Technology is not a pedagogy:
Peer Instruction with and without clickers

2009 AAPT Winter Meeting
Chicago, IL, 16 February 2009
Have you used Peer Instruction?

1. Yes, with clickers
2. Yes, without clickers
3. No
On average, how many questions/class hour?

1. one
2. two
3. three
4. four or more
5. don’t use PI
How do you implement PI?

1. question, poll
2. question, poll, discuss, repoll
3. question, discuss, poll
4. other
5. don’t use PI
Introduction

do learning gains depend on setting and technology?
Outline

• Peer Instruction
• School setting
• Technology
Peer Instruction
Peer Instruction

lectures focus on delivery of information
Peer Instruction

Lectures focus on delivery of information.

But education is more than information transfer.
move information transfer out of classroom

- assign reading
- teach by questioning
Peer Instruction

brief
lecture
Peer Instruction

brief lecture

ConcepTest
Peer Instruction

brief lecture

ConcepTest

clicker poll 1
Peer Instruction

brief lecture

ConcepTest

clicker poll 1

> 70% correct
Peer Instruction

brief lecture

ConcepTest

clicker poll 1

> 70% correct

explanation
Peer Instruction

brief lecture

ConcepTest

clicker poll 1

> 70% correct

explanation

repeat from start
Peer Instruction

1. Brief lecture
2. ConcepTest
3. Clicker poll 1

- 30–70% correct
- > 70% correct

- Explanation
- Repeat from start
Peer Instruction

- brief lecture
- ConcepTest
- clicker poll 1
  - 30–70% correct: peer discussion
  - > 70% correct: explanation
    - repeat from start
Peer Instruction

1. Brief lecture
2. ConcepTest
3. Clicker poll 1
   - If 30–70% correct, peer discussion
   - If > 70% correct, explanation
4. Clicker poll 2
   - Repeat from start
Peer Instruction

brief lecture

ConcepTest

clicker poll 1

< 30% correct

30–70% correct

peer discussion

> 70% correct

explanation

repeat from start

clicker poll 2
Peer Instruction

1. Brief lecture
2. ConcepTest
3. Clicker poll 1
   - If < 30% correct, revisit concept
   - If 30–70% correct, peer discussion
   - If > 70% correct, explanation
4. Clicker poll 2
5. Repeat from start
Professors A and B teach the same mechanics class at the same college during different semesters. Professor A uses the traditional approach to teaching and lectures. Professor B uses Peer Instruction and students respond to the questions using clickers. Each class is evaluated using the traditional end-of-semester questionnaire and using the FCI to measure students’ comprehension of mechanics. Both professors are middle-aged and male. The results are as follows.

A: student evaluation: 1.5/5.0; \( <g> = 0.42 \)
B: student evaluation: 3.7/5.0; \( <g> = 0.57 \)
What might account for the large difference in evaluation?

I. professor personality
II. technology
III. pedagogy

1. I only
2. II only
3. III only
4. II and III
5. I, II, and III
6. other combination
a couple of points worth noting:
Technology

a couple of points worth noting:

1. you got engaged
a couple of points worth noting:

1. you got engaged
2. no “correct” answer
Technology

a couple of points worth noting:

1. you got engaged
2. no “correct” answer
3. you got engaged
Outline

• Peer Instruction

• School setting

• Technology
School setting

traditional instruction

1990
FCI pretest

count

score
School setting

traditional instruction

1990
FCI posttest

count

score
School setting

traditional instruction

![Graph showing score distribution for 1990 combined]
School setting

first year of implementing PI

1991
FCI pretest

count

score

0 5 10 15 20 25

0 5 10 15 20 25 25 20 15 10 5 0
School setting

first year of implementing PI

![Bar chart showing data for the first year of implementing PI in 1991. The chart displays the count of scores ranging from 0 to 25.]
School setting

first year of implementing PI

![Graph showing score distribution for 1991 combined](image-url)
what about problem solving?
School setting
School setting
School setting

better understanding leads to better problem solving

1985/91 exam scores
School setting
School setting

FCI normalized gain

\[ g = \frac{S_f - S_i}{1 - S_i} \]
FCI normalized gain

\[ g = \frac{S_f - S_i}{1 - S_i} \]
School setting

FCI normalized gain

![Bar chart showing normalized gain for HU and JAC]

- HU: T (0.2) and PI (0.5)
- JAC: T (0.3)

