1 Peer Instruction**

**2 let's try it!**

**3 results**





**not just a polling tool, but an engagement tool!**





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