Confessions of a converted lecturer

Mt. Holyoke College
South Hadley, MA, 16 January 2015
• no ON/OFF button

• only last “click” counts

• display shows recorded answer
unique ID on back of clicker

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Think of something you are good at
Think of something you are good at

*How did you become good at this?*
Became good at it by:

1. trial and error
2. lectures
3. practicing
4. apprenticeship
5. other
better pay attention!
What happens in a lecture?
some people talk in their sleep
some people talk in their sleep

lecturers talk while other people are sleeping

(Albert Camus)
education
The result?
Lack of learning
Lack of learning
Lack of retention
not transfer but assimilation of information is key
1. transfer of information
1. transfer of information

2. assimilation of that information
1. transfer of information (in class)

2. assimilation of that information
1. transfer of information (in class)

2. assimilation of that information (out of class)
1. transfer of information (in class)

2. assimilation of that information (out of class)

Should focus on THIS!
1. transfer of information (in class)

2. assimilation of that information (out of class)
1. transfer of information (out of class)

2. assimilation of that information (in class)
1. transfer of information (out of class)

2. assimilation of that information (in class)
question

think

poll
1. education

2. PI

question

think

poll

discuss

repoll

explain
Let's try it!
all of them
Consider a rectangular metal plate with a circular hole in it.
Consider a rectangular metal plate with a circular hole in it.

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

1. increases.
2. stays the same.
3. decreases.
Consider a rectangular metal plate with a circular hole in it.

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

1. increases.
2. stays the same.
3. decreases.
Consider a rectangular metal plate with a circular hole in it.

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

1. increases.
2. stays the same.
3. decreases.
Before I tell you the answer...
Before I tell you the answer, let’s analyze what happened.
Before I tell you the answer, let’s analyze what happened.

You…
Before I tell you the answer, let’s analyze what happened.

You...

1. made a commitment
Before I tell you the answer, let’s analyze what happened.

You...

1. made a commitment
2. externalized your answer
Before I tell you the answer, let’s analyze what happened.

You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning
Before I tell you the answer, let’s analyze what happened.

You…

1. made a commitment
2. externalized your answer
3. moved from the answer/fact to reasoning
4. became emotionally invested in the learning process
Consider a rectangular metal plate with a circular hole in it.

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

1. increases.
2. stays the same.
3. decreases.
Consider a rectangular metal plate with a circular hole in it.

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

1. increases. ✔
2. stays the same.
3. decreases.
consider atoms at rim of hole
consider atoms at rim of hole
consider atoms at rim of hole
consider atoms at rim of hole

you won't forget this
Greater learning gains
Greater learning gains
Better retention
in a lecture, students...
in a lecture, students...

1. don’t pay utmost attention
in a lecture, students...

1. don’t pay utmost attention

2. think they know it
in a lecture, students...

1. don’t pay utmost attention

2. think they know it

3. are not confronted with misconceptions
in a lecture, students...

1. don’t pay utmost attention
2. think they know it
3. are not confronted with misconceptions

false sense of security
education  PI  test
an illusion...
Education is not just about:

• transferring information

• getting students to do what we do
Education is not just about:

• transferring information

• getting students to do what we do

active participation a must!
Join now!

PeerInstruction.net
Funding:
National Science Foundation

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mazur.harvard.edu

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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
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)
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

- topic 1 reading assignment
- online assignment
  
  - 2 conceptual questions
  - 1 feedback question
JIIT workflow

- Topic 1 reading assignment
- Online assignment
- Review feedback
- 2 conceptual questions
- 1 feedback question
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

- 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
- Clicker poll 1
PI & JiTT Overview

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

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

brief presentation

ConcepTest

clicker poll 1

30–70% correct
indicates peer discussion

> 70% correct indicates explanation and repeat from start
PI & JiTT Overview

brief presentation

ConcepTest

clicker poll 1

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

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

30–70% correct

peer discussion
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

**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.”
Let’s try it!

Bernard Gert’s moral system created by 10 rules:

1. Do not kill
2. Do not cause pain
3. Do not disable
4. Do not deprive of freedom
5. Do not deprive of pleasure
6. Do not deceive
7. Keep your promises
8. Do not cheat
9. Obey the law
10. Do your duty (as required by job, circumstances).
Heinz’s wife was near death, and her only hope was a drug that had been discovered by a pharmacist who was selling it for an exorbitant price. The drug cost $20,000 to make, and the pharmacist was selling it for $200,000. Heinz could only raise $50,000 and insurance wouldn’t make up the difference. He offered what he had to the pharmacist, and when his offer was rejected, Heinz said he would pay the rest later. Still the pharmacist refused. In desperation, Heinz broke into the store and stole the drug.
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Should Heinz have broken into the store to steal the drug for his wife?
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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
Let’s try it!

