Introduction

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

1. information transfer
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?
How to move information transfer out of classroom?

Use JiTT (before class) and PI (in class)!
• PI & JiTT Overview
• Implementing PI & JiTT
• ConcepTests
“How can I be sure that my students will prepare for class?”
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)
Just-in-time-Teaching (JiTT)

www.jitt.org
JiTT workflow

- topic 1
- reading assignment
JiTT workflow

- topic 1
  - reading assignment
  - online assignment
JiTT workflow

- topic 1 reading assignment
- online assignment
- 2 conceptual questions
JiTT workflow

1. Topic 1 reading assignment
2. Online assignment
   - 2 conceptual questions
   - 1 feedback question
PI & JiTT Overview

JiTT workflow

- topic 1 reading assignment
- online assignment
- review feedback
- 2 conceptual questions
- 1 feedback question
PI & JiTT Overview

JiTT workflow

1. **topic 1 reading assignment**
2. **online assignment**
3. **review feedback**
4. **address difficulties in class**
5. 2 conceptual questions
6. 1 feedback question
PI & JiTT Overview

JiTT workflow

- topic 1 reading assignment
- online assignment
- review feedback
- address difficulties in class
- repeat with next topic
- 2 conceptual questions
- 1 feedback question
JiTT:

• prepares you for class
• prepares students for class
• helps you address student difficulties
Peer Instruction (PI)
Main features:

- pre-class assignment
- in-class: depth, not ‘coverage’
- ConcepTests
brief presentation
PI & JiTT Overview

brief presentation

ConcepTest
PI & JiTT Overview

- brief presentation
  - ConcepTest
    - clicker poll 1
brief presentation

ConcepTest

clicker poll 1

> 70% correct
brief presentation

ConcepTest

clicker poll 1

> 70% correct

explanation
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

> 70% correct

explanation

repeat from start
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

30–70% correct

> 70% correct

explanation

repeat from start
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

30–70% correct

peer discussion

> 70% correct

explanation

repeat from start
PI & JiTT Overview

1. Brief presentation
2. ConcepTest
3. Clicker poll 1
   - 30–70% correct
   - > 70% correct
     - Peer discussion
     - Explanation
     - Repeat from start
4. Clicker poll 2
PI & JiTT Overview

- Brief presentation
  - ConcepTest
    - Clicker poll 1
      - < 30% correct
      - > 70% correct
      - Peer discussion
      - Clicker poll 2
    - 30–70% correct
      - Explanation
      - Repeat from start
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

< 30 % correct

revisit concept

30–70% correct

peer discussion

> 70% correct

explanation

clicker poll 2

repeat from start
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

< 30 % correct

revisit concept

30–70% correct

peer discussion

clicker poll 2

> 70% correct

explanation

repeat from start
PI & JiTT Overview

PI:

• helps students overcome difficulties

• encourages deep learning

• provides depth, not “coverage”

• helps you become aware of misconceptions
“How do I promote fruitful discussion?”
Find someone with a *different* answer
“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
“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.”
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.
Let’s try it!

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

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

1. Yes
2. No

You got all engaged!
Don’t need a correct answer!
Outline

• PI & JiTT Overview
• Implementing PI & JiTT
• ConcepTests
“How is preparing a PI class different from preparing a lecture-based class?”
Implementing PI & JiTT

preparing for a lecture-based class

1. Assign book for course
2. Prepare lecture
3. Deliver lecture
4. Hand out assignment
5. Repeat with next topic
6. Final assessment

Hand out assignment
Repeat with next topic
Final assessment
Implementing PI & JiTT

transitioning: where does the effort go?

assign book for course

prepare lecture

deliver lecture

hand out assignment

repeat with next topic

final assessment

prepare reading assignment

review feedback

prepare/select ConcepTests

lead class discussion

hand out assignment

repeat with next topic

final assessment
Implementing PI & JiTT

transitioning: where does the effort go?

assign book for course

prepare lecture

deliver lecture

hand out assignment

repeat with next topic

final assessment

prepare reading assignment

review feedback

prepare/select ConcepTests

lead class discussion

hand out assignment

repeat with next topic

final assessment
New activities:

1. Reading assignment
2. ConcepTests
“How do I cover everything using this method?”
<table>
<thead>
<tr>
<th></th>
<th>traditional</th>
<th>PI</th>
</tr>
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<tbody>
<tr>
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## Implementing PI & JiTT

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What good is coverage if little is retained?
“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
circumference of a circle of radius $R$ is $2\pi R$
Imagine a rope that fits snugly along the equator.
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
You all got fired up!
Clickers necessary?

