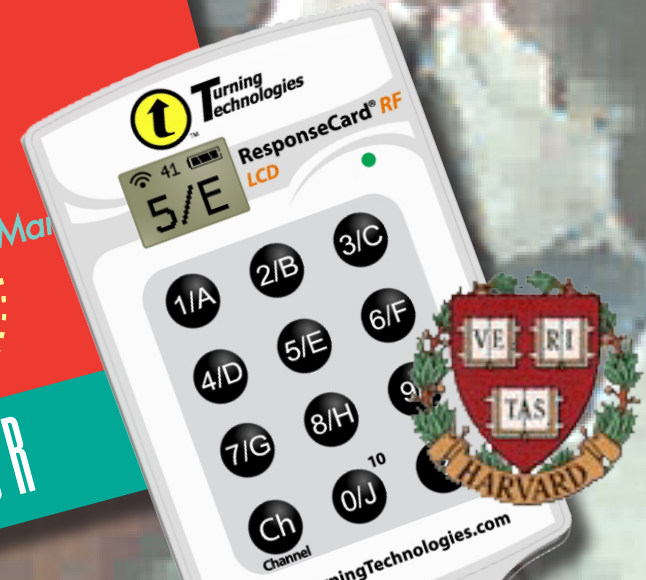


Peer Instruction



Universidad de Magallanes
Punta Arenas, Chile, 27 August 2012

Peer Instruction

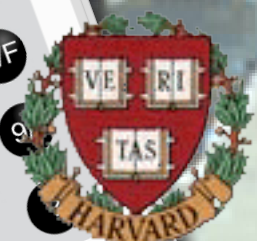


@eric_mazur

Includes
Class-Tested,
Ready-to-Use
Resources

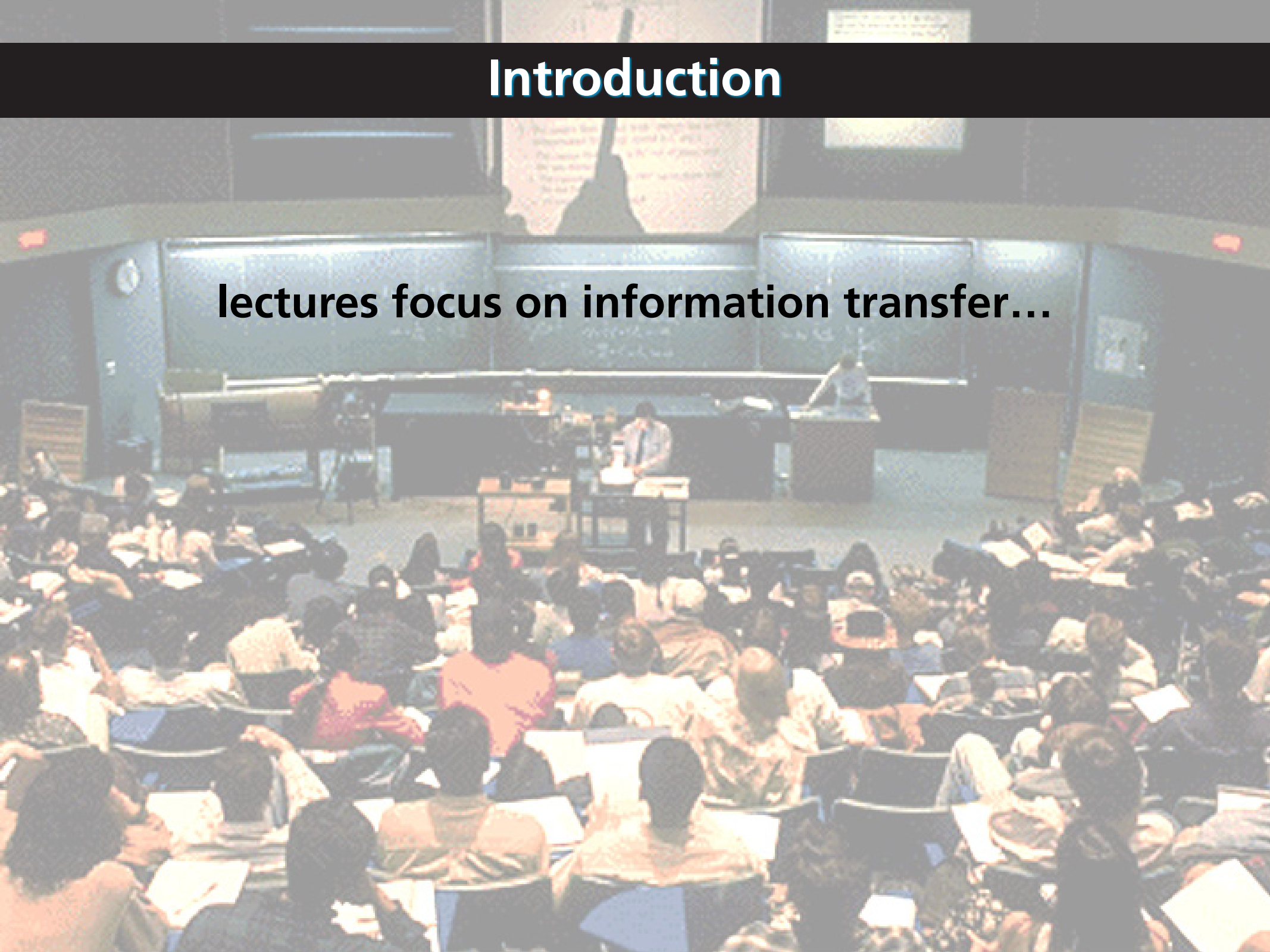


Universidad de Magallanes
Punta Arenas, Chile, 27 August 2012



Introduction

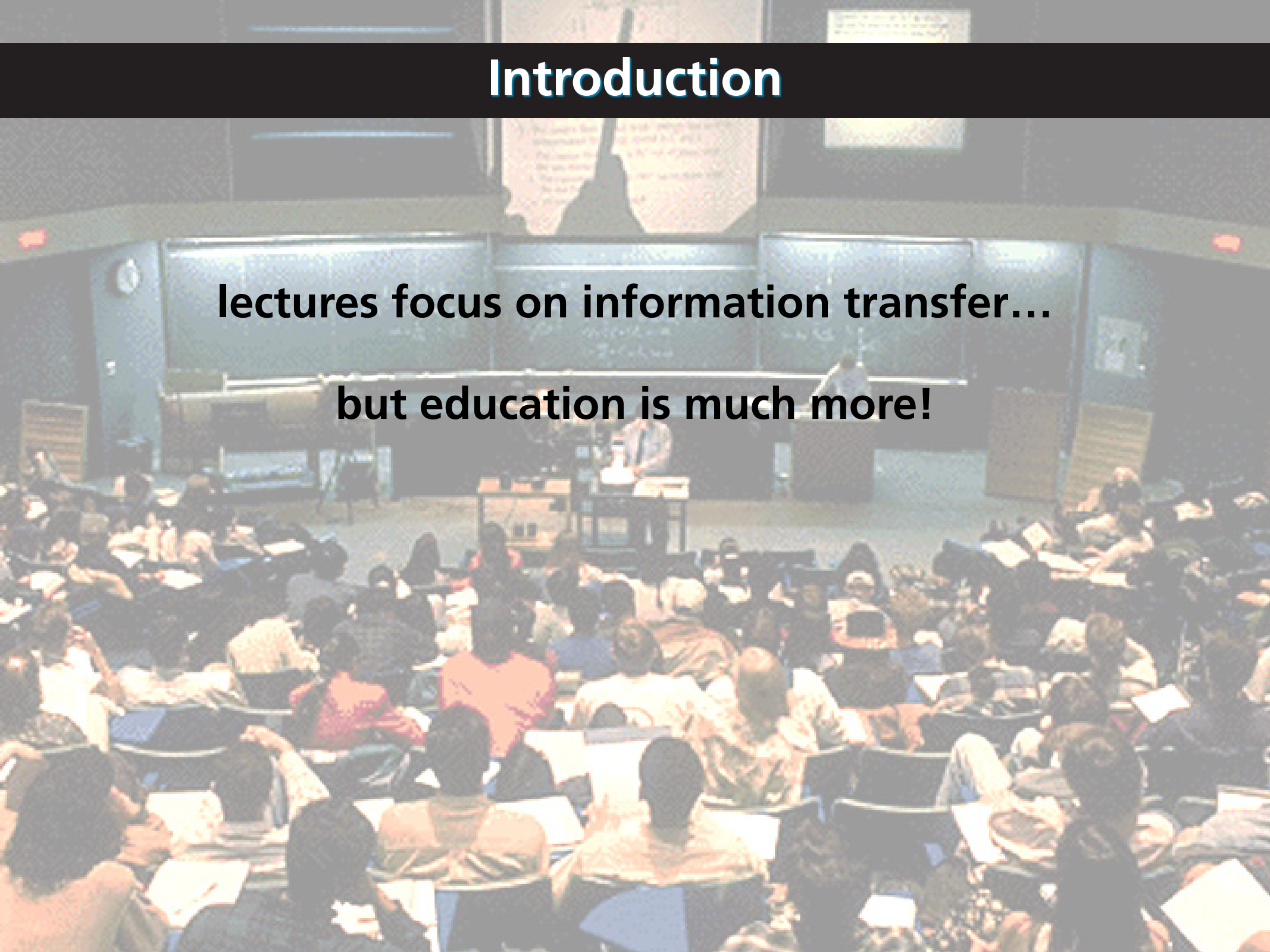
lectures focus on information transfer...



Introduction

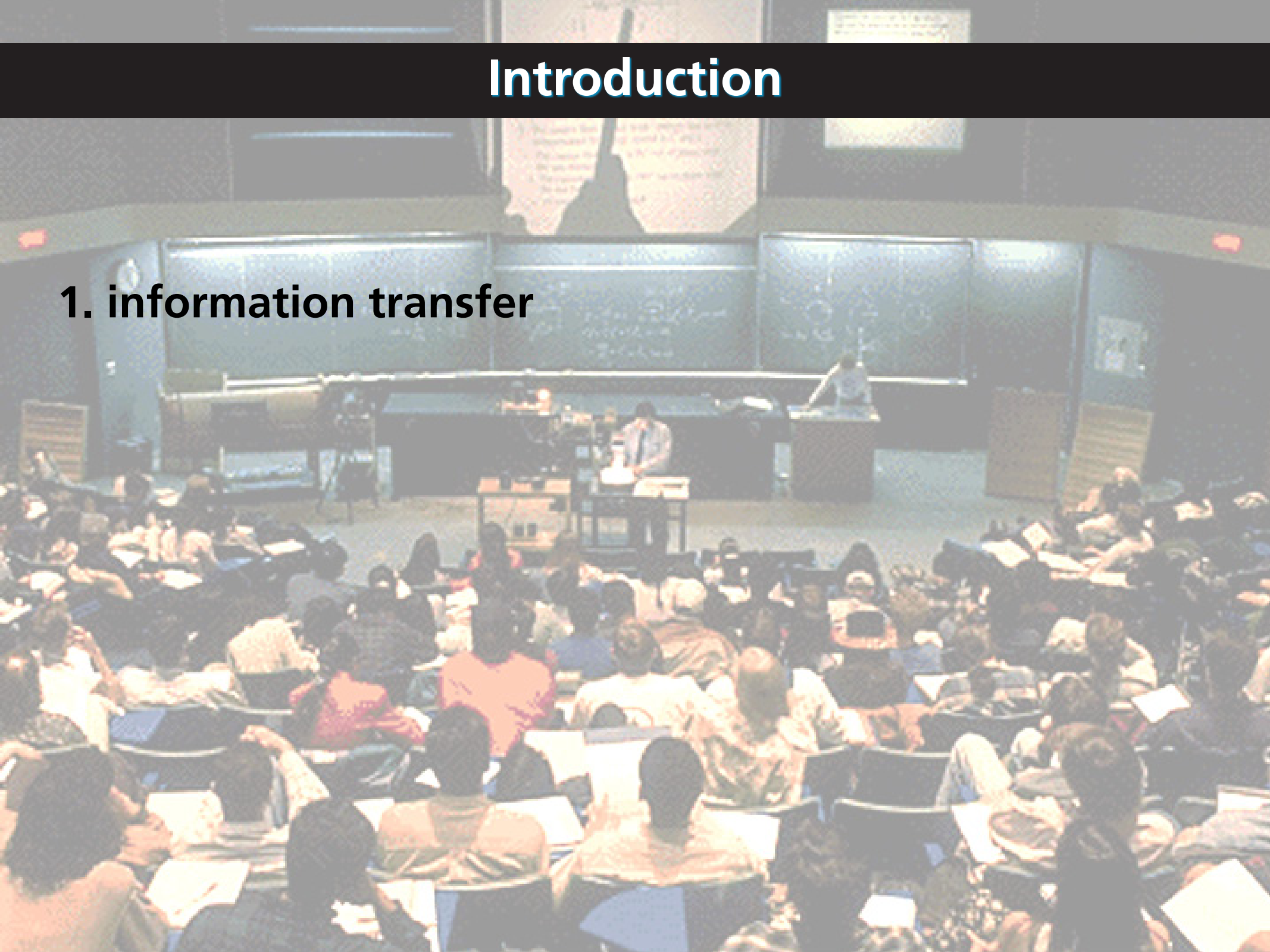
lectures focus on information transfer...

but education is much more!



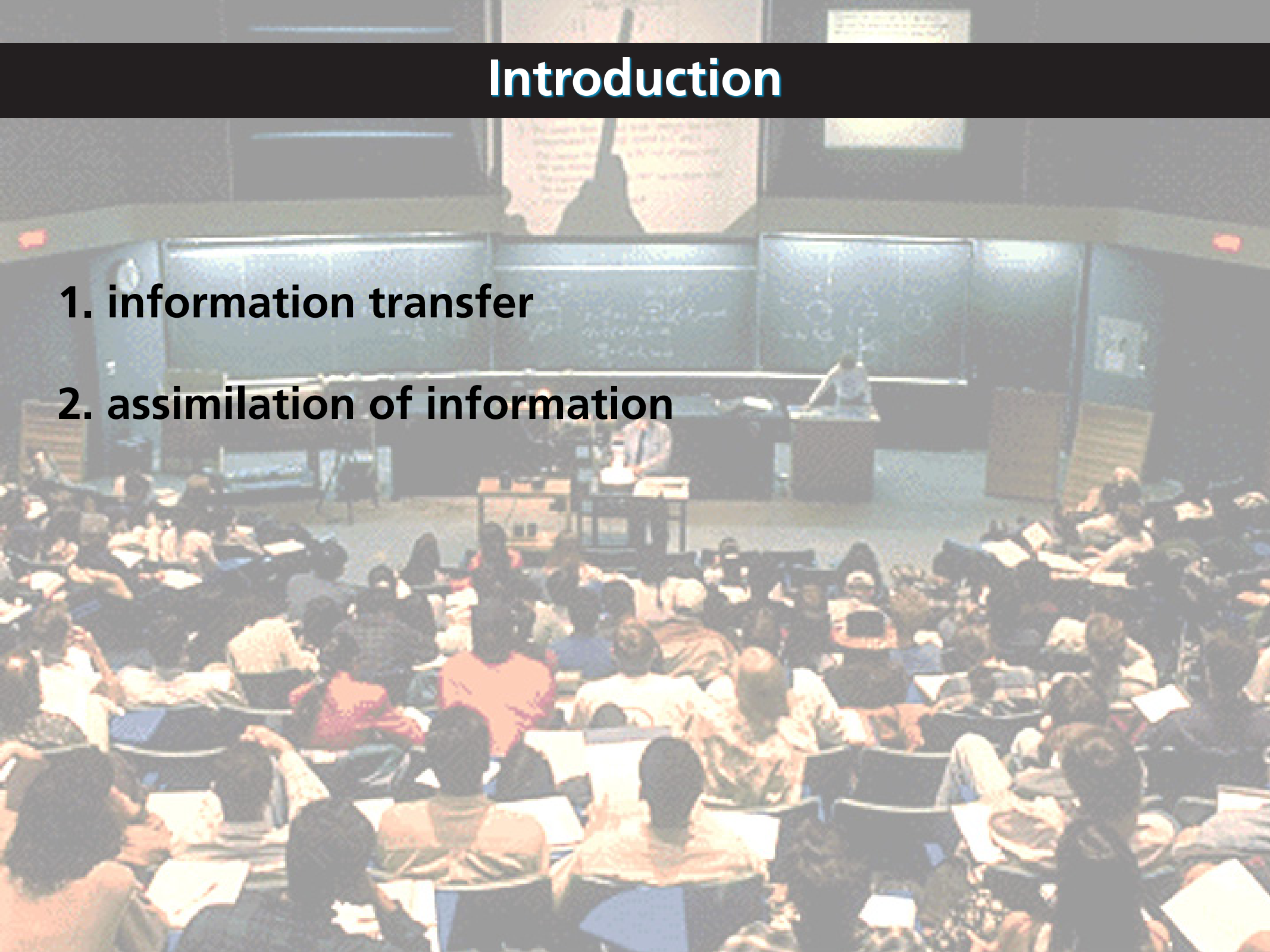
Introduction

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

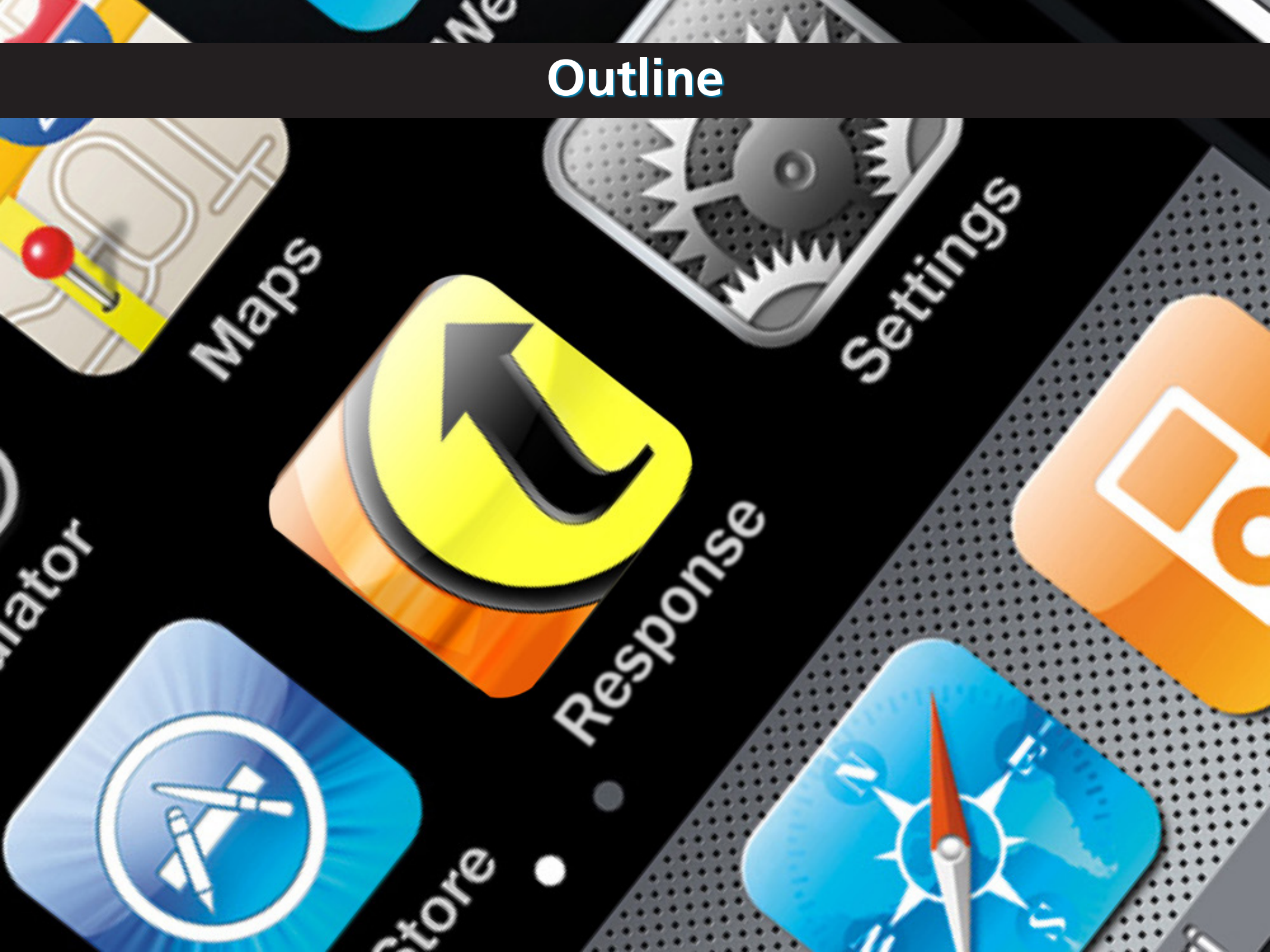
How to move information transfer out of classroom?

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**
- **ConcepTests**

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!

