

Creating the ultimate flipped classroom: A step by step guide for Peer Instruction



Master Class
World Educational Leadership Summit 2016
Singapore, 6 April 2016

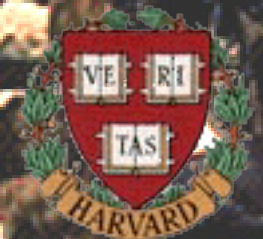


Creating the ultimate flipped classroom: A step by step guide for Peer Instruction



@eric_mazur

Master Class
World Educational Leadership Summit 2016
Singapore, 6 April 2016



Program

- 9:00** Peer Instruction and Just-in-Time-Teaching
- 10:30** Break
- 11:00** Technology/Hands-on with Peer Instruction
- 12:30** Lunch
- 13:30** Designing good questions for PI
- 15:00** Break
- 15:30** Discussion and wrap-up
- 16:30** Adjourn



@eric_mazur

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?

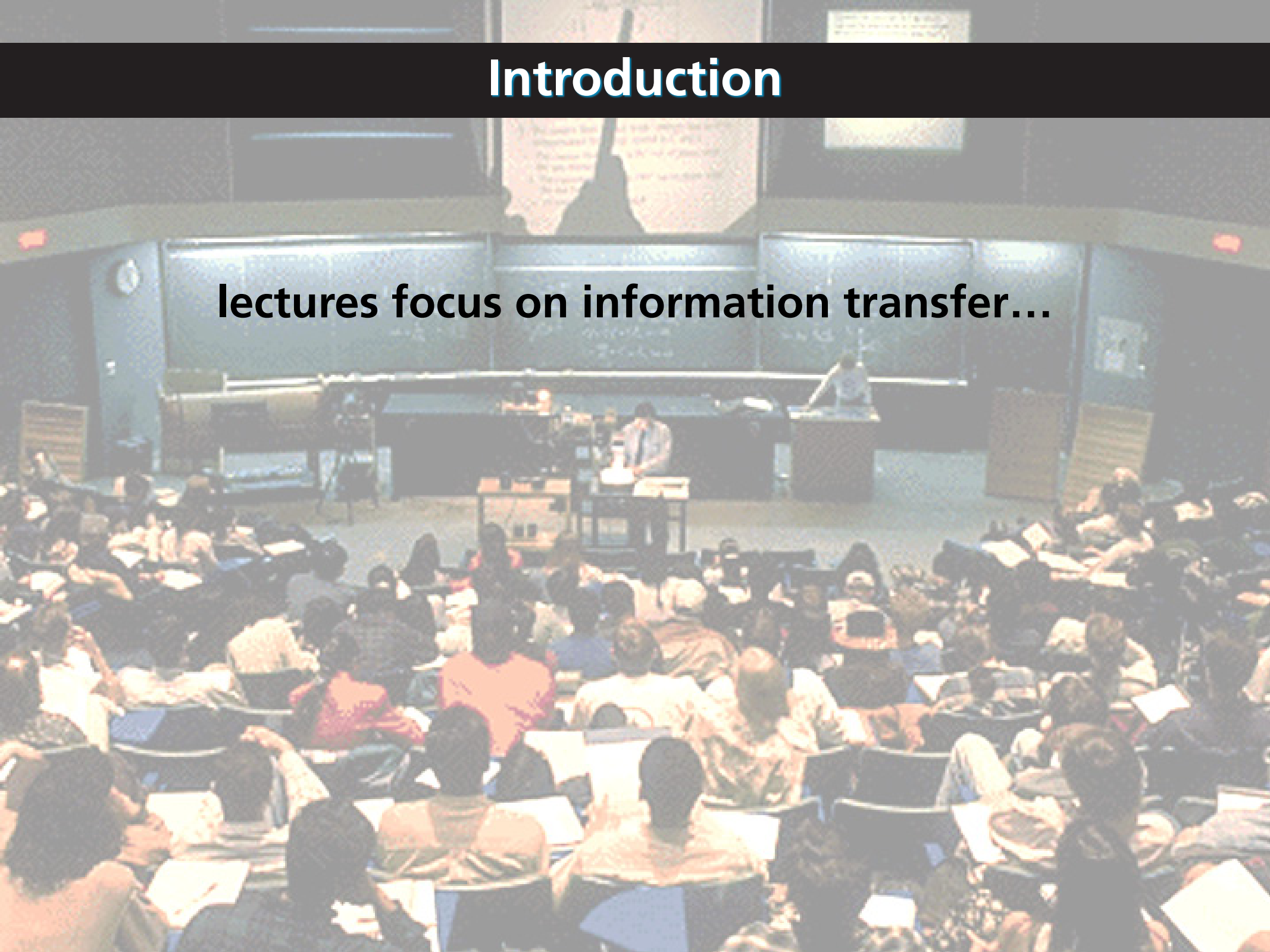
Became good at it by:

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



Introduction

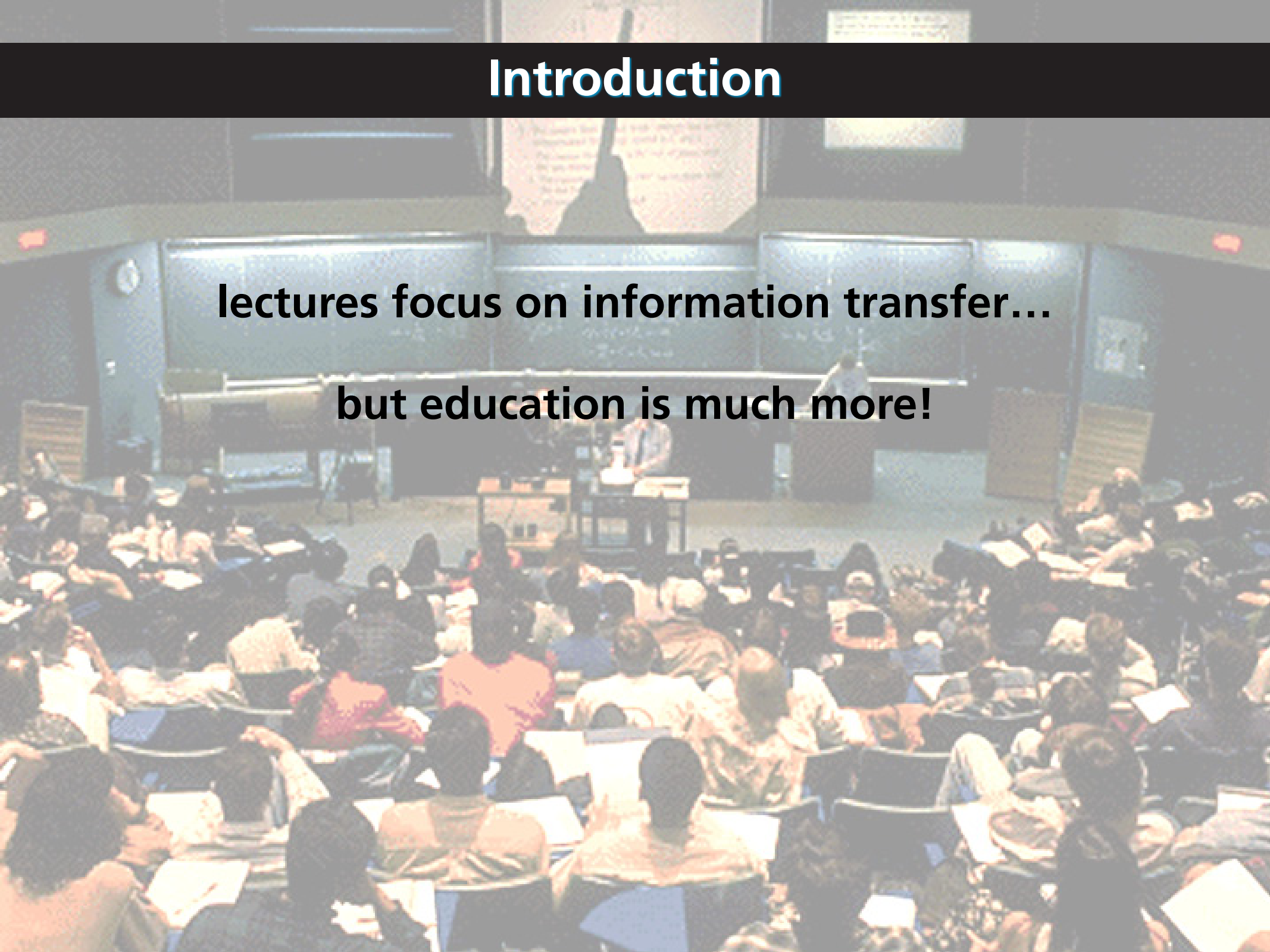
lectures focus on information transfer...



Introduction

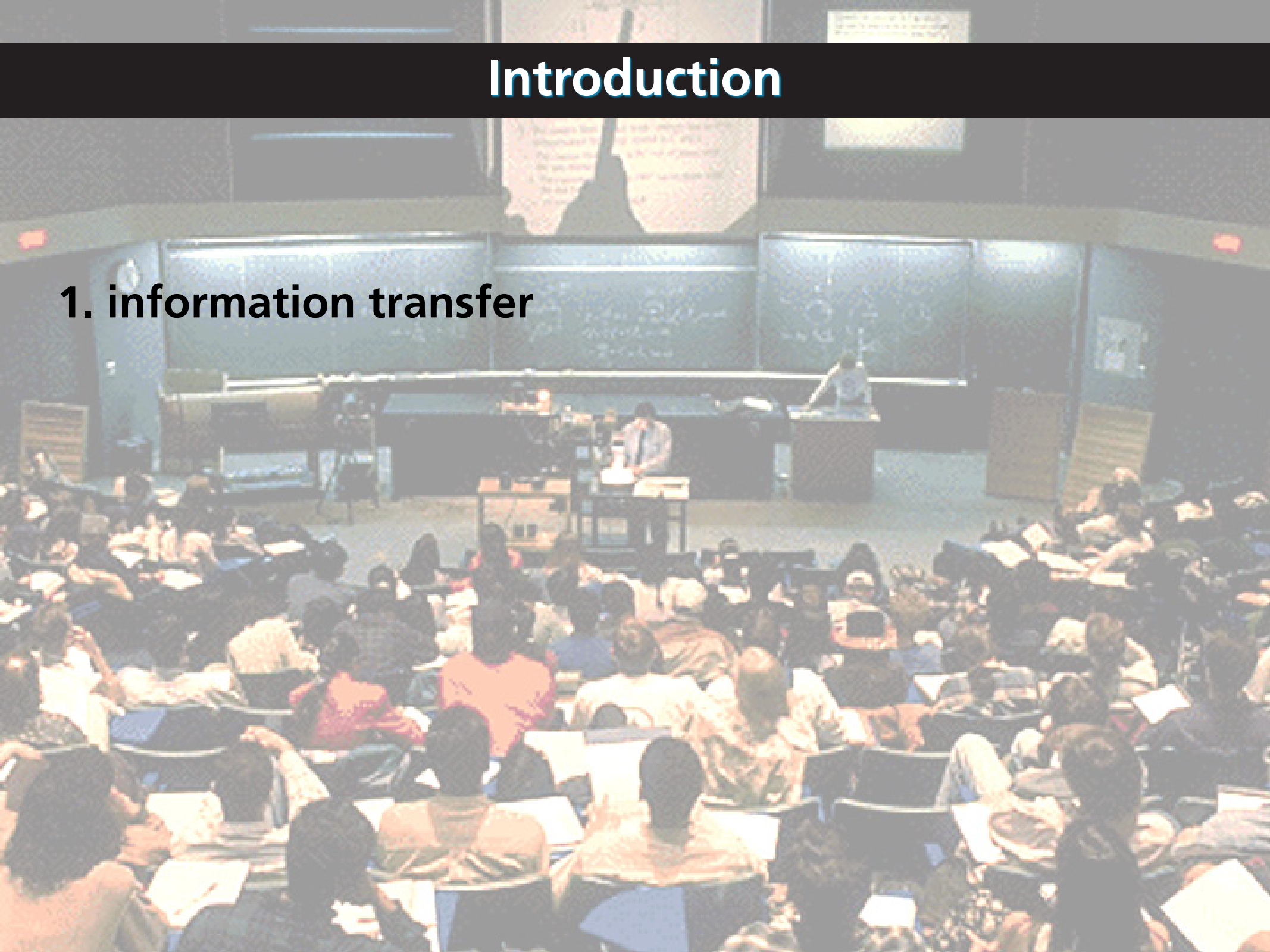
lectures focus on information transfer...

but education is much more!



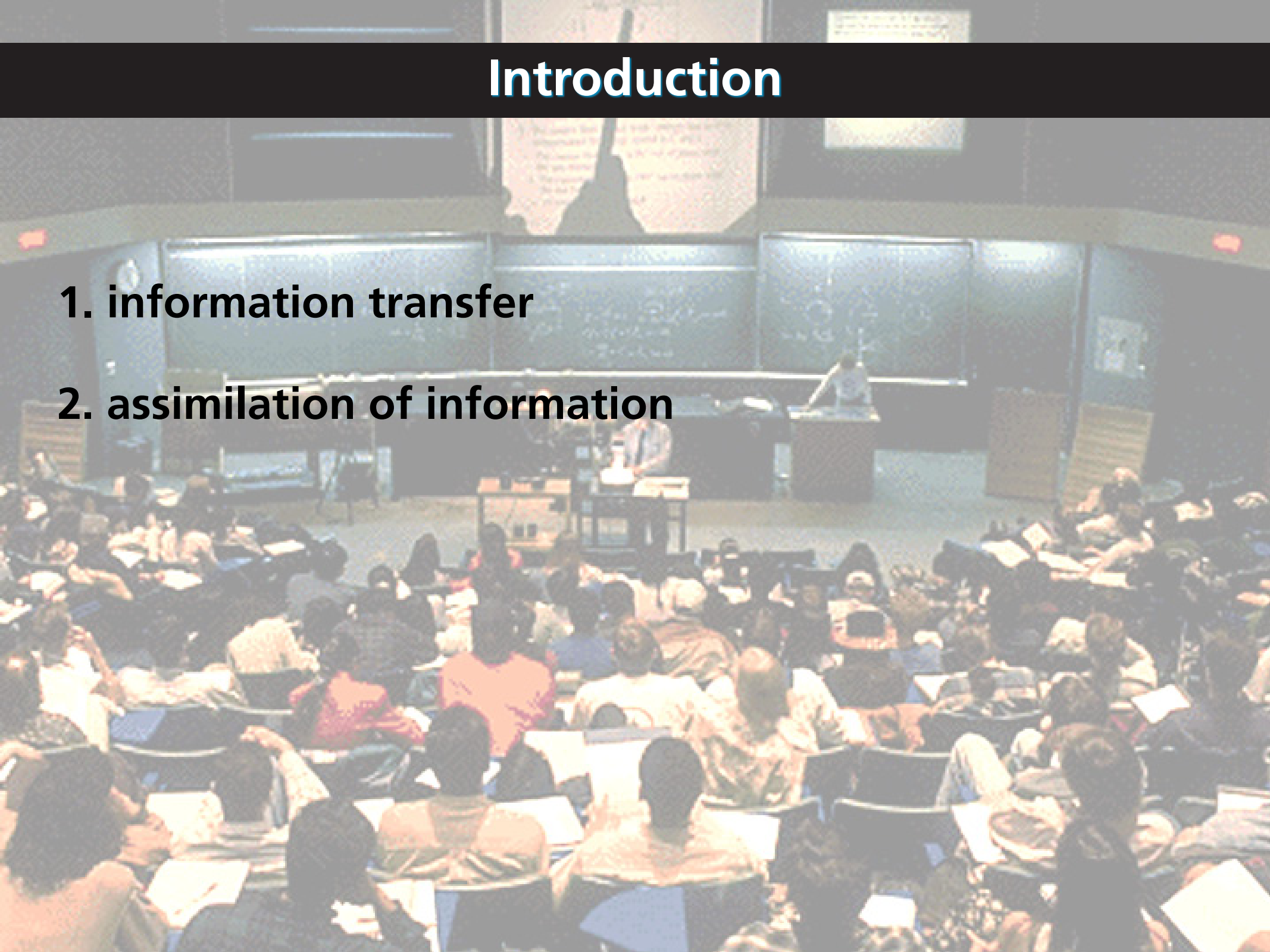
Introduction

1. information transfer



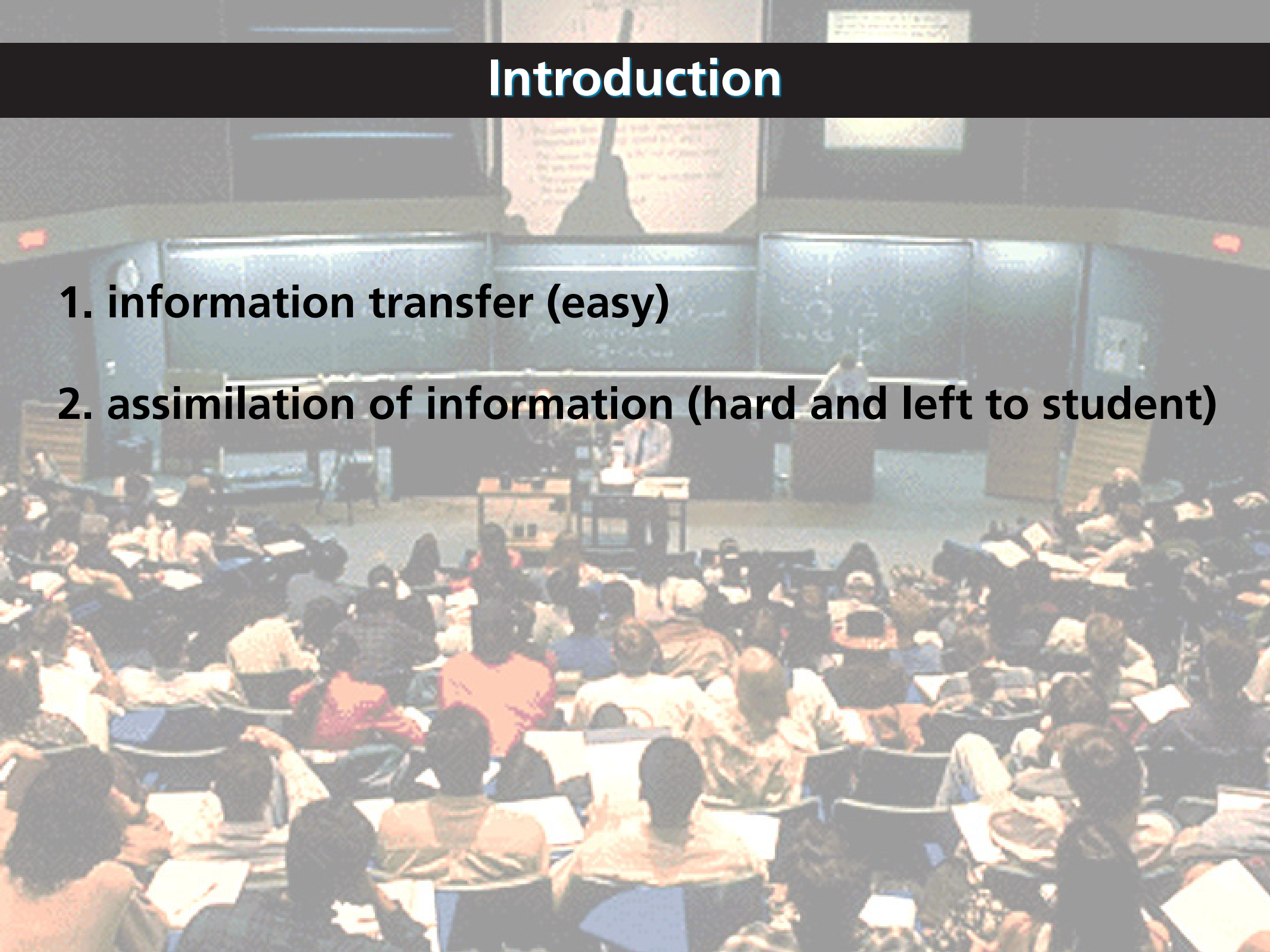
Introduction

1. information transfer
2. assimilation of information



Introduction

1. information transfer (easy)
2. assimilation of information (hard and left to student)



Introduction

Solution: move information transfer out of classroom!

Introduction

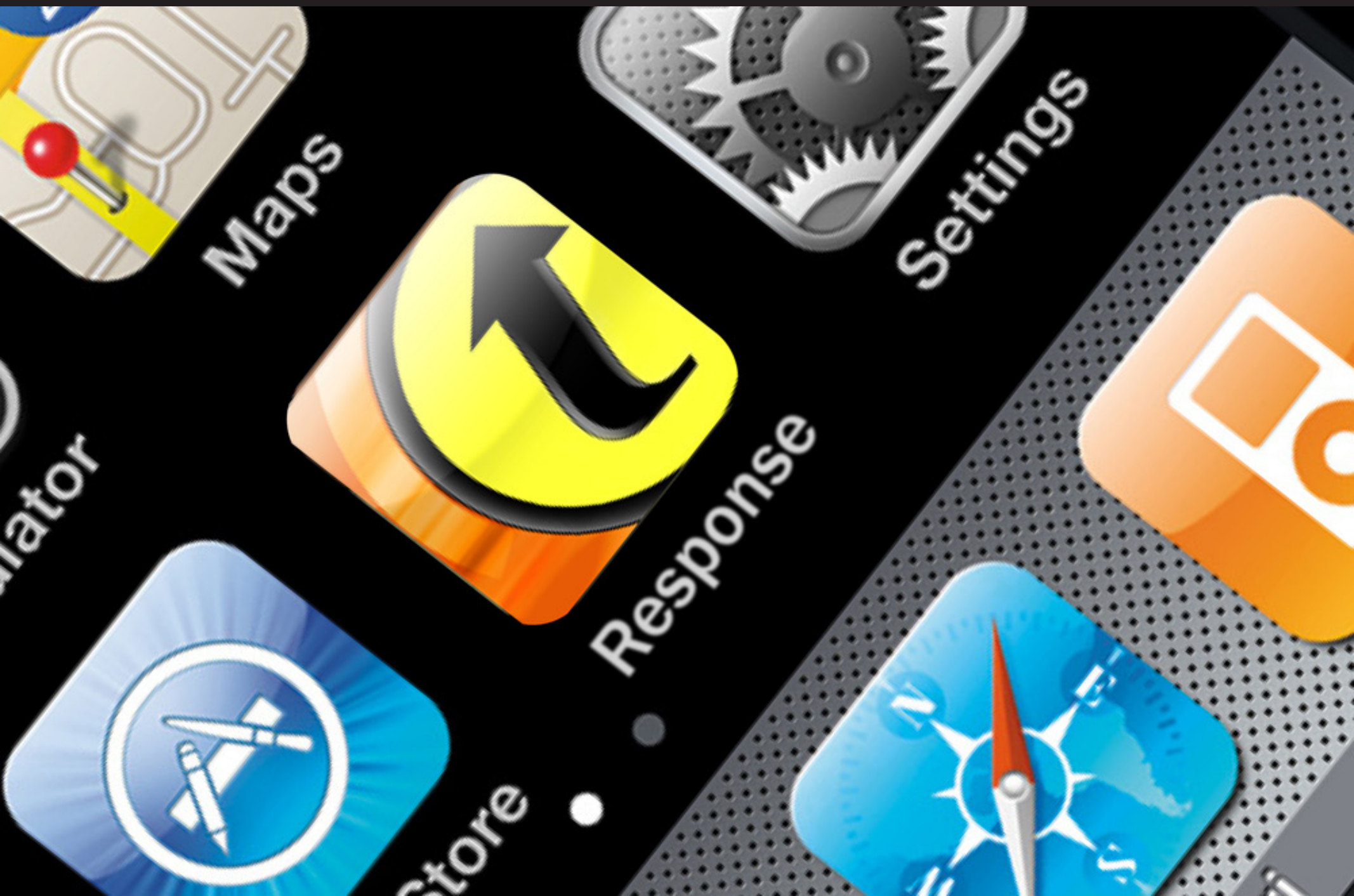
How to move information transfer out of classroom?

Introduction

How to move information transfer out of classroom?

Use JiTT (before class) and PI (in class)!

Outline



Outline

- **PI & JiTT Overview**
- **Implementing PI & JiTT**
- **ConceptTests**

PI & JiTT Overview

“How can I be sure that my students will prepare for class?”

PI & JiTT Overview

Students do not come to class prepared, because...