You all got fired up!

(WITHOUT CLICKERS!)
Imagine a rope that fits snugly along the equator.

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circumference at the equator:

\[2\pi R_E\]
circumference at the equator:

\[ 2\pi R_E \]

new circumference:

\[ 2\pi R_E + 1 \text{ m} \]
circumference at the equator:

\[ 2\pi R_E \]

new circumference:

\[ 2\pi R_E + 1 \text{ m} \]

radius of circle with new circumference:

\[ 2\pi R = 2\pi R_E + 1 \text{ m}, \quad \text{and so} \quad R = R_E + \frac{1 \text{ m}}{2\pi}. \]
Research: same learning gains with and without clickers!

Clickers or Flashcards: Is There Really a Difference?
It’s not the technology, but the pedagogy!
Implementing PI & JiTT

It’s not the technology, but the pedagogy!

(but clickers do offer advantages)
“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
Implementing PI & JiTT

Traditional approach to course planning

course content

assessment
Implementing PI & JiTT

Traditional approach to course planning

- course defined by content
- assessment

course content
Implementing PI & JiTT

Backward design

desired outcomes
Implementing PI & JiTT

Backward design

acceptable evidence  desired outcomes
Implementing PI & JiTT

Backward design

instructional approach  acceptable evidence  desired outcomes
Implementing PI & JiTT

Backward design

- instructional approach
- acceptable evidence
- desired outcomes

course defined by outcomes
Implementing PI & JiTT

Evaluate assessment by comparing student performance on various kinds of problems
Need to test meaningful skills!
Implementing PI & JiTT

Some additional ideas:

• Open book/computer exam

• Collaborative exam

• Multidimensional testing
“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!
Subject: concerns

Professor Mazur,

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

1) You are giving us WAY too 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 of 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.
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!
Hello Prof. Mayor,

I wanted to thank you sincerely for your help and support throughout this semester. You have helped me tremendously, and I am truly grateful for all your support and guidance. Learning with you has been an incredible experience, and you have helped me grow as a student.

Thank you for all your assistance and for making this semester a success. You really made a difference in my life. So, thank you so much.

Best,
[Signature]
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.

THANKS
“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”.

Thanks
In my life. So Thank You!

Best,
[Signature]
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.”
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
“Where can I get examples of good questions?”
Books with ConcepTests:

- Physics (Prentice Hall)
Books with ConcepTests:

- Physics (Prentice Hall)
- Chemistry (Prentice Hall)
Books with ConcepTests:

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

Books with ConcepTests:

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

... or try searching Google:

<subject> “Peer Instruction”
<subject> ConcepTest
<subject> “Concept Test”
<subject> clickers
Types of questions

- survey
- model testing
- discussion
- select from list
Join now!

PeerInstruction.net
Good conceptual questions (ConcepTests):

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

ConcepTest data

% correct answers

after discussion vs. before discussion

no improvement
ConcepTests

ConcepTest data

% correct answers

before discussion

after discussion

no improvement
ConcepTests

ConcepTest data

% correct answers

after discussion

before discussion

61% before

no improvement
ConcepTests

ConcepTest data

![](chart.png)

- % correct answers
- 95% after
- 61% before

Diagram showing the improvement in correct answers before and after discussion.
ConcepTests

ConcepTest data

% correct answers

34% gain

before discussion

after discussion

no improvement
ConcepTests

ConcepTest data

% correct answers

before discussion

after discussion

no improvement

0 20 40 60 80 100

0 20 40 60 80 100
ConcepTests

ConcepTest data

% correct answers

before discussion

after discussion

no improvement
ConcepTests

ConcepTest data

% correct answers

after discussion

before discussion

no improvement
ConcepTests

ConcepTest

brief presentation

clicker poll 1

< 30% correct

revisit concept

30–70% correct

peer discussion

> 70% correct

explanation

repeat from start

clicker poll 2