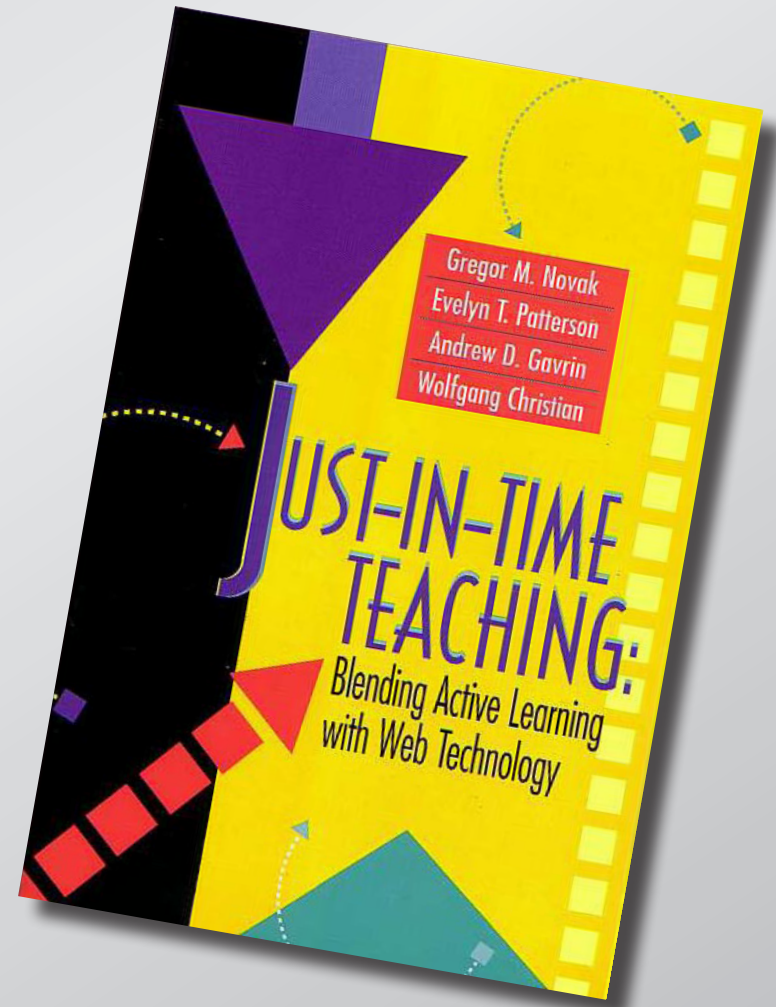
(select what you consider to be the main reason)



PI & JiTT Overview

Just-in-time-Teaching (JiTT)

www.jitt.org



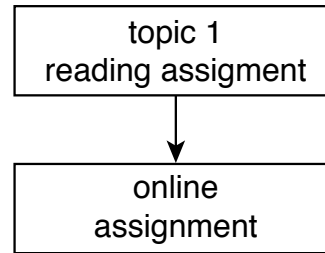
PI & JiTT Overview

JiTT workflow

topic 1
reading assignment

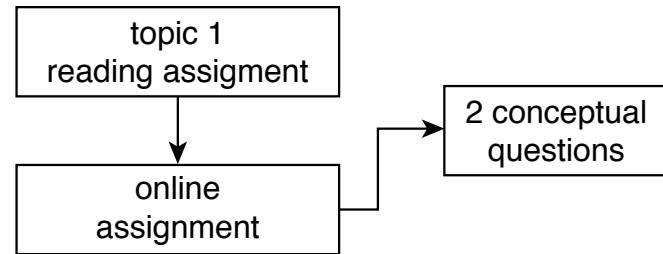
PI & JiTT Overview

JiTT workflow



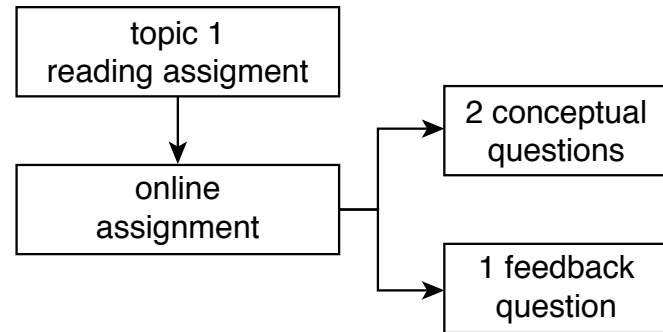
PI & JiTT Overview

JiTT workflow



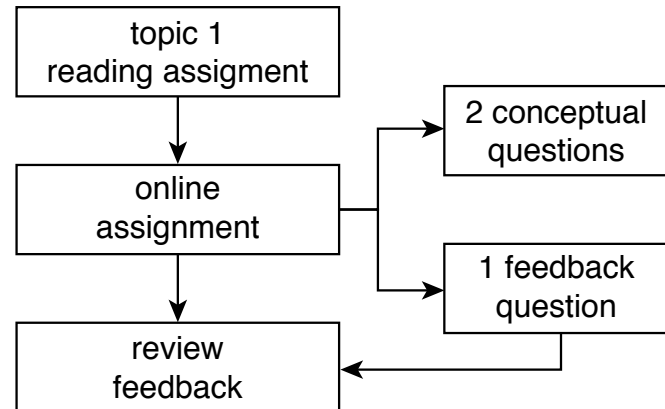
PI & JiTT Overview

JiTT workflow



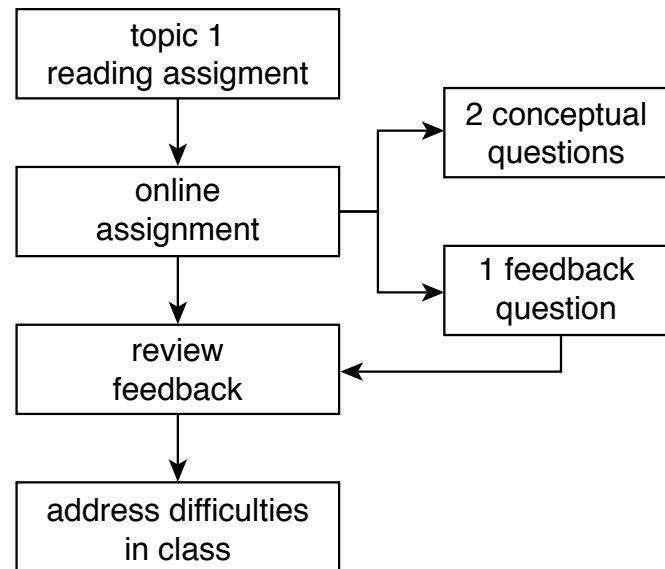
PI & JiTT Overview

JiTT workflow



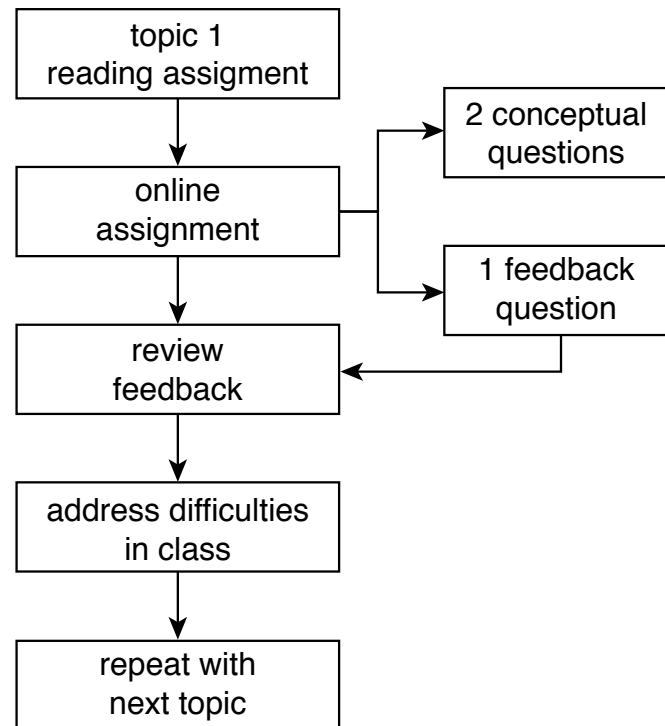
PI & JiTT Overview

JiTT workflow



PI & JiTT Overview

JiTT workflow



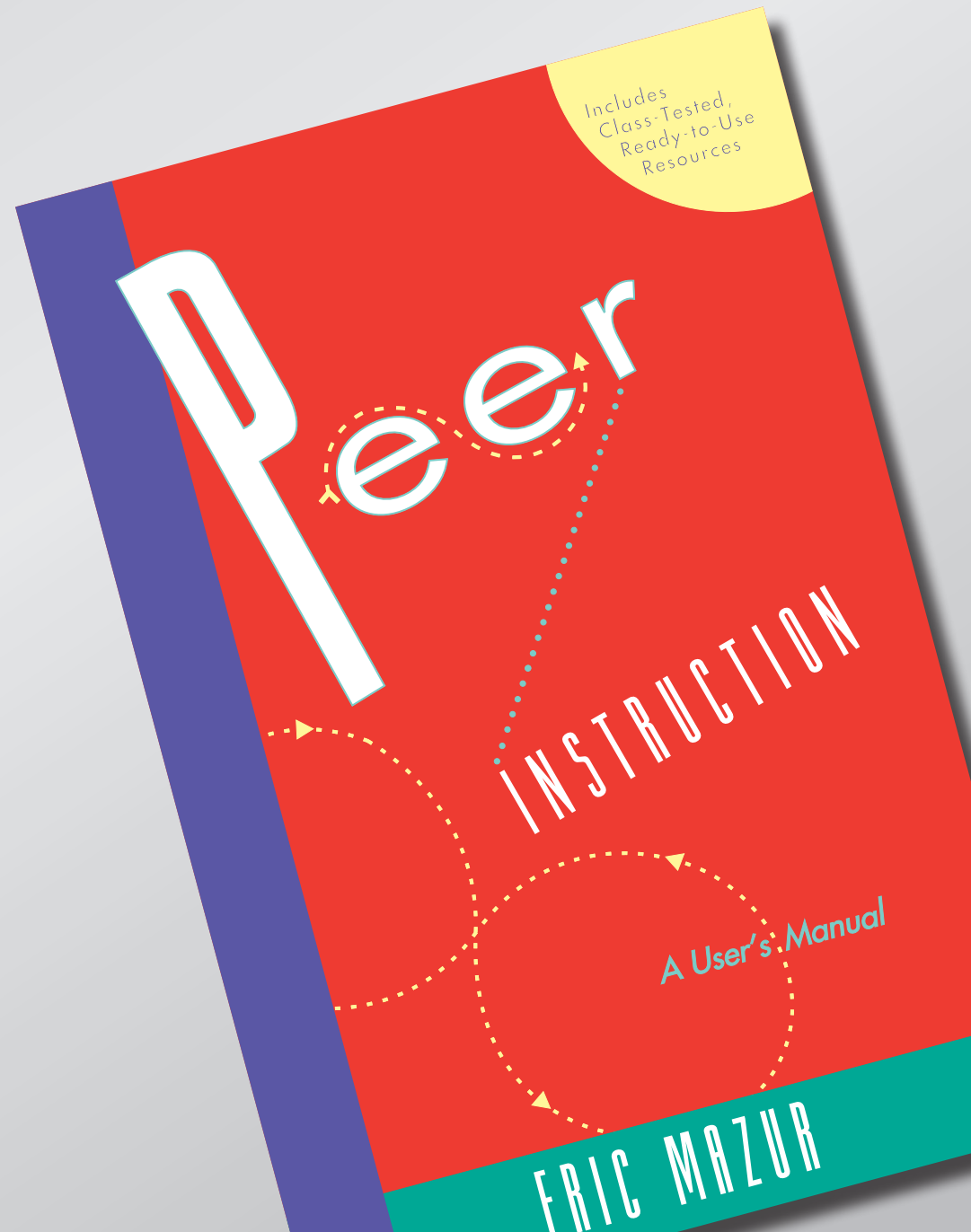
PI & JiTT Overview

JiTT:

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

PI & JiTT Overview

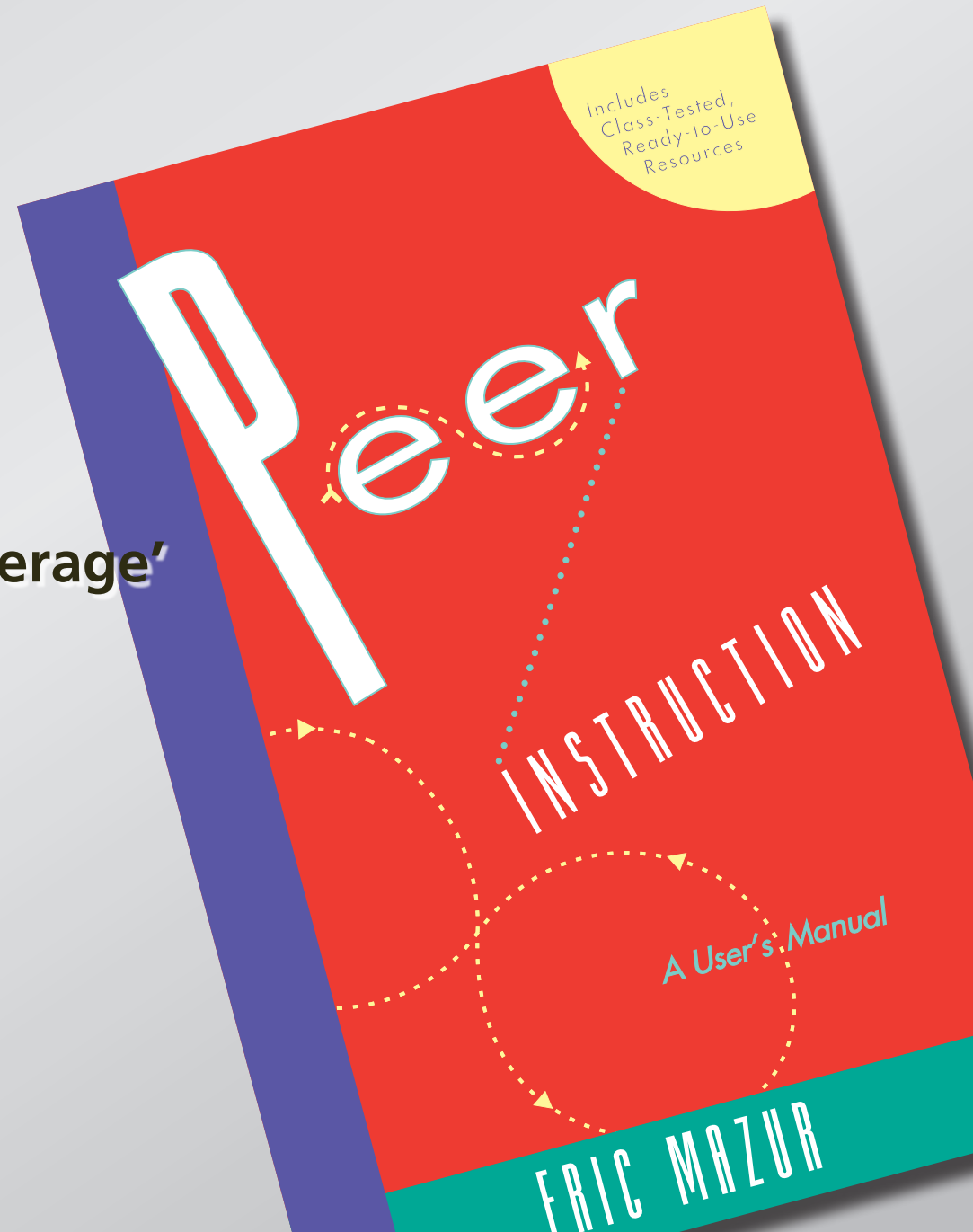
Peer Instruction (PI)



PI & JiTT Overview

Main features:

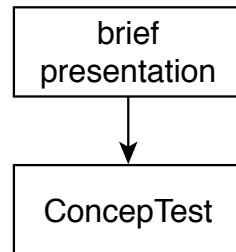
- pre-class assignment
- in-class: depth, not 'coverage'
- ConcepTests