- 1. they don't have time.**
- 2. they are not motivated to learn.**
- 3. their instructors take away the incentive.**
- 4. they do not have the requisite skills.**
- 5. of some other reason.**
- 6. They do come prepared in my class!**

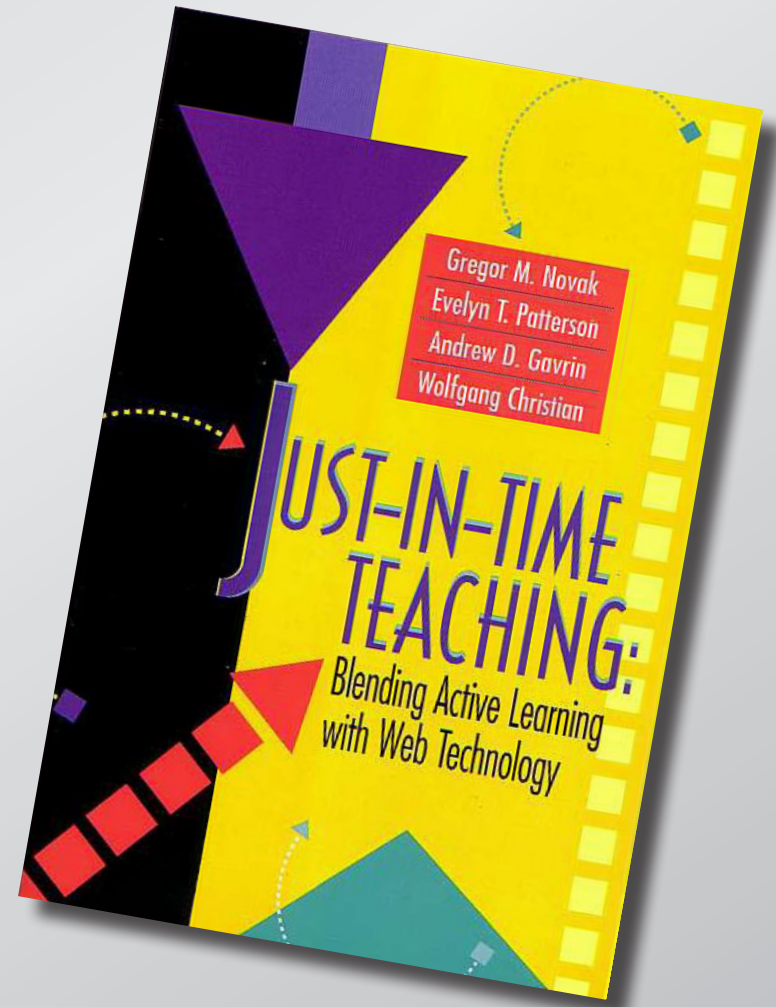
(select what you consider to be the main reason)



PI & JiTT Overview

Just-in-time-Teaching (JiTT)

www.jitt.org



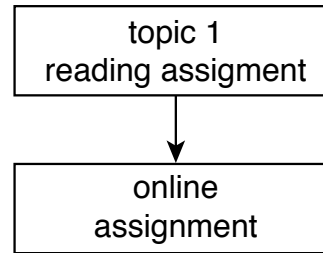
PI & JiTT Overview

JiTT workflow

topic 1
reading assignment

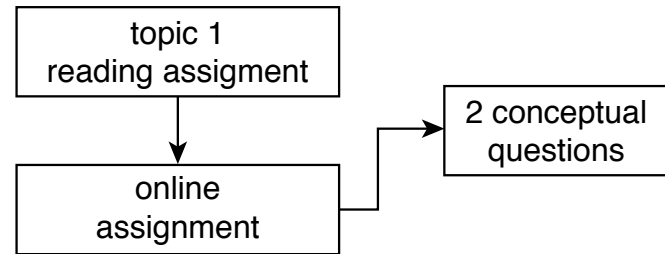
PI & JiTT Overview

JiTT workflow



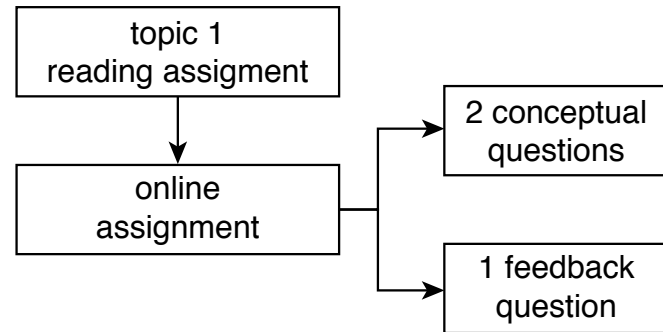
PI & JiTT Overview

JiTT workflow



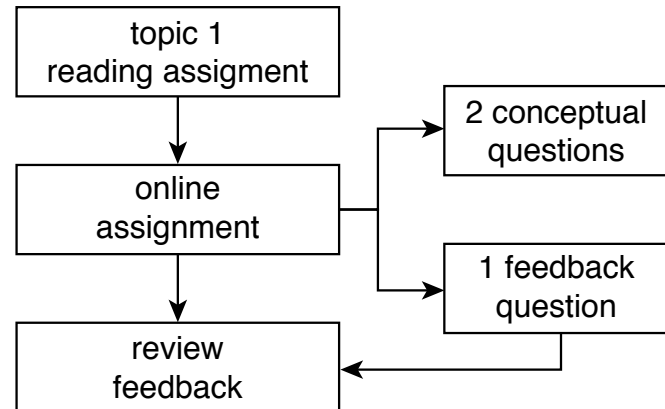
PI & JiTT Overview

JiTT workflow



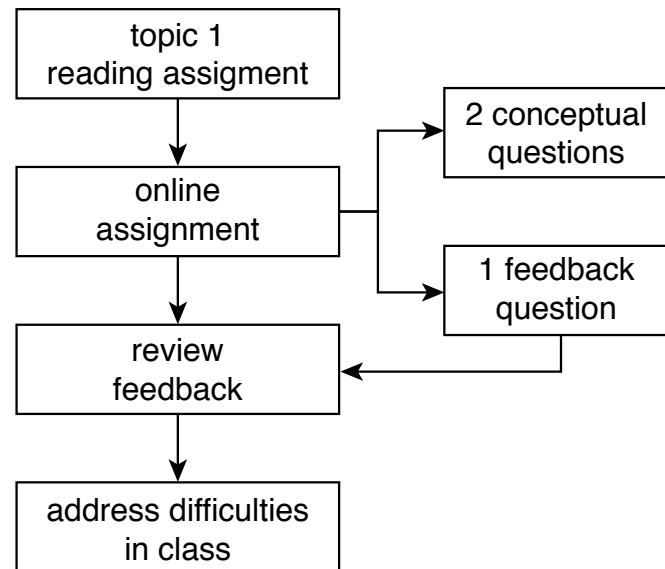
PI & JiTT Overview

JiTT workflow



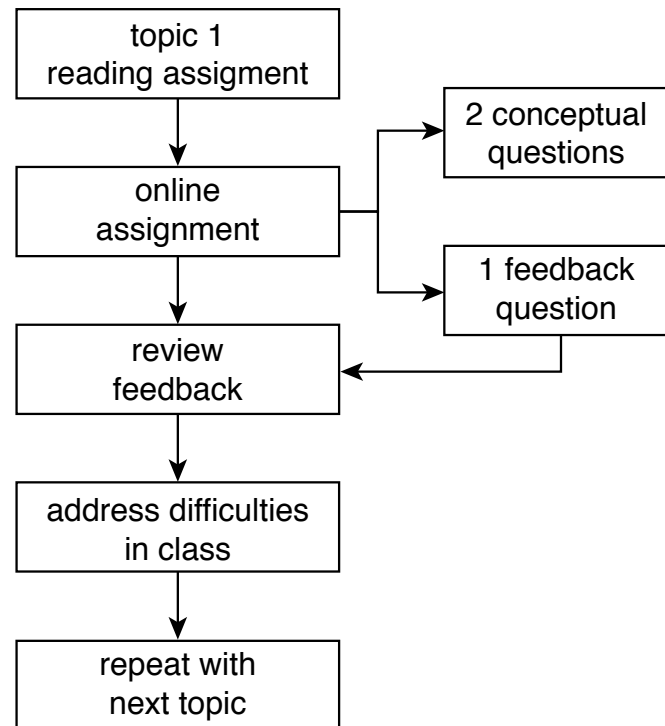
PI & JiTT Overview

JiTT workflow



PI & JiTT Overview

JiTT workflow



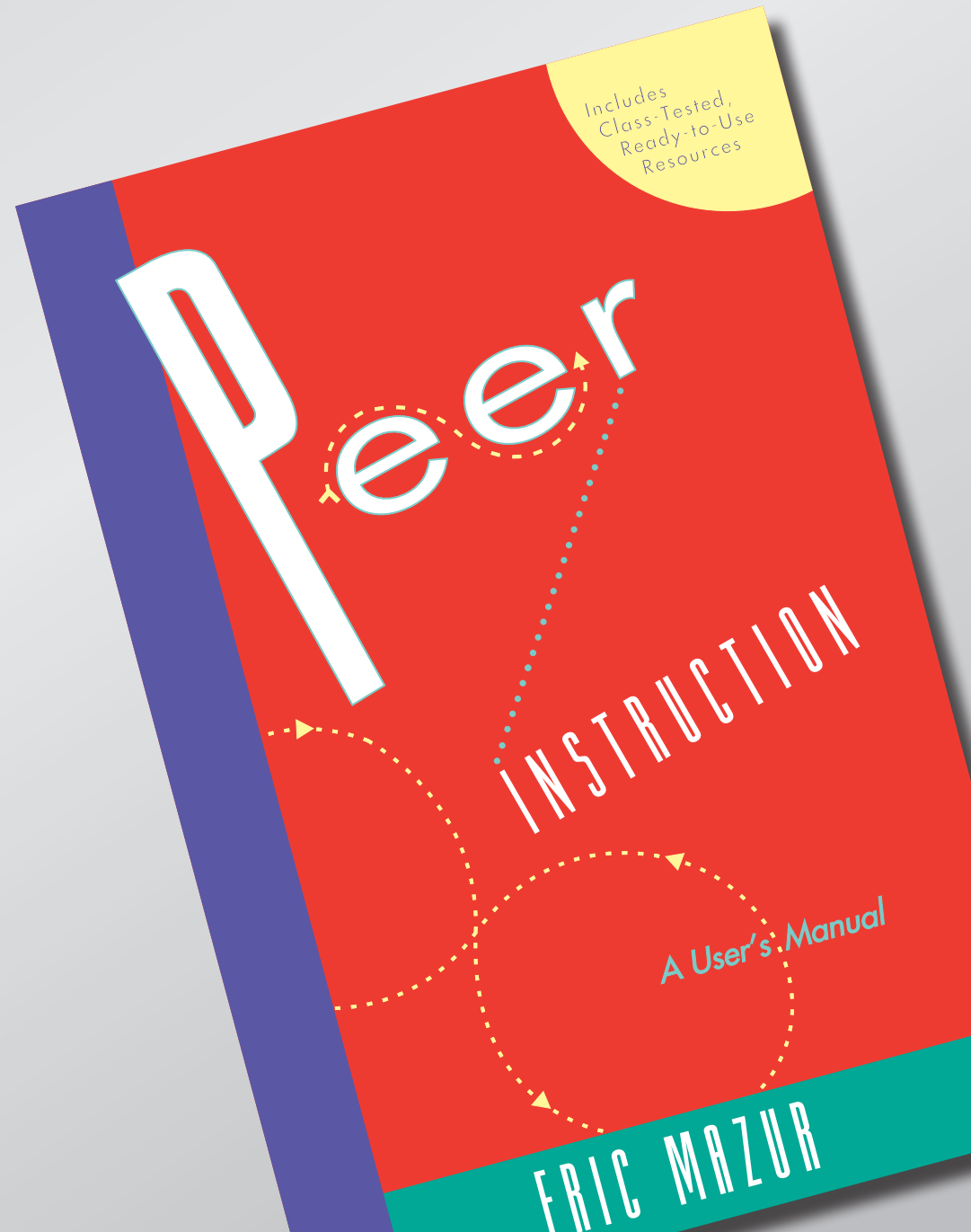
PI & JiTT Overview

JiTT:

- prepares you for class
- prepares students for class
- helps you address student difficulties

PI & JiTT Overview

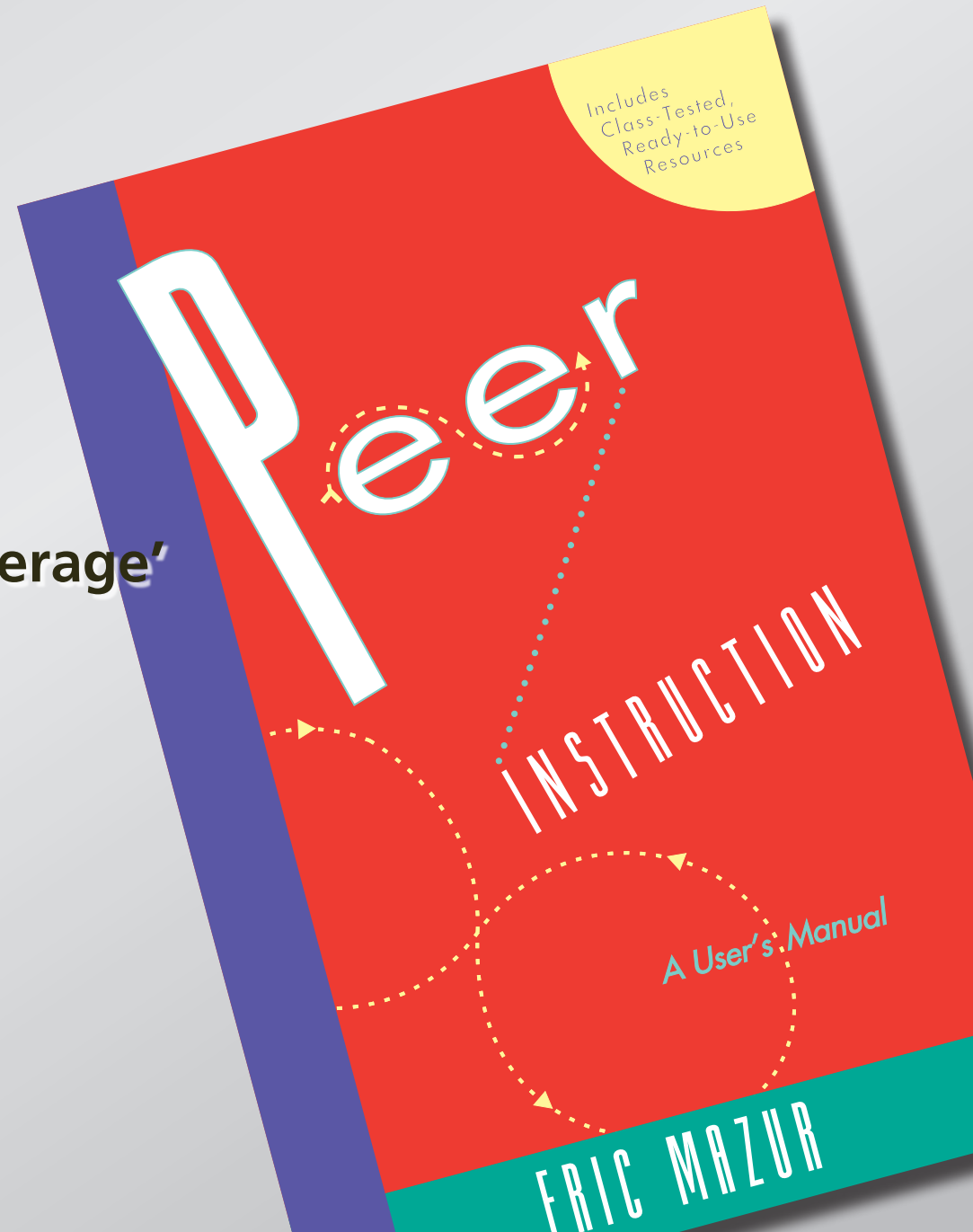
Peer Instruction (PI)



PI & JiTT Overview

Main features:

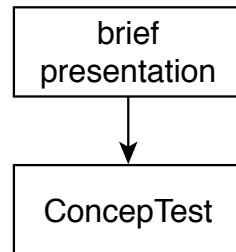
- pre-class assignment
- in-class: depth, not 'coverage'
- ConcepTests



