Introduction

lectures focus on information transfer...
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)
Solution: move information transfer out of classroom!
How to move information transfer out of classroom?
How to move information transfer out of classroom?

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

- 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)
PI & JiTT Overview

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**
PI & JiTT Overview

JiTT workflow

- Topic 1 reading assignment
- Online assignment
  - 2 conceptual questions
  - 1 feedback question
JiTT workflow

1. topic 1 reading assignment
2. online assignment
3. review feedback
4. 2 conceptual questions
5. 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
JiTT workflow

1. **topic 1 reading assignment**
2. **online assignment**
3. **review feedback**
4. **address difficulties in class**
5. **repeat with next topic**

- 2 conceptual questions
- 1 feedback question
PI & JiTT Overview

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’
• ConceptTests
brief presentation
PI & JiTT Overview

brief presentation

ConcepTest
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

> 70% correct
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

> 70% correct

explanation
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

brief presentation

ConcepTest

clicker poll 1

30–70% correct

peer discussion

clicker poll 2

> 70% correct

explanation

repeat from start
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

< 30 % correct

30–70% correct

> 70% correct

peer discussion

explanation

clicker poll 2

repeat from start

> 70% correct

30–70% correct

< 30 % correct
Pl & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

< 30 % correct

revisit concept

30–70% correct

peer discussion

> 70% correct

explanation

repeat from start

clicker poll 2
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!
Let’s try it!

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!
Don’t need a correct answer!
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

\[ g = \frac{S_f - S_i}{1 - S_i} \]
Implementing PI & JiTT

FCI normalized gain

\[ g = \frac{S_f - S_i}{1 - S_i} \]
Implementing PI & JiTT

FCI normalized gain

![Diagram showing FCI normalized gain for HU and JAC](chart.png)
Implementing PI & JiTT

FCI normalized gain

![Bar chart showing normalized gain for HU and JAC. The chart compares normalized gain for different conditions labeled T and PI.]

- HU
  - T: around 0.2
  - PI: around 0.5

- JAC
  - T: around 0.3
  - PI: around 0.5
Implementing PI & JiTT

exam performance

<table>
<thead>
<tr>
<th></th>
<th>HU</th>
<th>JAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>
Implementing PI & JiTT

exam performance

![Bar chart showing final exam scores for HU and JAC. The chart compares two groups: T and PI. The T group has slightly higher scores in both HU and JAC, with HU having higher scores overall.]
Implementing PI & JiTT

student retention

![Bar chart showing student retention](chart.png)
Implementing PI & JiTT

student retention

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>HU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JAC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Implementing PI & JiTT

student retention

![Bar chart showing student retention rates for HU and JAC. The chart indicates a significant decrease in dropped courses from traditional (T) to PI for both HU and JAC, with HU having a lower rate overall.](chart.png)
Implementing PI & JiTT

similar learning gains in different environments
“How do I cover everything using this method?”
<table>
<thead>
<tr>
<th></th>
<th>traditional</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>in-class coverage</td>
<td>complete</td>
<td>partial</td>
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## Implementing PI & JiTT

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## Implementing PI & JiTT

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<td>material learned</td>
<td>little</td>
<td>substantial</td>
</tr>
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<td>PI</td>
</tr>
<tr>
<td>-------------------------------</td>
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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
“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

course content
assessment
Implementing PI & JiTT

Backward design
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
Outline

- PI & JiTT Overview
- Implementing PI & JiTT
- ConcepTests
“Where can I get examples of good questions?”
Books with ConcepTests:

• Physics (Prentice Hall)
ConcepTests

Books with ConcepTests:

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

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)
... or try searching Google:

<subject> "Peer Instruction"

<subject> ConcepTest

<subject> "Concept Test"

<subject> clickers
“How can I promote active/fruitful discussions?”
ConcepTests

ConcepTest data

% correct answers

after discussion

before discussion

no improvement
ConcepTests

ConcepTest data

% correct answers

before discussion

after discussion

no improvement

before discussion

after discussion
ConcepTests

ConcepTest data

% correct answers

61% before
ConcepTests data

- 61% before discussion
- 95% after discussion

Graph showing % 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
ConcepTests

ConcepTest data

% correct answers

before discussion

after discussion

0 20 40 60 80 100

0 20 40 60 80 100

no improvement

no improvement
ConcepTests

ConcepTest data

% correct answers

after discussion vs. before discussion

no improvement
ConcepTests

brief presentation

ConcepTest

clicker poll 1

< 30% correct

revisit concept

30–70% correct

peer discussion

clicker poll 2

> 70% correct

explanation

repeat from start
Implementing PI & JiTT

Evaluate assessment by comparing student performance on various kinds of problems
“What constitutes a good problem?”
On a Saturday afternoon, you pull into a parking lot with unme-tered 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.
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How long do you have to wait before someone frees up a space?
On a Saturday afternoon, you pull into a parking lot with unmeetered 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
On a Saturday afternoon, you pull into a parking lot with unme-tered 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.**

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Requires:

Developing a model
Applying that model
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Assuming people leave at regularly-spaced intervals, how long do you have to wait before someone frees up a space?
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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 unmeetered 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?
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How long do you have to wait before someone frees up a space?

\[ t_{\text{wait}} = \frac{T_{\text{shop}}}{N_{\text{spaces}}} \]
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How long do you have to wait before someone frees up a space?

Requires:

Using a calculator

\[ t_{\text{wait}} = \frac{T_{\text{shop}}}{N_{\text{spaces}}} \]
Implementing PI & JiTT

Need to test meaningful skills!
Some additional ideas:

- Open book/computer exam
- Collaborative exam
- Multidimensional testing
“How do I deal with students who resist this new approach to studying?”
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 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 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 express my sincere gratitude for the invaluable support you have provided throughout my academic journey. Your guidance and mentorship have been instrumental in shaping my academic and personal growth. You have consistently gone above and beyond to ensure my success, and I am truly grateful for your unwavering commitment.

Your teaching style has not only been inspiring but has also changed the way I perceive learning. I now have a deeper understanding of the subject matter and am more confident in my ability to tackle challenges. You have made a significant difference in my life, and I am forever grateful for your dedication and care.

THANKS

You made a difference in my life. So Thank you!
“I wanted to hand you this card as a token of my deep appreciation of how you have helped me throughout the semester.
“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!
“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.”
Implementing PI & JiTT

and don’t forget...
Implementing PI & JiTT

and don’t forget...

PI leads to better learning and retention!