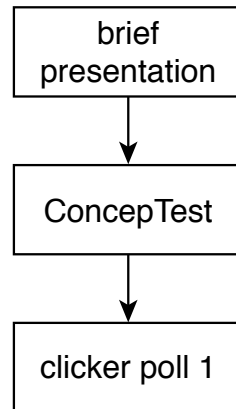
PI & JiTT Overview

brief
presentation

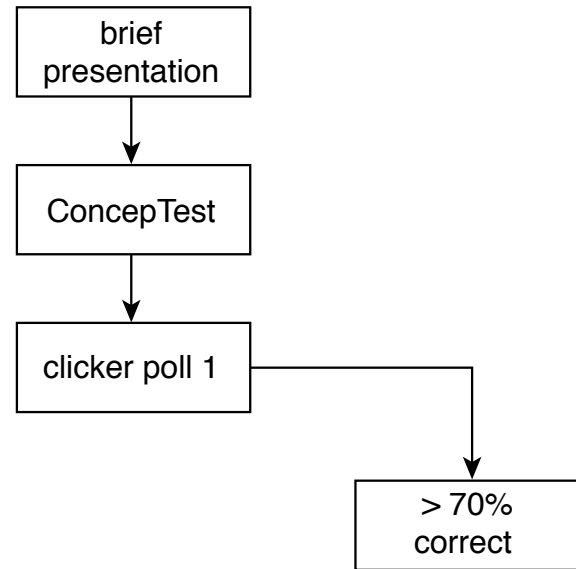
PI & JiTT Overview



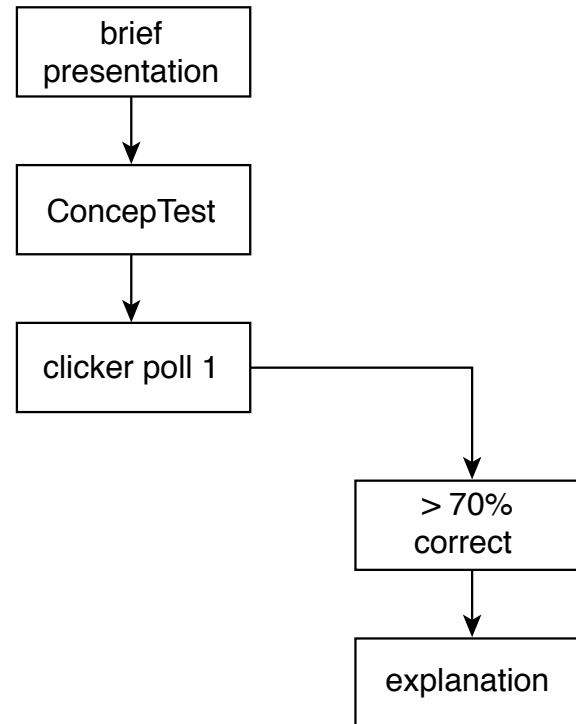
PI & JiTT Overview



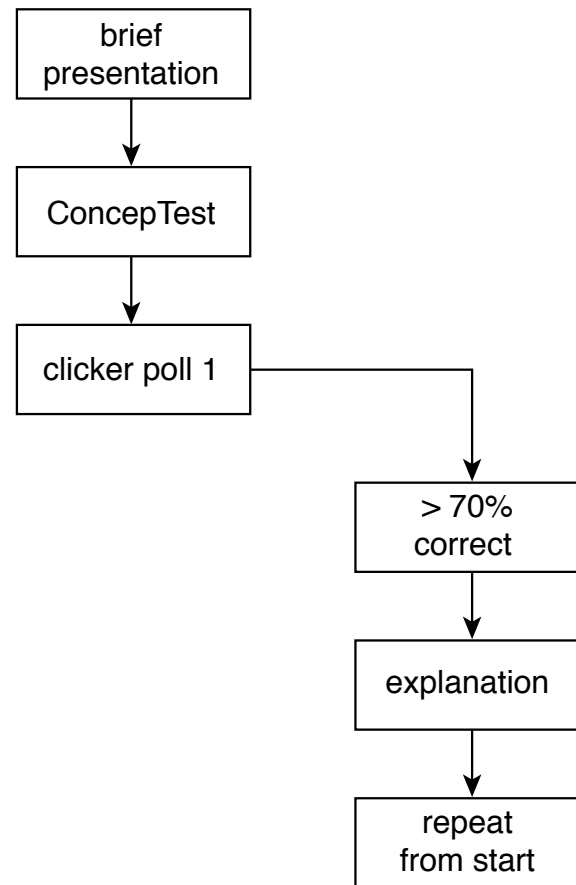
PI & JiTT Overview



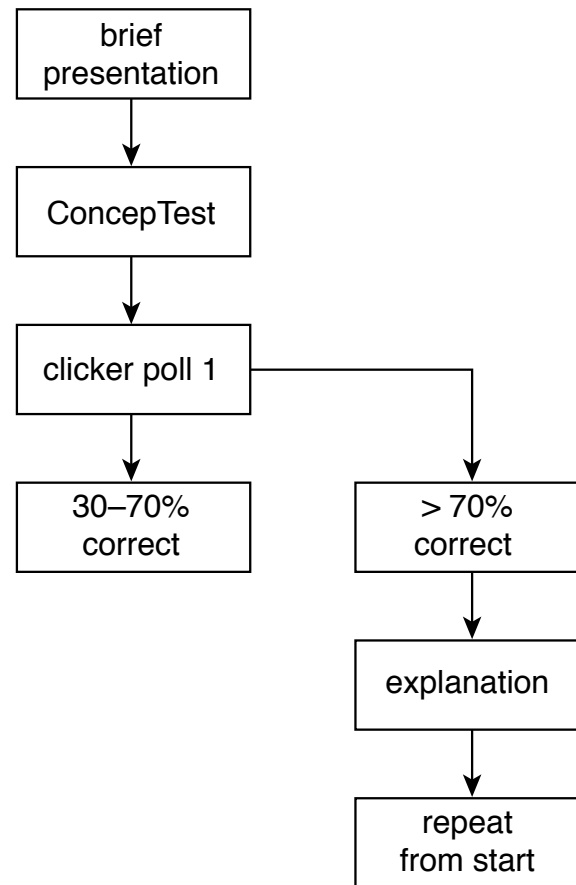
PI & JiTT Overview



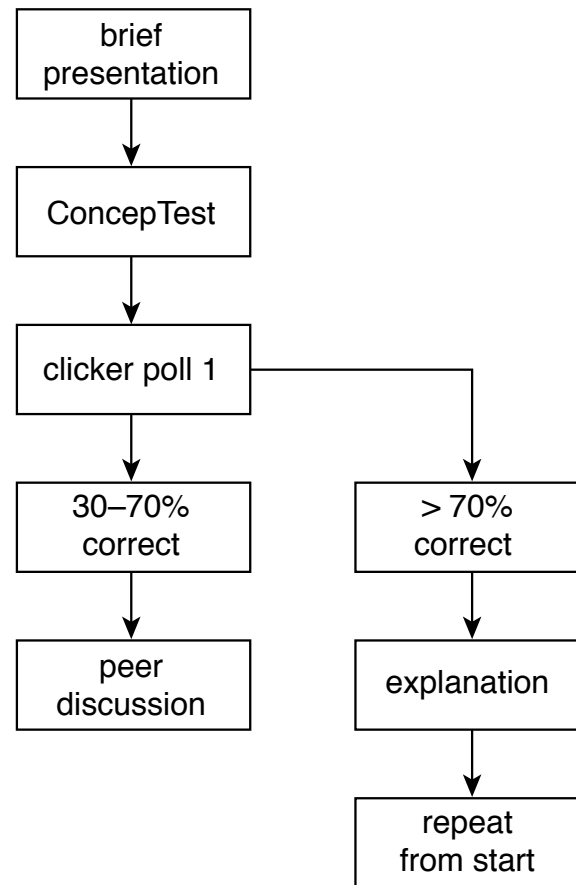
PI & JiTT Overview



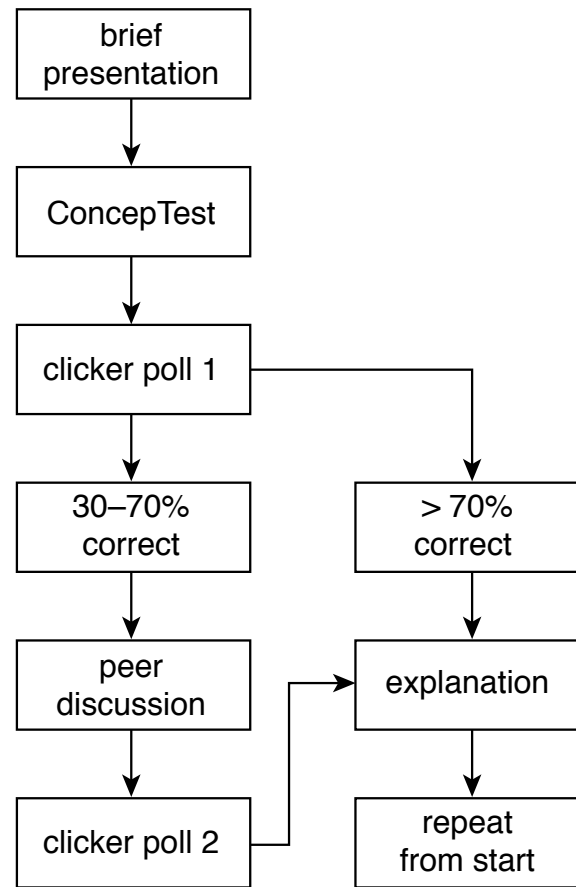
PI & JiTT Overview



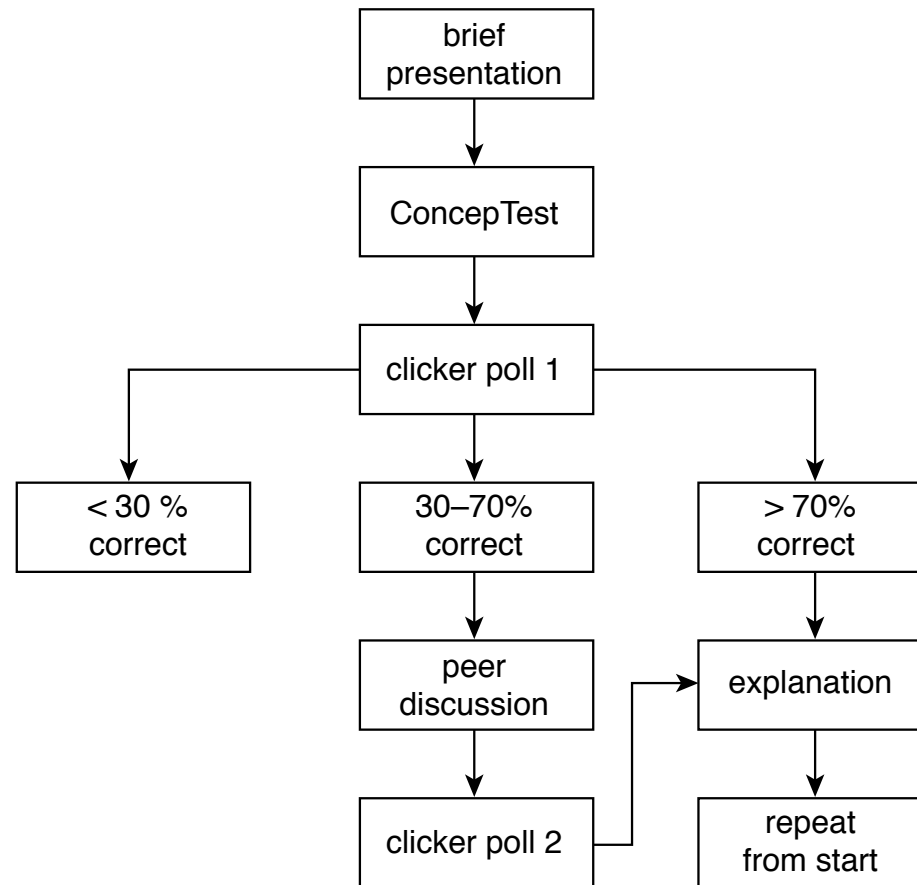
PI & JiTT Overview



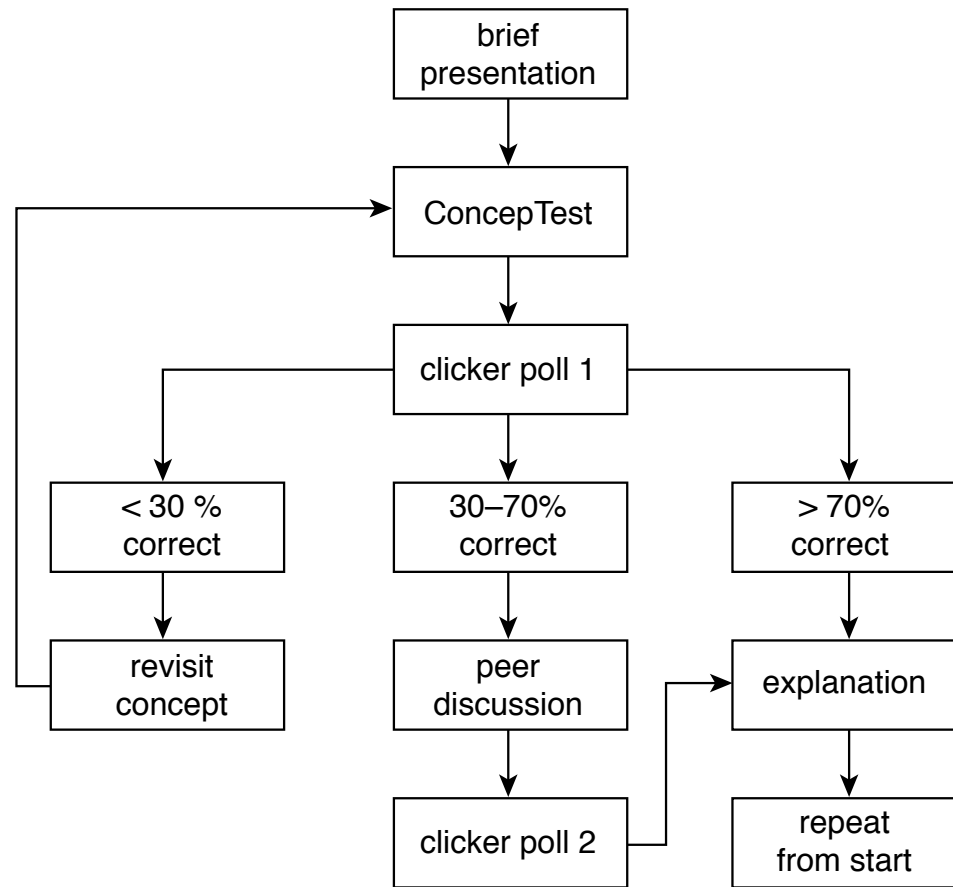
PI & JiTT Overview



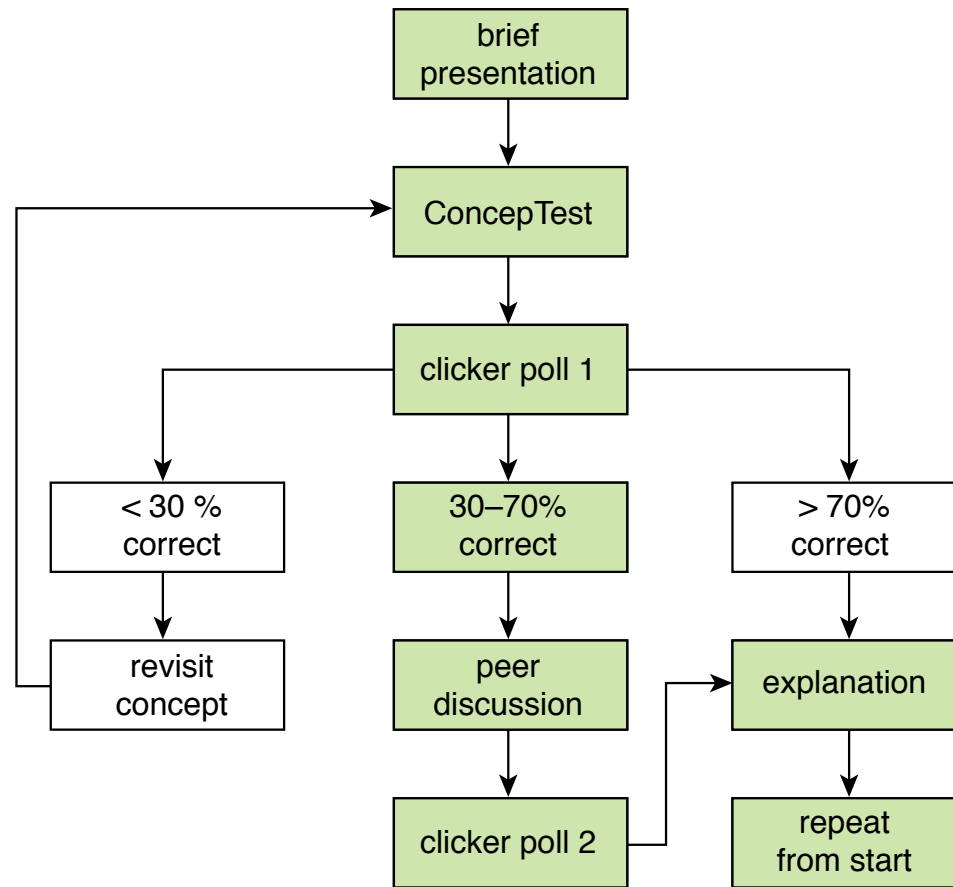
PI & JiTT Overview



PI & JiTT Overview



PI & JiTT Overview



PI & JiTT Overview

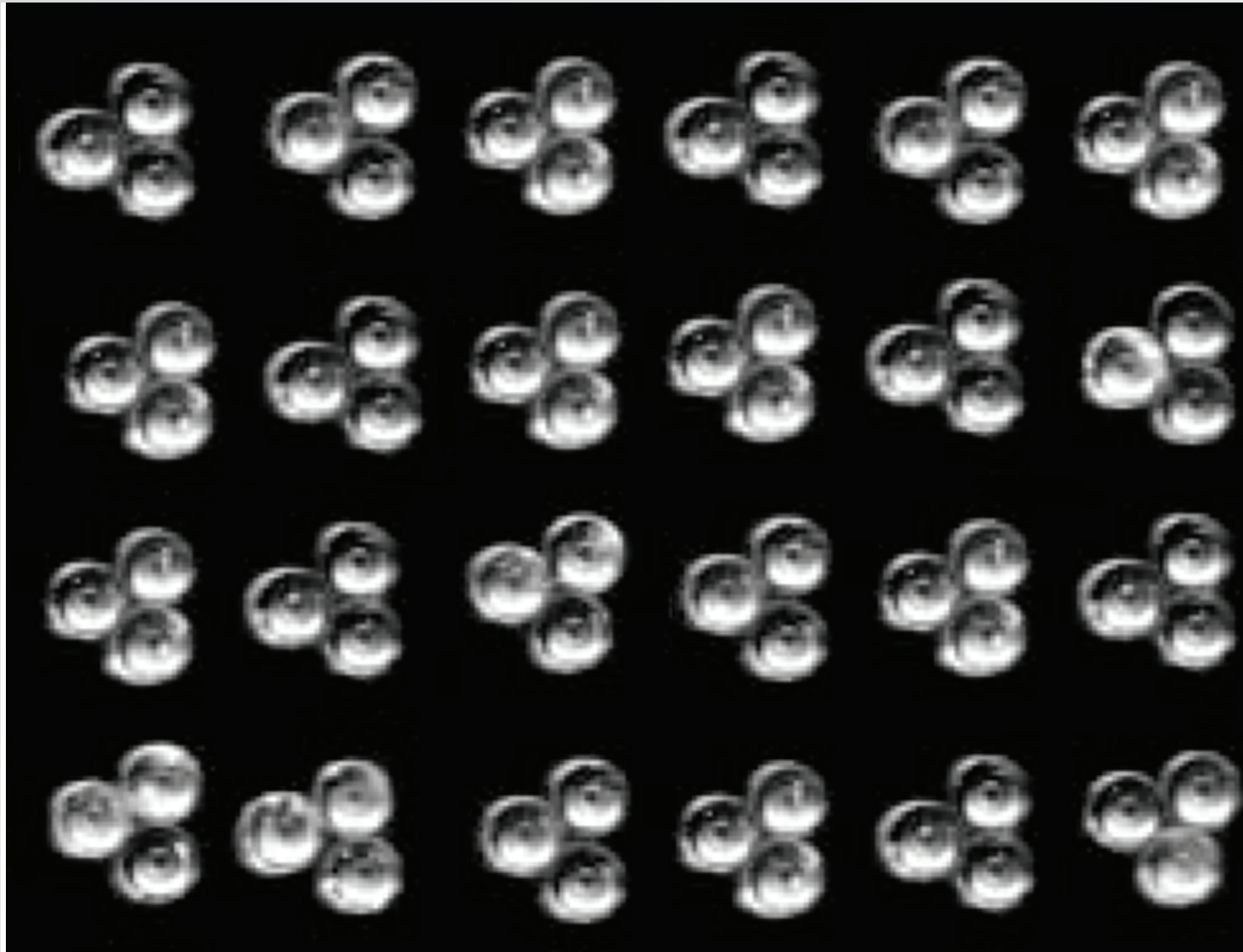
PI:

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

PI & JiTT Overview

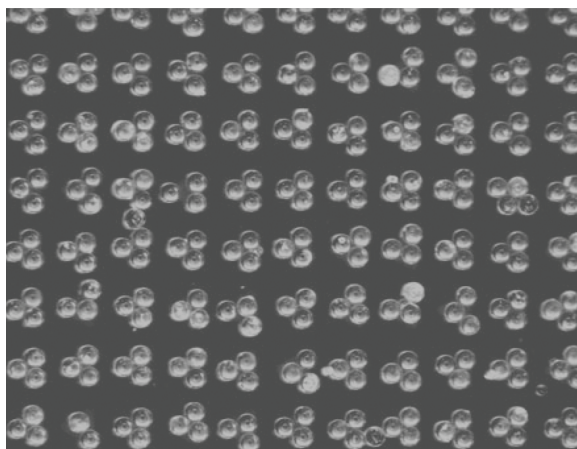
*“Can this method be used in my class,
where questions don’t necessarily have right answers?”*

Let's try it!

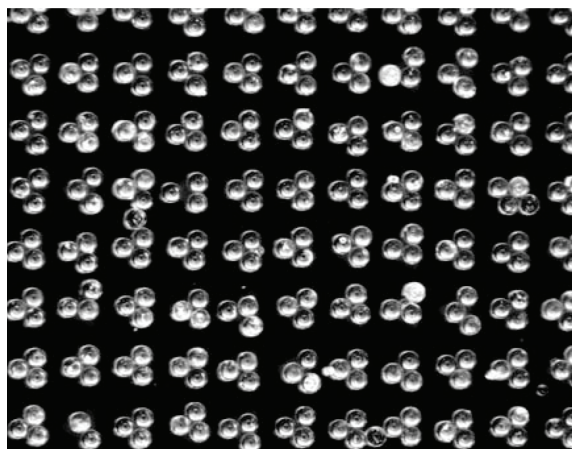


Let's try it!

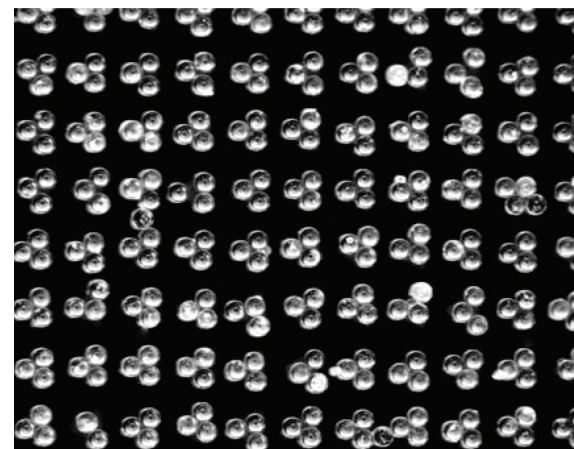
original



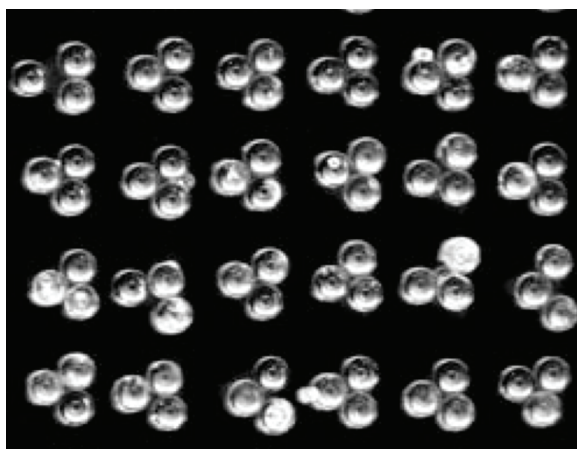
1. adjust contrast



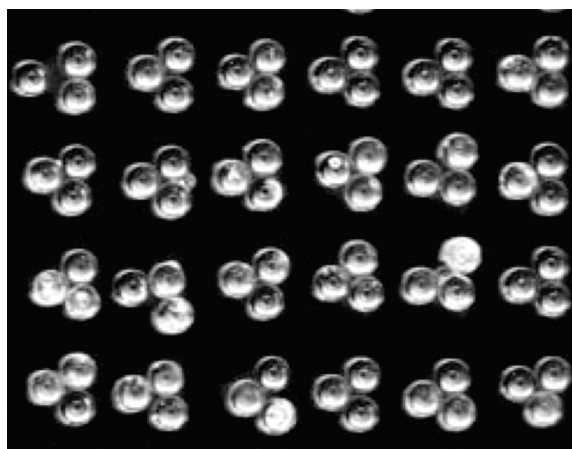
2. remove blemishes



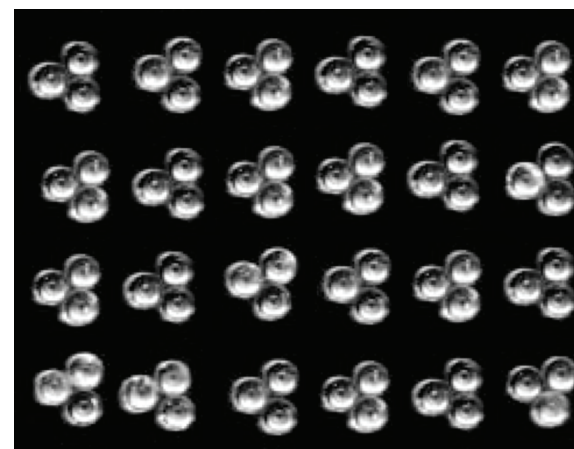
3. crop



4. remove outliers

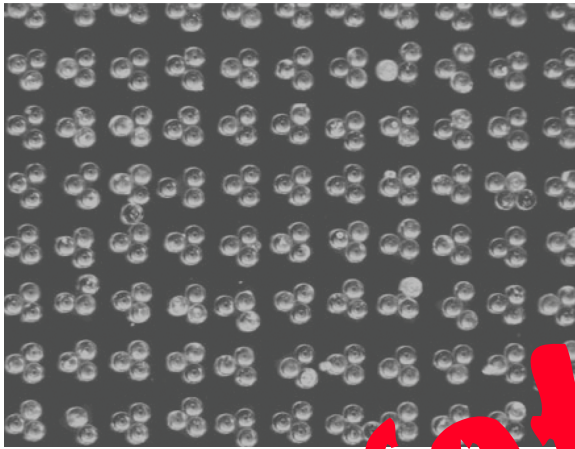


5. reconstruct



Let's try it!

original



1. adjust contrast



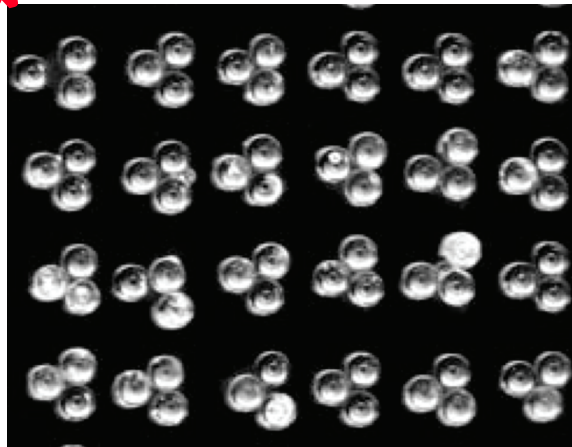
2. remove blemishes



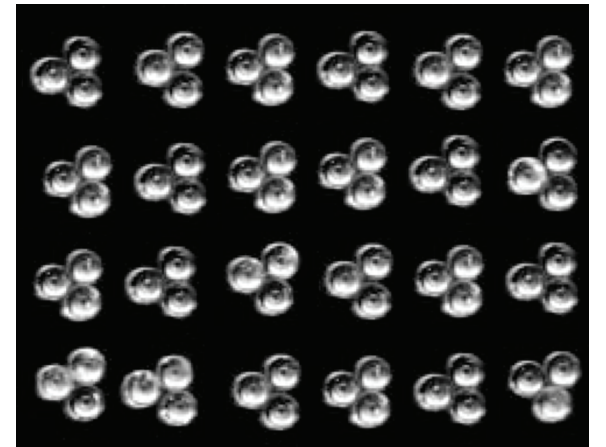
3. crop



4. remove outliers



5. reconstruct



you got all engaged!

Let's try it!

You are triaging patients in a pediatric urgent care clinic and the following patients are waiting.



Let's try it!

You are triaging patients in a pediatric urgent care clinic and the following patients are waiting.

1. 3-yr old F with a FUO and $T = 40^{\circ}\text{C}$ who is riding a tricycle in the waiting room



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You are triaging patients in a pediatric urgent care clinic and the following patients are waiting.

1. 3-yr old F with a FUO and $T = 40\text{ }^{\circ}\text{C}$ who is riding a tricycle in the waiting room
2. 6-wk old term M, cc: fussy breast, $T = 38.6\text{ }^{\circ}\text{C}$



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3. 14-yr old M with hx of epilepsy who had a seizure at home lasting 5 minutes about half hour ago



Let's try it!

You are triaging patients in a pediatric urgent care clinic and the following patients are waiting.

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3. 14-yr old M with hx of epilepsy who had a seizure at home lasting 5 minutes about half hour ago

Whom would you triage first?



Let's try it!

You are triaging patients in a pediatric urgent care clinic and the following patients are waiting.

1. 3-yr old F with a FUO and $T = 40\text{ }^{\circ}\text{C}$ who is riding a tricycle in the waiting room

2. 6-wk old term M c/o: fussy, breast, $T = 38.6\text{ }^{\circ}\text{C}$

3. 14-yr old M with hx of epilepsy who had a seizure at home lasting 5 minutes about half hour ago

Whom would you triage first?



PI & JiTT Overview

Don't need a correct answer!

PI & JiTT Overview

“Why does it work?”

PI & JiTT Overview

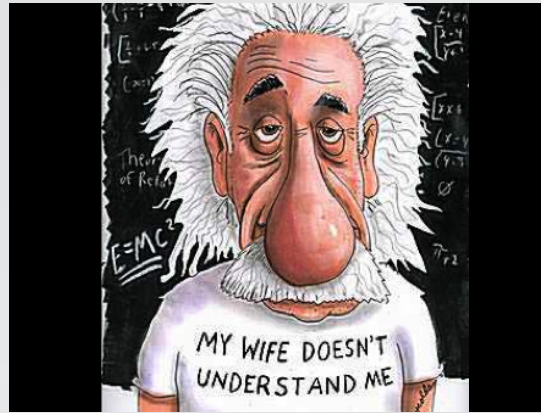
discussion or more time to think?