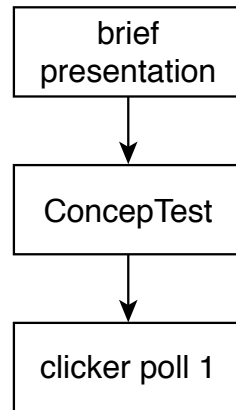
PI & JiTT Overview

brief
presentation

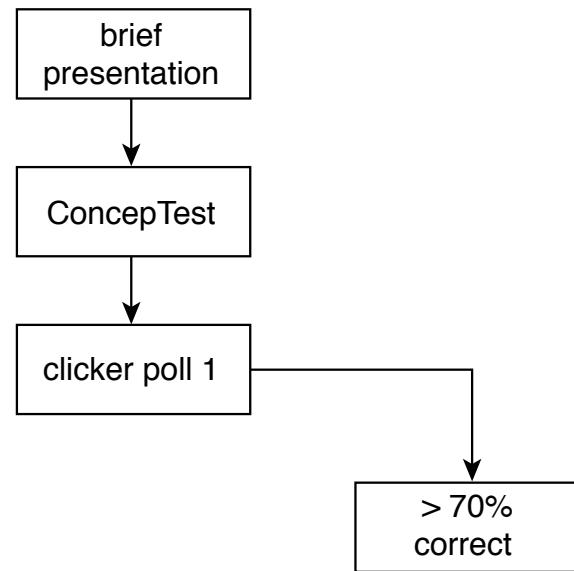
PI & JiTT Overview



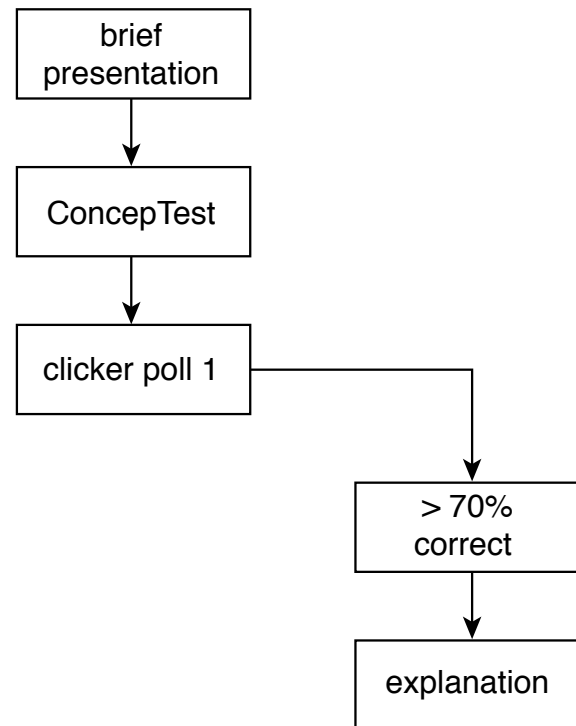
PI & JiTT Overview



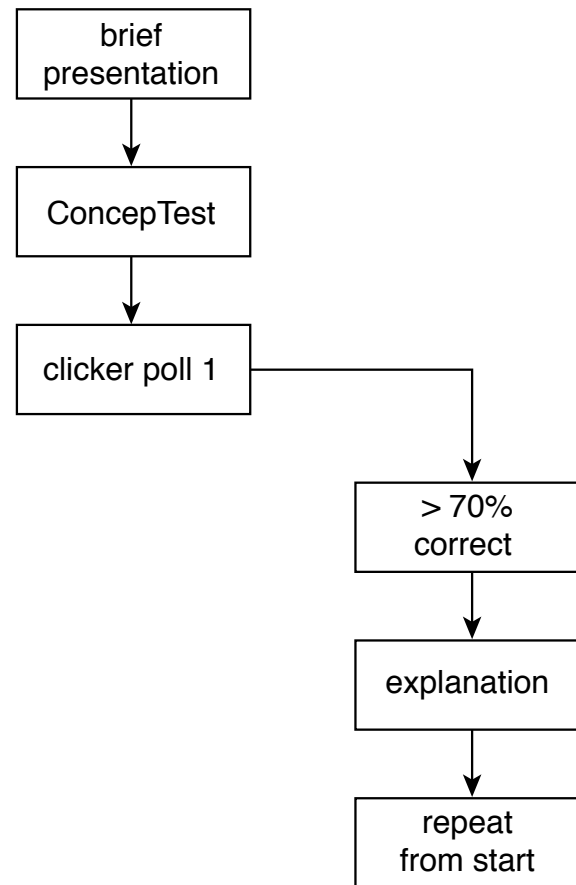
PI & JiTT Overview



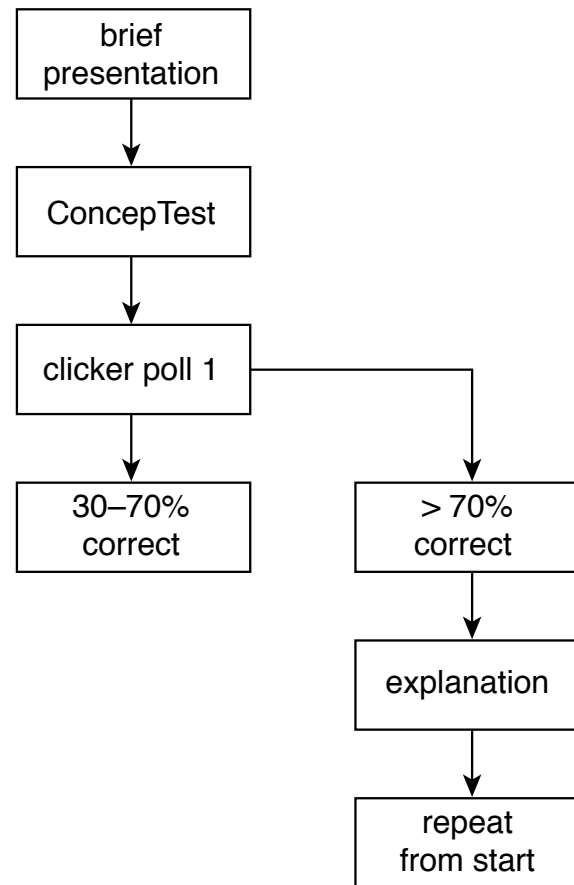
PI & JiTT Overview



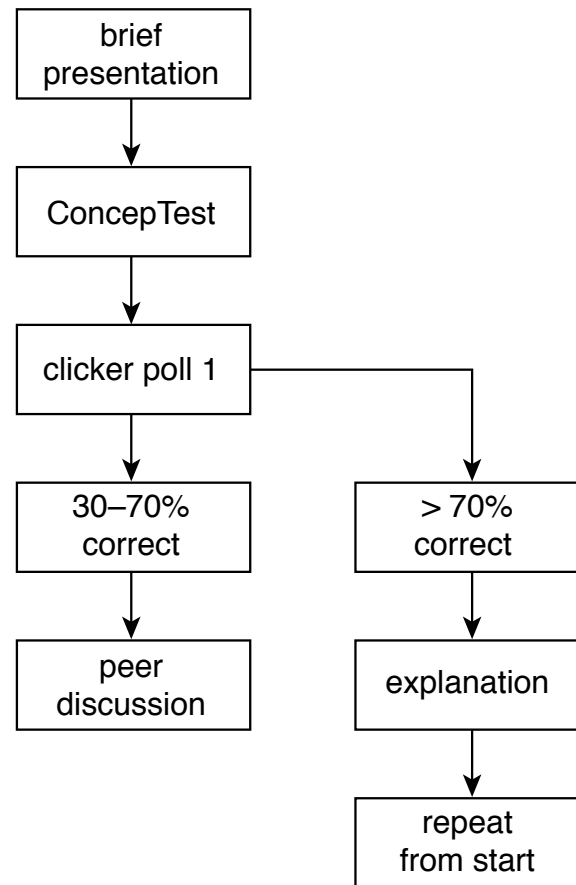
PI & JiTT Overview



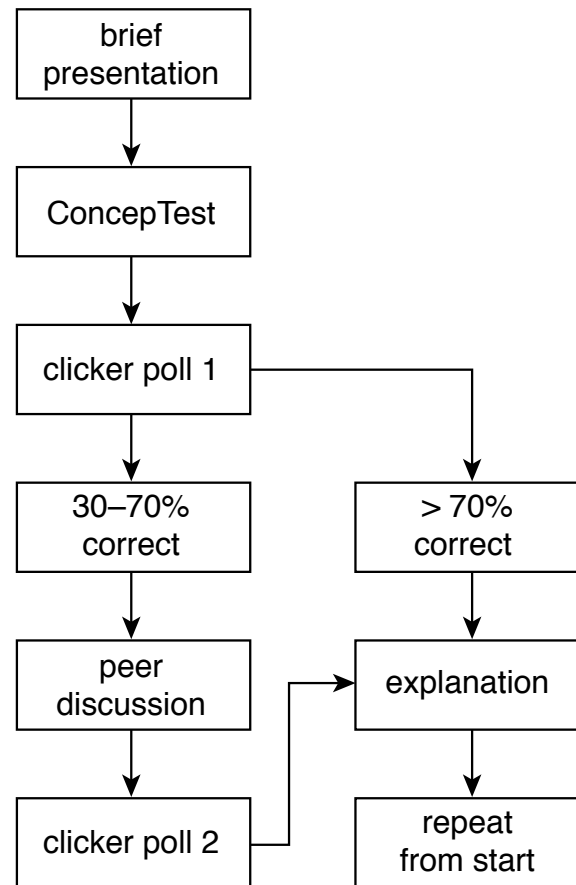
PI & JiTT Overview



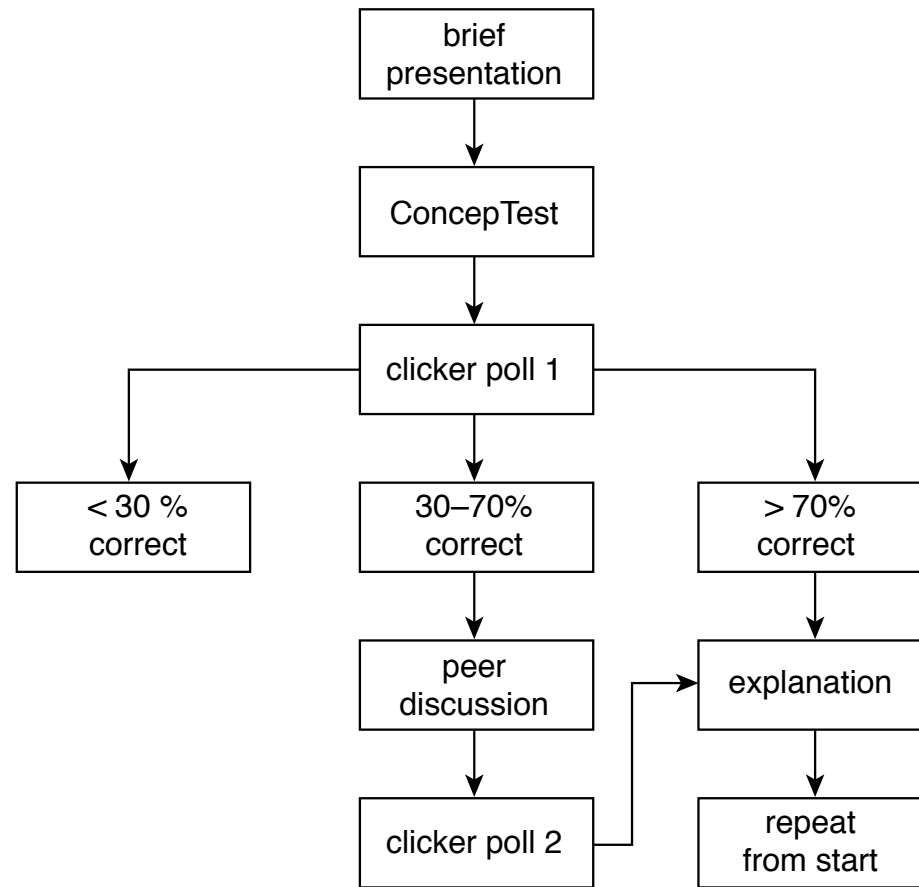
PI & JiTT Overview



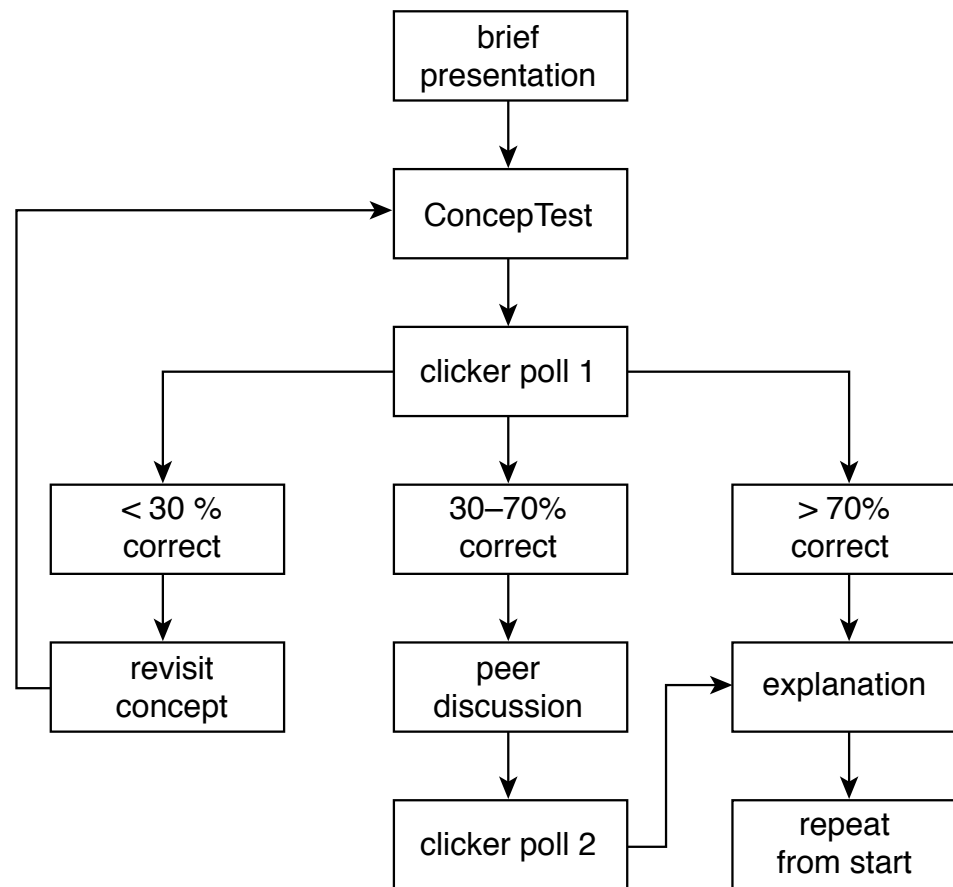
PI & JiTT Overview



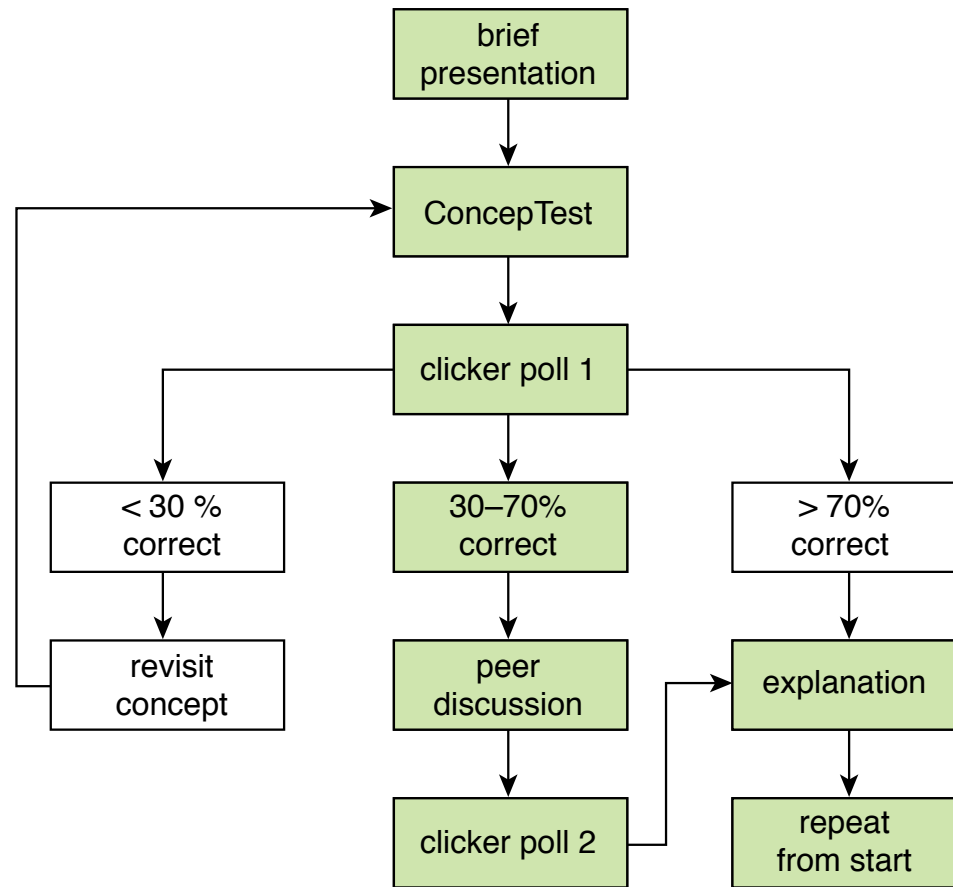
PI & JiTT Overview



PI & JiTT Overview



PI & JiTT Overview



PI & JiTT Overview

PI:

- **helps students overcome difficulties**
- **encourages deep learning**
- **provides depth, not “coverage”**
- **helps you become aware of misconceptions**

PI & JiTT Overview

“How do I promote fruitful discussion?”

PI & JiTT Overview

Find someone with a *different* answer

PI & JiTT Overview

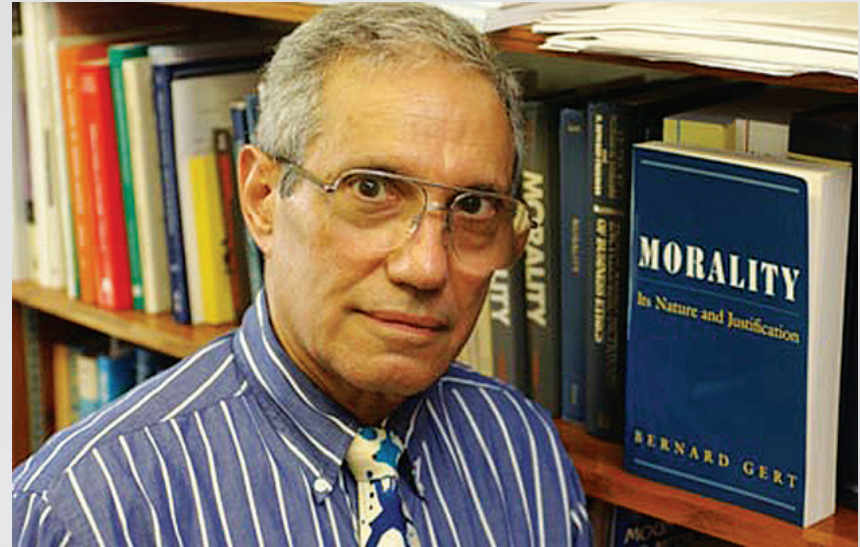
*“Can this method be used in my class,
where questions don’t necessarily have right answers?”*

Let's try it!

Bernard Gert (1934 – 2011)

Moral philosopher

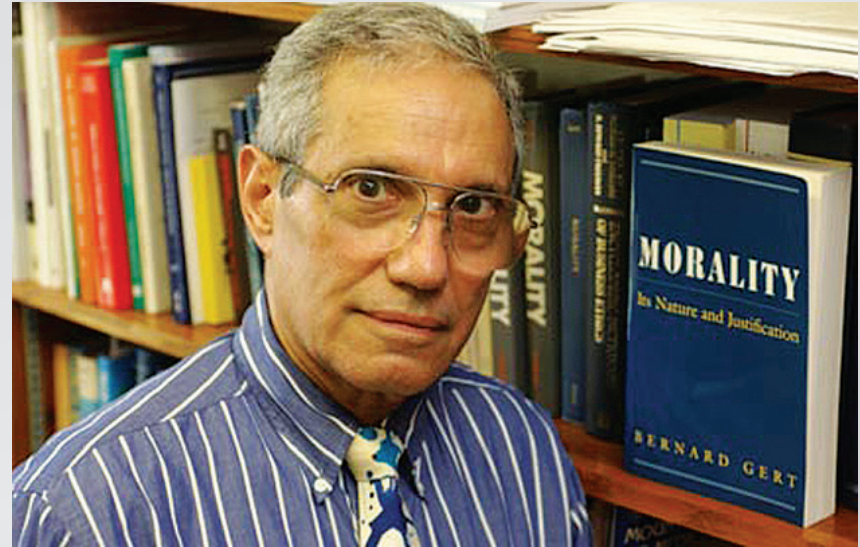
Professor at Dartmouth



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.”

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).**

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.

Let's try it!

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

Let's try it!

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Let's try it!

Bernard Gert's moral system created by 10 rules:

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4. Do not deprive of freedom
5. Do not deprive of privacy
6. Do not deceive
7. Keep your promises
8. Do not cheat
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Should Heinz have broken into the store to steal the drug for his wife?

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



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
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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!



PI & JiTT Overview

Don't need a correct answer!

Outline

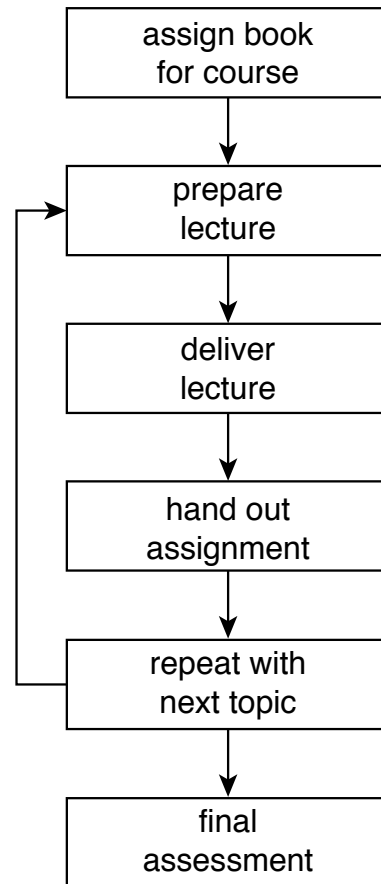
- **PI & JiTT Overview**
- **Implementing PI & JiTT**
- **ConceptTests**

Implementing PI & JiTT

“How is preparing a PI class different from preparing a lecture-based class?”

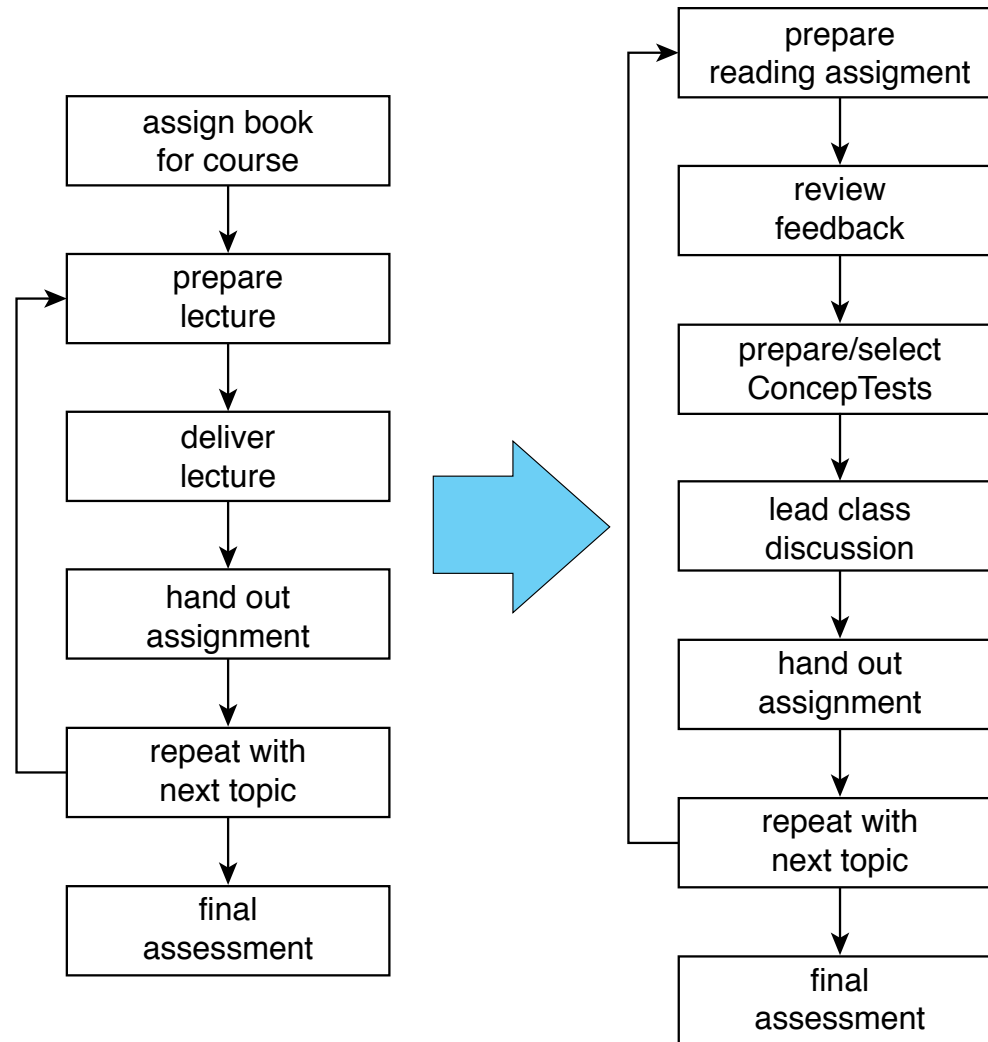
Implementing PI & JiTT

preparing for a lecture-based class



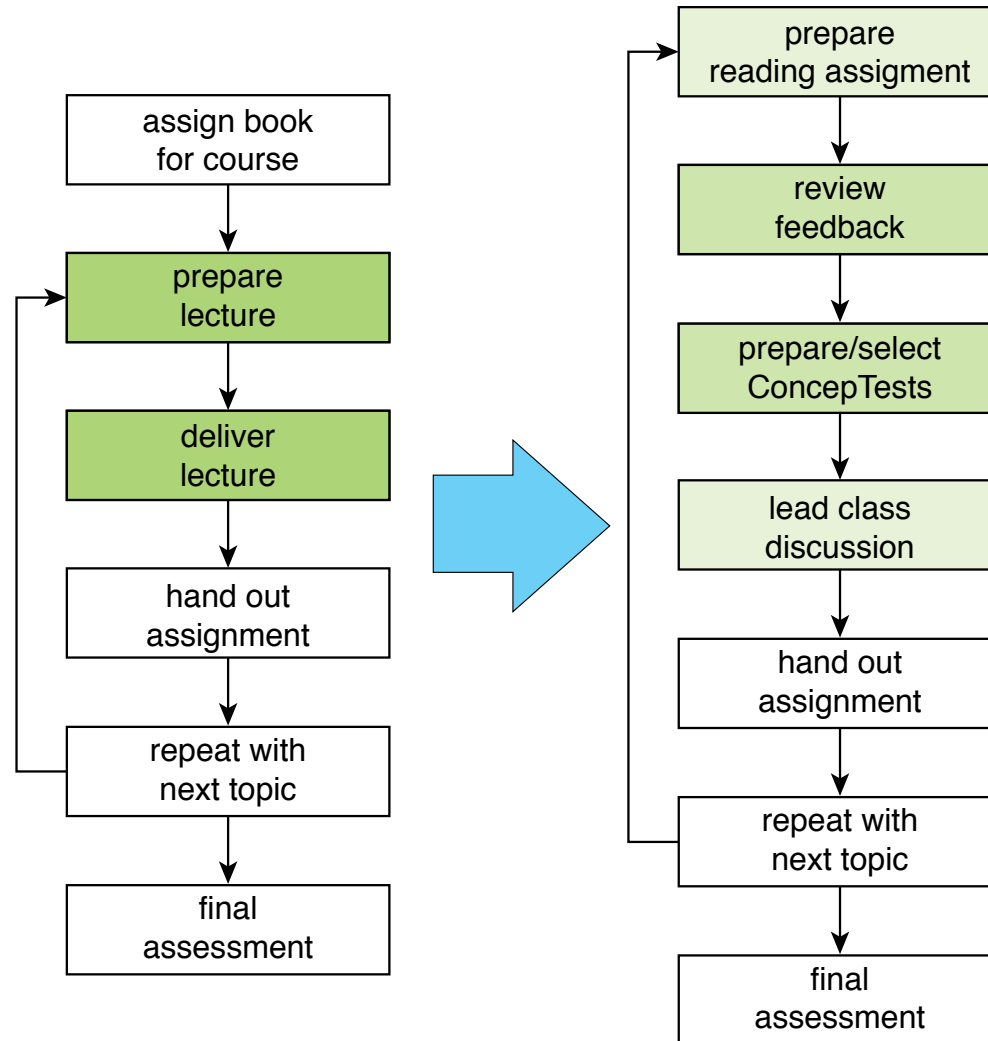
Implementing PI & JiTT

transitioning: where does the effort go?



Implementing PI & JiTT

transitioning: where does the effort go?



Implementing PI & JiTT

New activities:

- 1. Reading assignment**
- 2. ConcepTests**

Implementing PI & JiTT

“How do I cover everything using this method?”

Implementing PI & JiTT

	traditional	PI
in-class coverage	complete	partial

Implementing PI & JiTT

	traditional	PI
in-class coverage	complete	partial
out-of-class coverage	?	complete

Implementing PI & JiTT

	traditional	PI
in-class coverage	complete	partial
out-of-class coverage	?	complete
material learned	little	substantial

Implementing PI & JiTT

	traditional	PI
in-class coverage	complete	partial
out-of-class coverage	?	complete
material learned	little	substantial

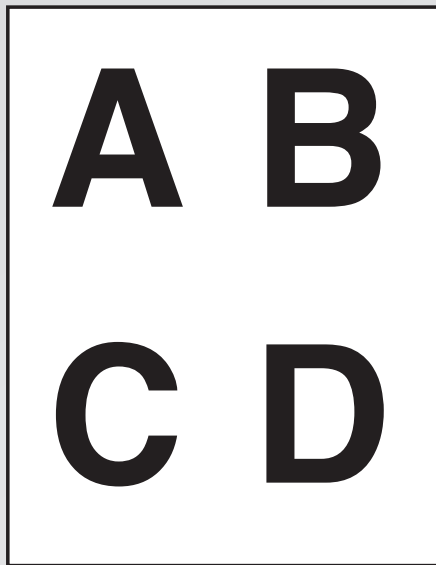
what good is coverage if little is retained?

Implementing PI & JiTT

“Do I need clickers?”

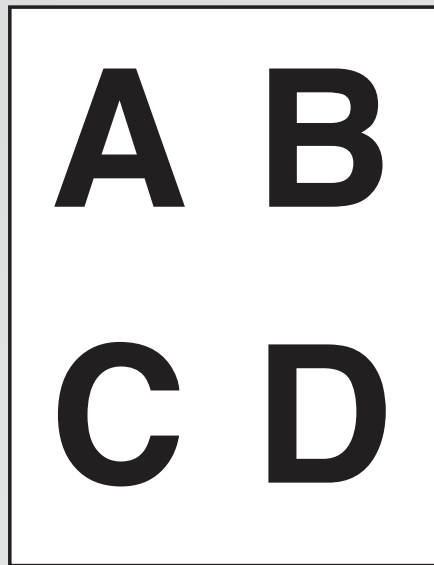
Implementing PI & JiTT

Flashcards: simple and effective



Implementing PI & JiTT

Flashcards: simple and effective



Meltzer and Mannivanan, South Eastern Louisiana University

Clickers necessary?

circumference

Implementing PI & JiTT

Research: same learning gains with and without clickers!

Clickers or Flashcards: Is There Really a Difference?
N. Lasry, *The Physics Teacher* 46 (2008) 242

Implementing PI & JiTT

It's not the technology, but the pedagogy!

Implementing PI & JiTT

It's not the technology, but the pedagogy!

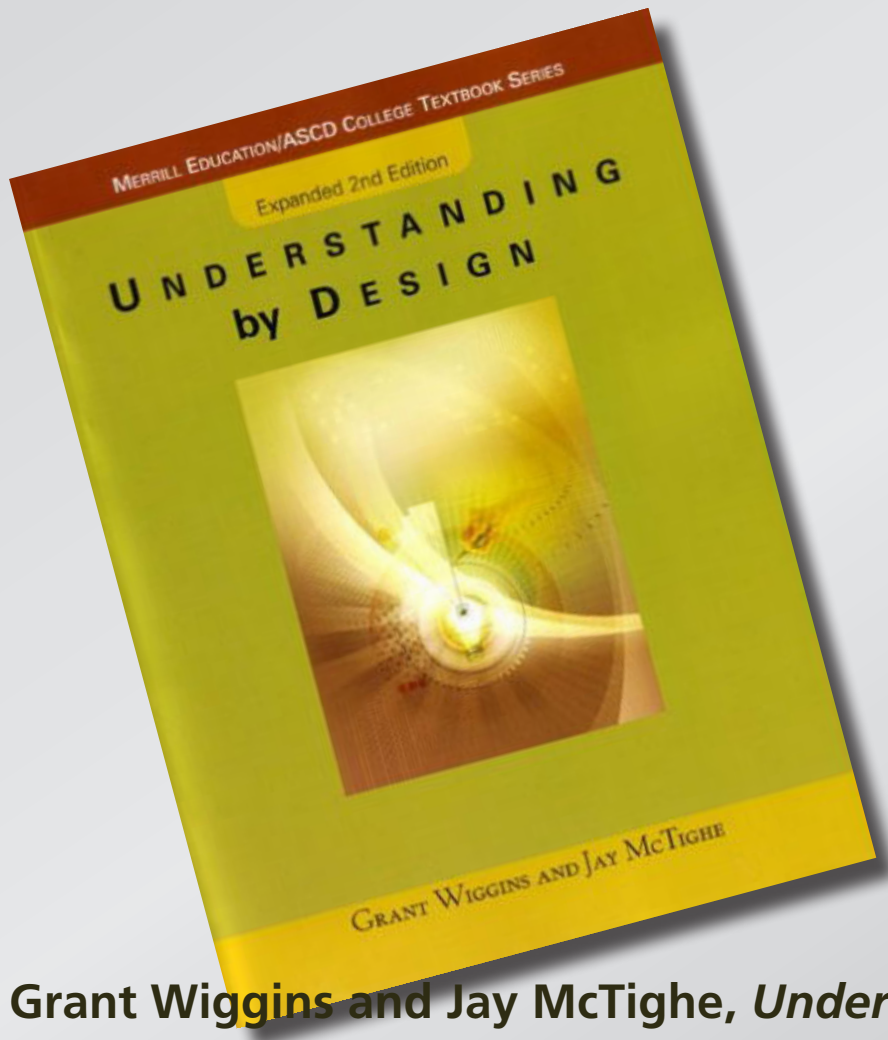
(but clickers do offer advantages)

Implementing PI & JiTT

*“How should I assess my students
when using this approach?”*

Implementing PI & JiTT

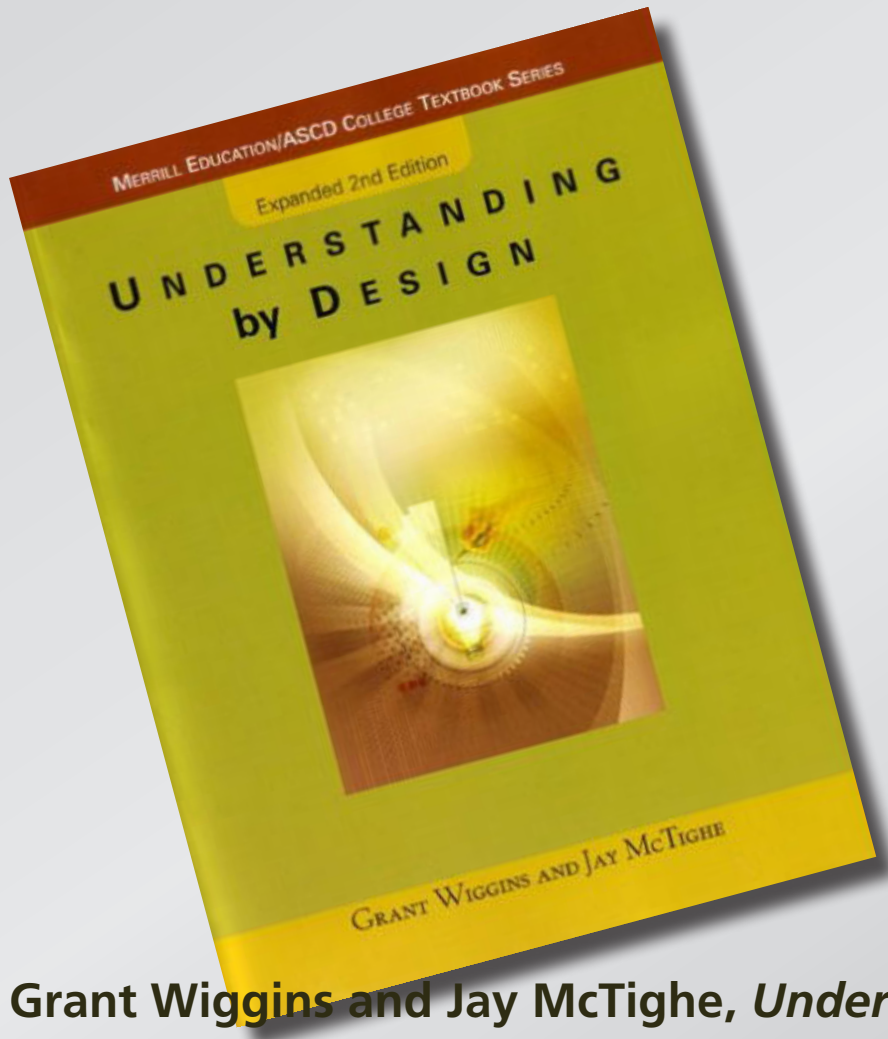
Begin by setting learning goals



Grant Wiggins and Jay McTighe, *Understanding by Design* (Prentice Hall, 2001)