Graph labels:
- Y-axis: normalized gain
- X-axis: HU and JAC

Legend:
- T
- PI
School setting

FCI normalized gain

normalized gain

HU

JAC

normalized gain

0.5

0.4

0.3

0.2

0.1

0

T

PI

T

PI
exam performance

<table>
<thead>
<tr>
<th></th>
<th>HU</th>
<th>JAC</th>
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<tbody>
<tr>
<td>PI</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>80</td>
<td></td>
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</table>
School setting

exam performance

![Graph showing final exam scores for HU and JAC, comparing PI and T groups. The graph indicates that the PI group consistently scores higher than the T group in both HU and JAC settings.](image-url)
School setting

student retention

![Bar graph showing dropped course (%)]

- **HU**: 0%
- **JAC**: 0%
- **T**: 25%
School setting

student retention

![Bar chart showing student retention rates for different courses and programs. The chart compares HU and JAC, with dropped course (%) on the y-axis and course type on the x-axis. The chart indicates a significant difference in retention rates between the two settings.]
School setting

student retention

![Bar chart showing student retention rates for two different settings, HU and JAC. The chart compares the percentage of dropped courses between T and PI groups.](chart.jpg)
similar learning gains in both environments
Outline

• Peer Instruction

• School setting

• Technology
Professor C teaches mechanics at a private institution with very selective admissions. She uses Peer Instruction and requires her students to purchase clickers. Professor D teaches a similar course at a community college with many under-prepared students. Neither Professor D’s college, nor his students have the means to purchase clickers, so Professor D prints out flashcards for his students. Each class’ performance is compared to a similar (control) class taught using the traditional lecture approach at the same institution using both FCI pre and post testing and free-response questions on the final examination.

C: \( g = 0.49 \) (control 0.25); exam 11% improvement
D: \( g = 0.46 \) (control 0.32); exam 8% improvement
<table>
<thead>
<tr>
<th>Professor</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>college technology</td>
<td>selective</td>
<td>community college technology</td>
</tr>
<tr>
<td>FCl &lt;g&gt;</td>
<td>0.49 (0.25)</td>
<td>0.46 (0.32)</td>
</tr>
<tr>
<td>exam improvement</td>
<td>11%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Identify conclusions you would draw from this comparison:

I. interactive teaching works across all levels
II. clickers are a useless gimmick
III. you really can’t draw any conclusions

1. I only
2. II only
3. I and II
4. II and III
5. I, II, and III
FCI scores at John Abbott College

![Bar chart showing FCI scores for flashcards pretest.](chart.png)
FCI scores at John Abbott College

The graph shows the distribution of FCI scores using flashcards for the posttest. The x-axis represents the score range, and the y-axis represents the count of scores. The highest count is observed around the score of 30.
Technology

normalized gain: 0.47

![Chart showing normalized gain](chart.png)
FCI scores at John Abbott College

- **clickers**
- **pretest**

The bar chart shows the distribution of scores for clickers during the pretest. The scores range from 0 to 30, with a significant concentration around the 10 to 15 range.
FCI scores at John Abbott College
Technology

normalized gain: 0.44

count

score

0 5 10 15 20 25 30

0 5 10 15 20 25 30

1 2 3 4 5 6 7 8

clickers combined
similar gains for flashcards (0.47) and clickers (0.44)
Remember the Professor C/D question?
Remember the Professor C/D question?

The technology didn’t really fail…, we tricked you, but…
Remember the Professor C/D question?

The technology didn’t *really* fail…, we tricked you, but…

notice you still got engaged!

(it’s not the clickers, but your brain that matters)
Technology

the importance of discussion

poll-activity-repoll
Technology

the importance of discussion
Technology

the importance of discussion

poll-repoll change (%)

<table>
<thead>
<tr>
<th></th>
<th>poll-repoll change (%)</th>
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<tbody>
<tr>
<td>distract</td>
<td>3</td>
</tr>
<tr>
<td>reflect</td>
<td>10</td>
</tr>
</tbody>
</table>
the importance of discussion

- Poll-repoll change (%)
  - Distract
  - Reflect
  - Discuss

- Technology

- Reflect is moderately high, while Distract and Discuss are significantly lower.
Technology

but clickers do offer advantages
but clickers do offer advantages

- permit fast and accurate tally
- provide data archive
- help promote change
Conclusion

• clickers great teaching aid

• learning gains determined by pedagogy

• can start now and get clickers later
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