PI & JiTT Overview

compare three activities



question



distract



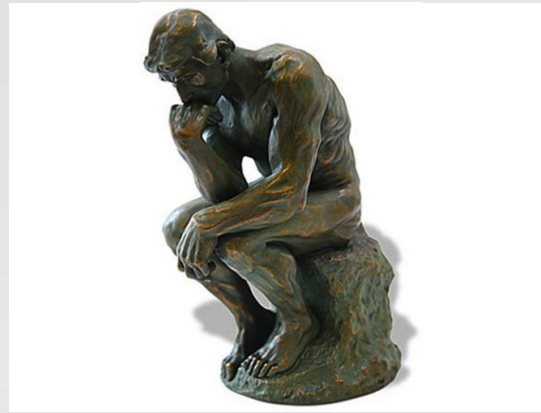
question

PI & JiTT Overview

compare three activities



question



reflect



question

PI & JiTT Overview

compare three activities



question



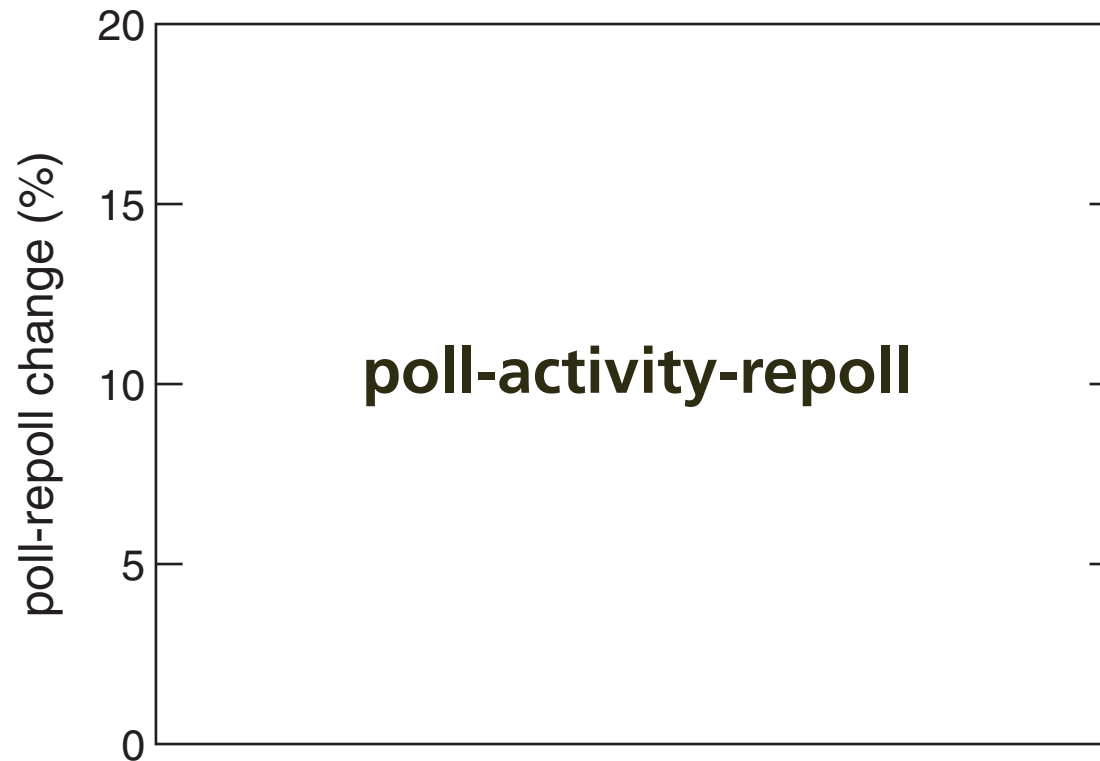
discuss



question

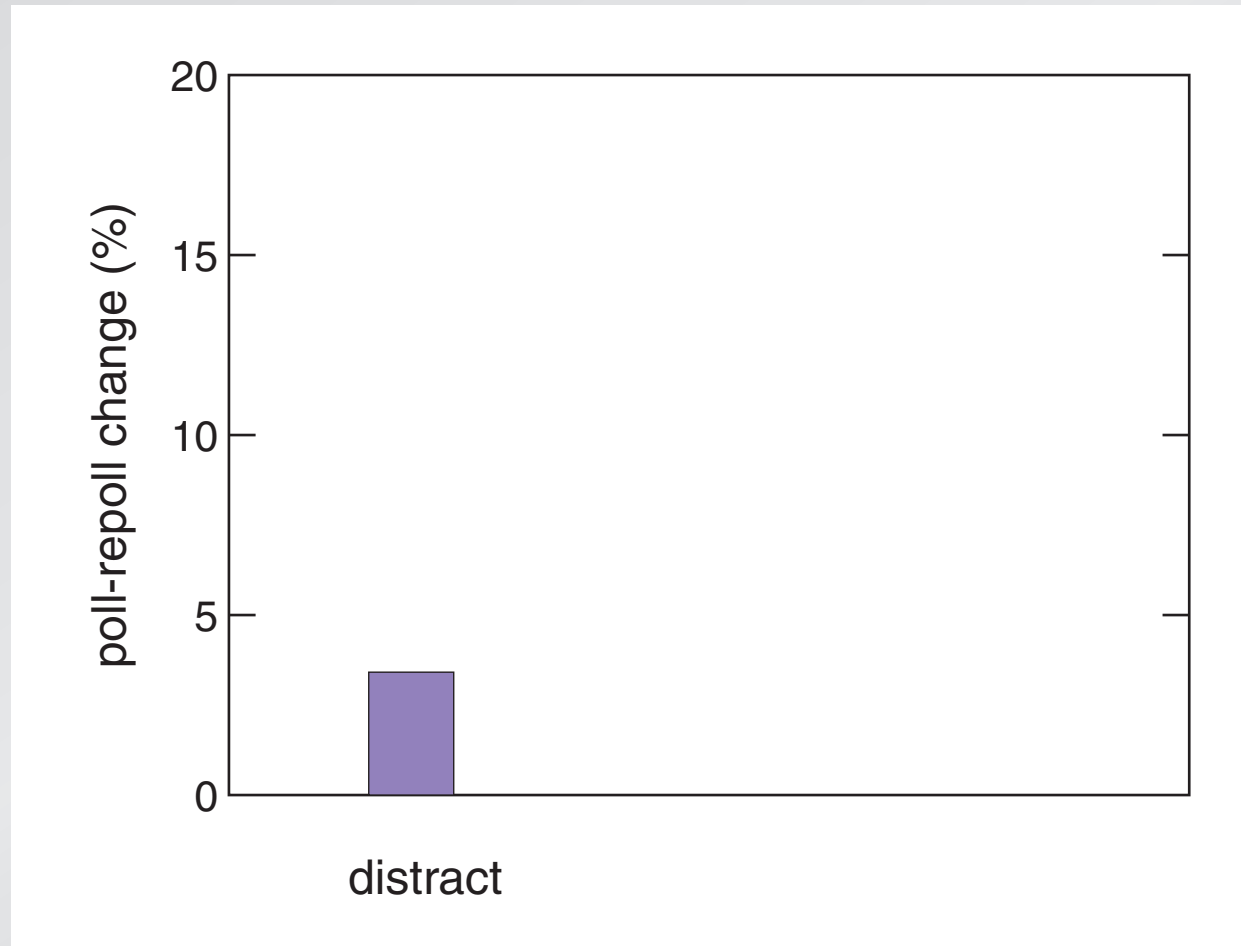
PI & JiTT Overview

the importance of discussion



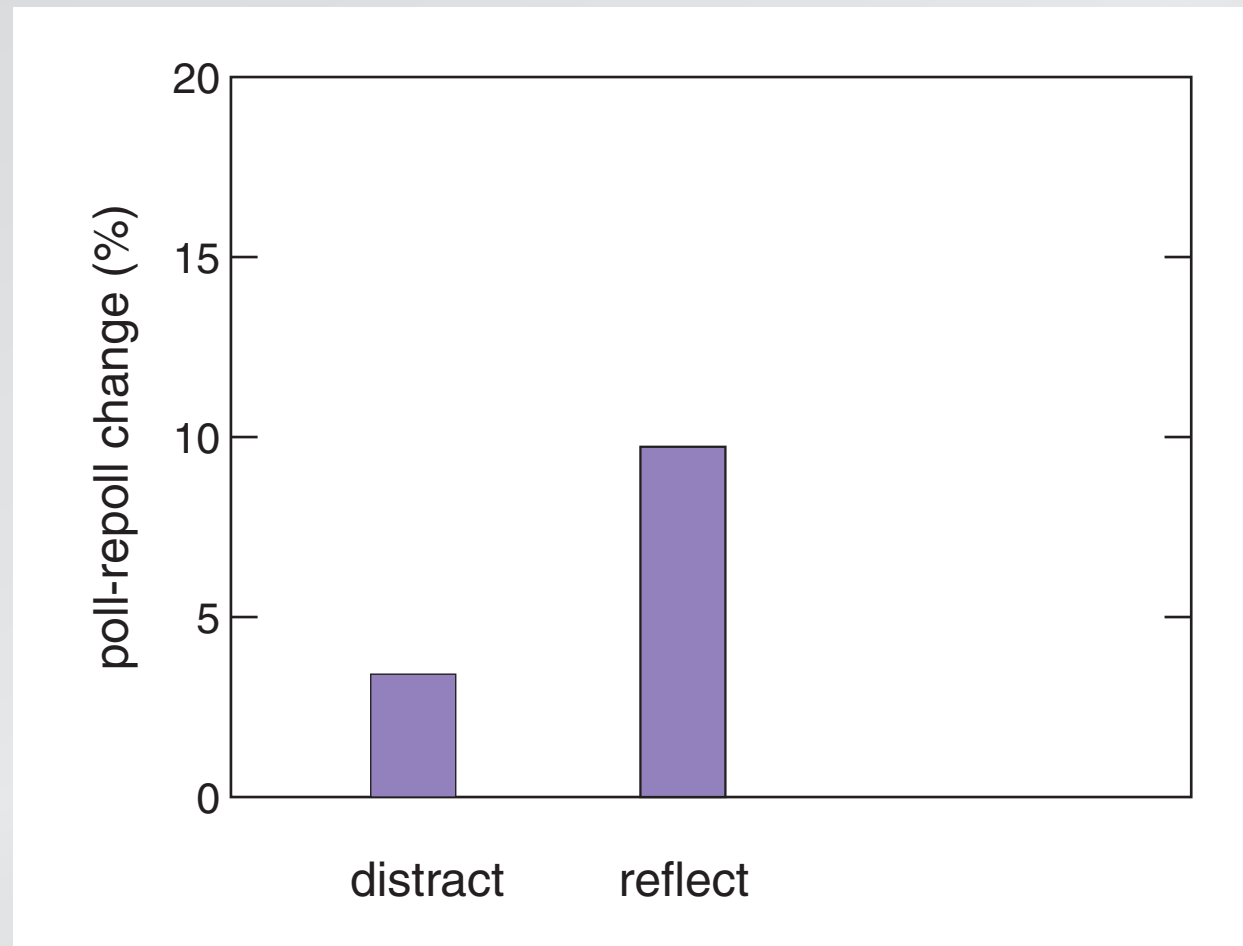
PI & JiTT Overview

the importance of discussion



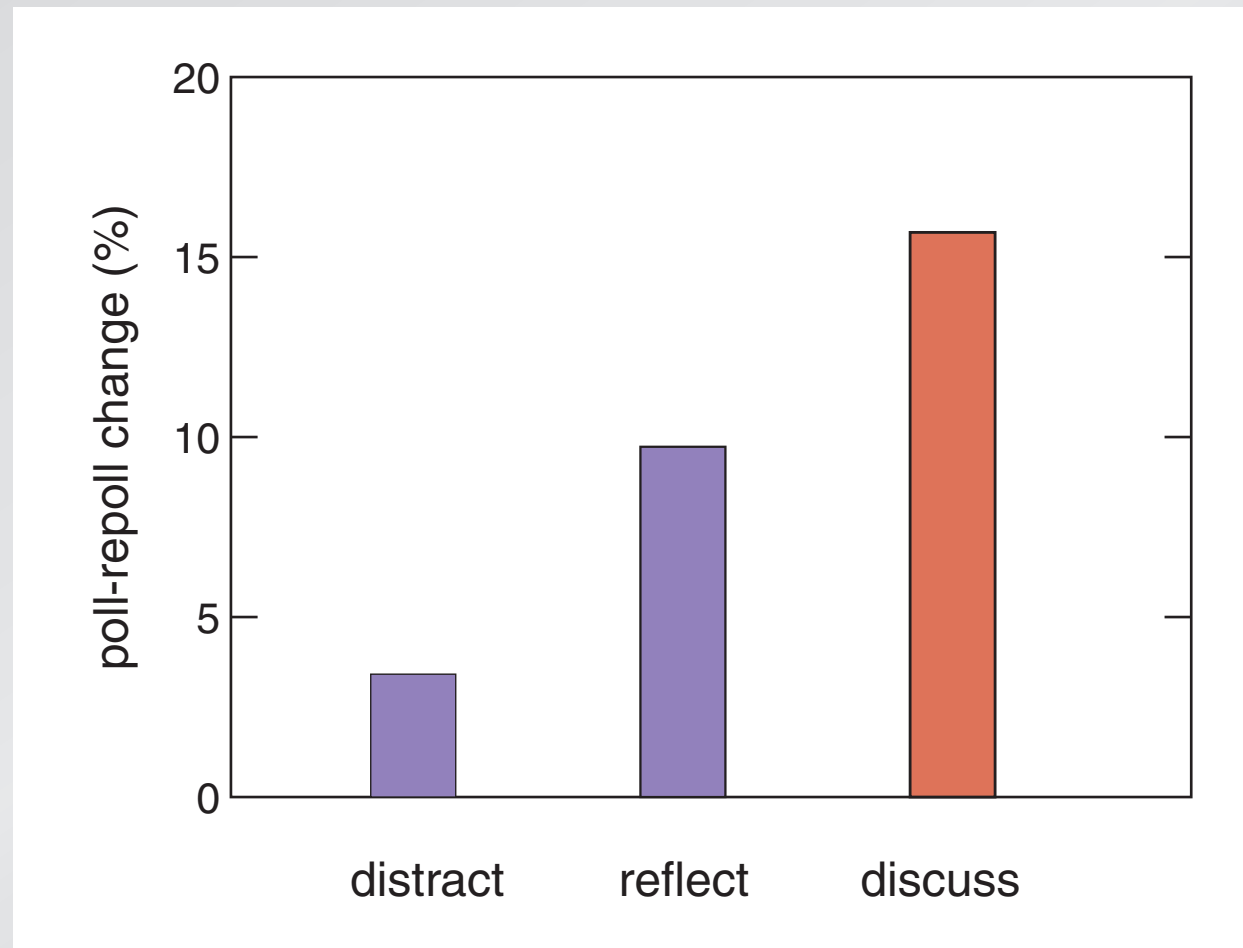
PI & JiTT Overview

the importance of discussion



PI & JiTT Overview

the importance of discussion



Outline

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

Implementing PI & JiTT

“Will it work at my institution?”

It works here...

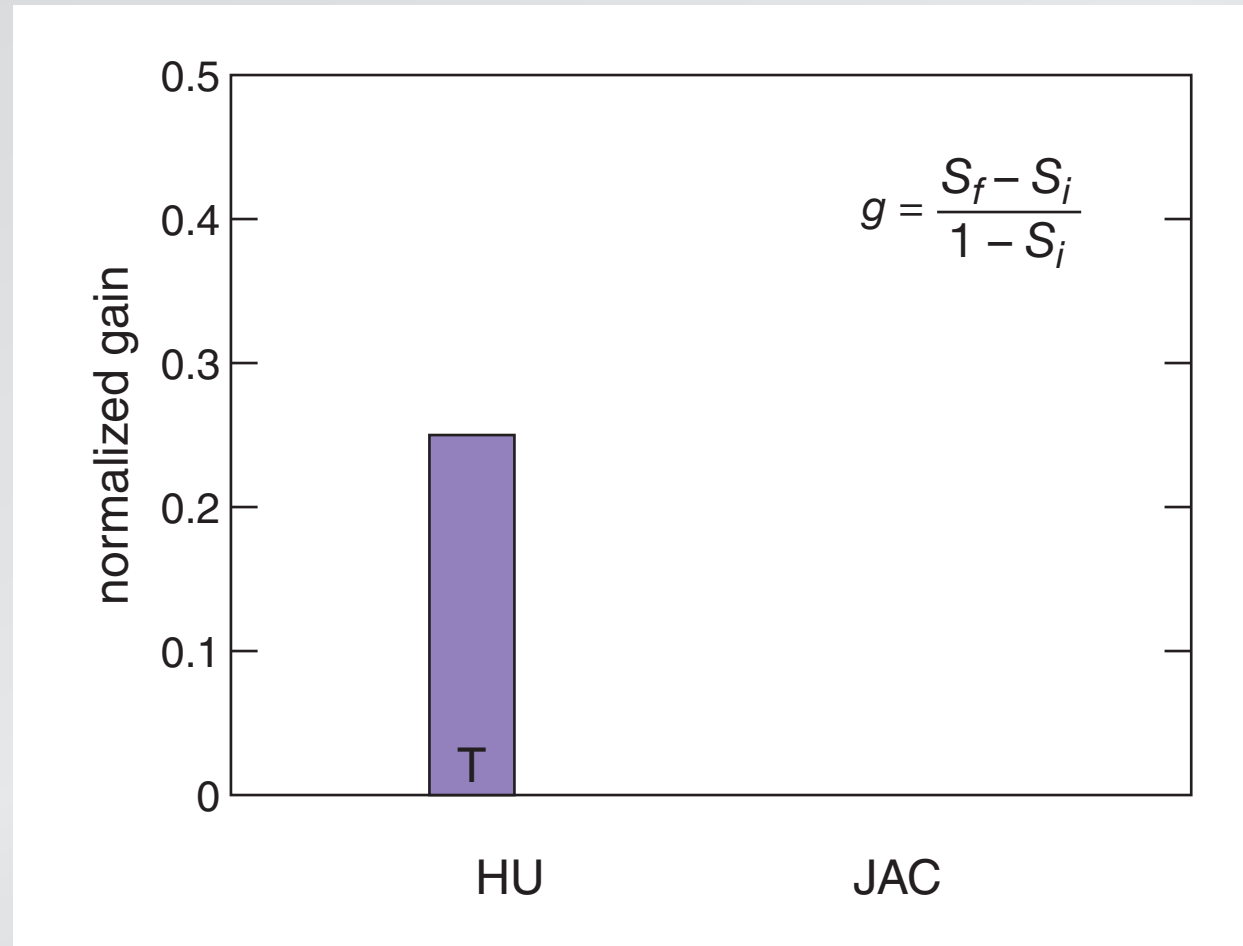


...but will it work here?