Implementing PI & JiTT

Begin by setting learning goals

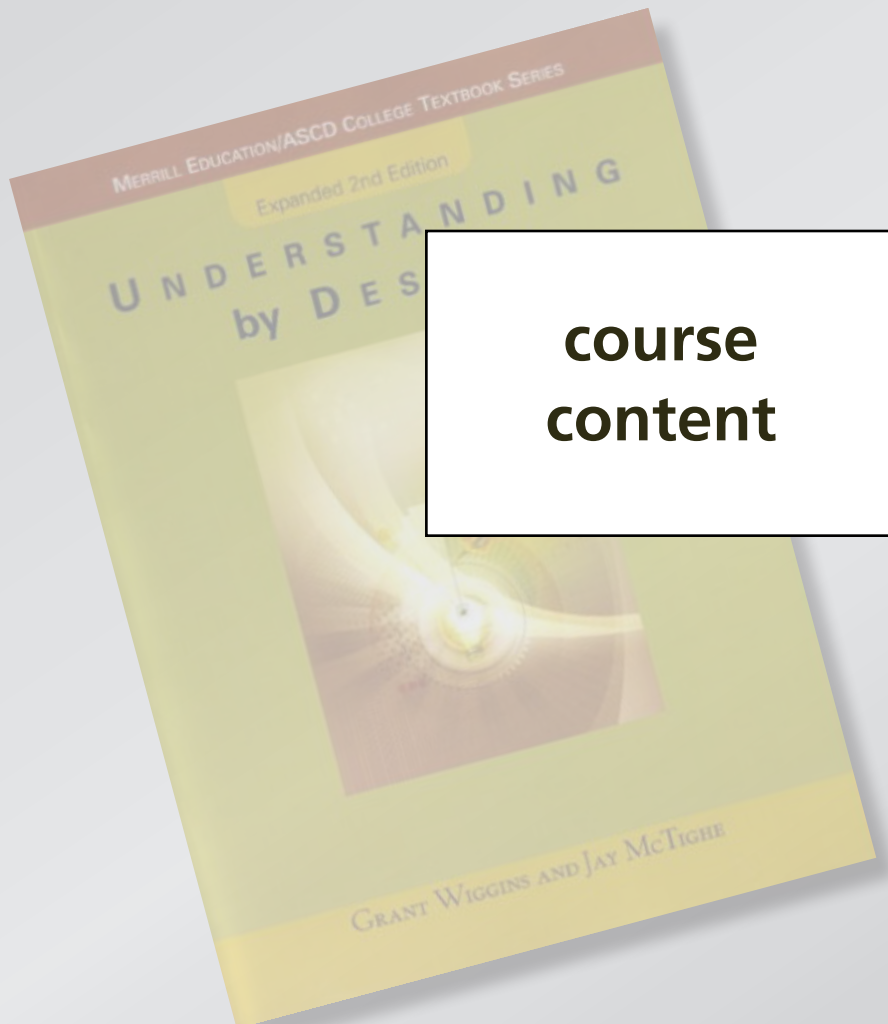


- approach, not content
- focus on understanding
- backward design

Grant Wiggins and Jay McTighe, *Understanding by Design* (Prentice Hall, 2001)

Implementing PI & JiTT

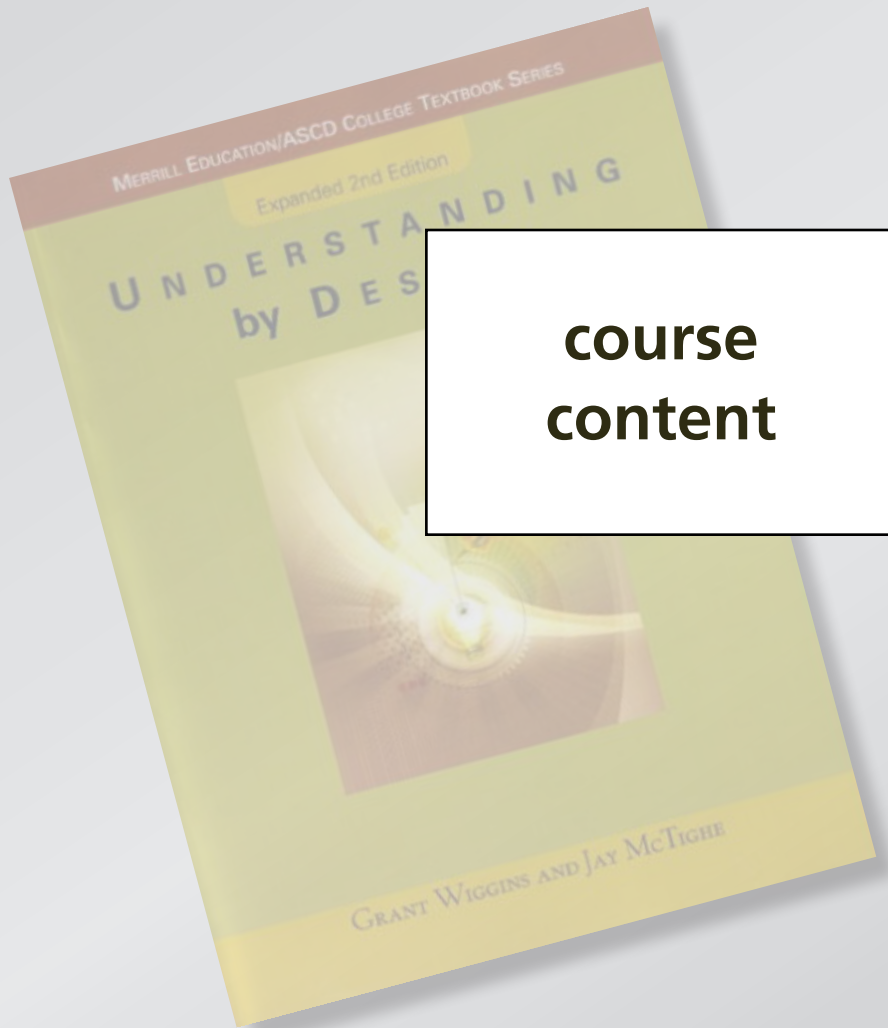
Traditional approach to course planning



**course
content**

Implementing PI & JiTT

Traditional approach to course planning



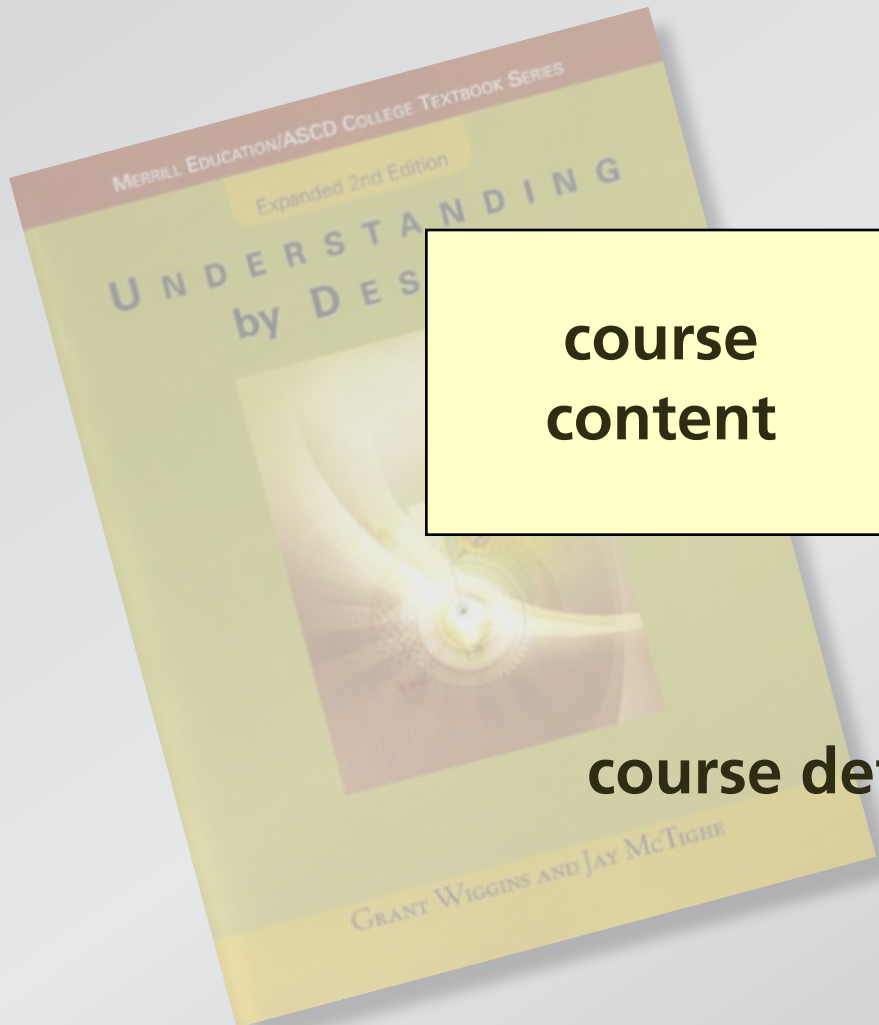
**course
content**



assessment

Implementing PI & JiTT

Traditional approach to course planning



**course
content**

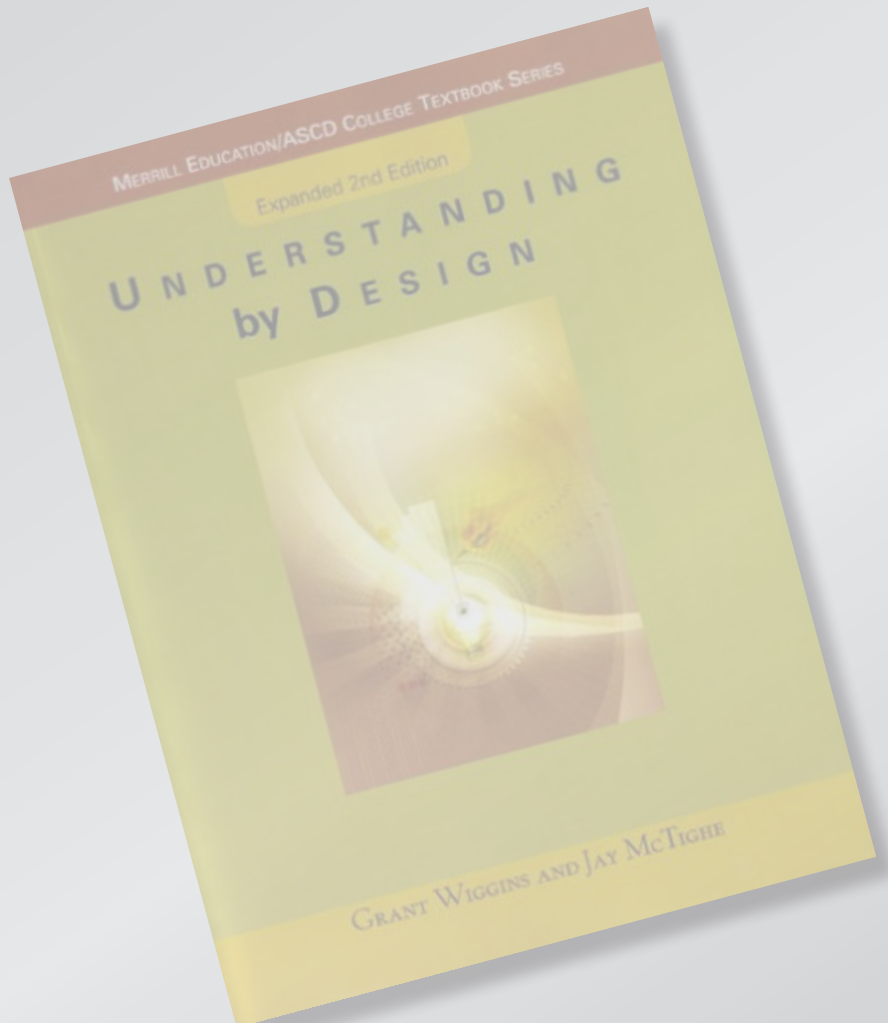


assessment

course defined by content

Implementing PI & JiTT

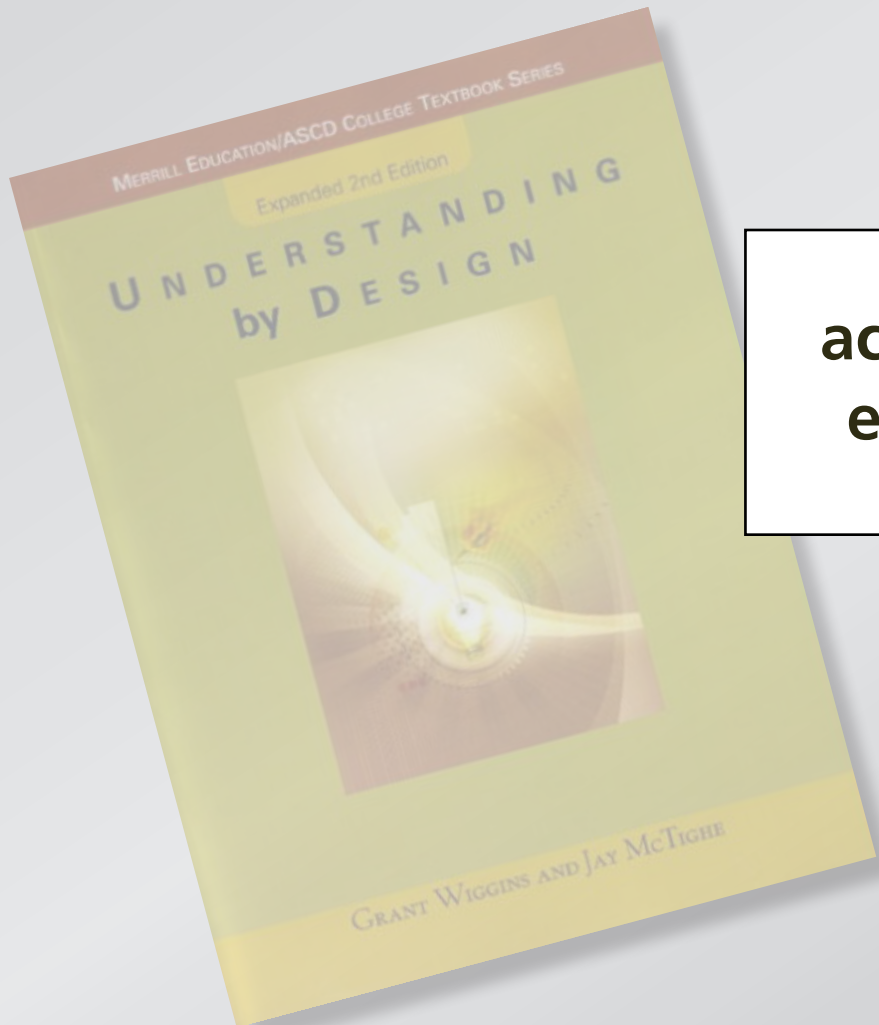
Backward design



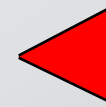
**desired
outcomes**

Implementing PI & JiTT

Backward design



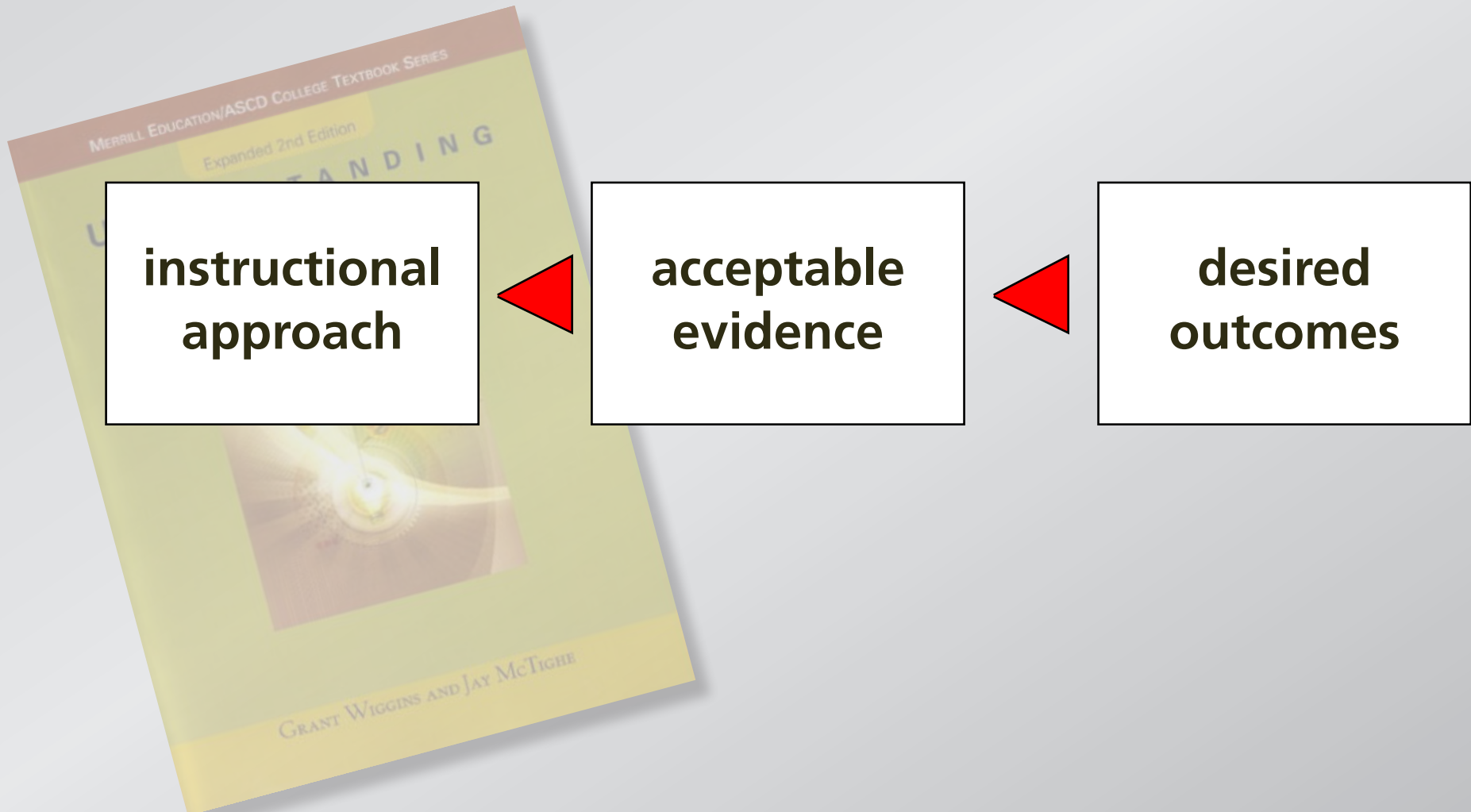
**acceptable
evidence**



**desired
outcomes**

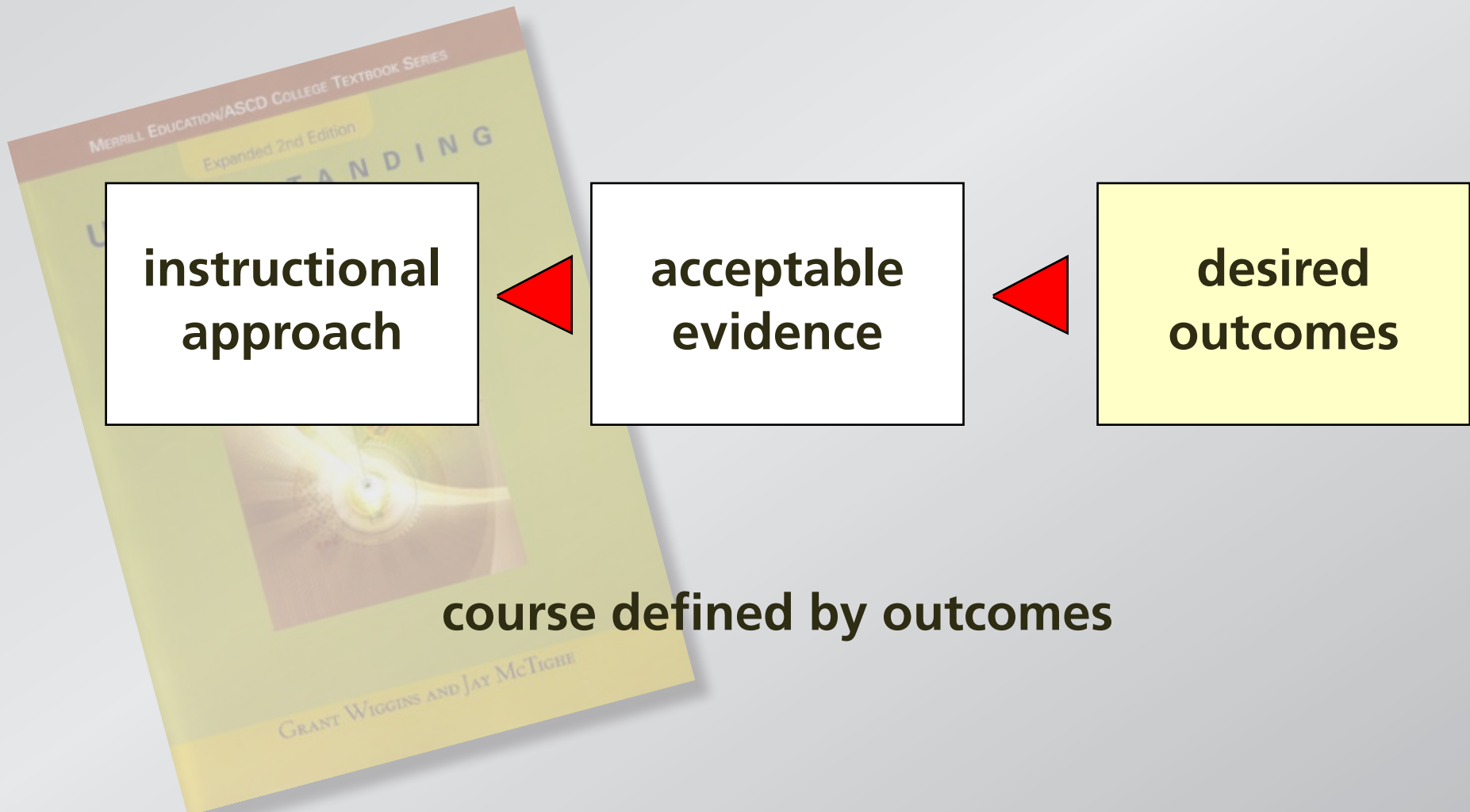
Implementing PI & JiTT

Backward design



Implementing PI & JiTT

Backward design



Implementing PI & JiTT

**Evaluate assessment by comparing
student performance on various kinds of problems**

Implementing PI & JiTT

Need to test meaningful skills!

Implementing PI & JiTT

Some additional ideas:

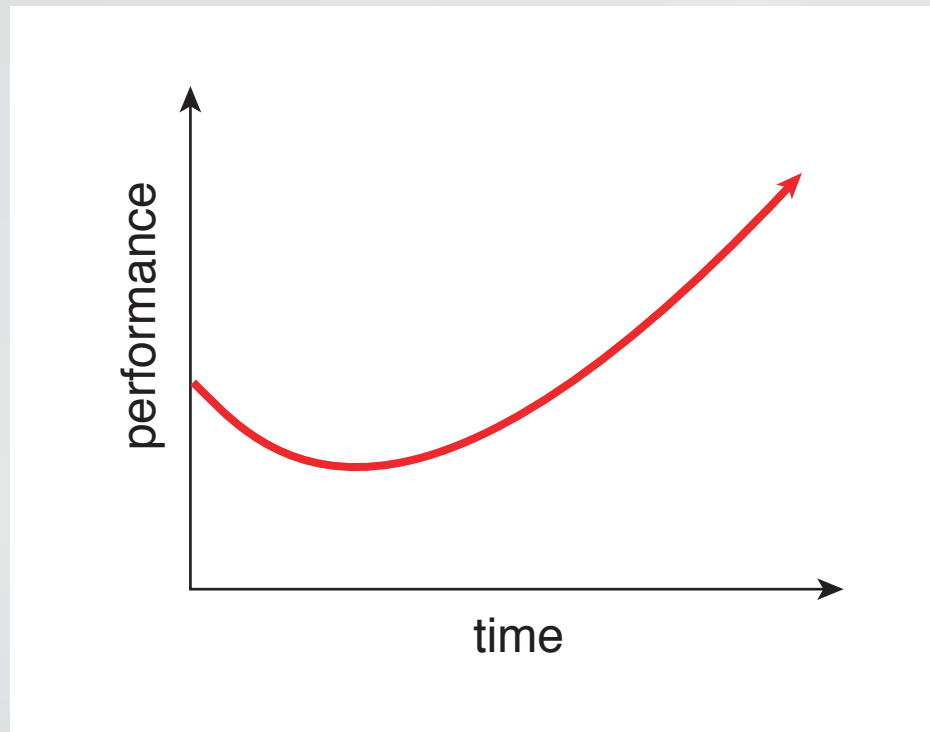
- **Open book/computer exam**
- **Collaborative exam**
- **Multidimensional testing**

Implementing PI & JiTT

*“How do I deal with students who resist
this new approach to studying?”*

Implementing PI & JiTT

After changing, things might get *worse* before they get better!