Bernard Gert’s moral system created by 10 rules:

1. Do not kill
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8. Do not cheat
9. Obey the law
10. Do your duty (as required by job, circumstances).

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

1. Yes
2. No

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

• PI & JiTT Overview

• Implementing PI & JiTT

• ConcepTests
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

![FCI normalized gain chart]

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

FCI normalized gain

![Bar chart showing FCI normalized gain for HU and JAC with PI and T compared]
Implementing PI & JiTT

FCI normalized gain

![FCI normalized gain graph](image)
Implementing PI & JiTT

exam performance

![Chart showing final exam scores](chart.png)
Implementing PI & JiTT

exam performance

![Bar chart showing exam performance with HU and JAC]

- HU: T (60%) and PI (70%)
- JAC: T (55%) and PI (65%)

Note: The chart shows the final exam score (%) for HU and JAC with and without PI implementation.
Implementing PI & JiTT

student retention

![Bar chart showing student retention dropped course percentage]

- HU: 0%
- JAC: 0%
- T: 10%

- Y-axis: dropped course (%)
- X-axis: HU, JAC
Implementing PI & JiTT

student retention

![Bar chart showing student retention percentages for HU and JAC with PI and T](image)
Implementing PI & JiTT

student retention

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

similar learning gains in different environments
“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

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 ConceptTests

Lead class discussion

Hand out assignment

Repeat with next topic

Final assessment
Implementing PI & JiTT

transitioning: where does the effort go?

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

7. Prepare reading assignment
8. Review feedback
9. Prepare/select ConceptTests
10. Lead class discussion
11. Hand out assignment
12. Repeat with next topic
13. Final assessment
New activities:

1. Reading assignment
2. ConcepTests
“How do I cover everything using this method?”
## Implementing PI & JiTT

<table>
<thead>
<tr>
<th></th>
<th>traditional</th>
<th>PI</th>
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</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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<td>material learned</td>
<td>little</td>
<td>substantial</td>
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what good is coverage if little is retained?
Outline

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

- Physics (Prentice Hall)
Books with ConcepTests:

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

Books with ConcepTests:

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

- Physics (Prentice Hall)
- Chemistry (Prentice Hall)
- Astronomy (Prentice Hall)
- Calculus (Wiley)
Join now!

PeerInstruction.net
... or try searching Google:

<subject> “Peer Instruction”

<subject> ConcepTest

<subject> “Concept Test”

<subject> clickers
ConcepTests

Good conceptual questions (ConcepTests):

• are based on common student difficulties
• focus on single concept
• require more than “plug and chug” or recall
• are clear and concise
• are of manageable difficulty
“How can I promote active/fruitful discussions?”
ConcepTests

ConcepTest data

% correct answers

after discussion

before discussion

no improvement
ConcepTests

ConcepTest data

% correct answers

<table>
<thead>
<tr>
<th>% correct answers</th>
<th>before discussion</th>
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<tr>
<td>100</td>
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<tr>
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<td>20</td>
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</tbody>
</table>

after discussion

before discussion

no improvement

Diamond mark indicates no improvement.
ConcepTests

ConcepTest data

% correct answers

before discussion

after discussion

61% before

no improvement
ConcepTests

ConcepTest data

% correct answers

95% after

61% before

before discussion

after discussion

no improvement
ConcepTests

ConcepTest data

Graph showing the percentage of correct answers before and after discussion. The graph indicates a 34% gain in correct answers after discussion.
ConcepTests

ConcepTest data

% correct answers

after discussion

before discussion

no improvement
ConcepTests

ConcepTest data

% correct answers

before discussion

after discussion

% correct answers

before discussion

no improvement

no improvement
ConcepTests

ConcepTest data

% correct answers

after discussion

before discussion

no improvement

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
clickers:

www.turningtechnologies.com

(please return or leave them behind!)
Funding:

National Science Foundation

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http://mazur.harvard.edu

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“What constitutes a good problem?”
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 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.

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

How long do you have to wait before someone frees up a space?
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
On a Saturday afternoon, you pull into a parking lot with unmetered 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?**
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
On a Saturday afternoon, you pull into a parking lot with unme-tered 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

On a Saturday afternoon, you pull into a parking lot with unme-tered 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?

\[ t_{\text{wait}} = \frac{T_{\text{shop}}}{N_{\text{spaces}}} \]
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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
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!
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 Wednesday Feb 16, two weeks into 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!
Hello Prof. Major,

I wanted to thank you for not only 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." I also wanted to thank you for how understanding you were of all my circumstances. You really made a difference in my life. So Thank you!

THANKS

All the Best,

You made a difference.
“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
in my life. So Thank you!

In the Best,

THANKS
for your understanding,
you were all my circumstances.
You really made a difference.

I learned to thank you for the support...
“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”.

Thx,
“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!