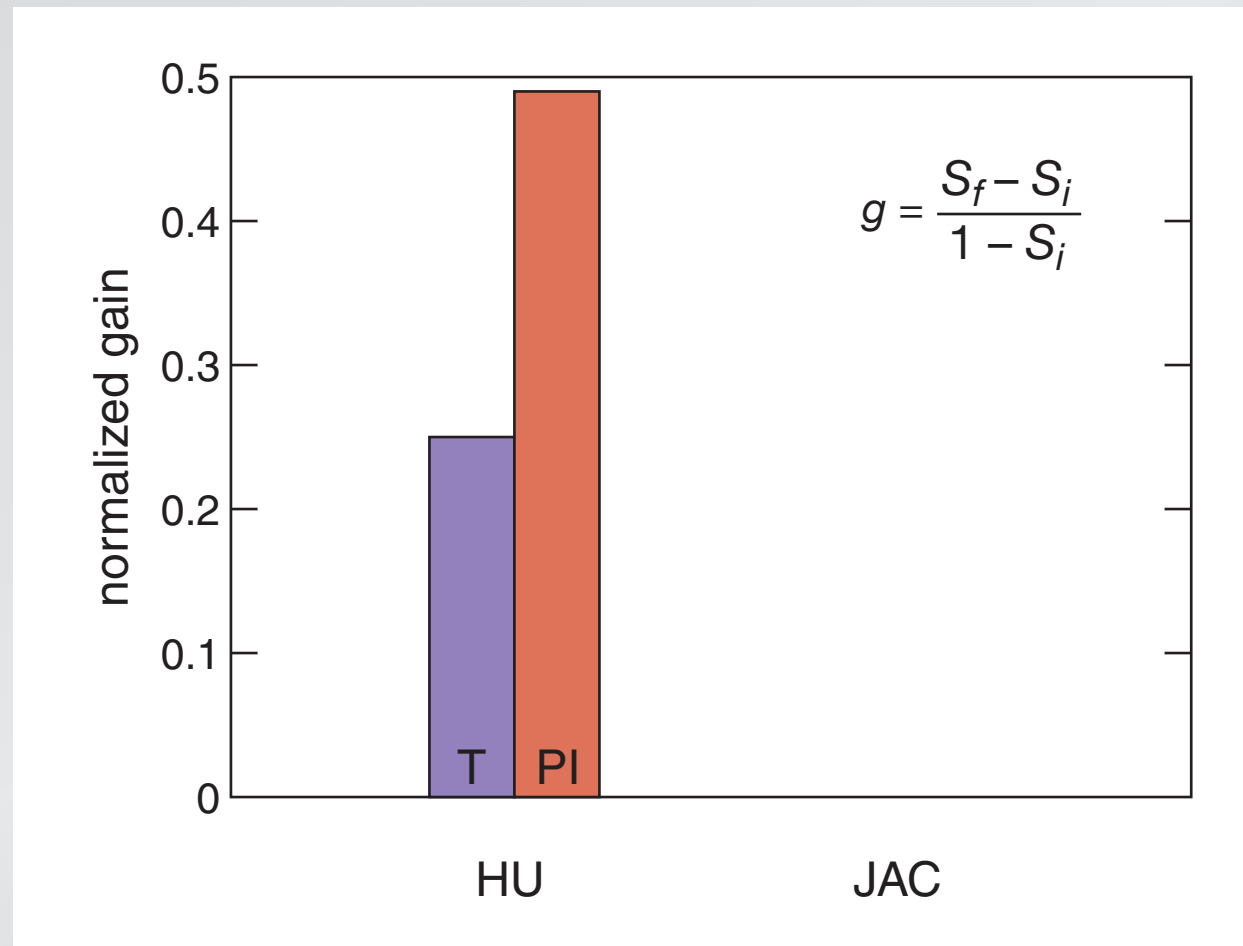
Implementing PI & JiTT

FCI normalized gain



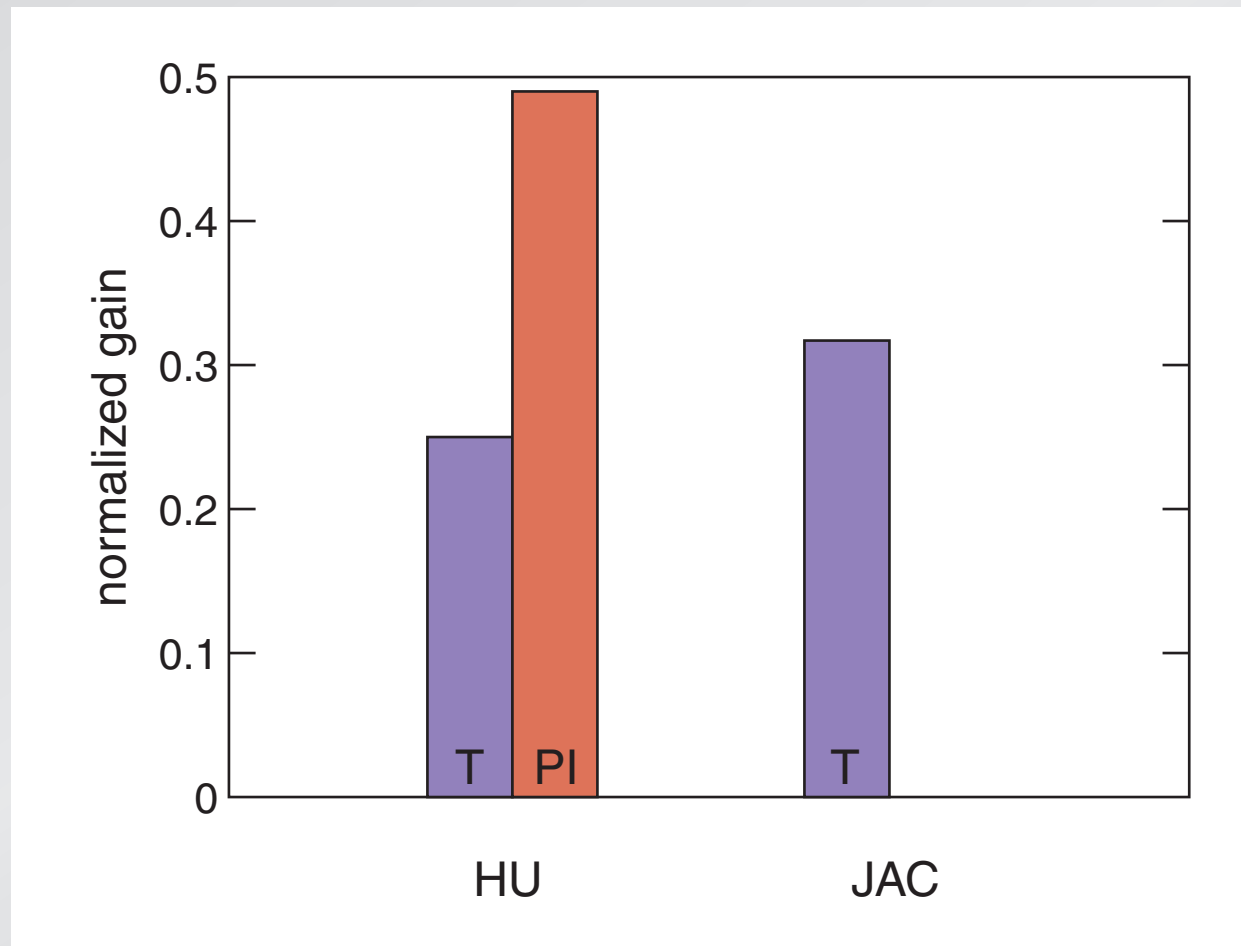
Implementing PI & JiTT

FCI normalized gain



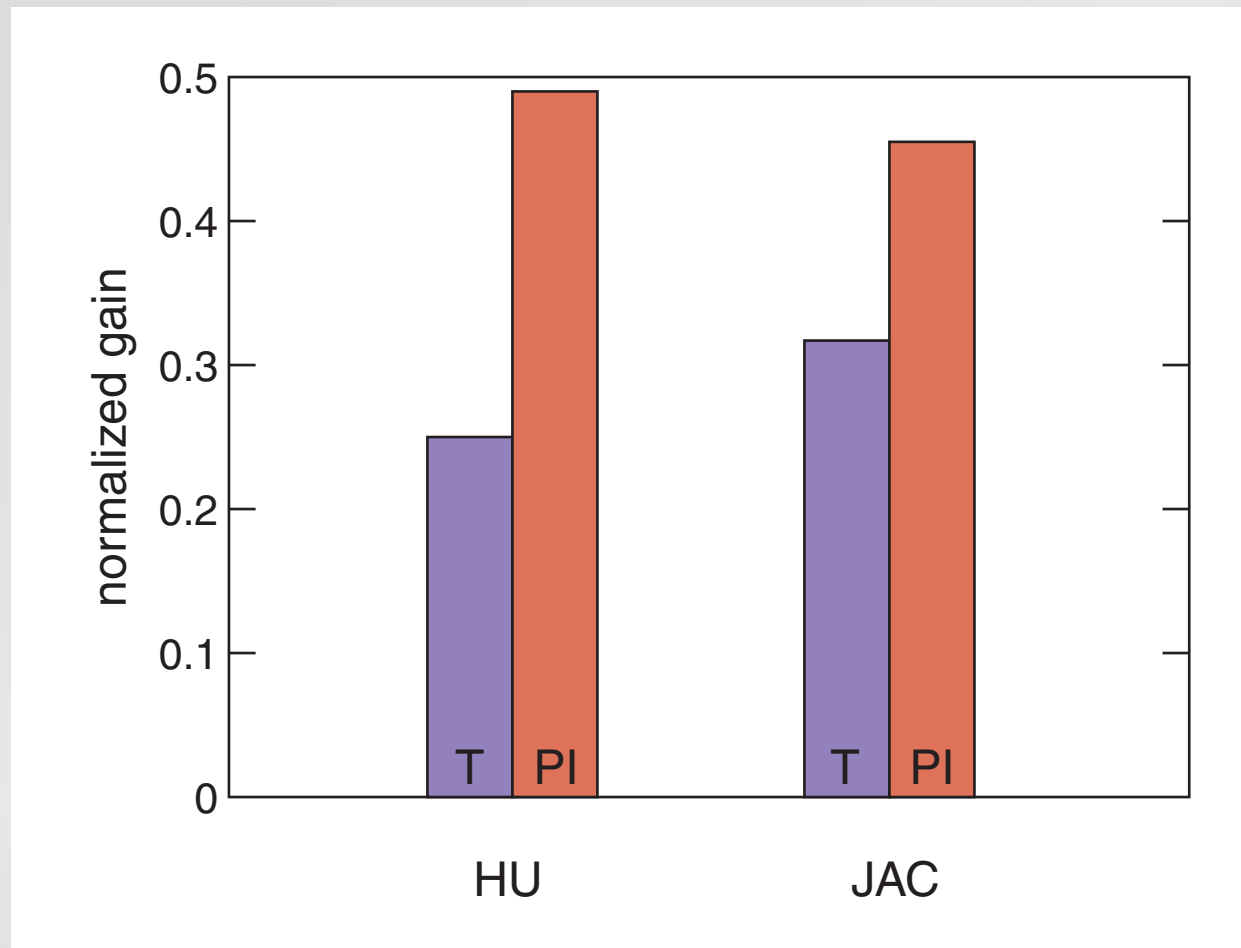
Implementing PI & JiTT

FCI normalized gain



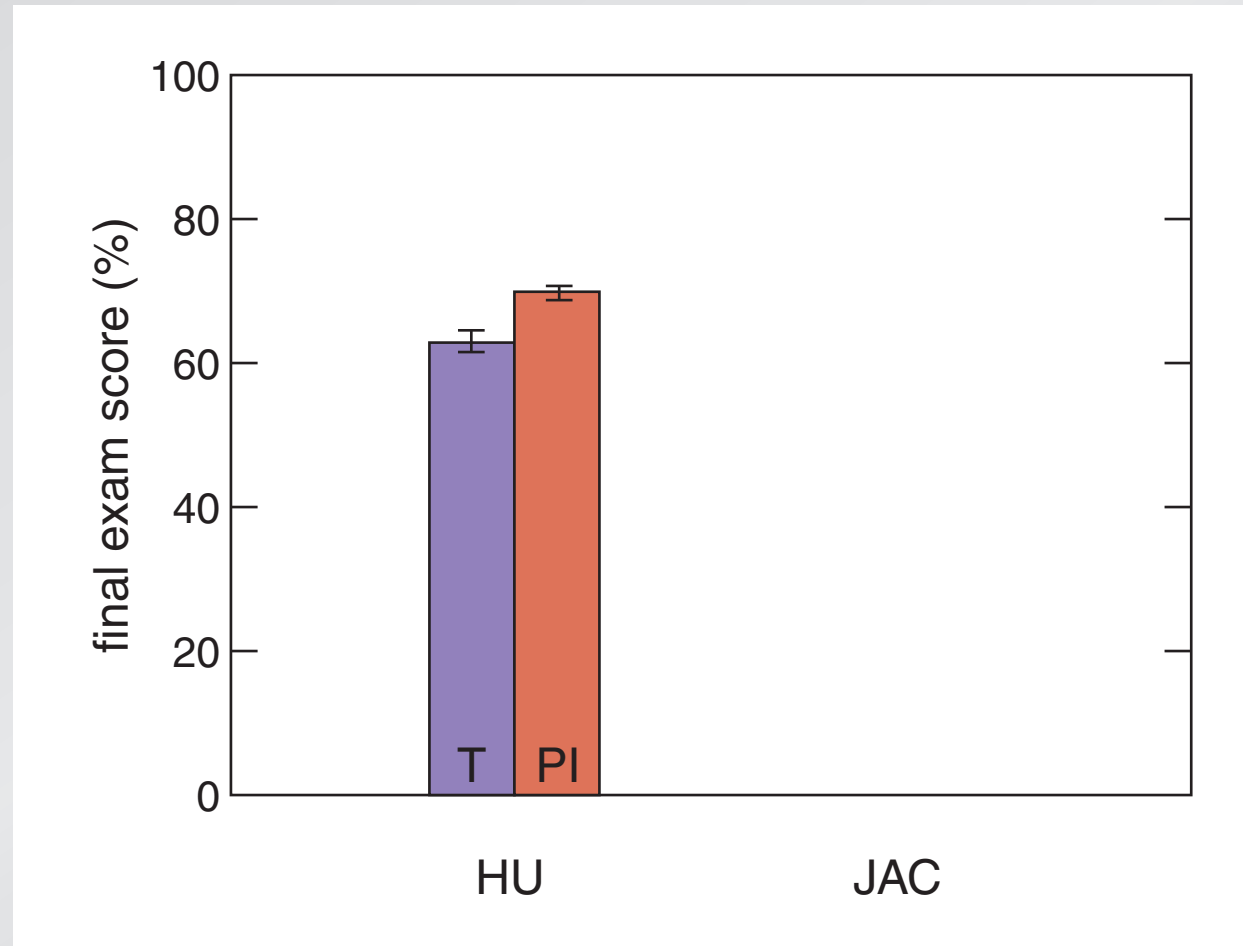
Implementing PI & JiTT

FCI normalized gain



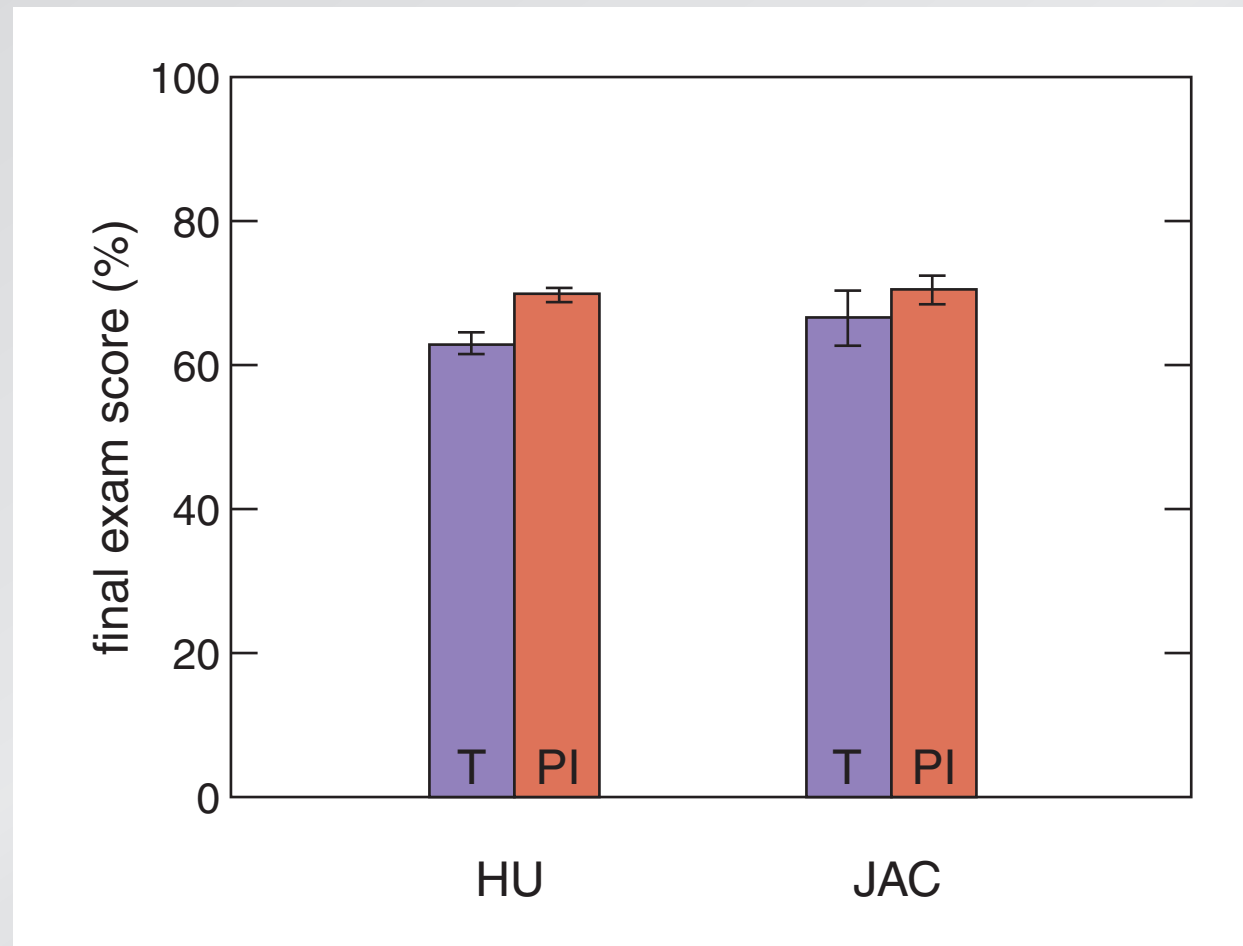
Implementing PI & JiTT

exam performance



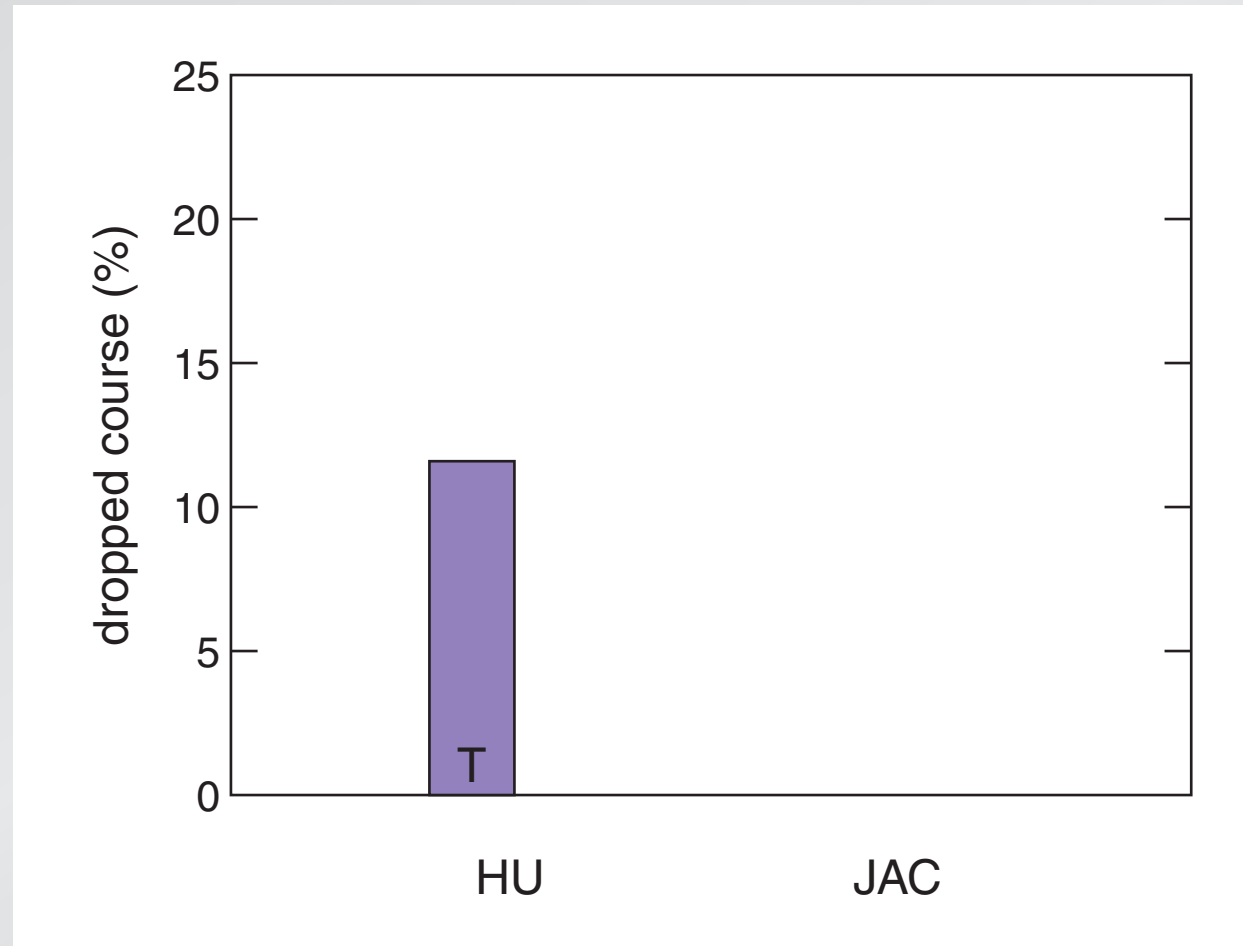
Implementing PI & JiTT

exam performance



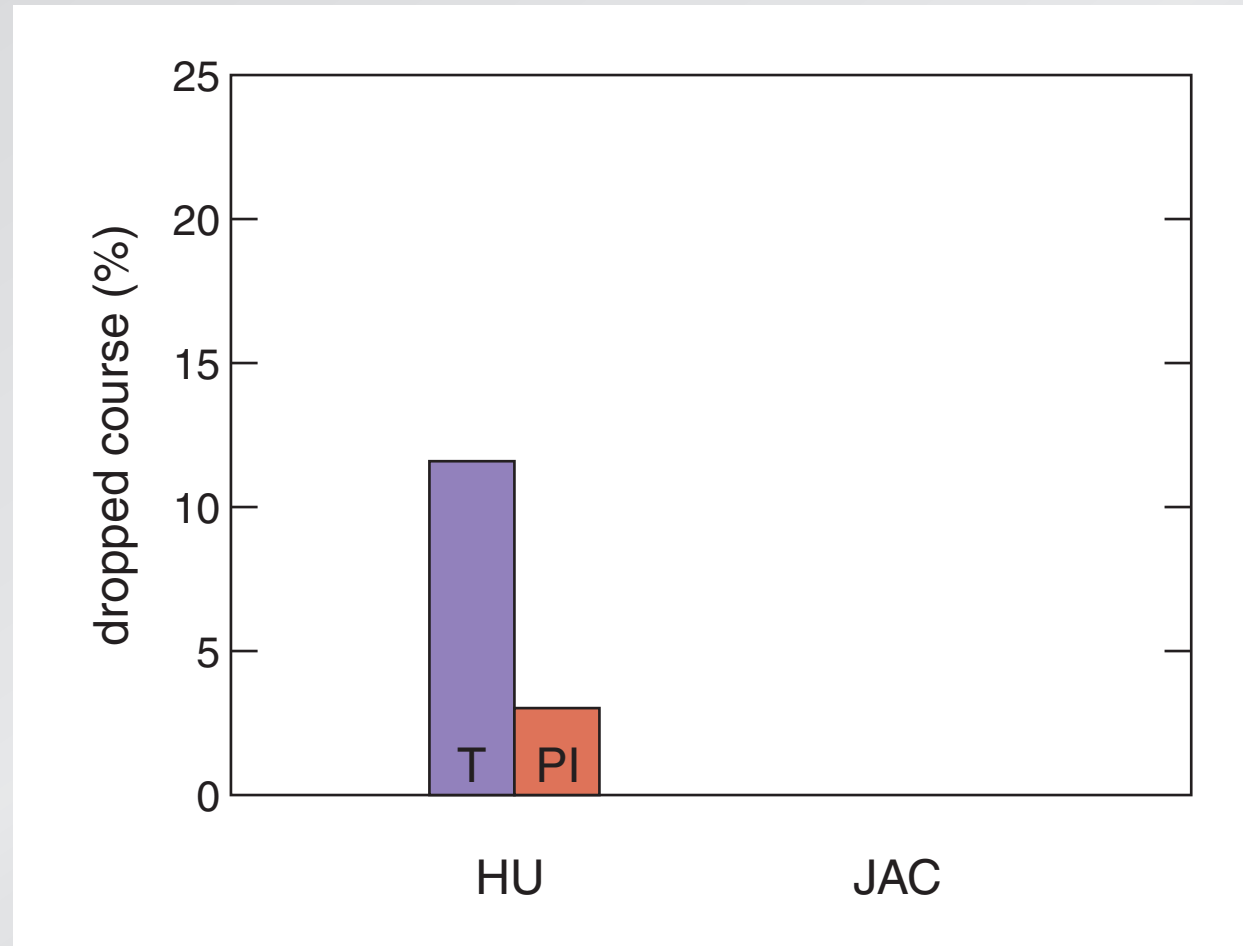
Implementing PI & JiTT

student retention



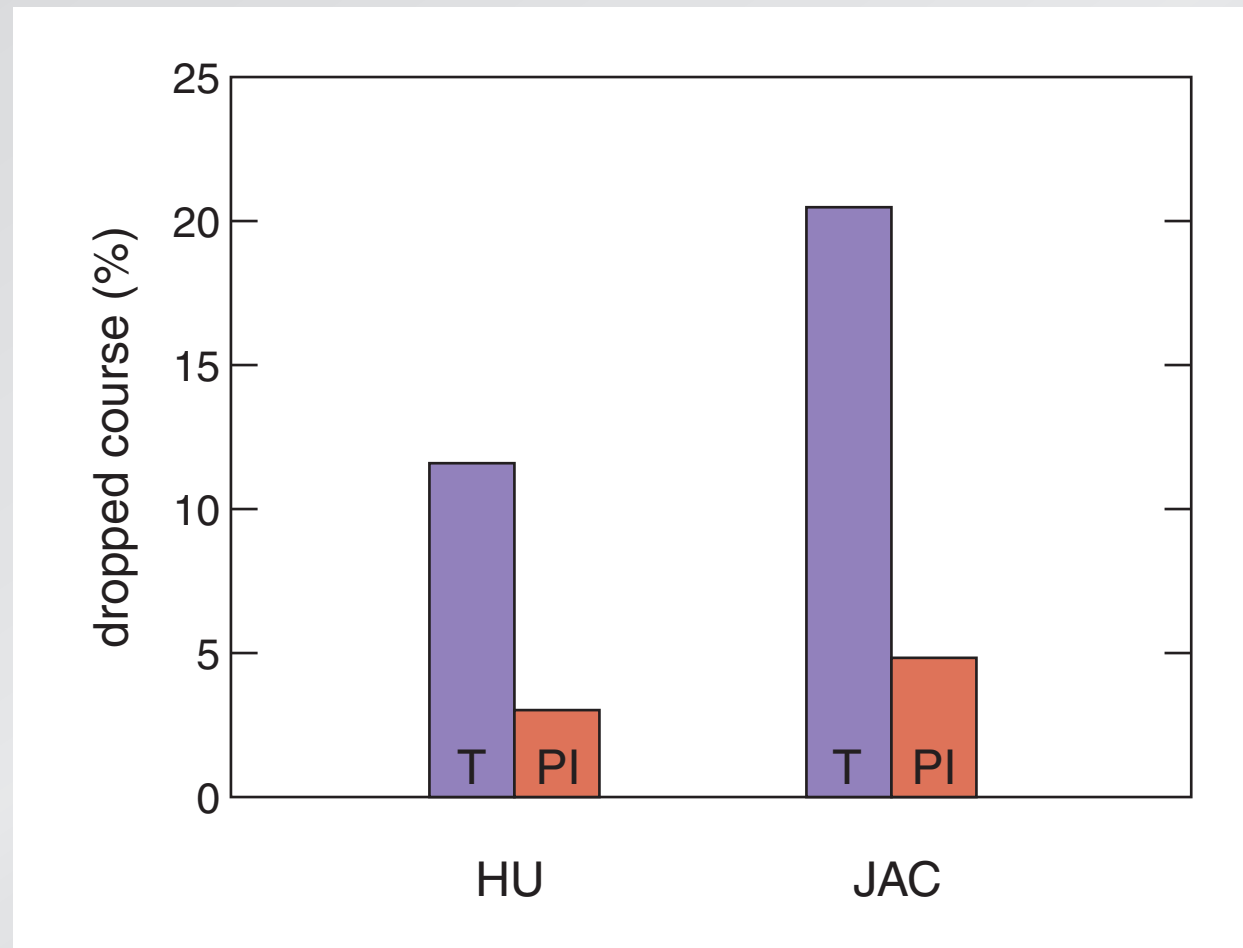
Implementing PI & JiTT

student retention



Implementing PI & JiTT

student retention



Implementing PI & JiTT

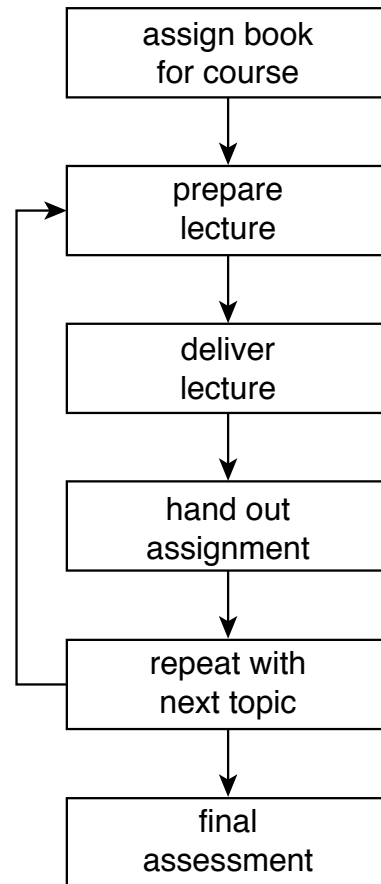
similar learning gains in different environments