Implementing PI & JiTT

Written on Wednesday Feb 16, two weeks into the course:

Subject: concerns

Professor Mazur,

Here are a few concerns. I speak for many of my classmates.

1) You are giving us WAY to much work. After spending multiple hours on the problem set, and not being able to figure out many of the questions, I now see that we have an additional 6 or 7 pages or homework in the workbook. I just spent 4 hours on the lab, and I am not confident on almost half of the questions. This is more work than I have had all semester in all of my other classes combined.

2) If you are going to give us this much work, I would suggest re-structuring the lectures. I find the readings very difficult to understand. I am not a bad student (I got a solid A in physics 1a), but it is very difficult to internalize the readings. You should spend most of the lecture going over, point by point, the readings in their entirety. While the PRS clickers are fun, they do not help me understand the complex material.

I am extremely flustered by the incredibly large amount of work, and my inability to understand it, and I am strongly considering dropping the course.

Implementing PI & JiTT

Written on Monday May 23, just after the final exam:

Subject: Thanks!

Professor Mazur,

First of all I want to thank you for a great semester. You are an excellent professor, and it is clear that you truly care about each and every student.

The exam went well today. I'm not sure to what extent you will curve the final grades (if at all), but it looks like I may be right around the cutoff point between an A and an A-. I studied as hard as I could and I'm keeping my fingers crossed about the A, but no matter what happens with my grade you should know that you are one of the best professors that I have ever had at Harvard.

Thanks again!

Implementing PI & JiTT

Hello Prof. Mayer,
I wanted to hand you this card as
a token of my deep appreciation of
how you have helped me throughout
the semester. You are truly
an inspiring and have
changed how I look at
"learning". I also wanted
to thank you for
how understanding
you were of all
my circumstances.
You really made a difference
in my life. So THANKS
Thank you!



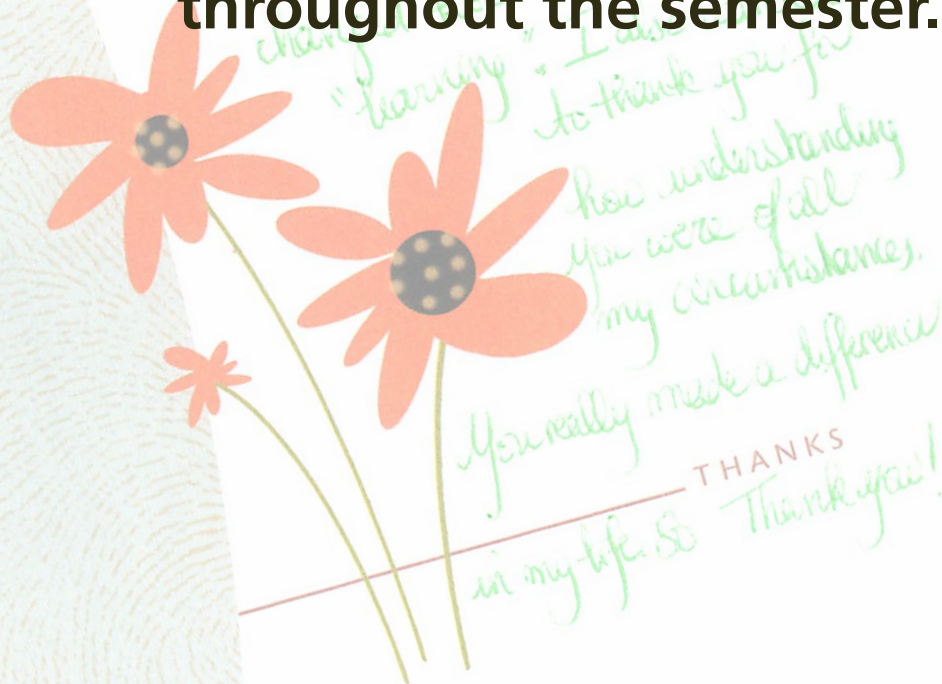
You made a difference.

Best

Implementing PI & JiTT

"I wanted to hand you this card as a token of my deep appreciation of how you have helped me throughout the semester.

You made a difference.



Implementing PI & JiTT

"I wanted to hand you this card as a token of my deep appreciation of how you have helped me throughout the semester. You are truly awe inspiring and have changed how I look at "learning". [....] You really made a difference in my life."

You made a difference.

*THANKS
in my life. So Thank you!*

Best

Implementing PI & JiTT

and don't forget...

Implementing PI & JiTT

and don't forget...

PI leads to better learning and retention!

Outline

- **PI & JiTT Overview**
- **Implementing PI & JiTT**
- **ConceptTests**

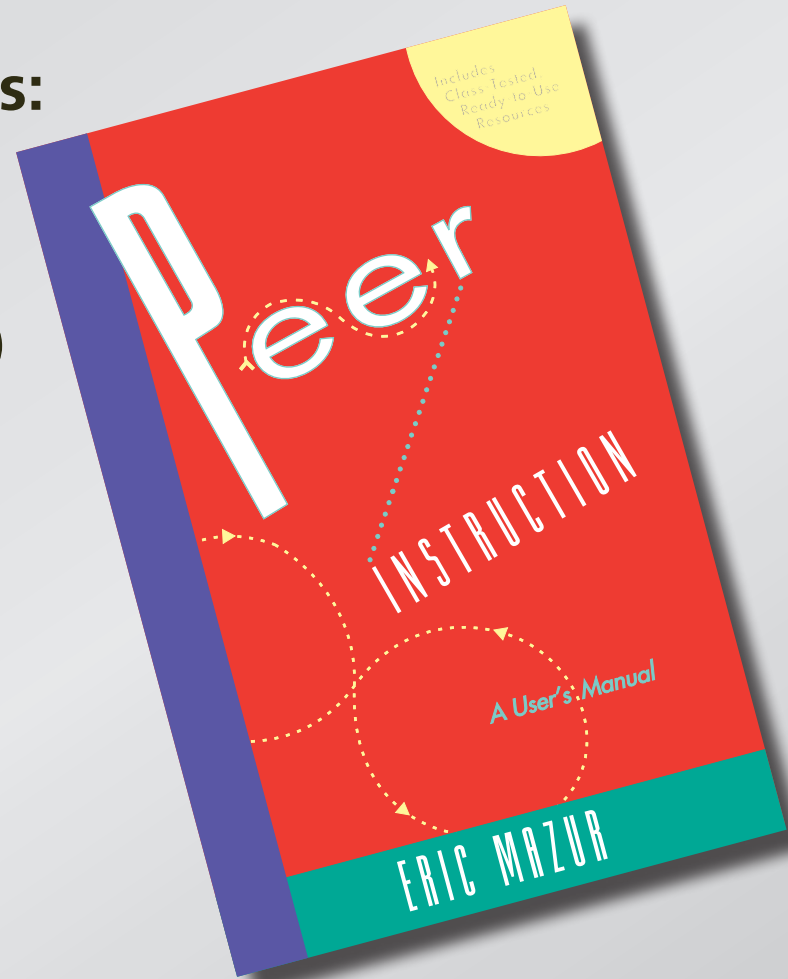
ConceptTests

“Where can I get examples of good questions?”

ConceptTests

Books with ConceptTests:

- Physics (Prentice Hall)



ConceptTests

Books with ConceptTests:

- Physics (Prentice Hall)
- Chemistry (Prentice Hall)



ConceptTests

Books with ConceptTests:

- Physics (Prentice Hall)
- Chemistry (Prentice Hall)
- Astronomy (Prentice Hall)



ConcepTests

Books with ConcepTests:

- Physics (Prentice Hall)
- Chemistry (Prentice Hall)
- Astronomy (Prentice Hall)
- Calculus (Wiley)



ConceptTests

... or try searching Google:

<subject> "Peer Instruction"

<subject> ConcepTest

<subject> "Concept Test"

<subject> clickers

ConceptTests

Types of questions

- **survey**
- **model testing**
- **discussion**
- **select from list**



Join now!

PeerInstruction.net

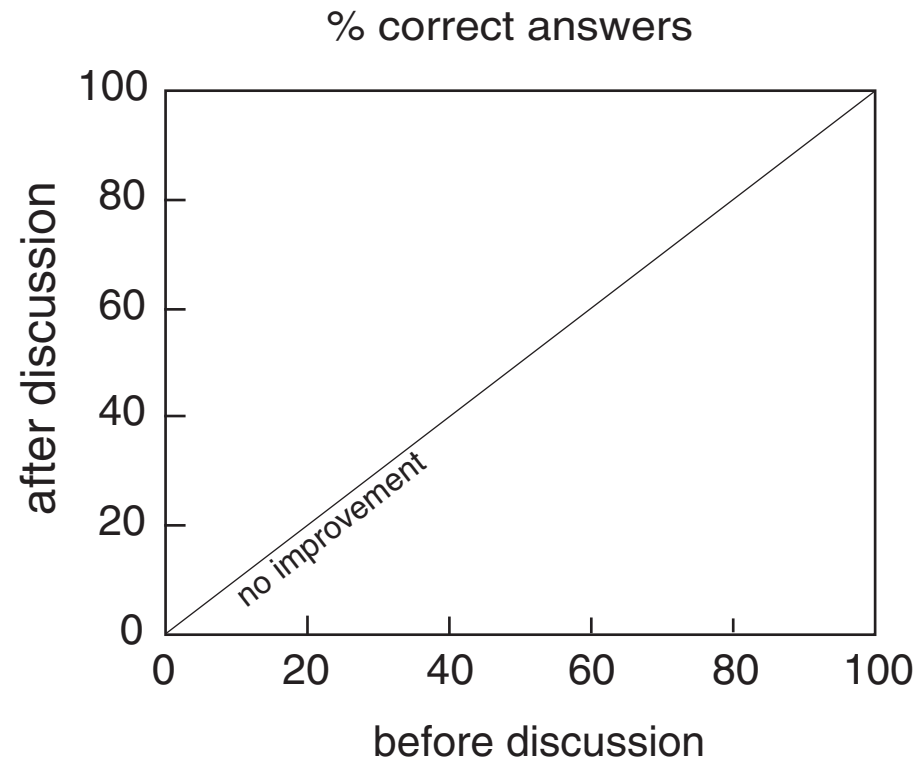
ConceptTests

Good conceptual questions (ConceptTests):

- **focus on interpretation/model (not recall)**
- **stimulate discussion**
- **are not “leading questions”**
- **are of manageable difficulty**

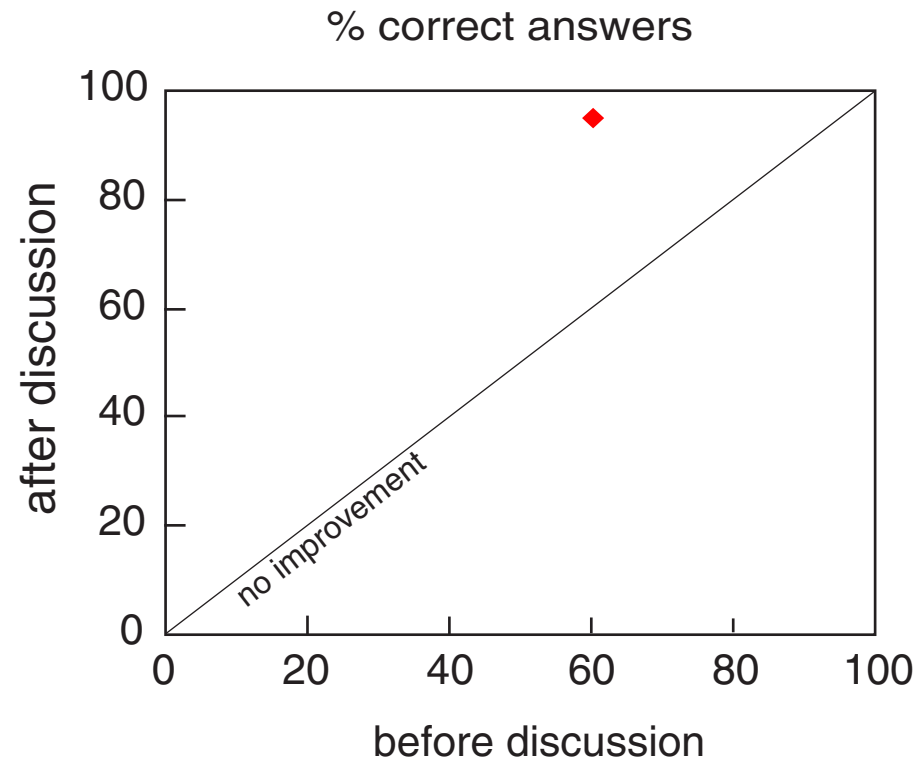
ConceptTests

ConceptTest data



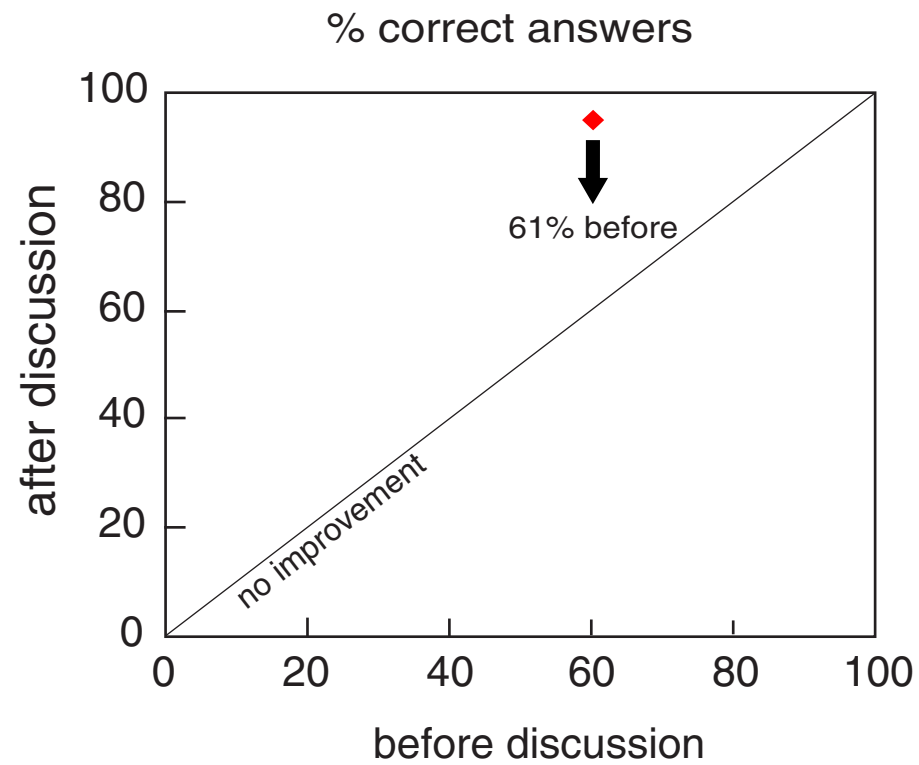
ConceptTests

ConceptTest data



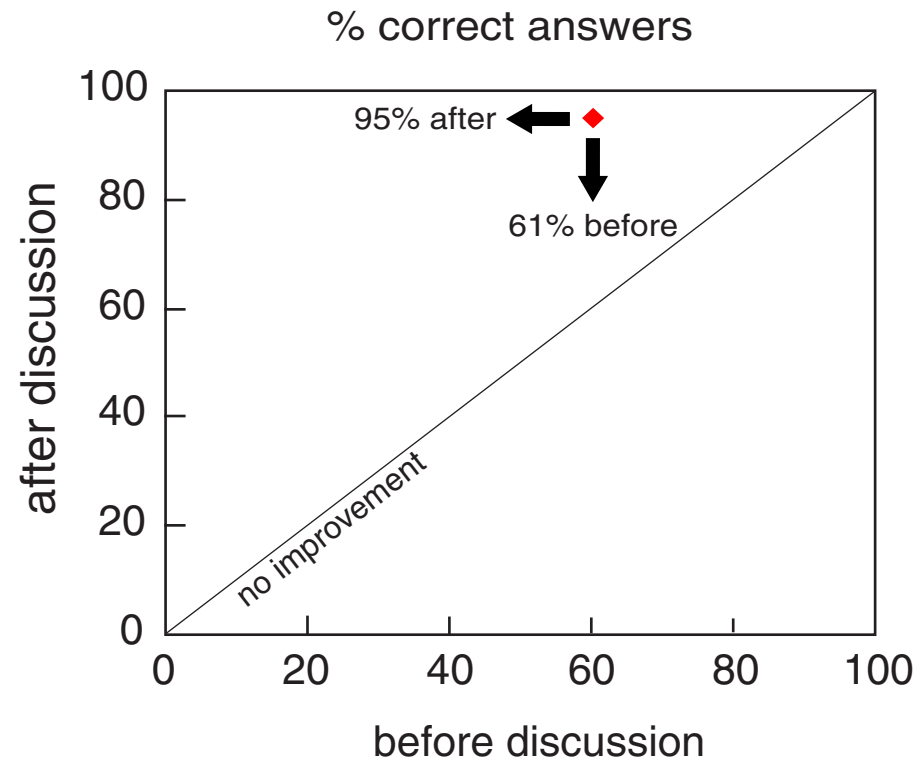
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ConceptTest data



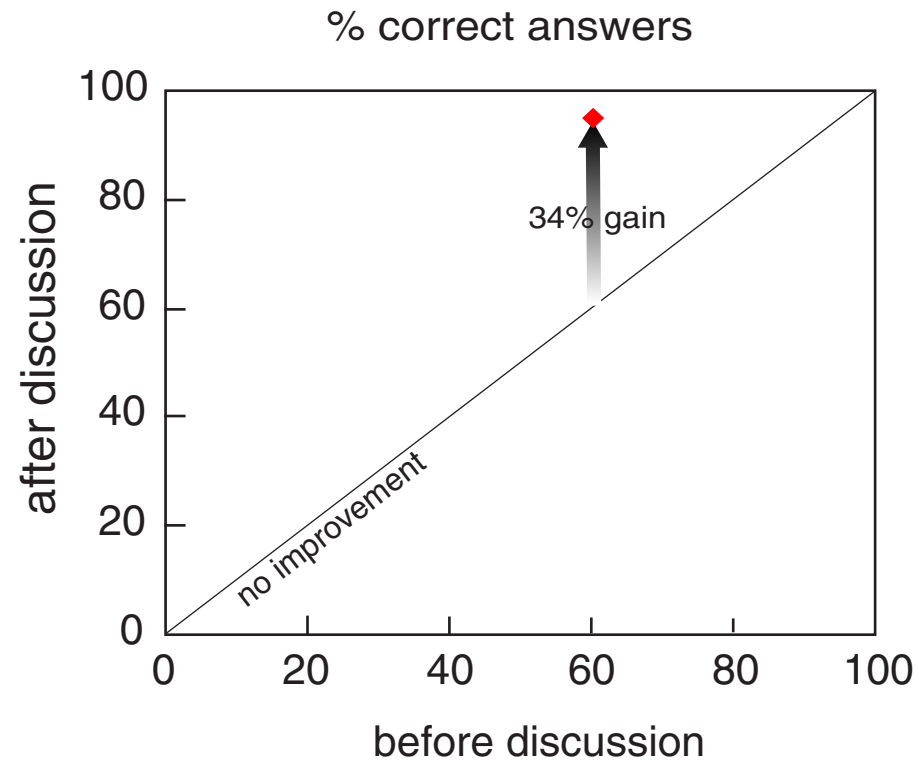
ConceptTests

ConceptTest data



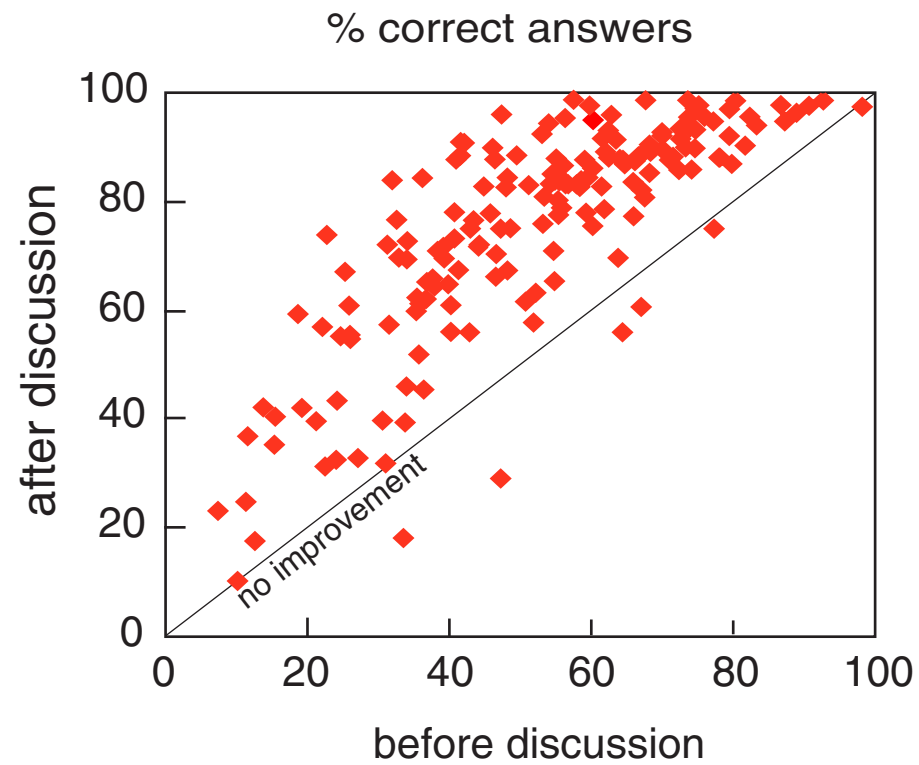
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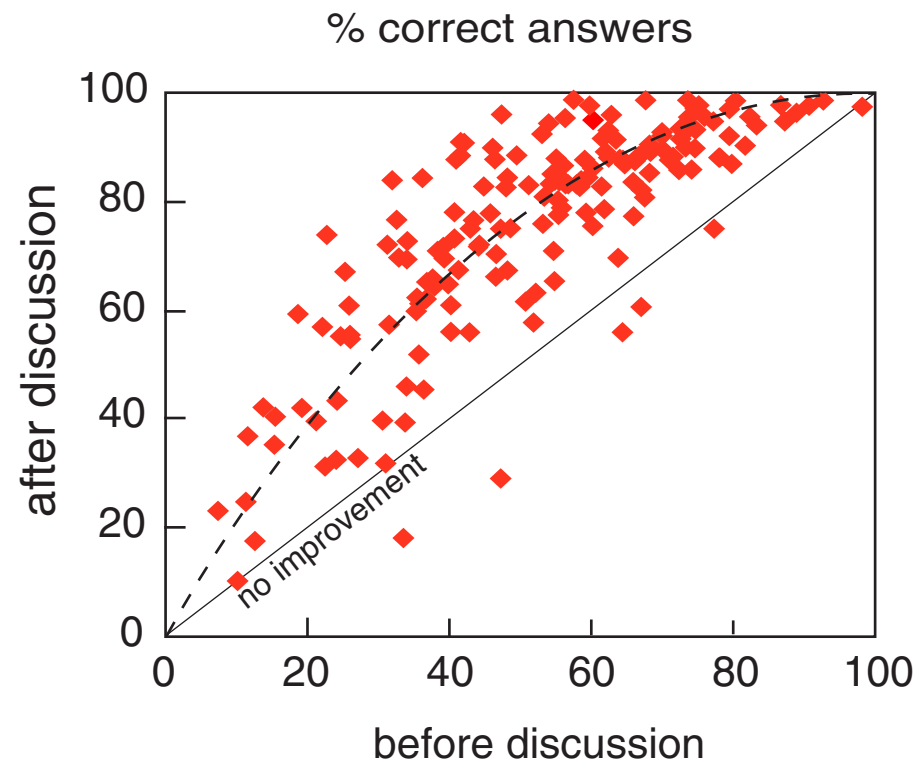
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ConceptTest data



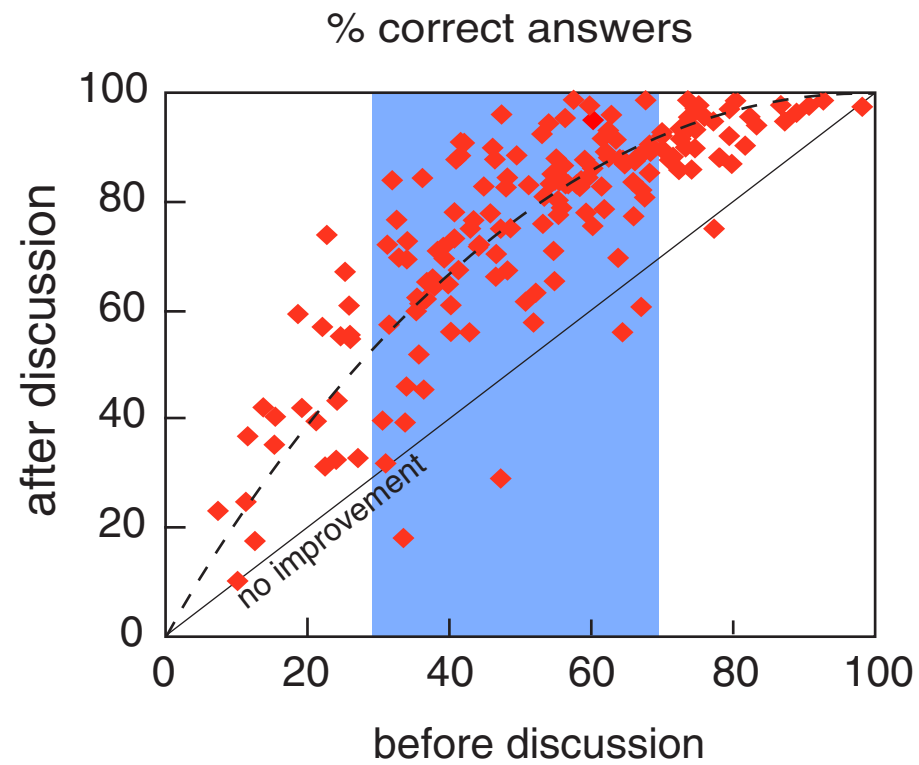
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ConceptTest data