Implementing PI & JiTT

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

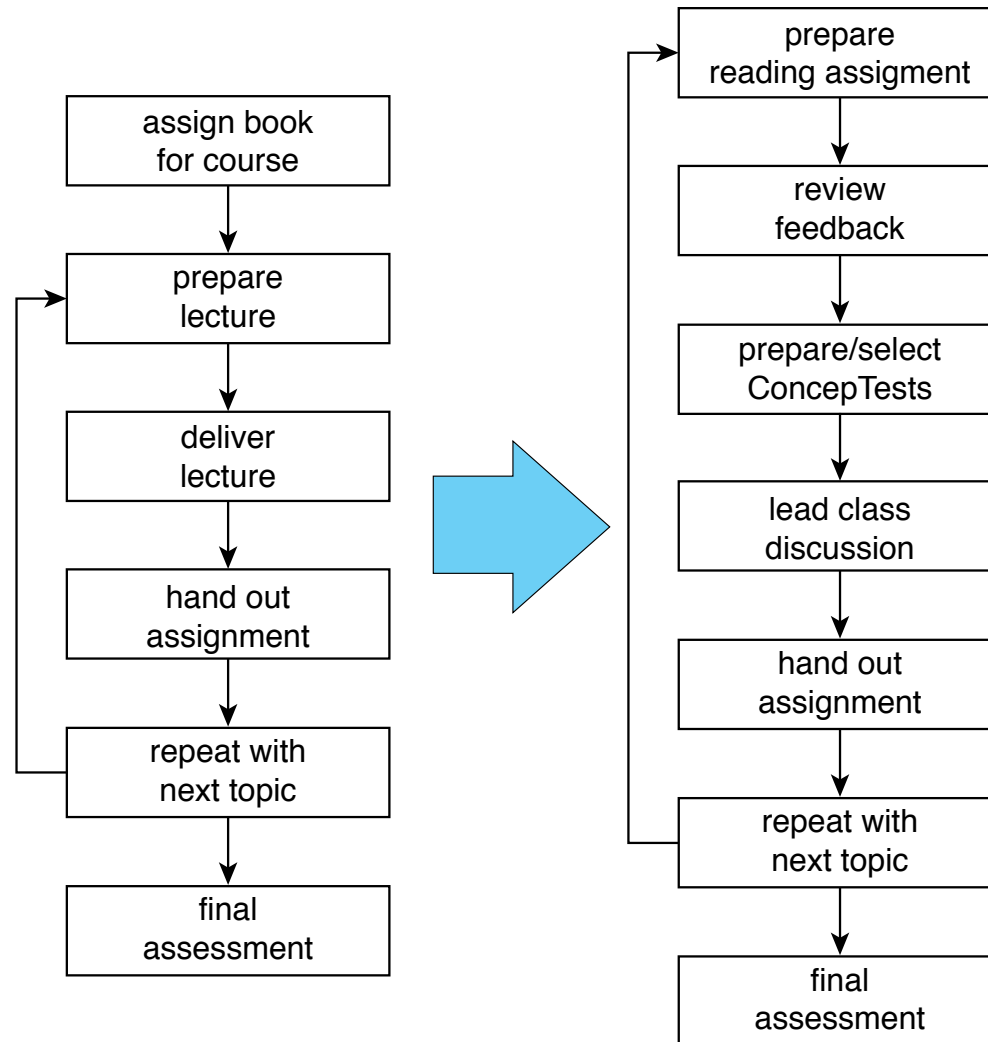
Implementing PI & JiTT

preparing for a lecture-based class



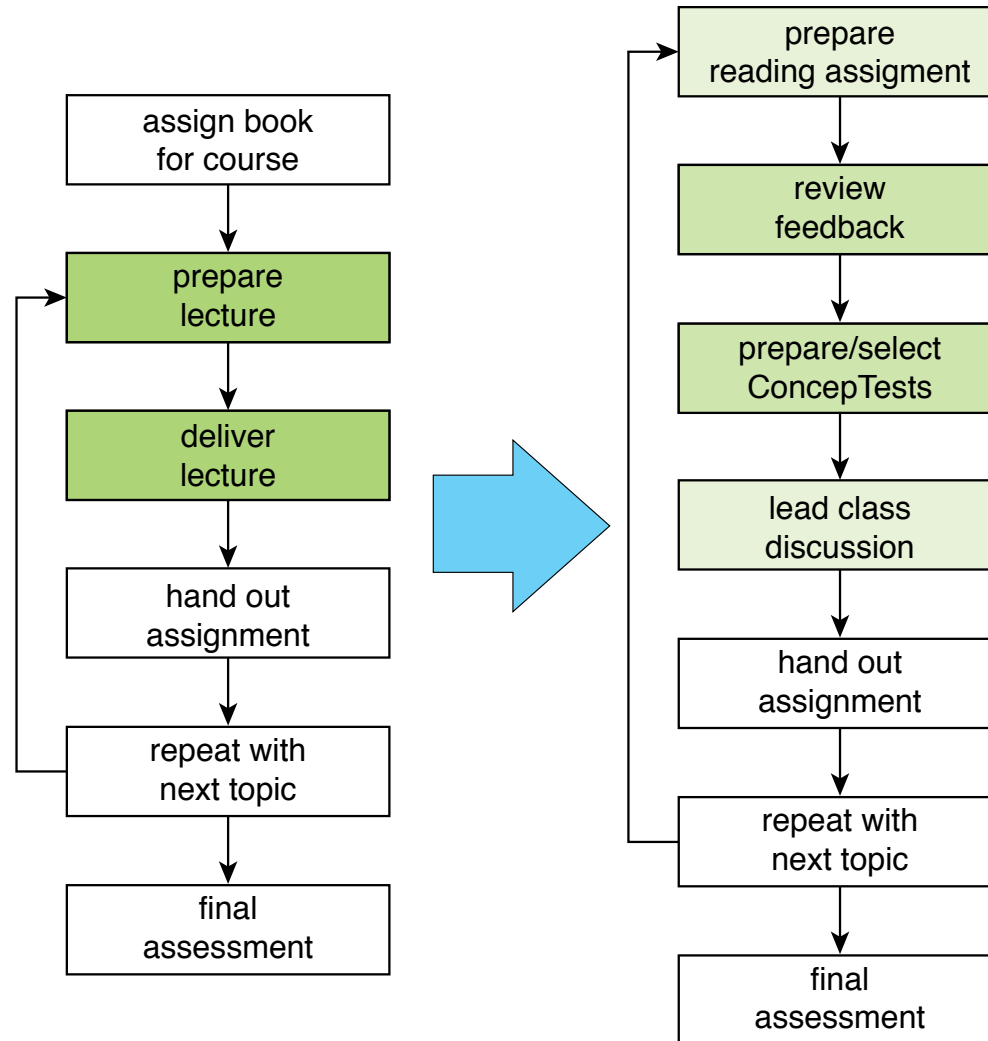
Implementing PI & JiTT

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

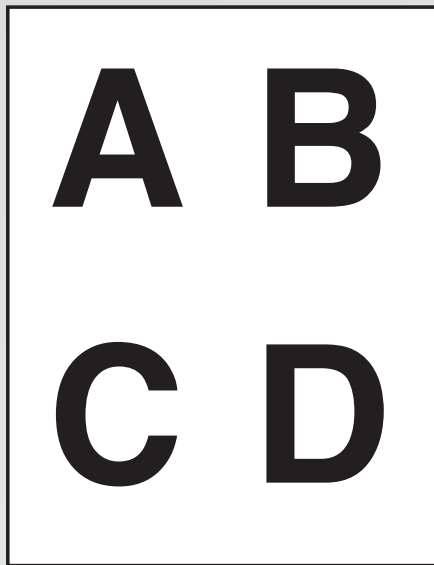
what good is coverage if little is retained?

Implementing PI & JiTT

“Do I need clickers?”

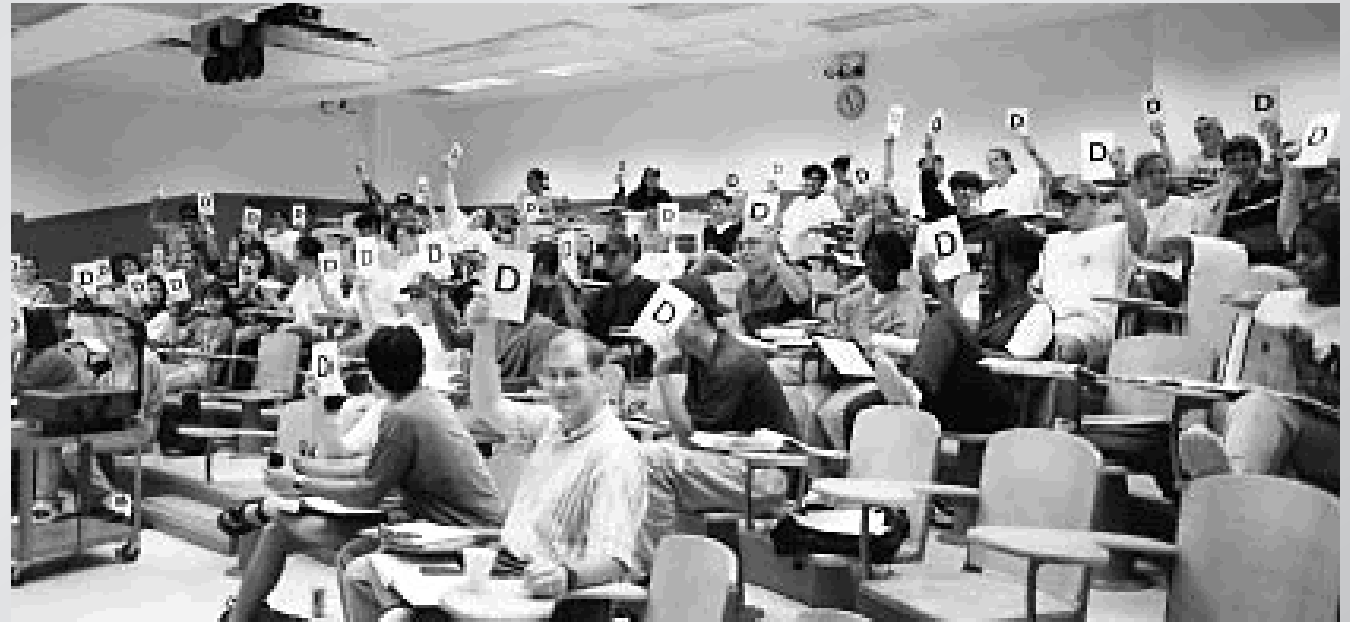
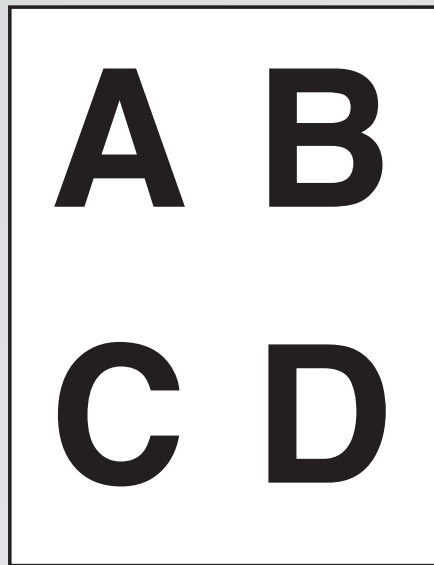
Implementing PI & JiTT

Flashcards: simple and effective



Implementing PI & JiTT

Flashcards: simple and effective



Meltzer and Mannivanan, South Eastern Louisiana University

Let's try it!

circumference

Let's try it!

circumference

of a circle of radius R is $2\pi R$

Let's try it!

Imagine a rope that fits snugly along the equator.



Let's try it!

Imagine a rope that fits snugly along the equator.

Suppose the rope is cut and 1 m of rope is inserted between the cut ends. If the rope were to maintain a circular shape, how far off the surface of the Earth would it float?



Let's try it!

Imagine a rope that fits snugly along the equator.

Suppose the rope is cut and 1 m of rope is inserted between the cut ends. If the rope were to maintain a circular shape, how far off the surface of the Earth would it float?



1. the width of a few atoms
2. the width of a few hairs
3. about 0.15 m
4. exactly 1 m
5. more than 1 m



Let's try it!

Imagine a rope that fits snugly along the equator.

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2. the width of a few hairs
3. about 0.15 m
4. exactly 1 m
5. more than 1 m



you got all fired up!

without clickers

Let's try it!

Imagine a rope that fits snugly along the equator.

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1. the width of a few atoms
2. the width of a few hairs
3. about 0.15 m ✓
4. exactly 1 m
5. more than 1 m



Let's try it!

circumference at the equator:

$$2\pi R_E$$

Let's try it!

circumference at the equator:

$$2\pi R_E$$

new circumference:

$$2\pi R_E + 1 \text{ m}$$

Let's try it!

circumference at the equator:

$$2\pi R_E$$

new circumference:

$$2\pi R_E + 1 \text{ m}$$

radius of circle with new circumference:

$$2\pi R = 2\pi R_E + 1 \text{ m}, \quad \text{and so} \quad R = R_E + \frac{1 \text{ m}}{2\pi}.$$

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!

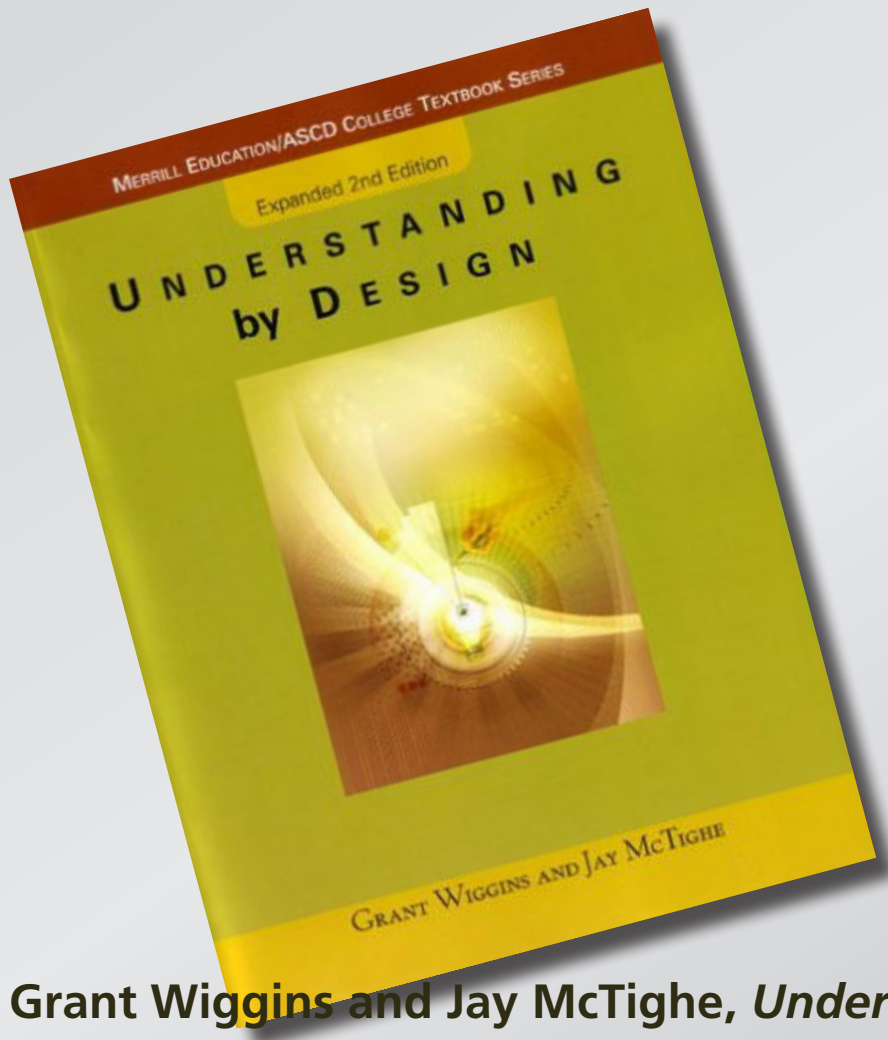
(but clickers do offer advantages)

Implementing PI & JiTT

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

Implementing PI & JiTT

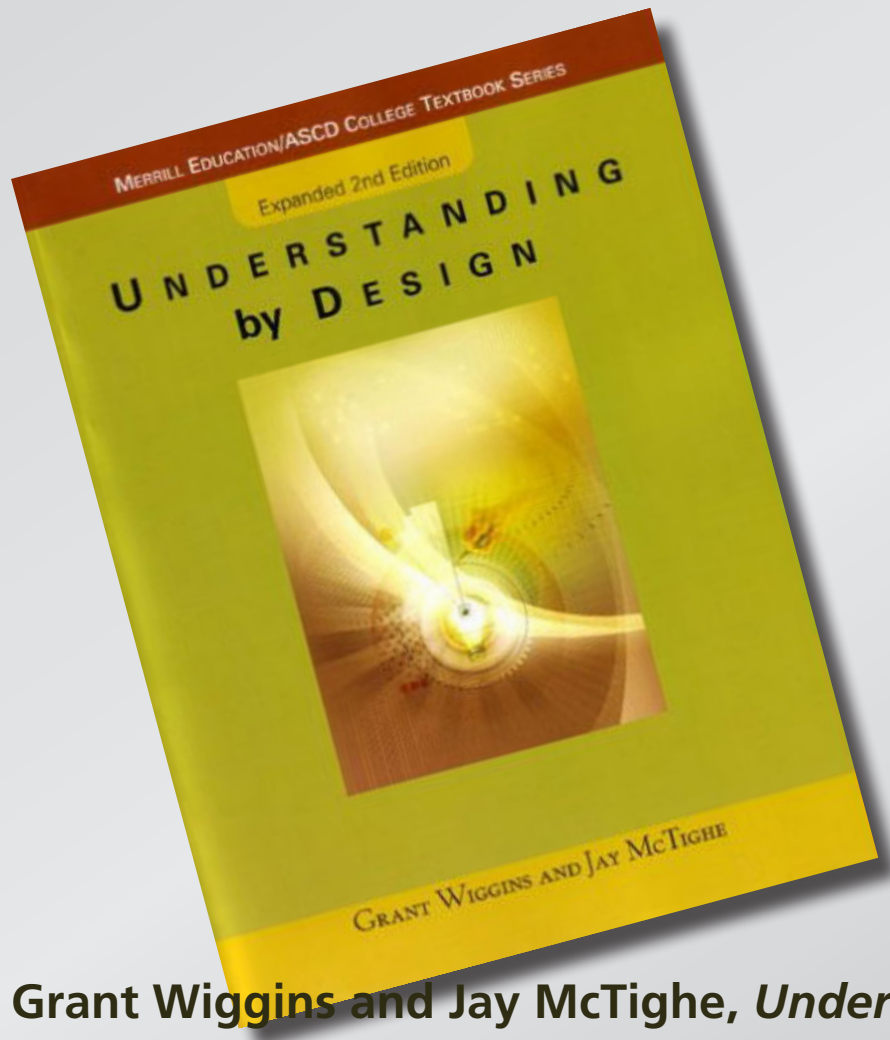
Begin by setting learning goals



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

Implementing PI & JiTT

Begin by setting learning goals

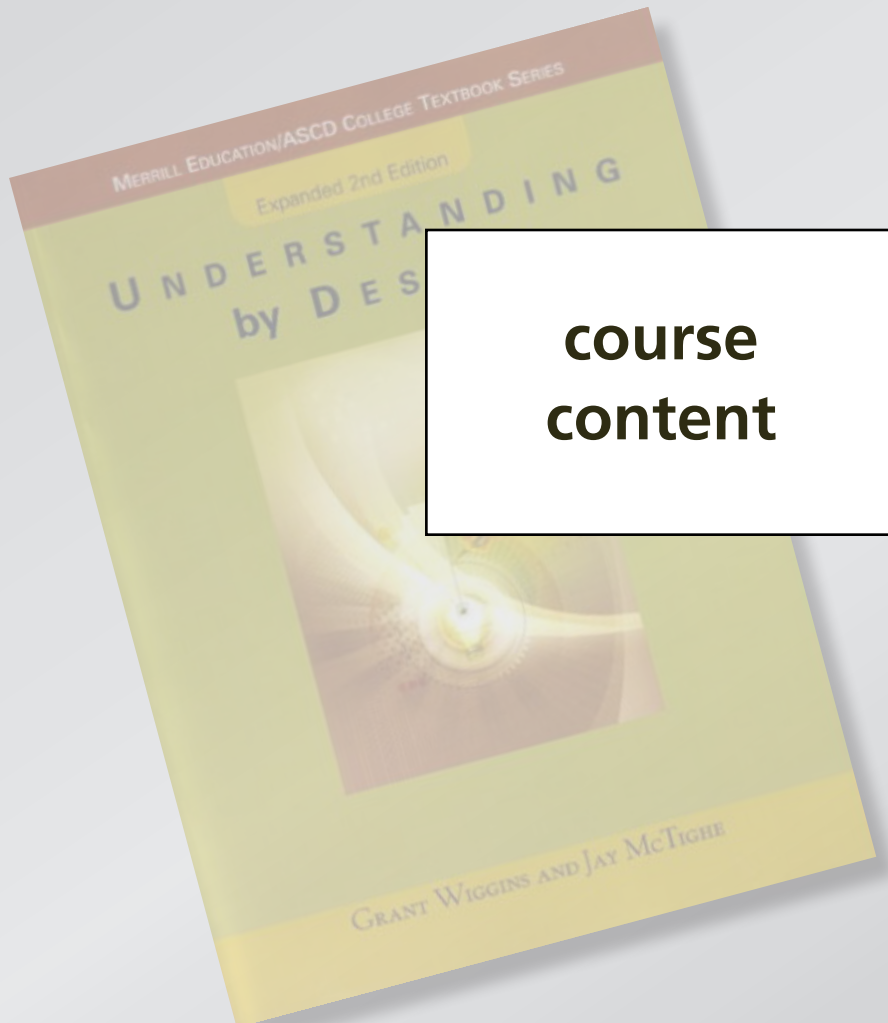


- approach, not content
- focus on understanding
- backward design

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

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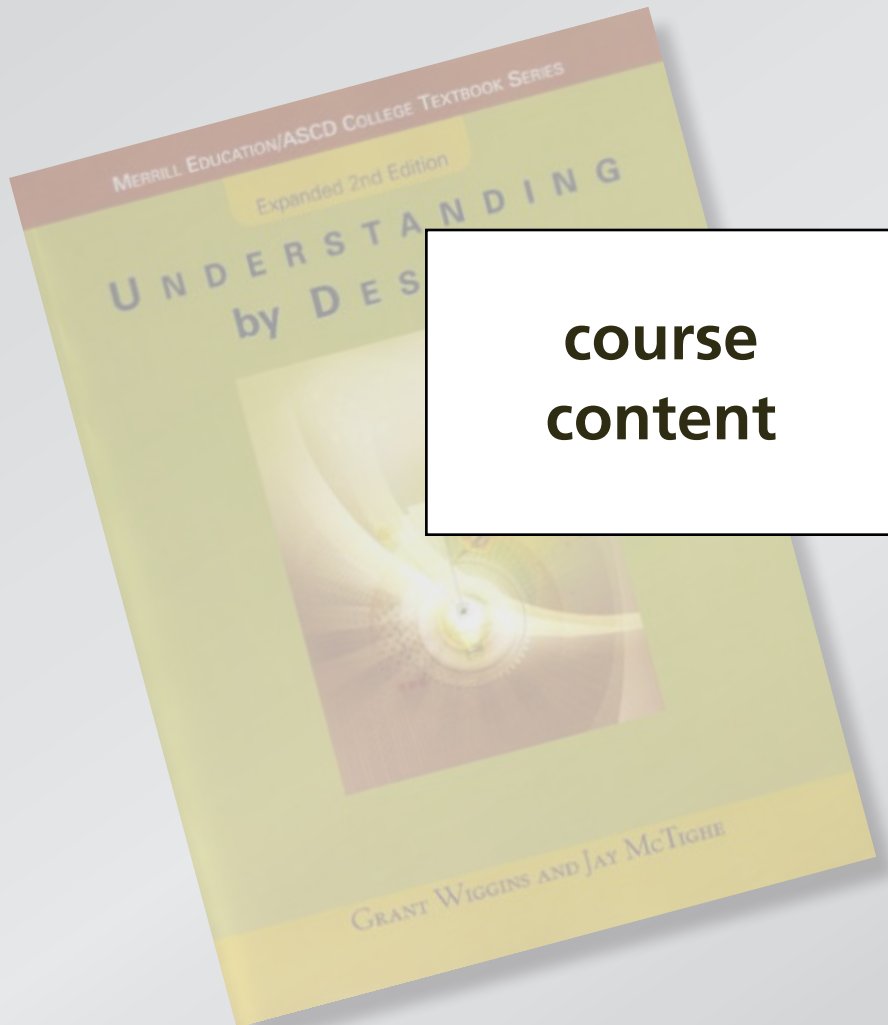
Traditional approach to course planning



**course
content**

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Traditional approach to course planning



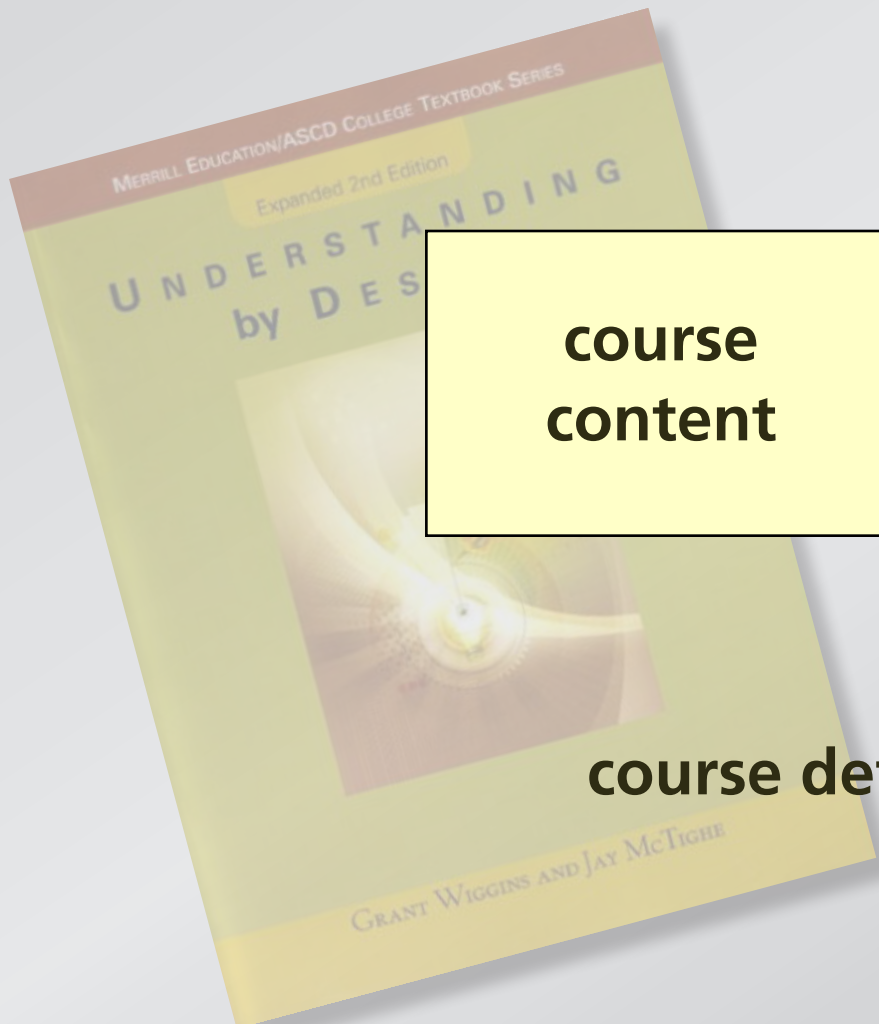
**course
content**



assessment

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Traditional approach to course planning



**course
content**

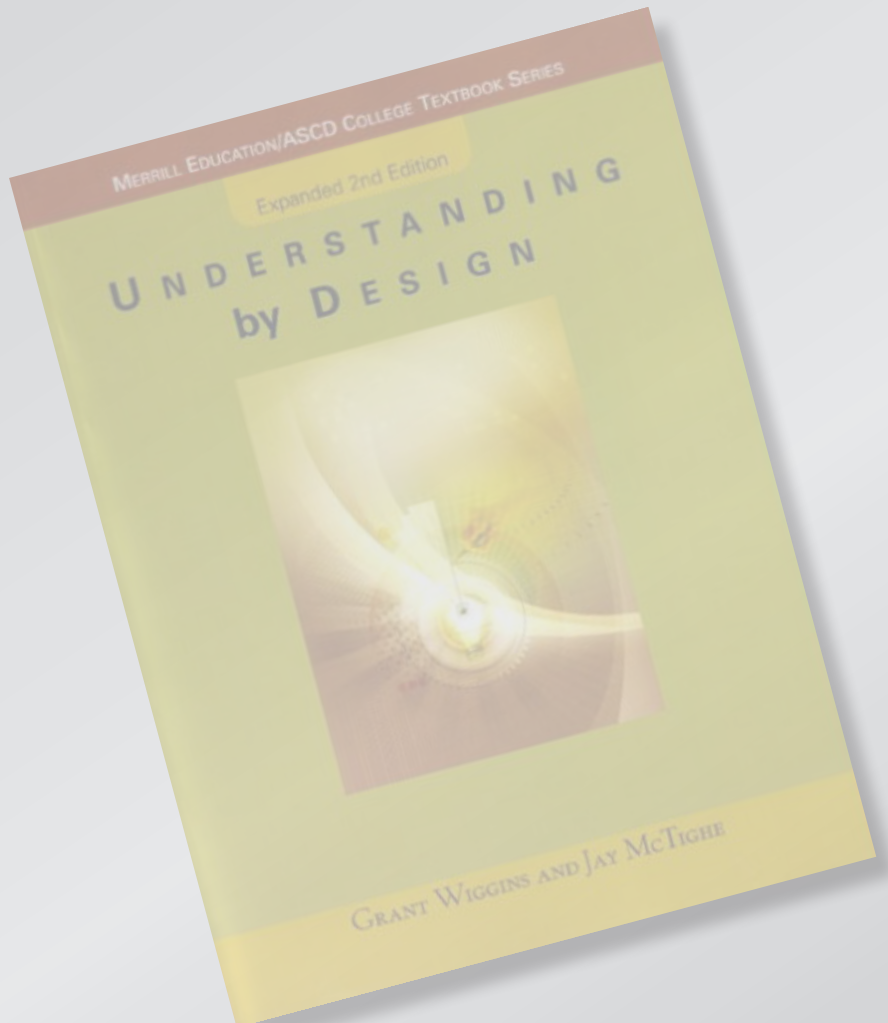


assessment

course defined by content

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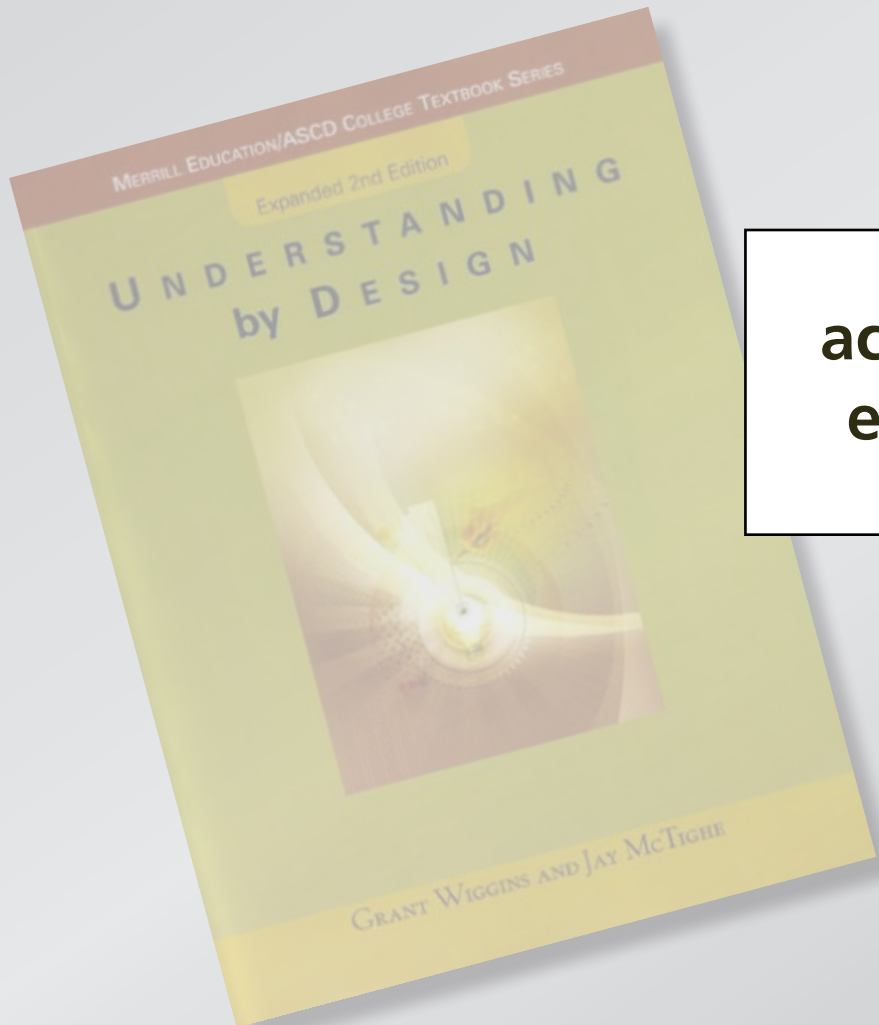
Backward design



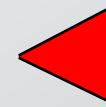
**desired
outcomes**

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Backward design



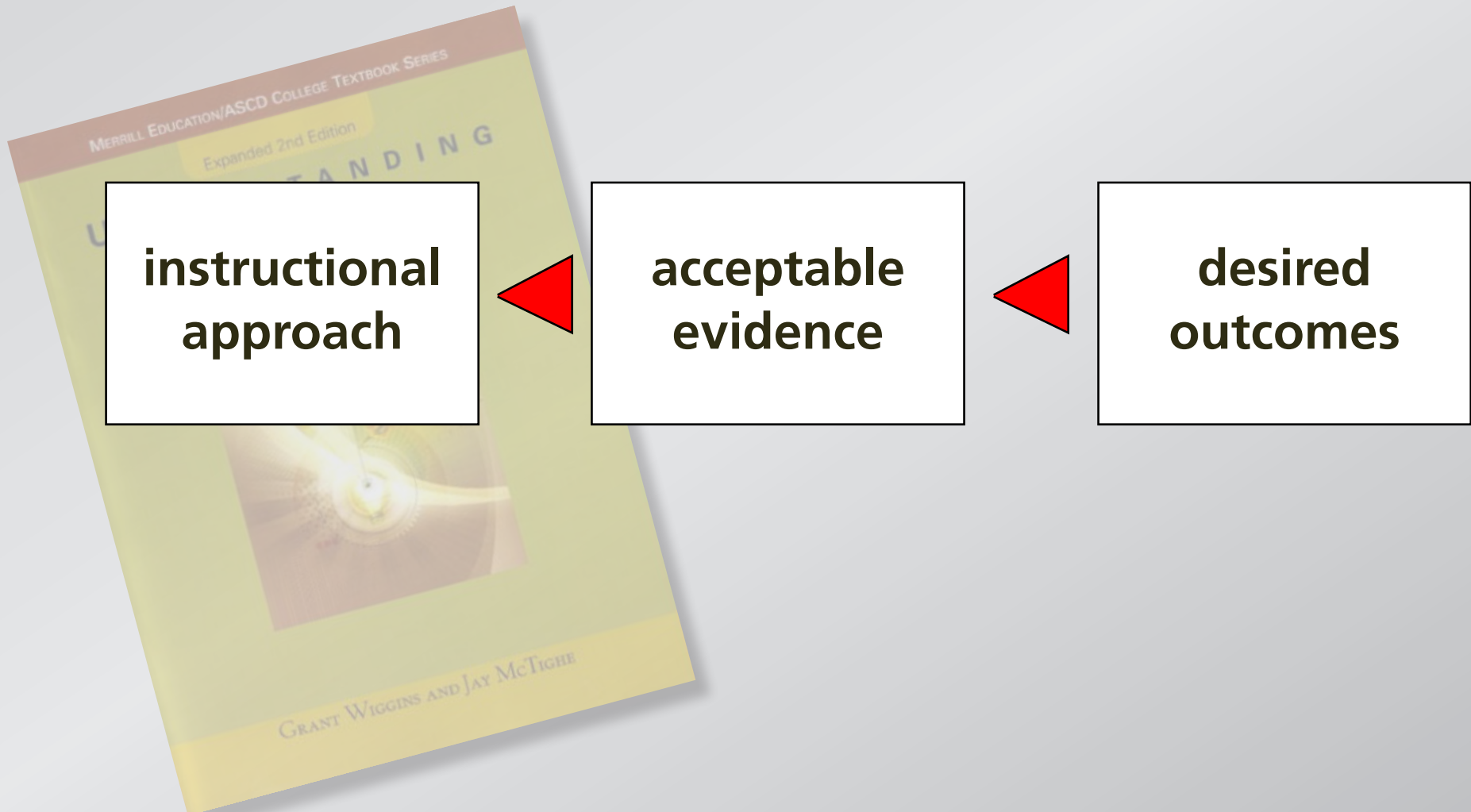
**acceptable
evidence**



**desired
outcomes**

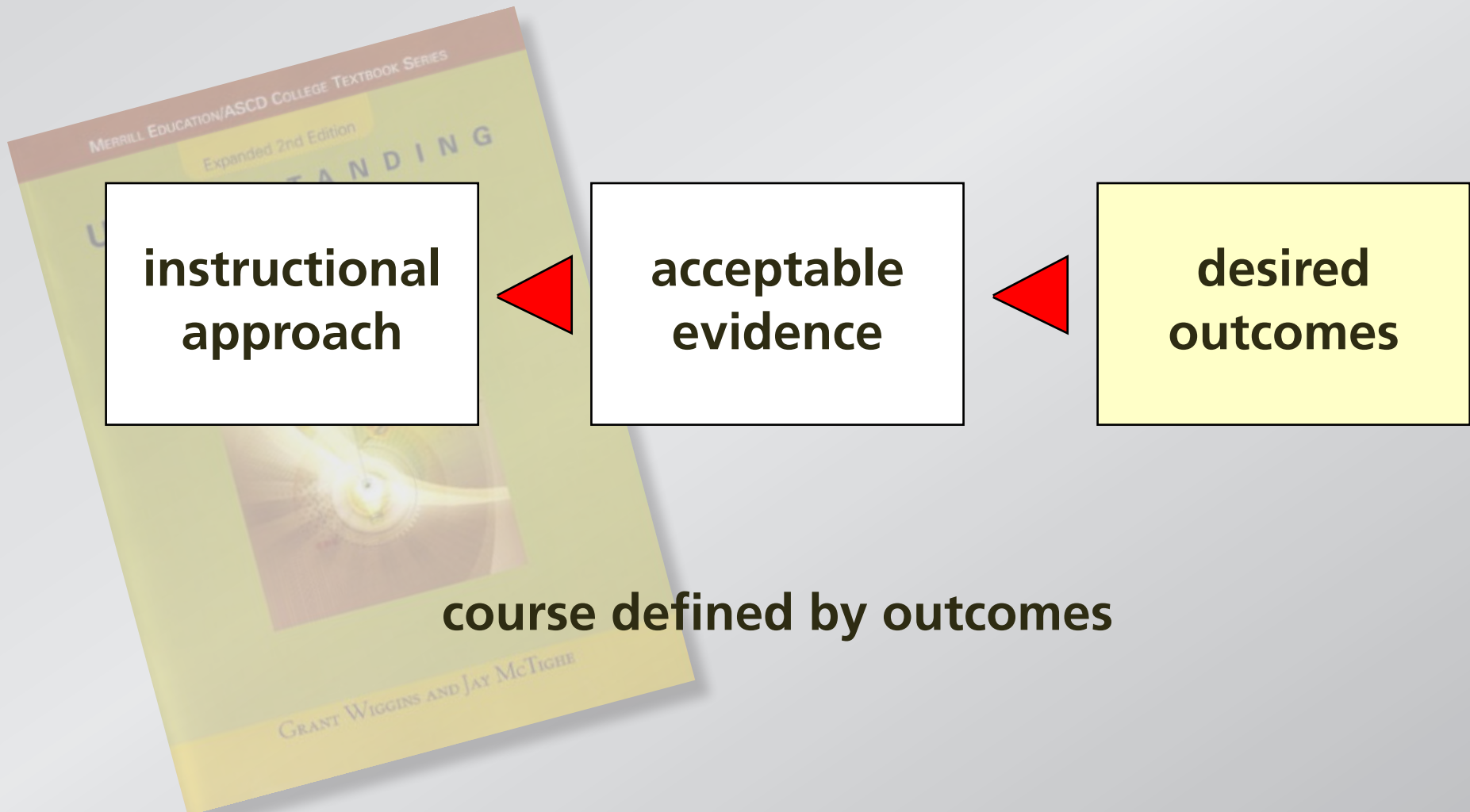
Implementing PI & JiTT

Backward design



Implementing PI & JiTT

Backward design



Implementing PI & JiTT

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

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“What constitutes a good problem?”

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

How long do you have to wait before someone frees up a space?

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

How long do you have to wait before someone frees up a space?

Requires:

Assumptions

Developing a model

Applying that model

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces. **On average people shop for 2 hours.**

How long do you have to wait before someone frees up a space?

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces. **On average people shop for 2 hours.**

How long do you have to wait before someone frees up a space?

Requires:

Developing a model
Applying that model

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces. On average people shop for 2 hours.

Assuming people leave at regularly-spaced intervals, how long do you have to wait before someone frees up a space?

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces. On average people shop for 2 hours.

Assuming people leave at regularly-spaced intervals, how long do you have to wait before someone frees up a space?

Requires:

Applying a (new) model

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area, where people are known to shop, on average, for 2 hours. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

How long do you have to wait before someone frees up a space?

Implementing PI & JiTT

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How long do you have to wait before someone frees up a space?

$$t_{wait} = \frac{T_{shop}}{N_{spaces}}$$

Implementing PI & JiTT

On a Saturday afternoon, you pull into a parking lot with unmeasured spaces near a shopping area, where people are known to shop, on average, for 2 hours. You circle around, but there are no empty spots. You decide to wait at one end of the lot, where you can see (and command) about 20 spaces.

How long do you have to wait before someone frees up a space?

Requires:

Using a calculator

$$t_{wait} = \frac{T_{shop}}{N_{spaces}}$$

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Need to test meaningful skills!

Implementing PI & JiTT

Some additional ideas:

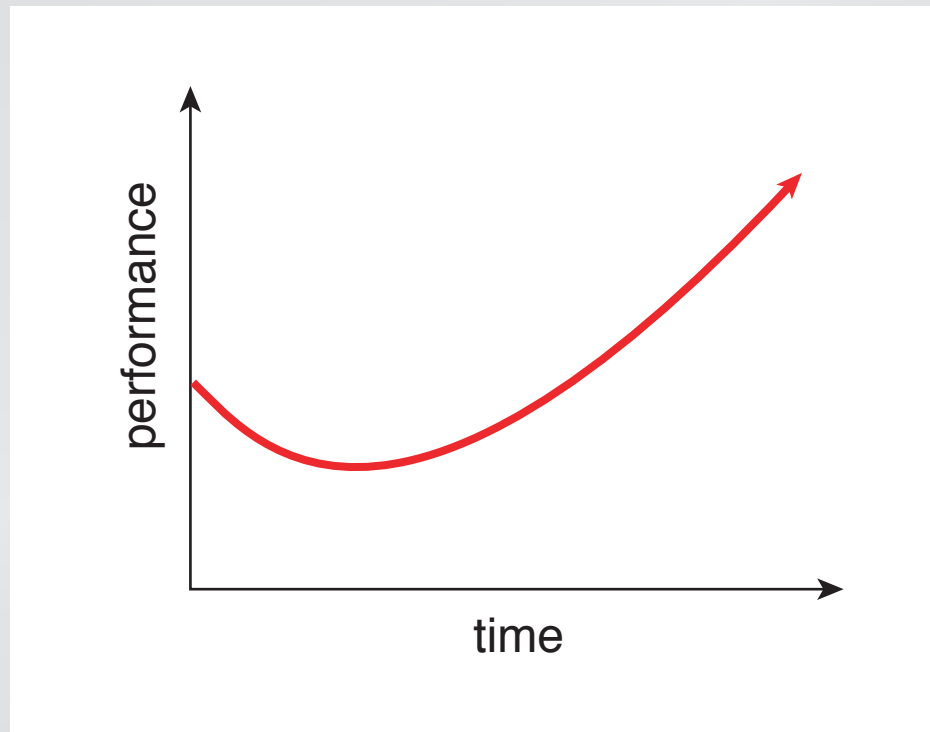
- **Open book/computer exam**
- **Collaborative exam**
- **Multidimensional testing**

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

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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.

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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!



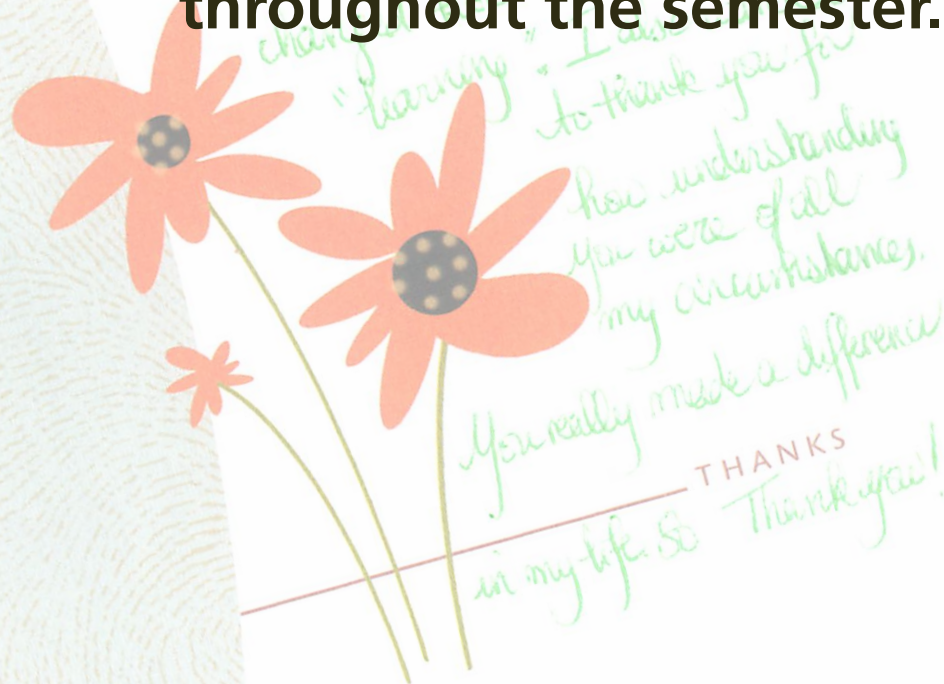
You made a difference.

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.

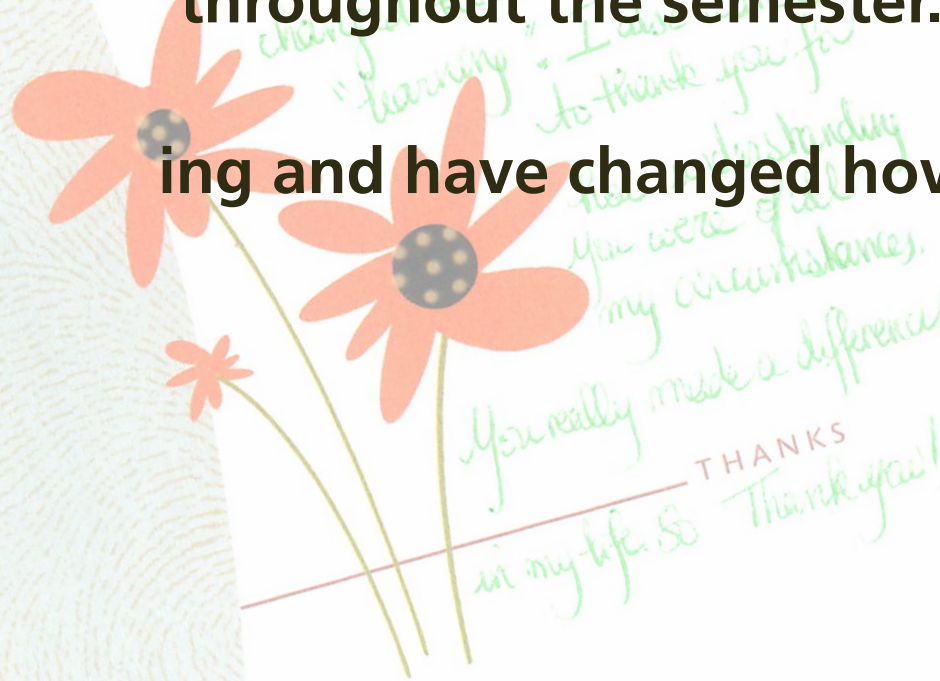
You made a difference.



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 made a difference.