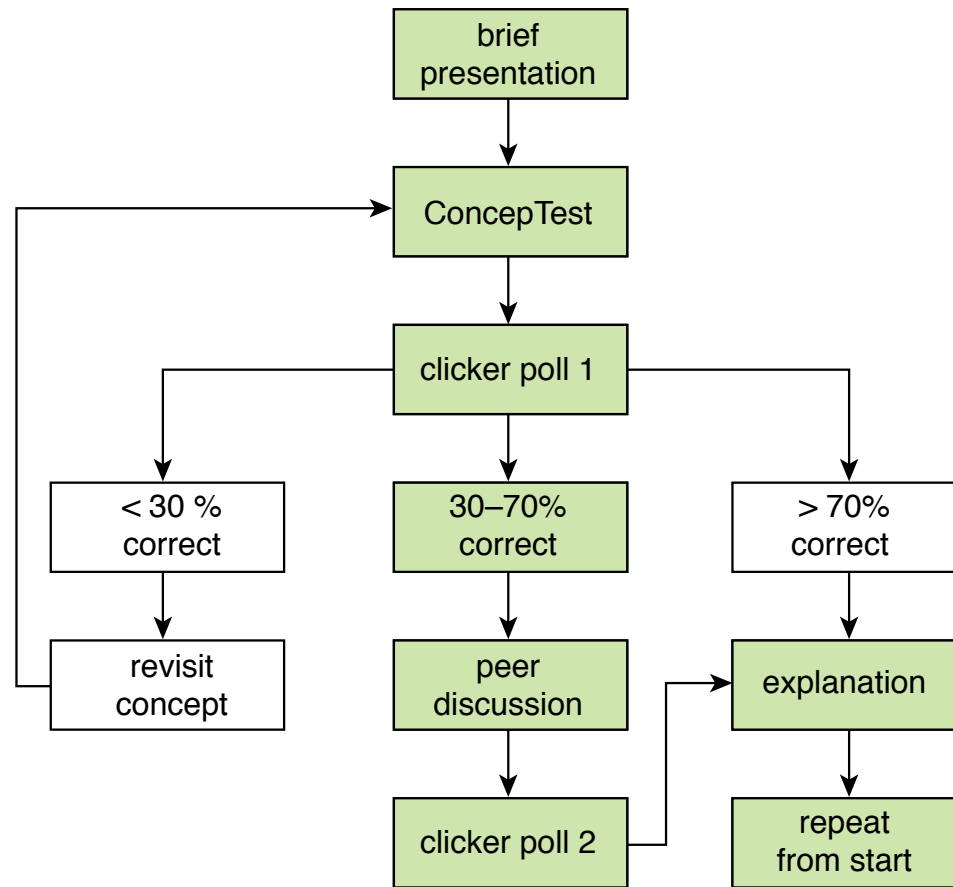


ConcepTests

ConcepTest data



ConceptTests



Program

- 9:00 Peer Instruction and Just-in-Time-Teaching
- 10:30 Break
- 11:00 Technology/Hands-on with Peer Instruction**
- 12:30 Lunch
- 13:30 Designing good questions for PI
- 15:00 Break
- 15:30 Discussion and wrap-up
- 16:30 Adjourn



@eric__mazur

1. Go to: learningcatalytics.com/demo

2. Enter info, click Start

3. Enter session ID (ask Eric), click Join

feedback

1 lecture

2 PI

3 PI 2.0



1991



1 lecture

2 PI

3 PI 2.0



1993

A black handheld remote control is shown at an angle. It features a numeric keypad with buttons for digits 1 through 9, 0, and a red power 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?

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

- lowest
- 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 overseas in 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. $\text{Assets} = \text{Liabilities} + \text{Owners' equity}$
 - b. $\text{Liabilities} = \text{Assets} + \text{Owners' equity}$
 - c. $\text{Owner's equity} = \text{Assets} + \text{Liabilities}$
 - d. $\text{Revenue} = \text{Assets} - \text{Liabilities}$
4. In order to present a business plan to a group of potential investors, a businessperson would most likely use which of the following?
- 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:
- a. A business model
 - b. A domain name
 - c. A marketing plan
 - d. Depreciation?

extensible plug-in architecture for question types

- 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%
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 - $\text{Revenue} = \text{Assets} - \text{Liabilities}$
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- Powerpoint
 - Quickbooks
 - Peoplesoft
 - Excel
5. In order to start an online business, an individual would need all but which of the following:
- Business model
 - Appreciation?

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:

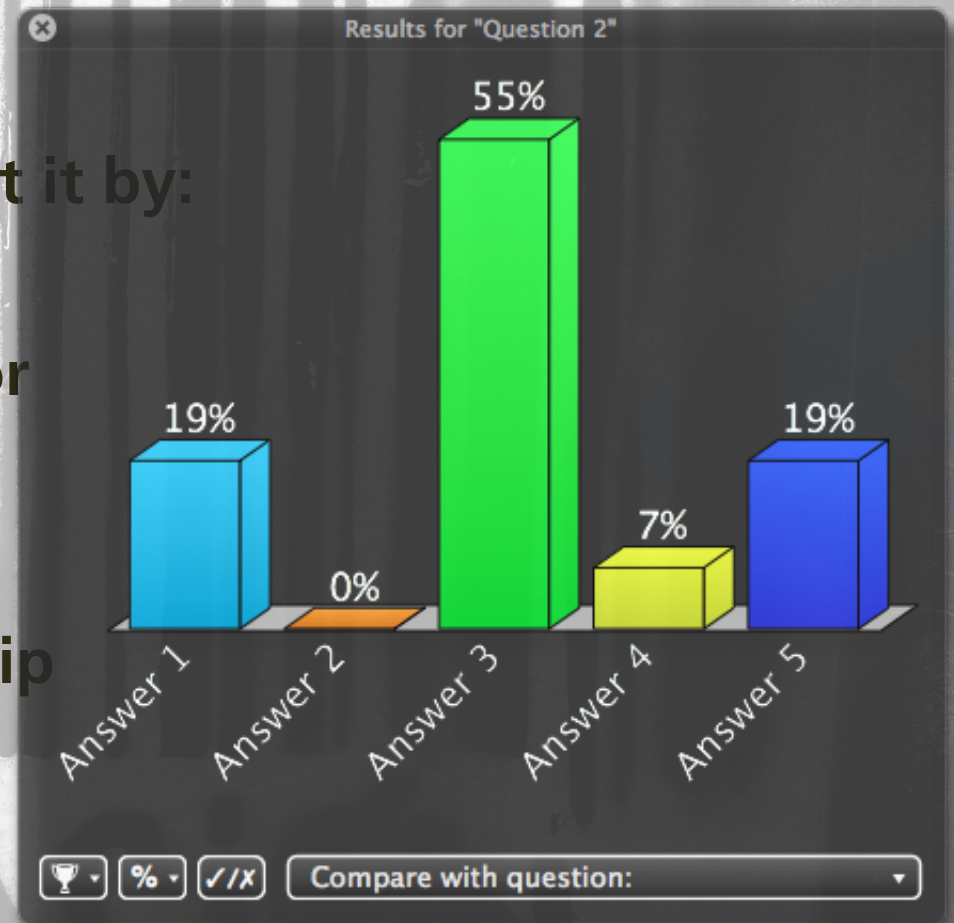
- 1. trial and error**
- 2. lectures**
- 3. practicing**
- 4. apprenticeship**
- 5. other**

EDUCACION



Became good at it by:

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





Carrier

10:24 PM

Logout

Leave

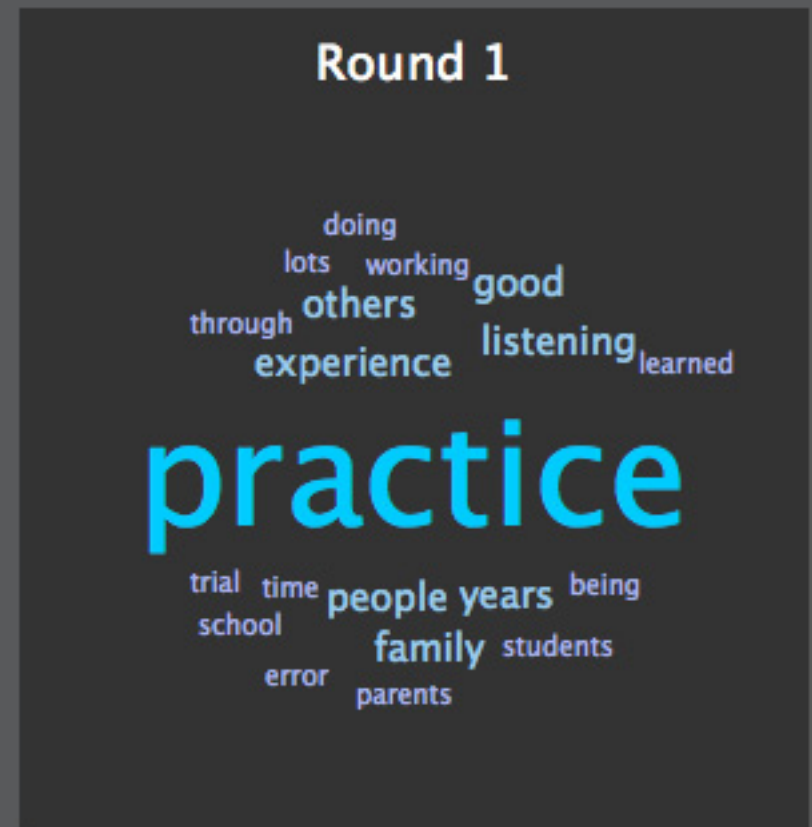
session 123456

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 learningcatalytics.com/demo **2** enter info **3** ID 123456789

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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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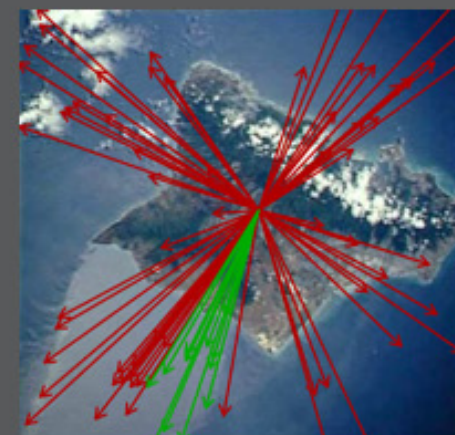
4. direction
prevailing

...le. The image provides several clues about the direction of
...on your screen.

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Round 1

77 responses, 16% correct



17 get it now
 3 still don't get it



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3 PI 2.0

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optics i

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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current session: **766079** | 69 students

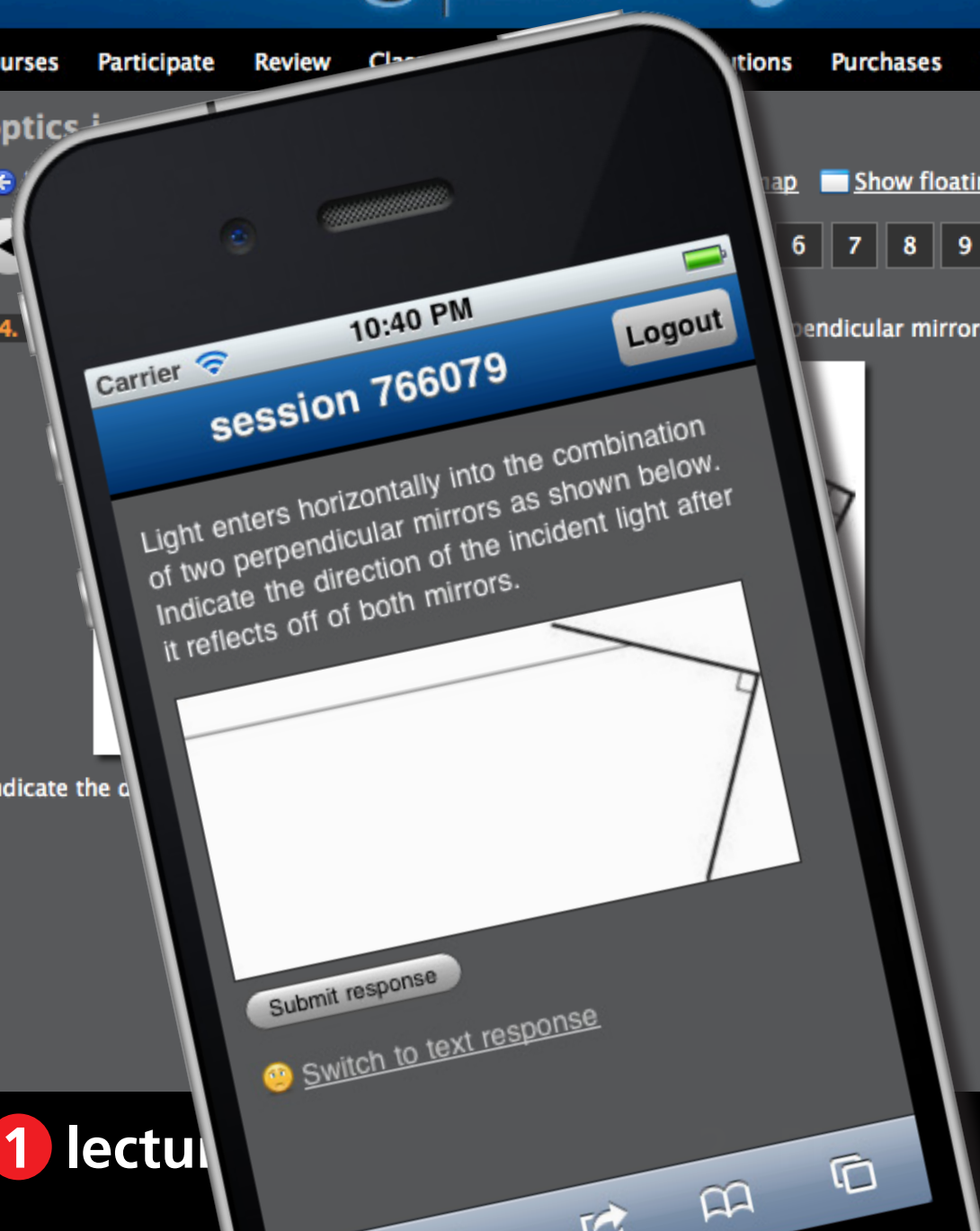
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6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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[feedback & support](#)



1 lecture

3 PI 2.0

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current session: **766079** | 69 students

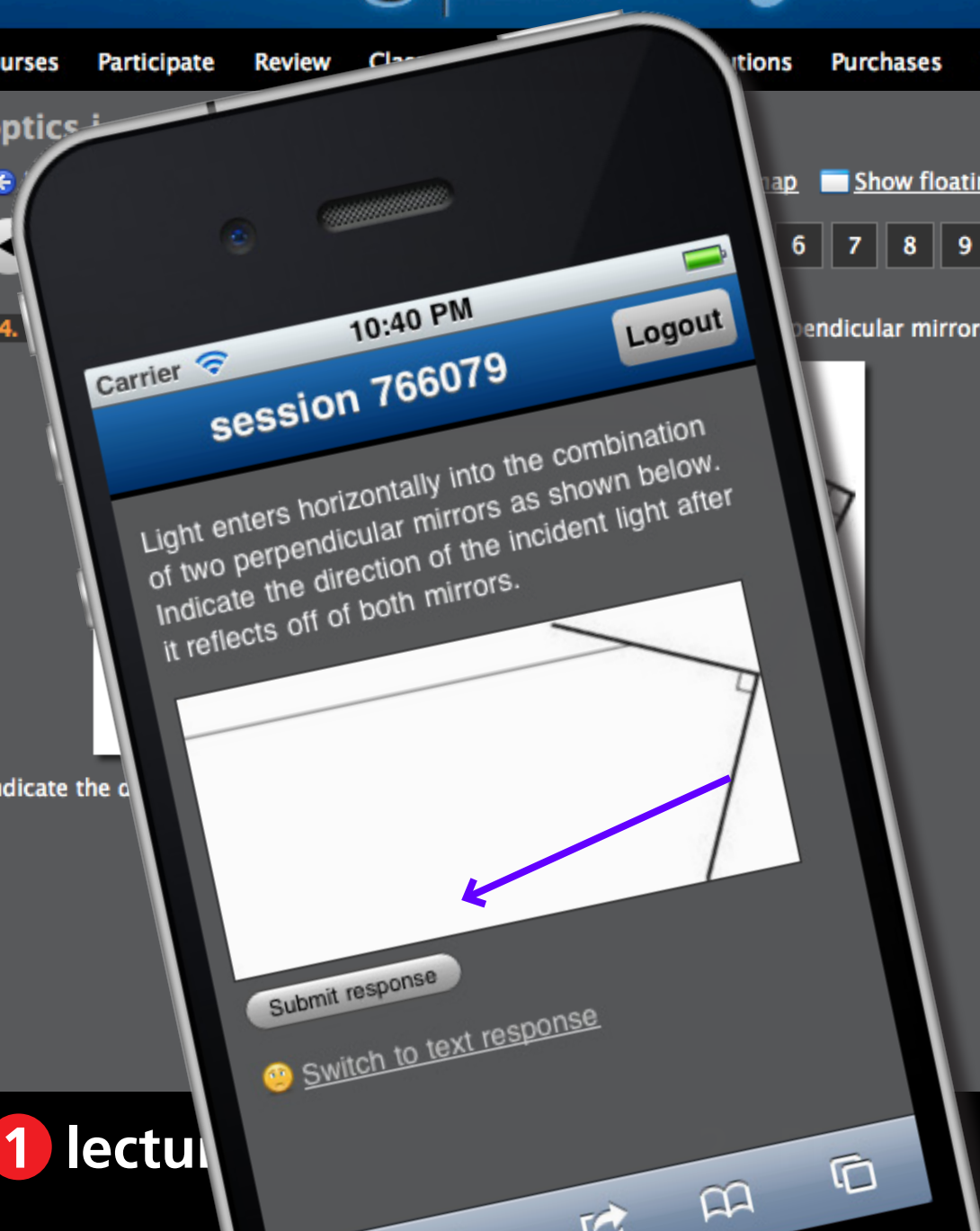
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6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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[feedback & support](#)



1 lecture

3 PI 2.0

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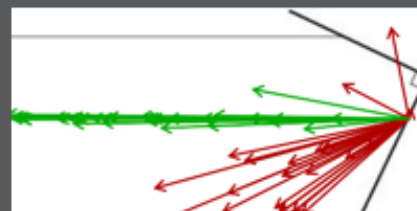
[Map](#) [Show floating session ID](#) [Edit](#) [Delete](#)

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



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1 lecture

3 PI 2.0

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current session: **766079** | 69 students

Map Show floating session ID Edit Delete

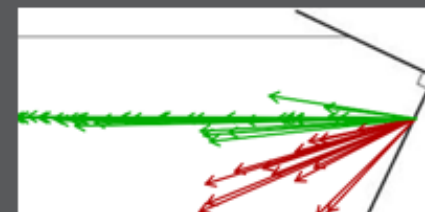
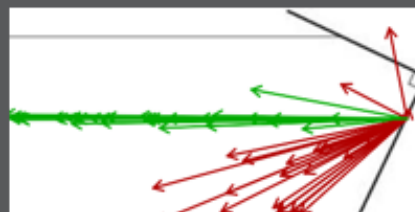
6 7 8 9 10 11 12 13 14 15

perpendicular mirrors as shown below.

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



1 lecture

3 PI 2.0

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

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transformations of parabolas

current session: **773885** | 9 students

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Jump to ▼

1

2

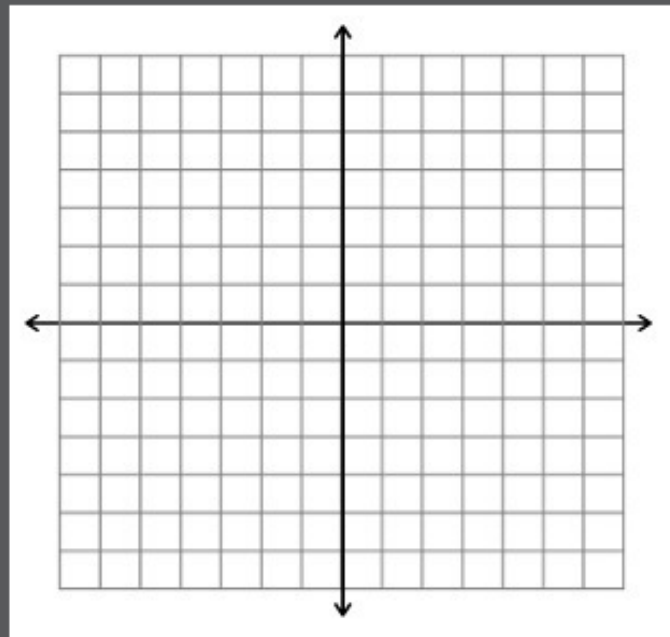
3

4



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

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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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1

2

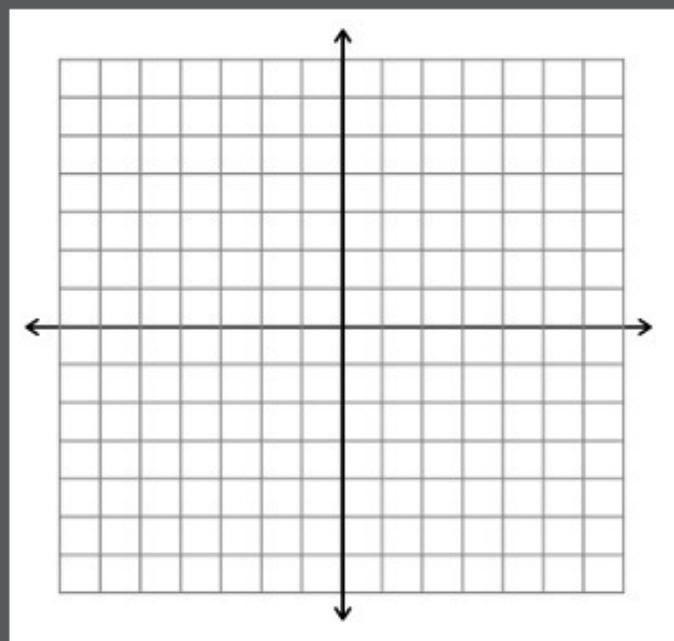
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4



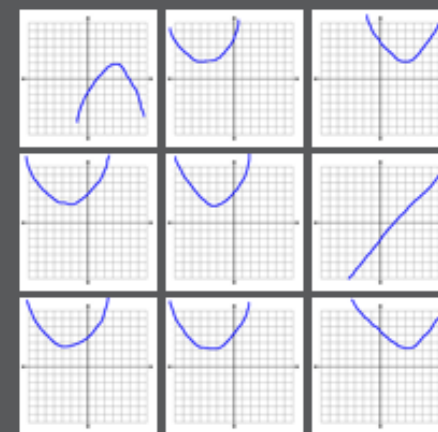
4. sketch Sketch a graph of the function $f(x) = (x - 3)^2 + 2$.

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Round 1

9 responses



1 education

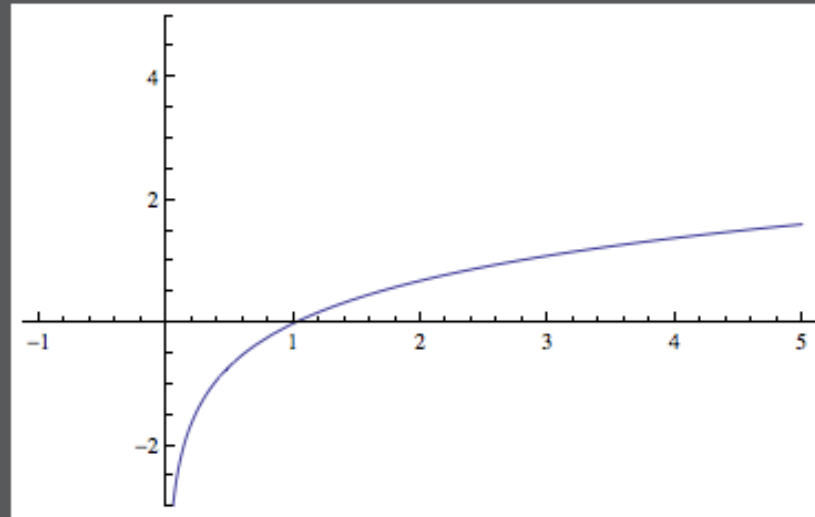
2 PI

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

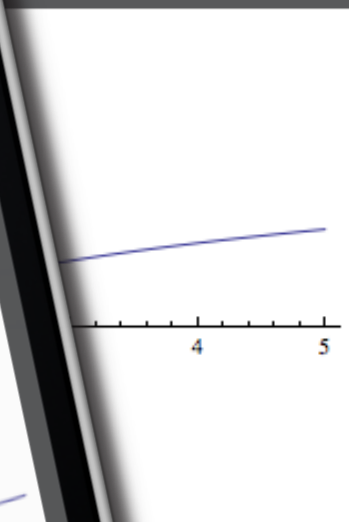
3 PI 2.0

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



1 education

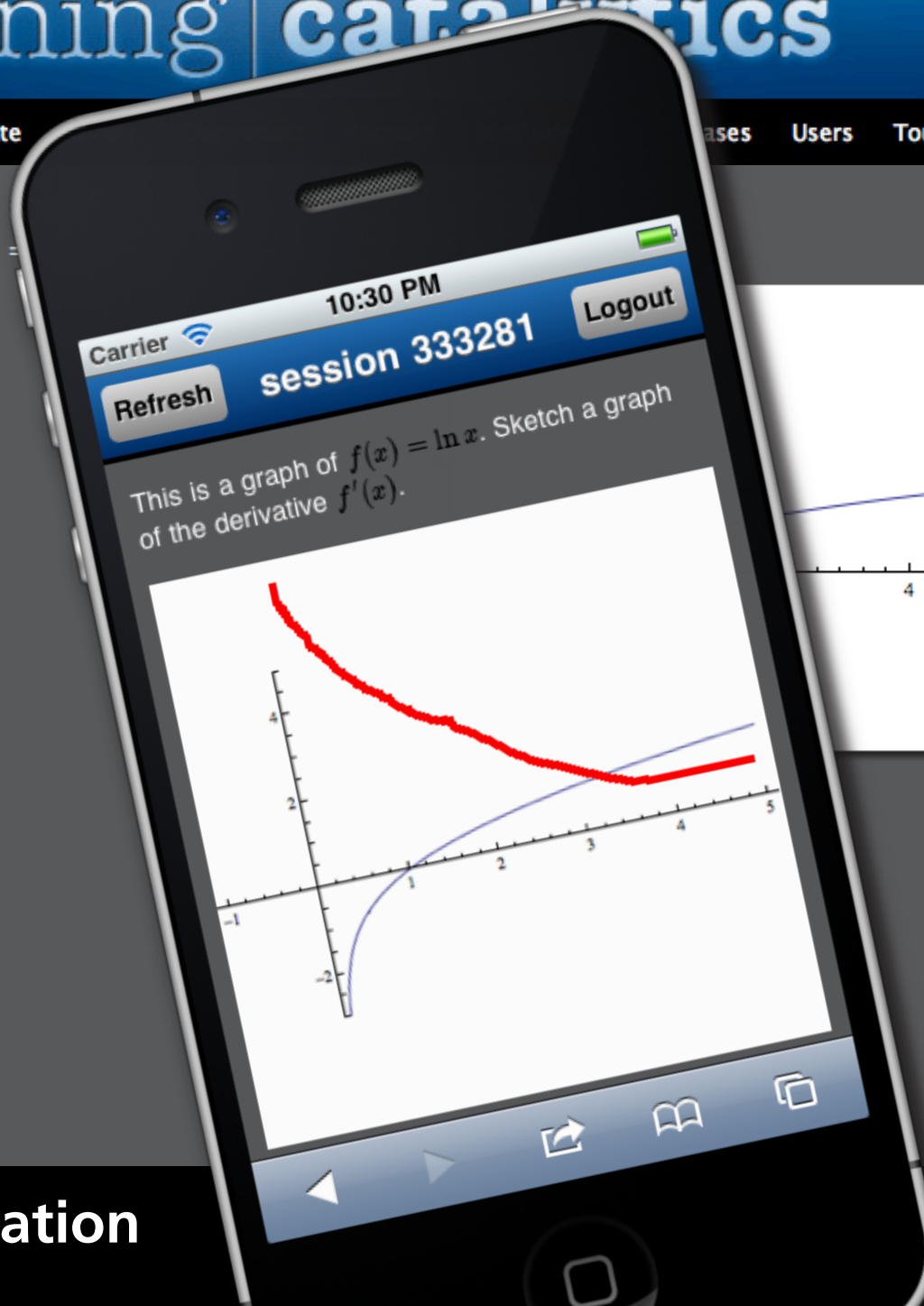
3 PI 2.0

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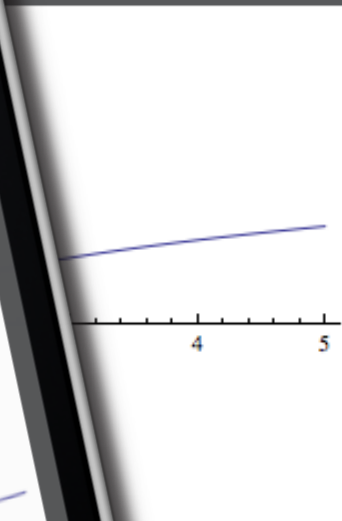
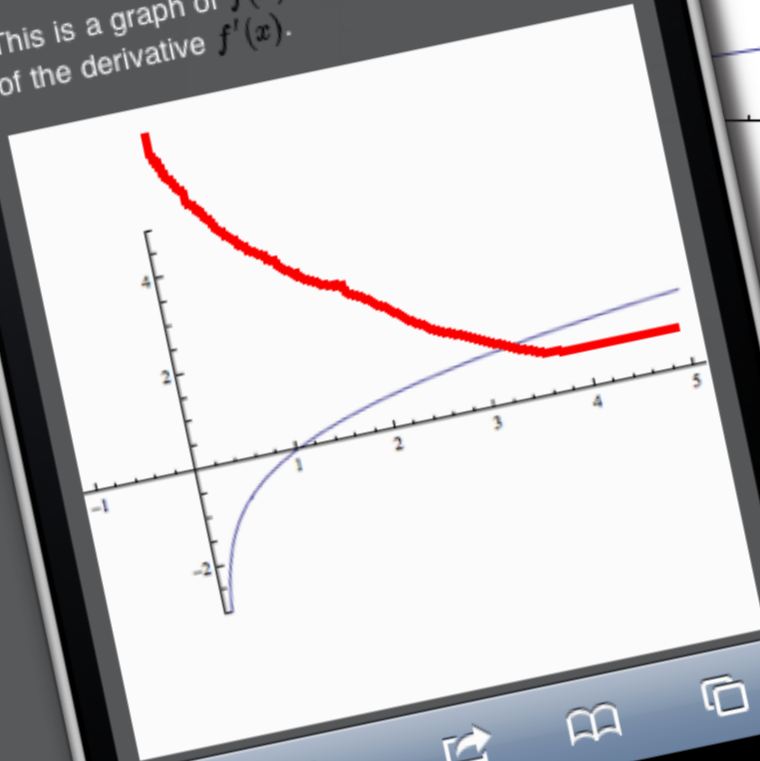
Courses Participate

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

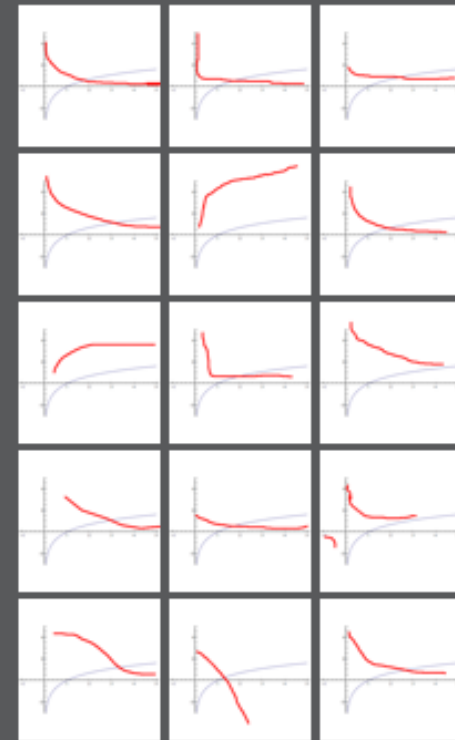


This is a graph of $f(x) = \ln x$. Sketch a graph of the derivative $f'(x)$.



Round 1

15 responses



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

1 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

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1. highlighting
sonnet?

this Shakespeare

[Stop delivery](#)

[Deliver again](#)

[Assign groups](#)

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1 educa

3 PI 2.0

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1. highlighting
sonnet?

this Shakespeare

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[Deliver again](#)

[Assign groups](#)

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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,



What do you see as the most important part of this Shakespeare sonnet?

Highlight the passage below by clicking or tapping once to set the beginning of your highlight, and then clicking or tapping again to set the end.

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!

1 educa

3 PI 2.0

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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review results for session 399757 in electrostatic work and energy ii

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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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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 as illustrated below.

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. positive
B. zero
C. negative
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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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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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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 as illustrated below. The potential difference from A to B is



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

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%

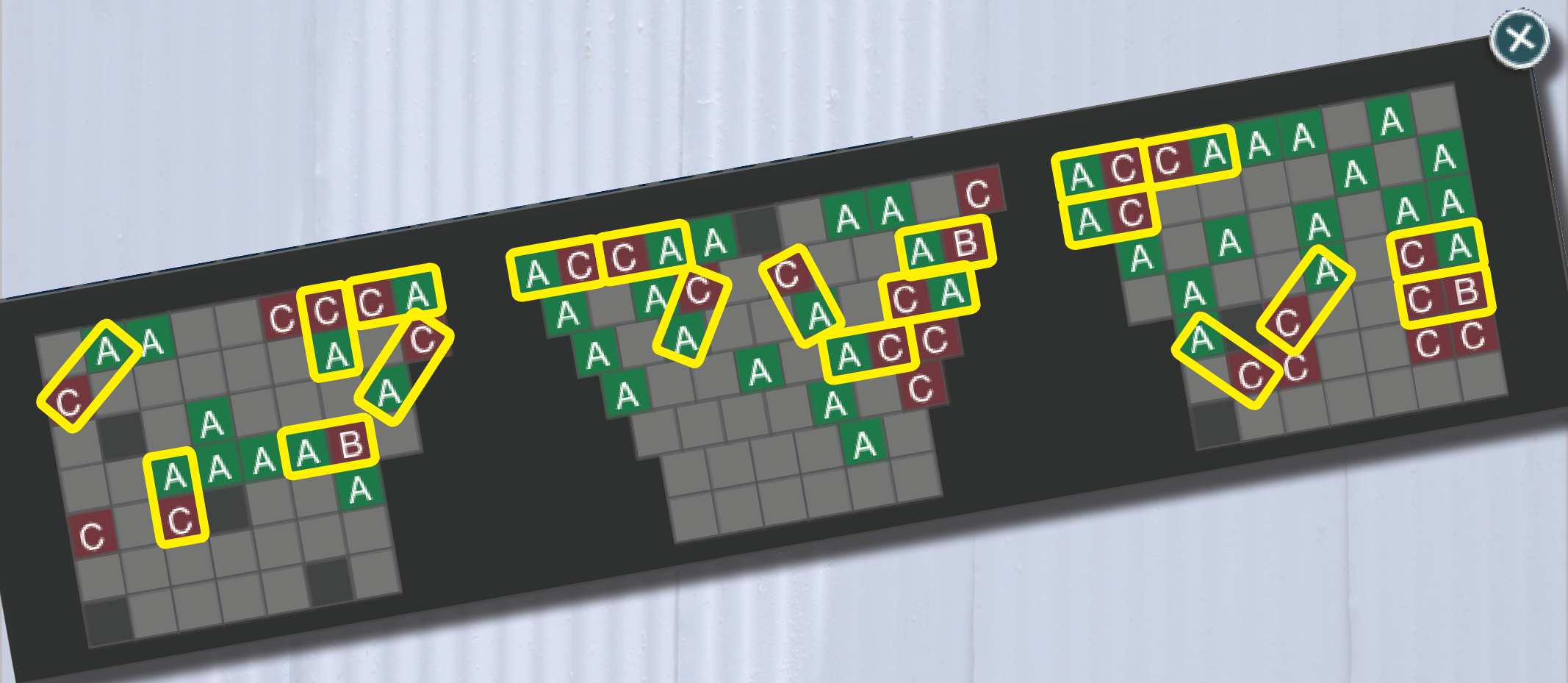
Search: _____

1 lecture

2 PI

3 PI 2.0

let system manage pairing



1 lecture

2 PI

3 PI 2.0

Leave

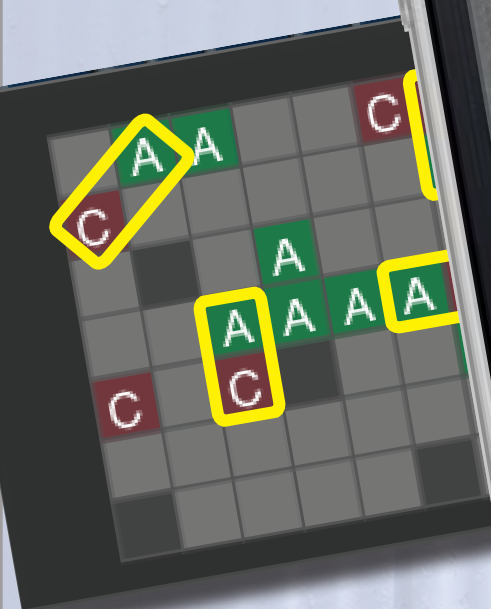
A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B at constant speed. The mechanical work required to cause this motion is



Please discuss your response with:

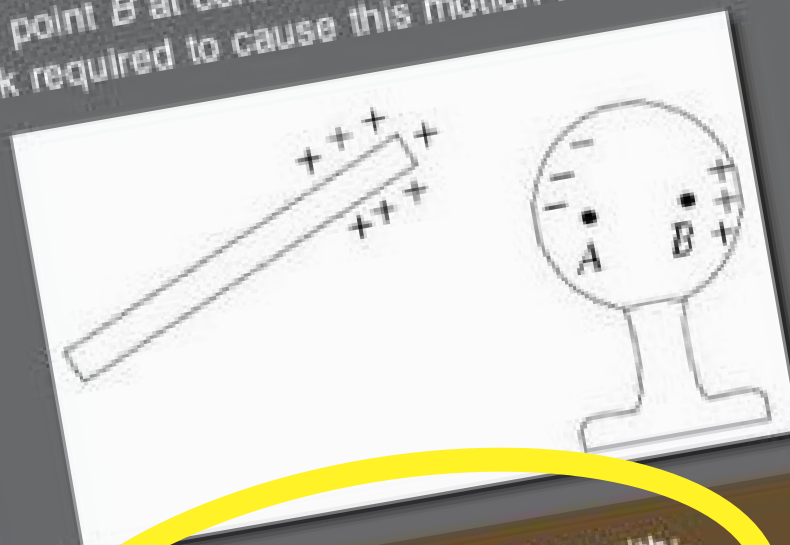
- Brian Lukoff (to your left)

I am talking to this person/people



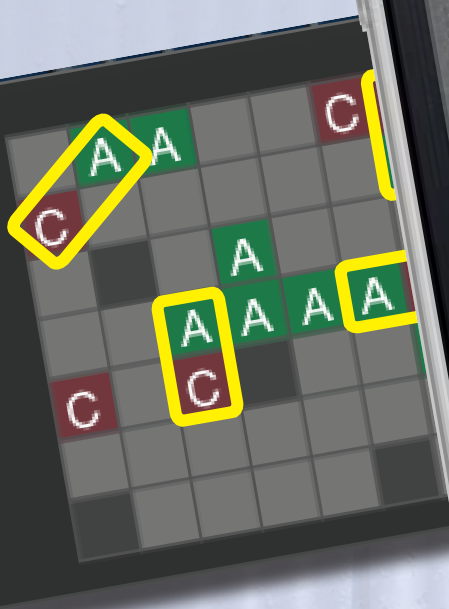
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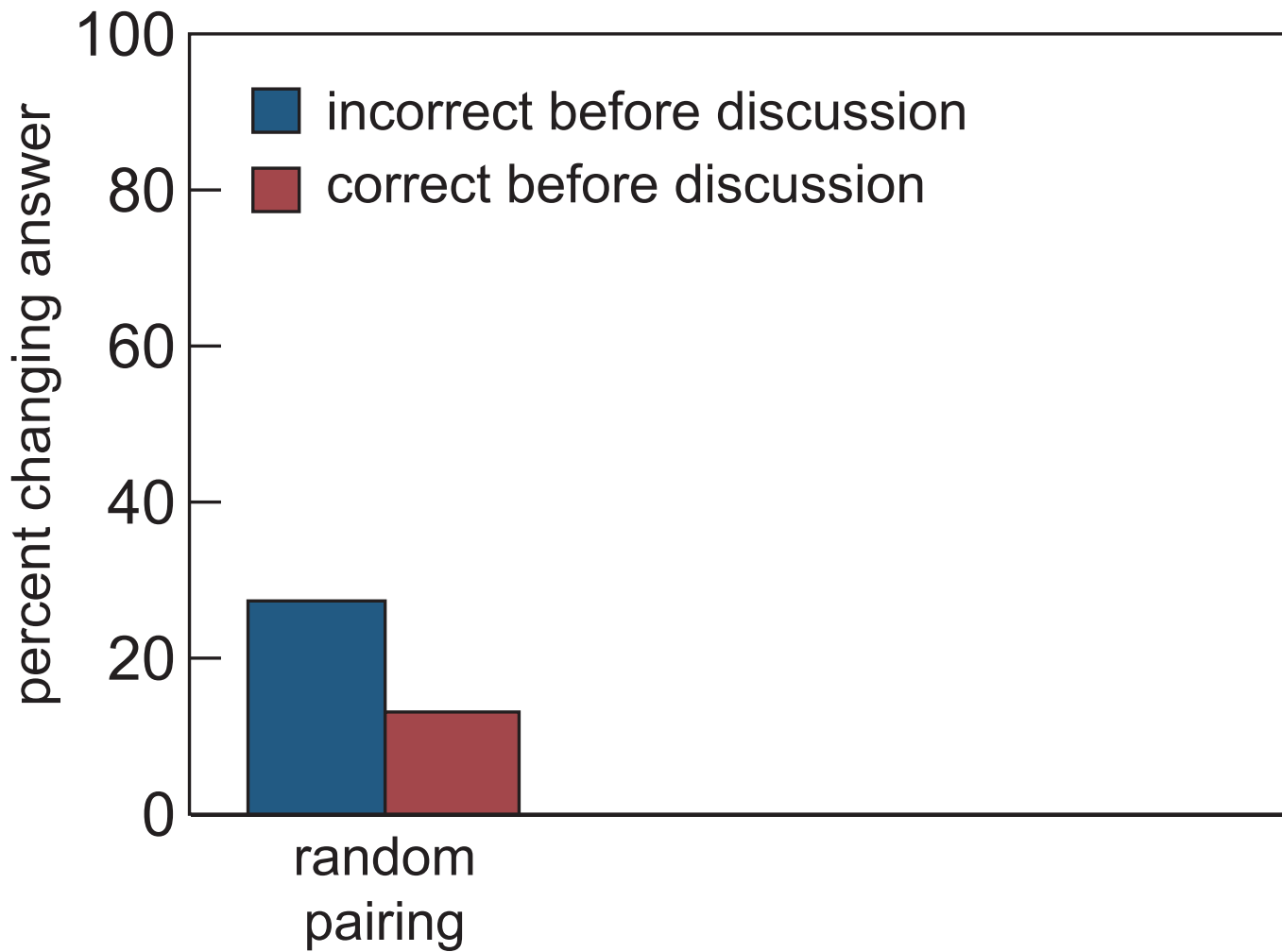
A positively charged rod is held near a neutral conducting sphere as illustrated below. A positively charged particle is moved from point A to point B at constant speed. The mechanical work required to cause this motion is

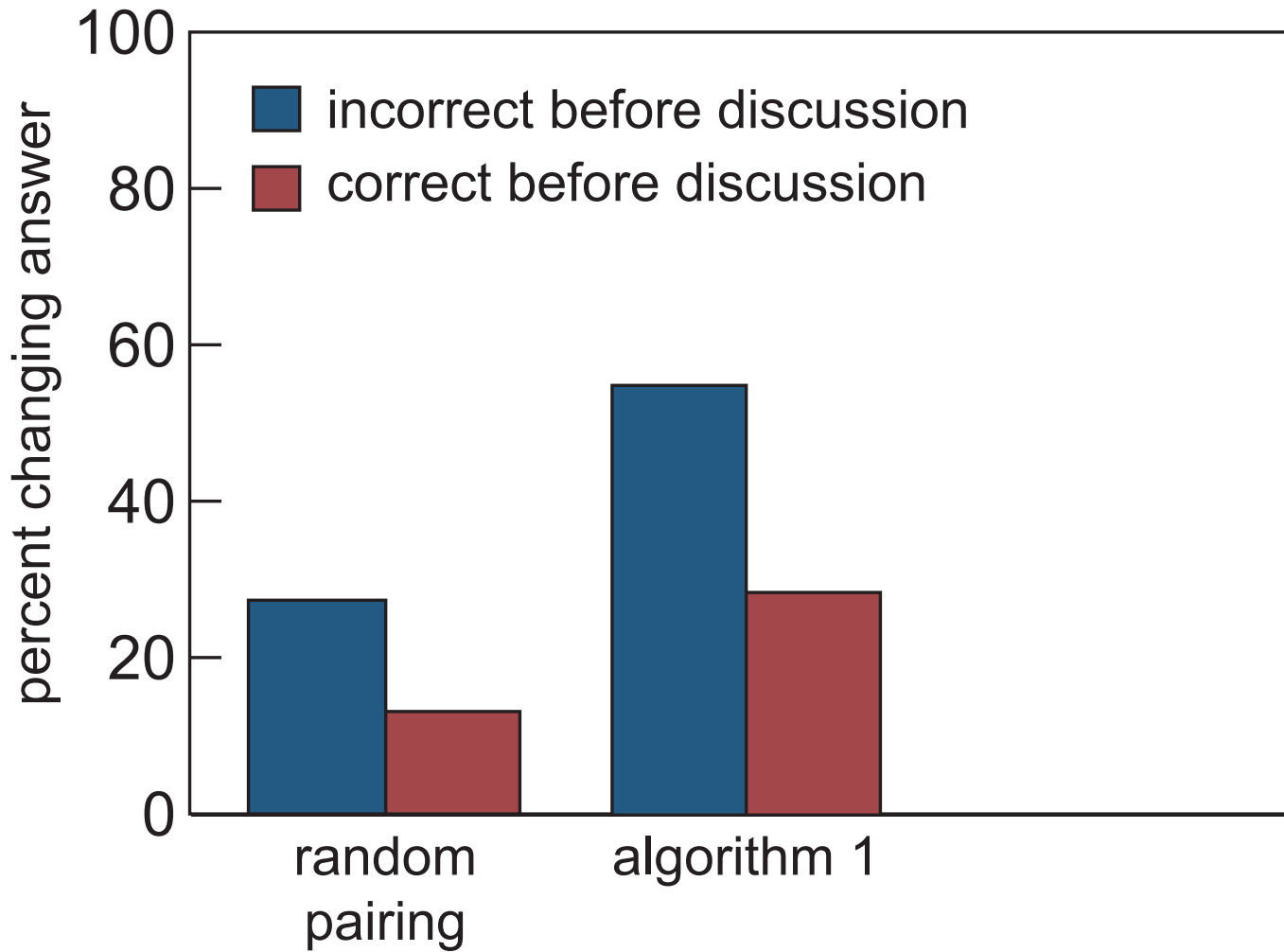


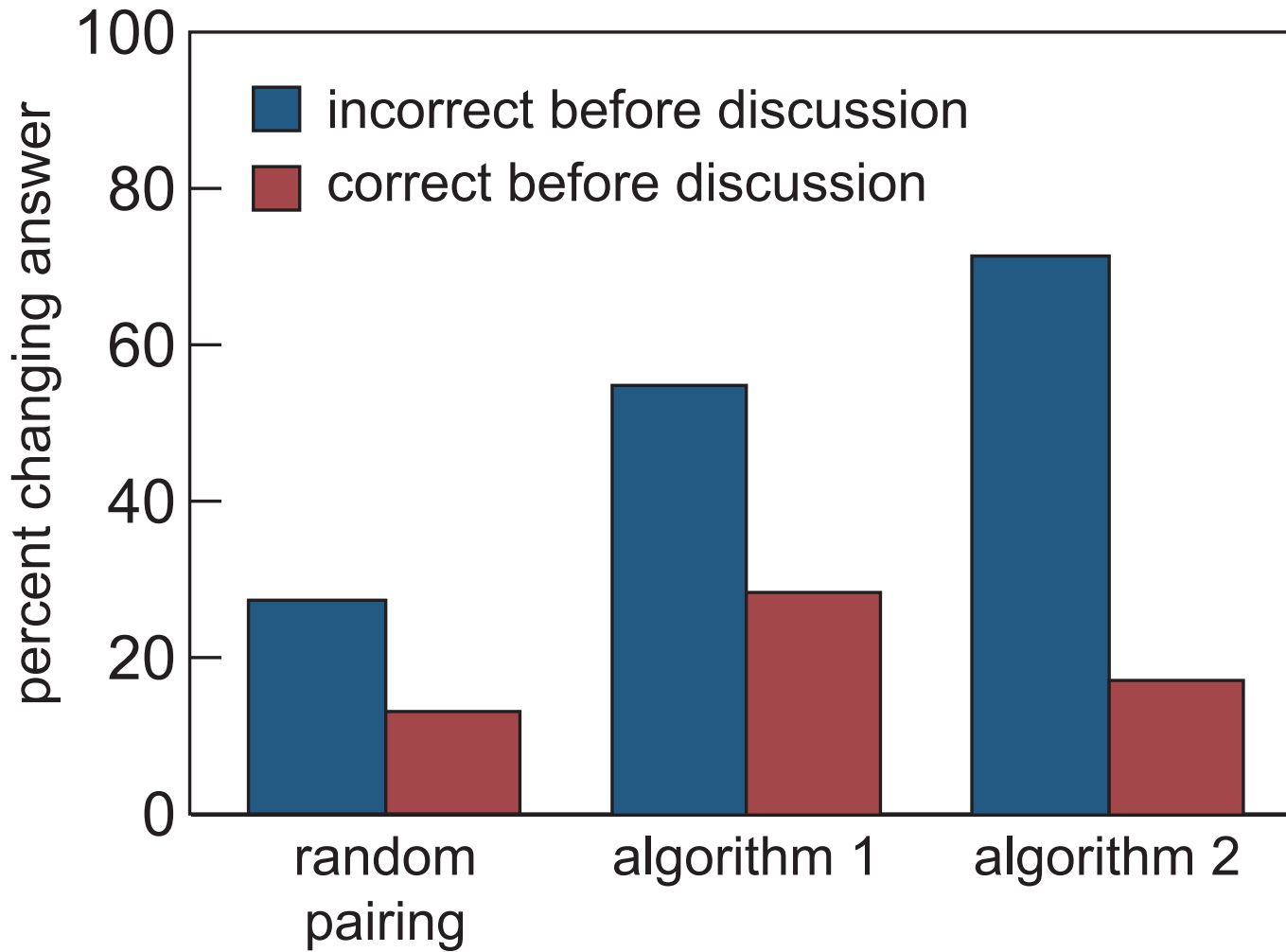
Please discuss your response with:

- Brian Lukoff (to your left)









brief
presentation

1 education

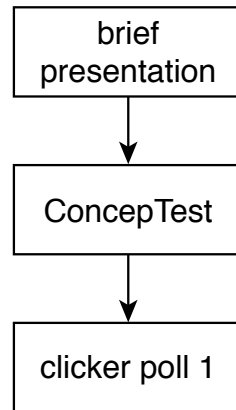
2 PI

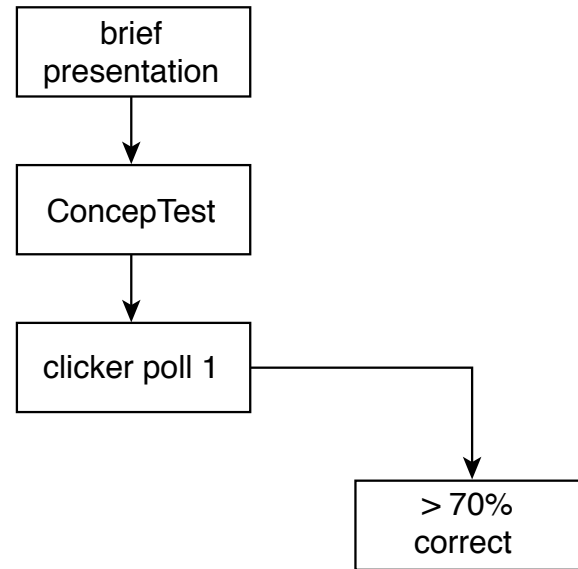
3 PI 2.0

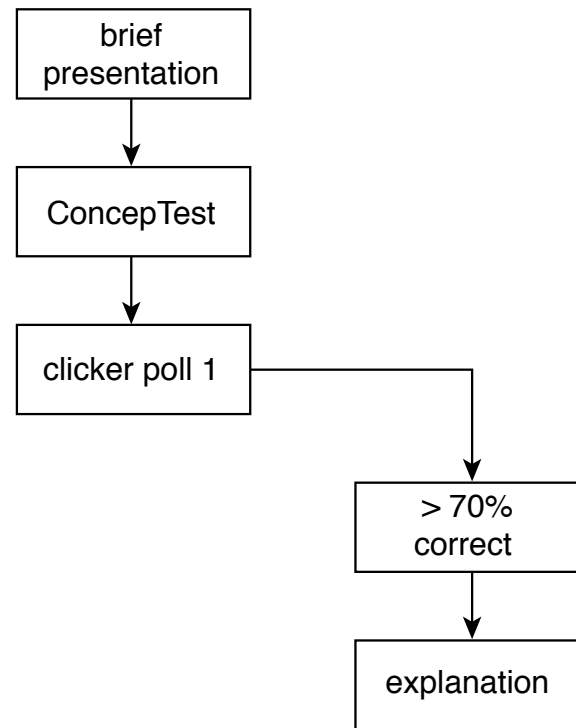
brief
presentation

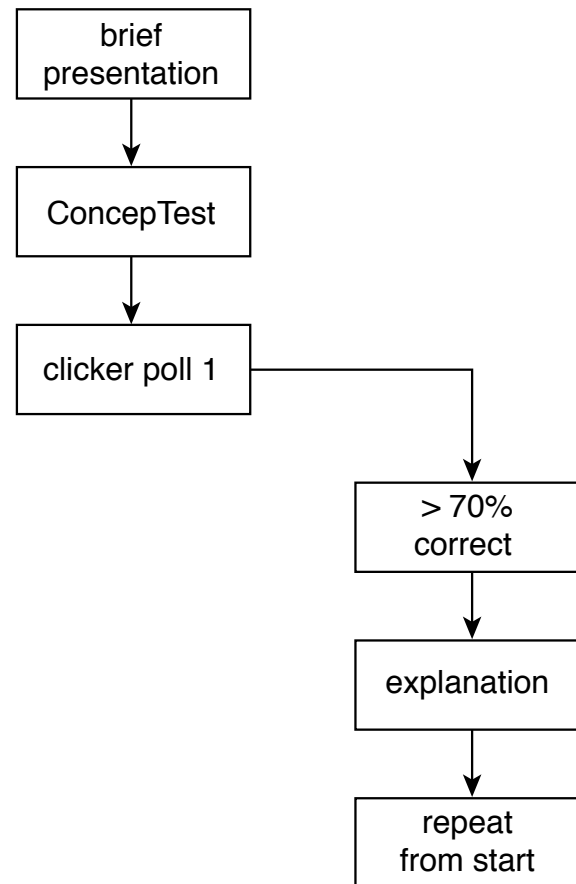


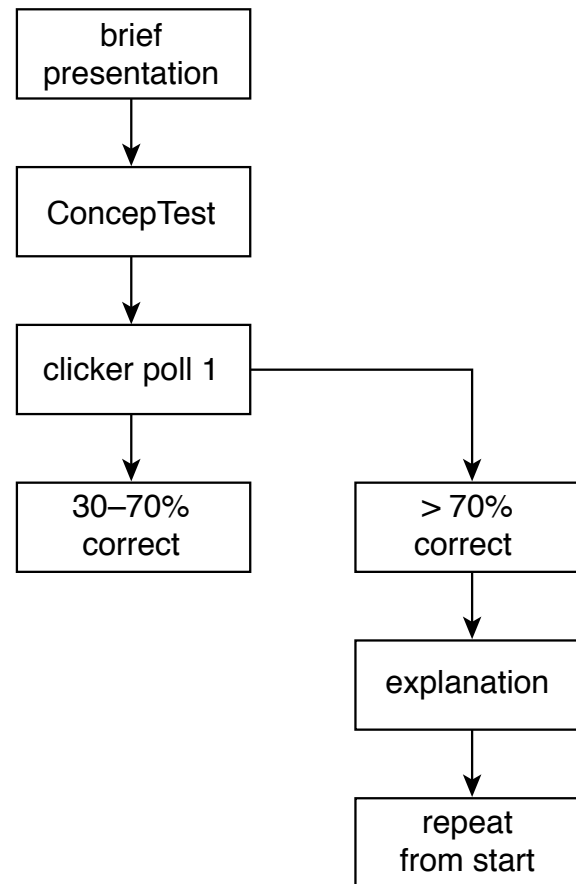
ConcepTest

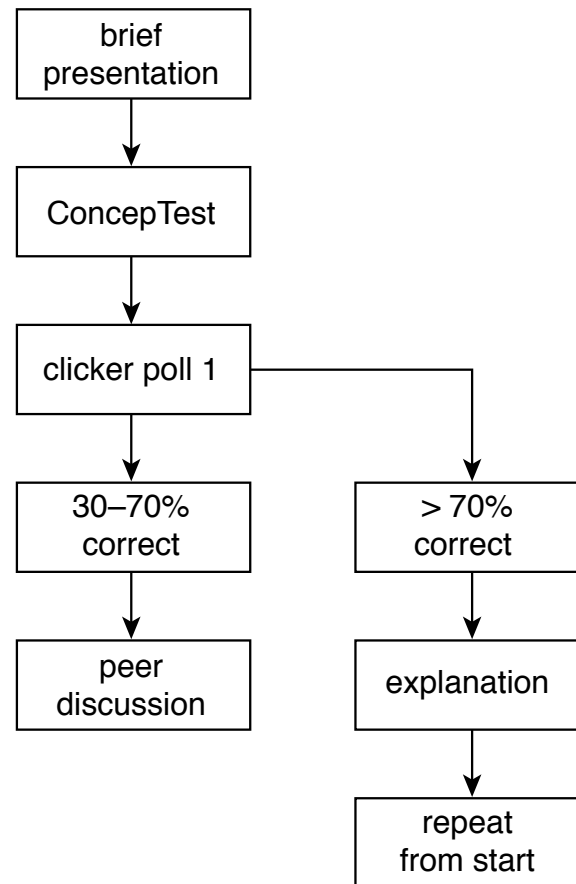


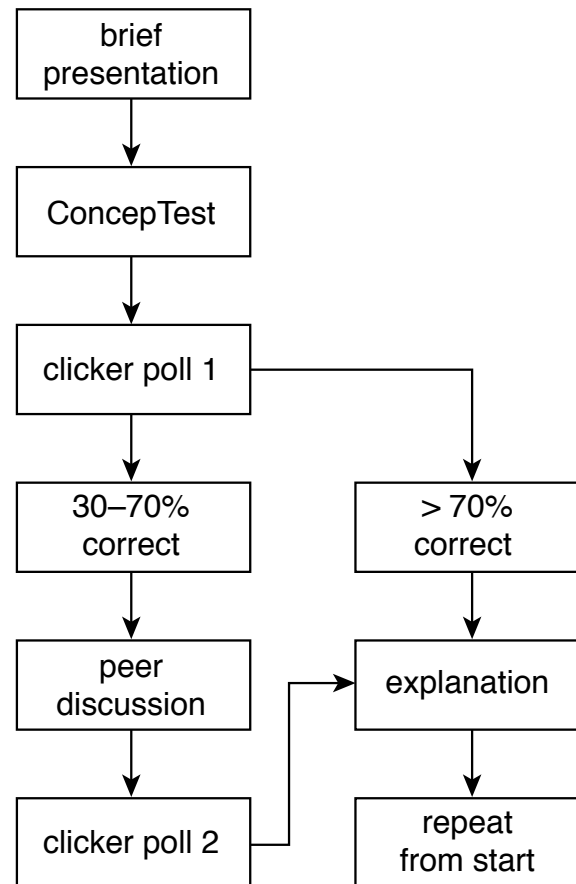


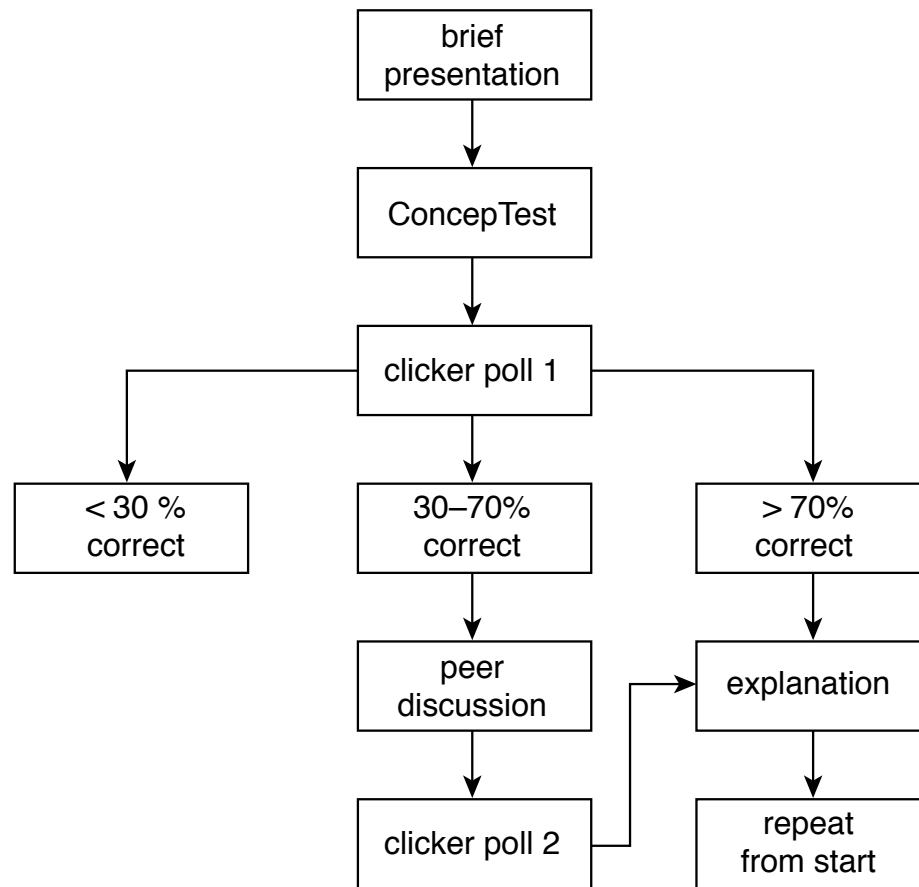


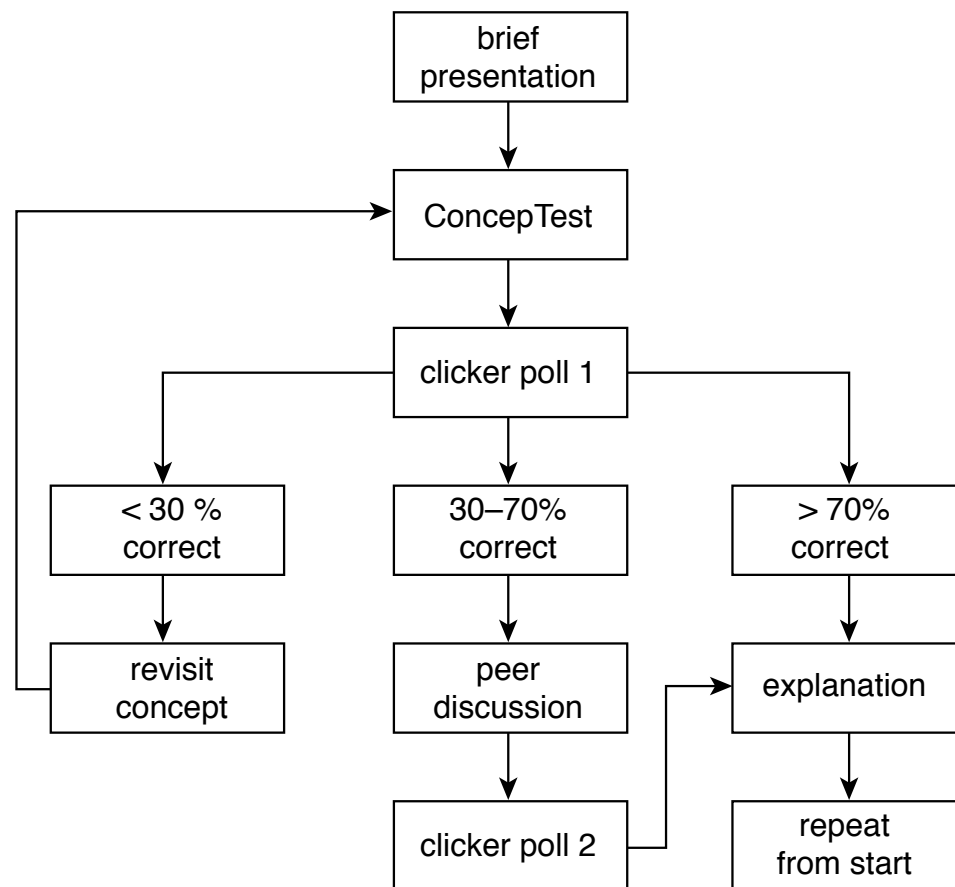


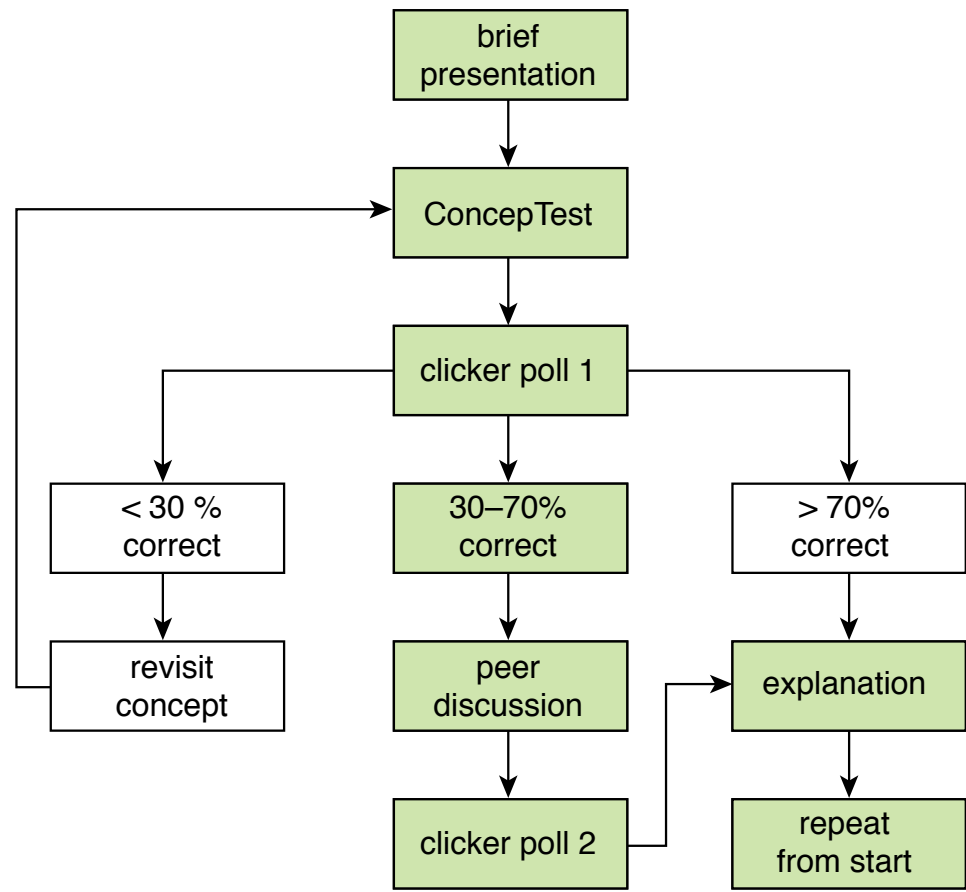


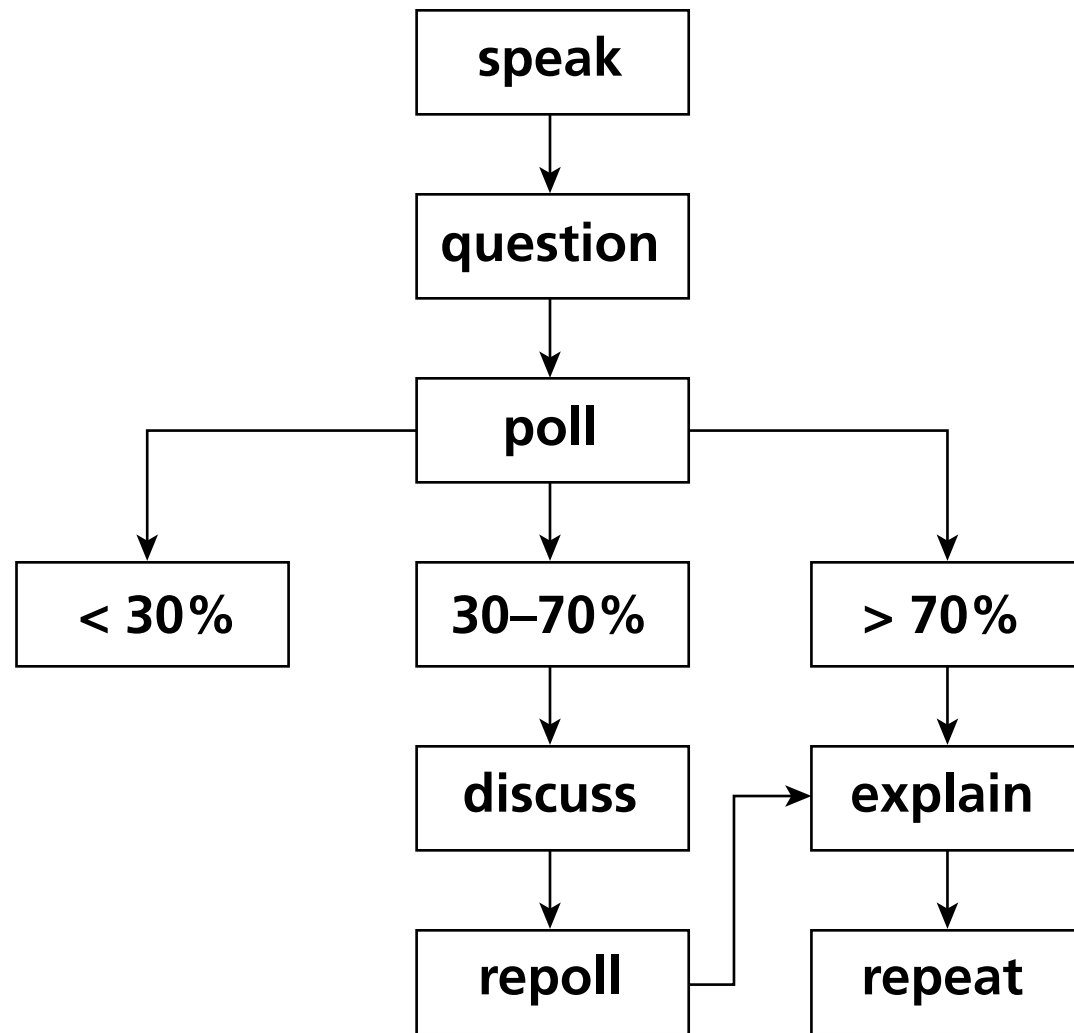


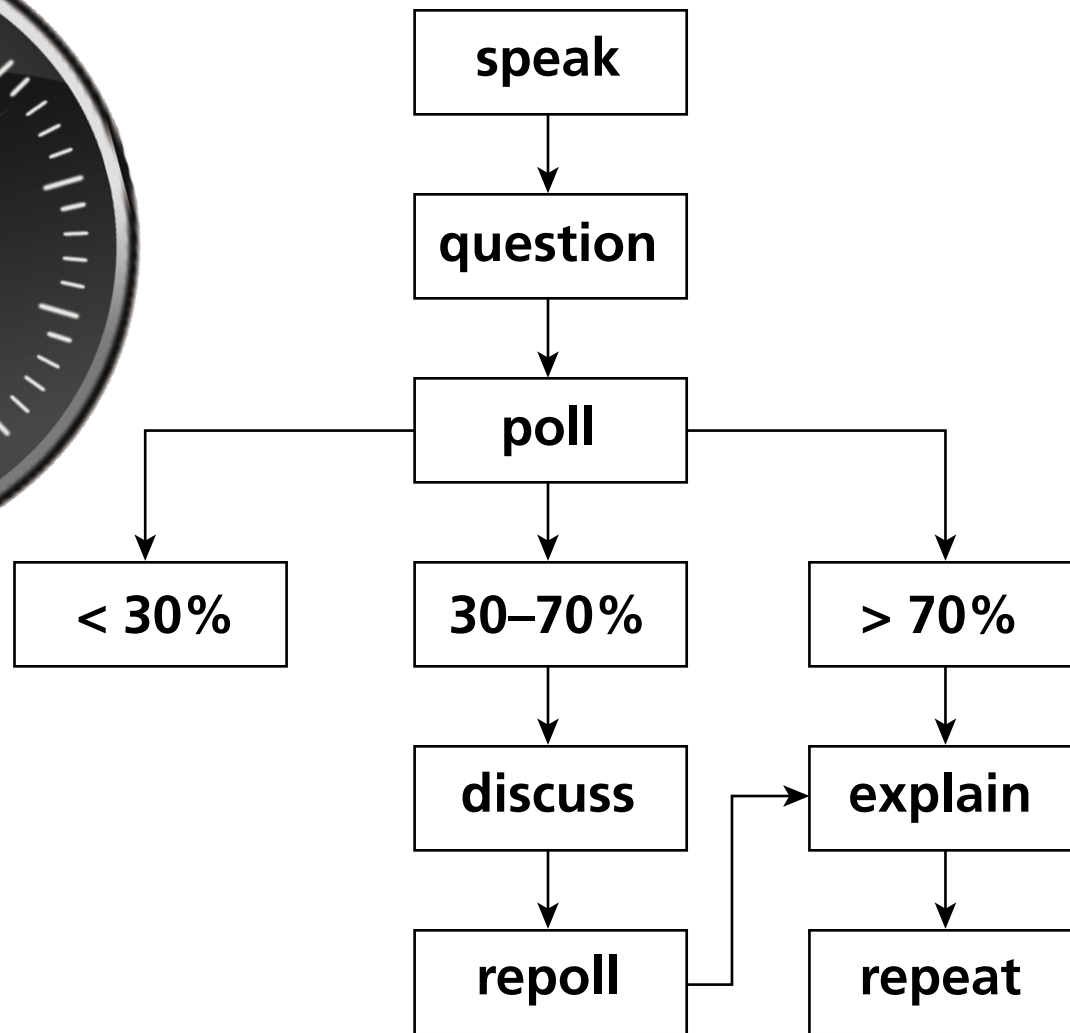














1 lecture

2 PI

3 PI 2.0



1 education

2 PI

3 PI 2.0



Learning Catalytics:

- implement proven, researched pedagogy



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- use consumer devices

Learning Catalytics:

- **implement proven, researched pedagogy**
- **use consumer devices**
- **avoid pitfalls of MC assessment**

Learning Catalytics:

- implement proven, researched pedagogy
- use consumer devices
- avoid pitfalls of MC assessment
- create a smart classroom *anywhere*

Program

- 9:00 Peer Instruction and Just-in-Time-Teaching
- 10:30 Break
- 11:00 Technology/Hands-on with Peer Instruction
- 12:30 Lunch
- 13:30 Designing good questions for PI**
- 15:00 Break
- 15:30 Discussion and wrap-up
- 16:30 Adjourn



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Designing good questions for PI

Let's evaluate the quality of questions!

Program

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