*You really made a difference
in my life. So THANKS
Thank you!*

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 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**

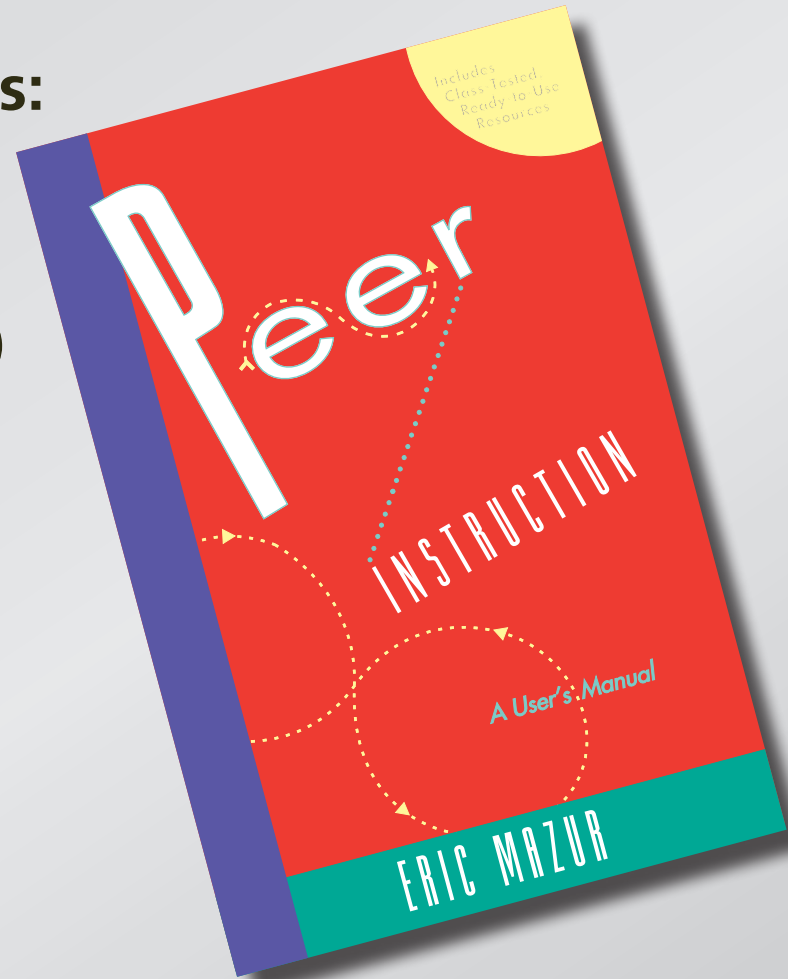
ConceptTests

“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)



ConceptTests

Books with ConceptTests:

- 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



Join now!

PeerInstruction.net

ConceptTests

Types of questions

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

ConceptTests

hole in plate/circumference

model

microscopy image

discussion

airline

fact

ConceptTests

hole in plate/circumference

model

microscopy image

discussion

airline

fact

fact-recall not engaging

ConceptTests

Good conceptual questions (ConceptTests):

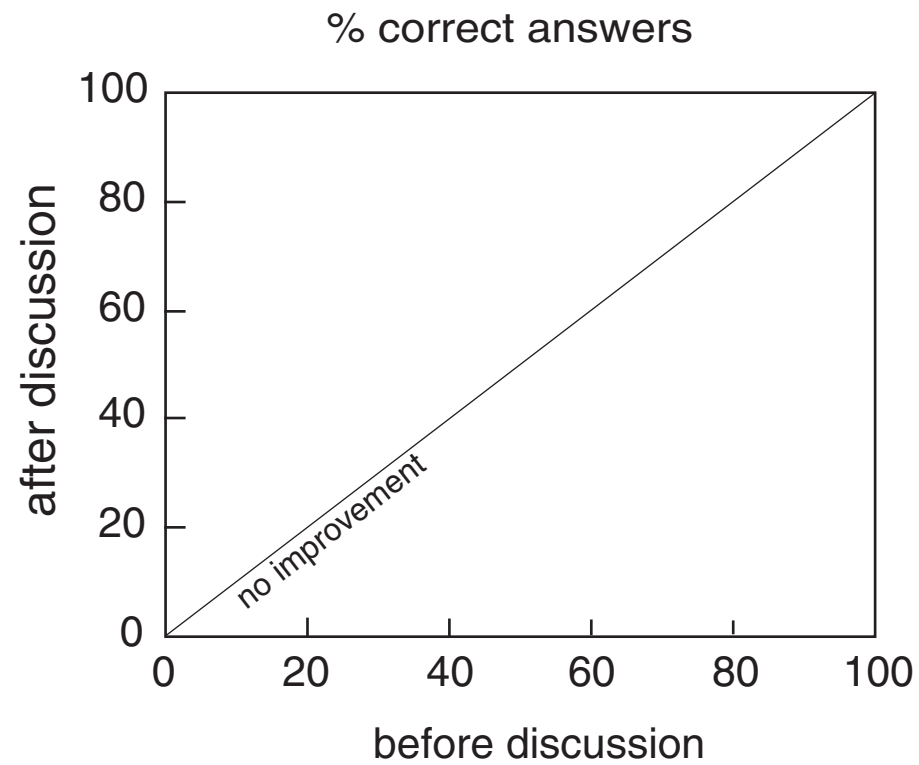
- **focus on interpretation/model (not recall)**
- **stimulate discussion**
- **are not “leading questions”**
- **are of manageable difficulty**

ConceptTests

“How can I promote active/fruitful discussions?”

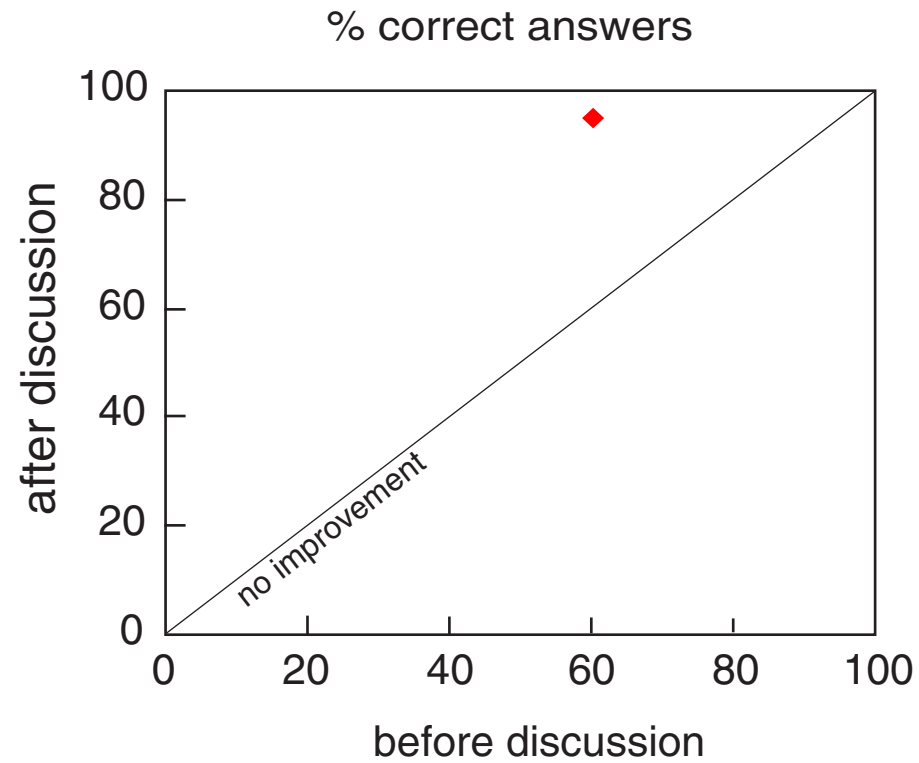
ConceptTests

ConceptTest data



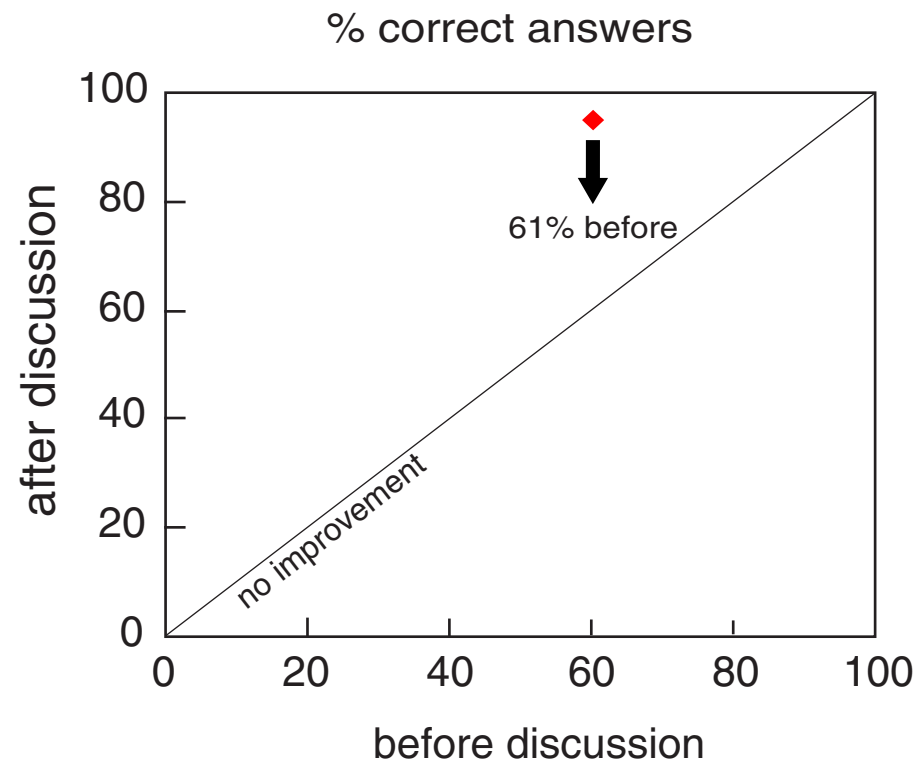
ConceptTests

ConceptTest data



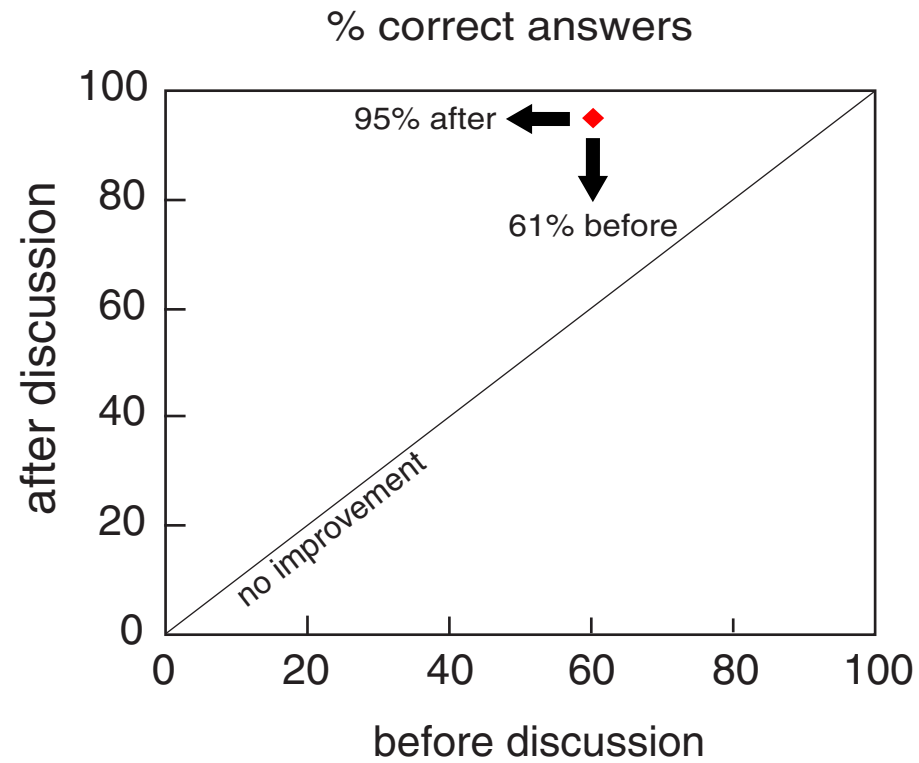
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ConceptTest data



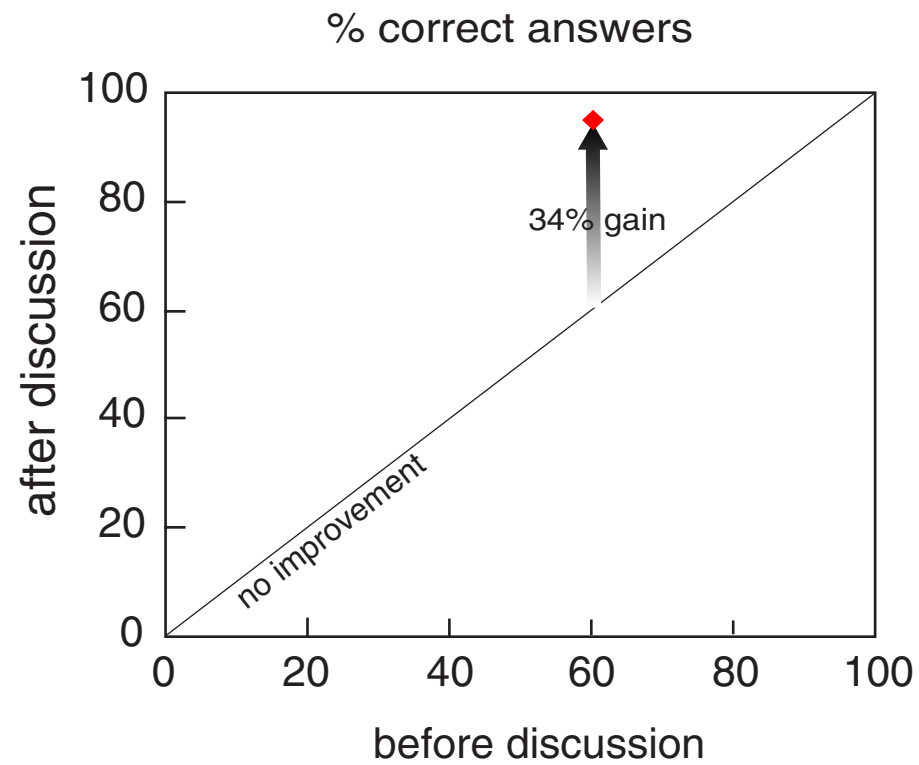
ConceptTests

ConceptTest data



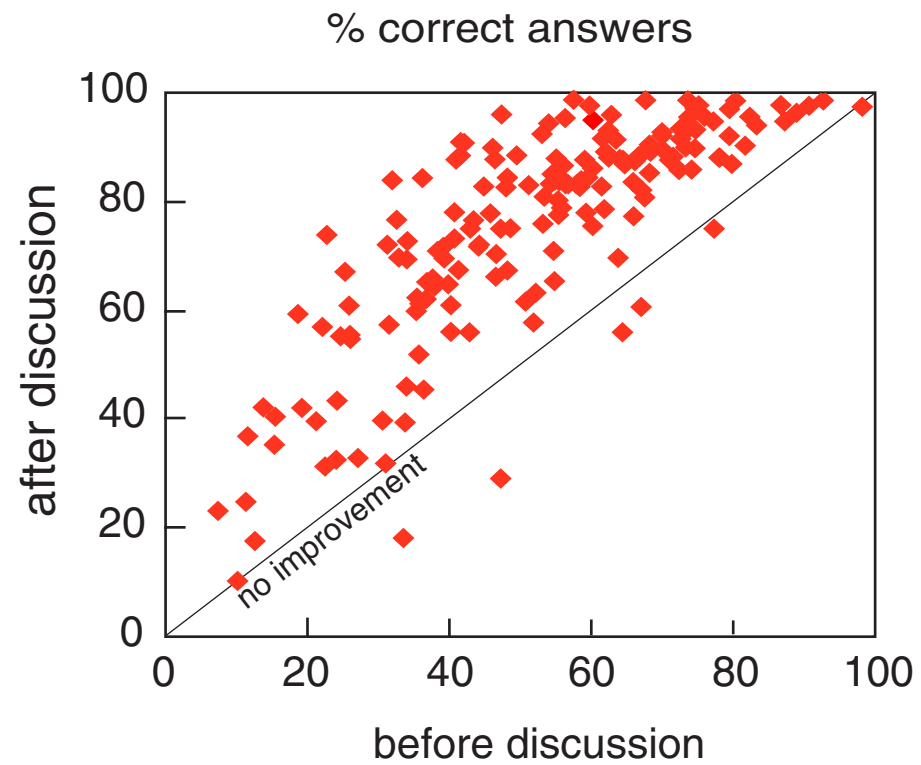
ConceptTests

ConceptTest data



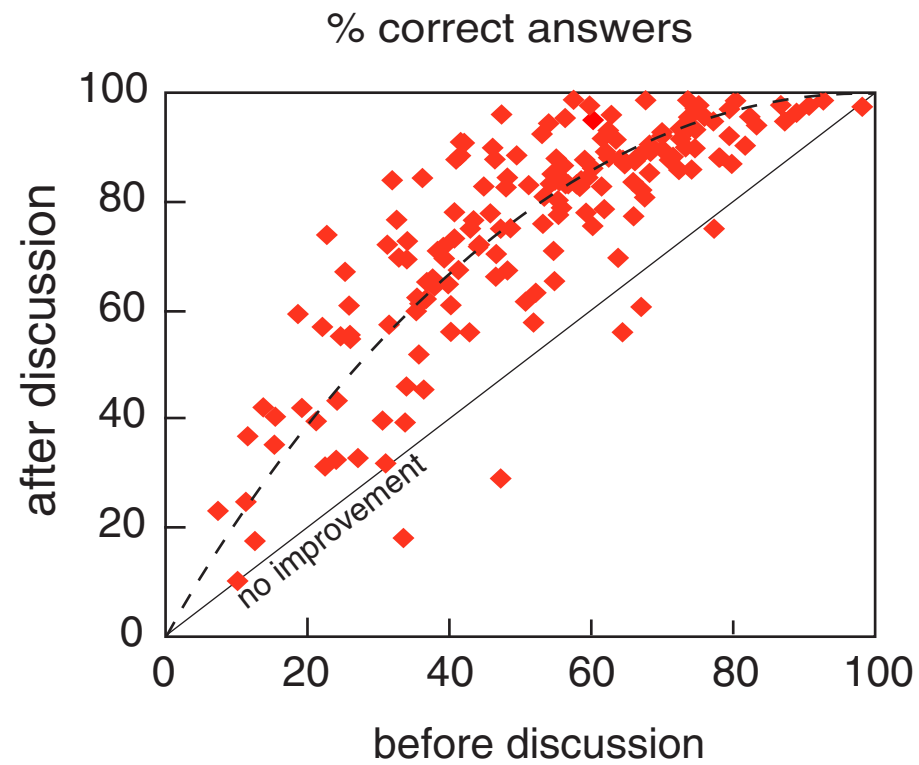
ConceptTests

ConceptTest data



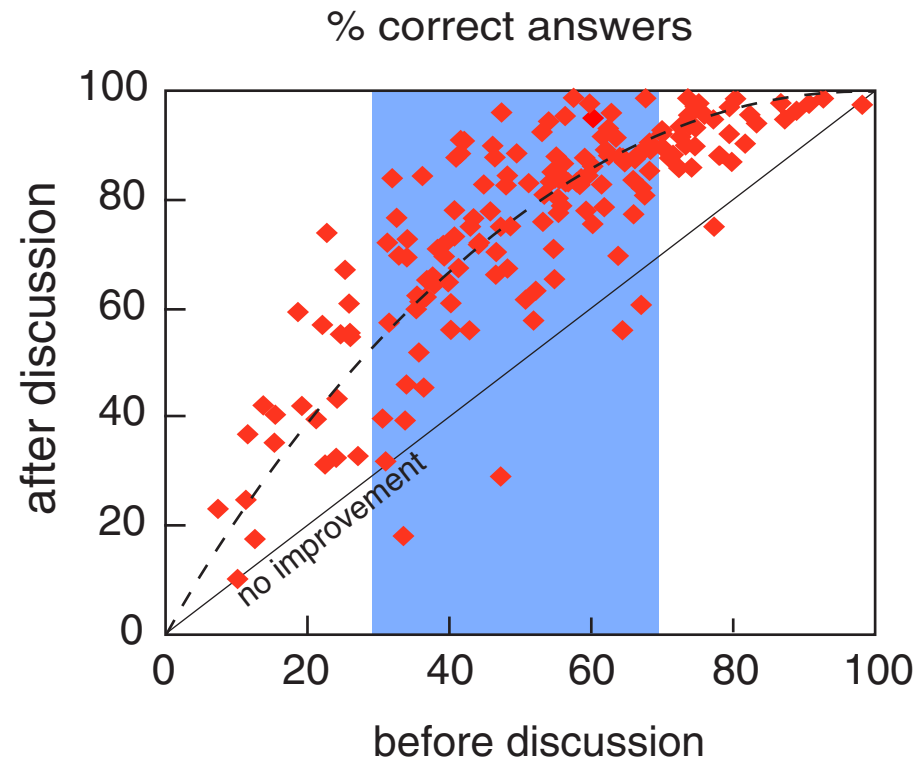
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ConceptTest data

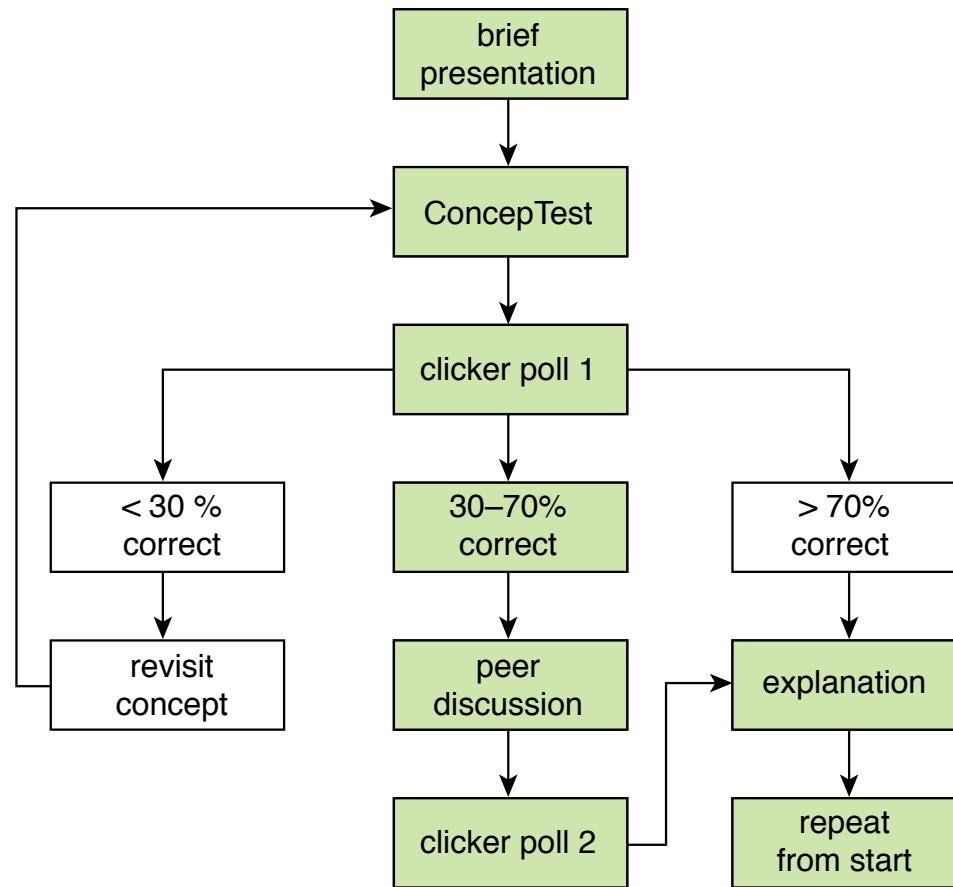


ConcepTests

ConcepTest data



ConcepTests



First International Asia-Pacific Conference on Peer Instruction



Beijing, China

mazur@harvard.edu

14-16 December 2012

Funding:

National Science Foundation

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