Peer Instruction observed in the wild

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Outline

- Context and P.I.
- Class outcomes
- Smart pens
- Student conversations
- Revisions to teaching resources
- Summary and conclusions

Context

Context

School of Physics & Astronomy

Context

Scottish undergraduate degree system:
- Bachelors degree in 4 years
- Masters degree in 5 years

First year calculus-based introductory physics course
- Newtonian mechanics (1st semester)
- Modern physics (2nd semester)

250-300 students
80:20 male and female
75:25 British and non-British students
Mixed cohort (50:50 majors and non-majors)

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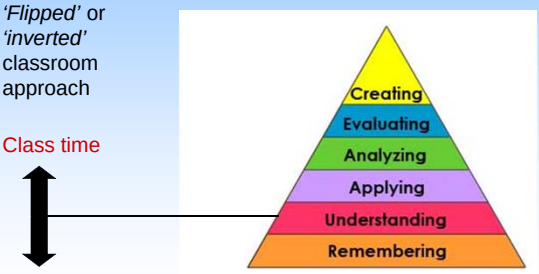
Context

'Flipped' or *'inverted'* classroom approach

Class time



Private study time

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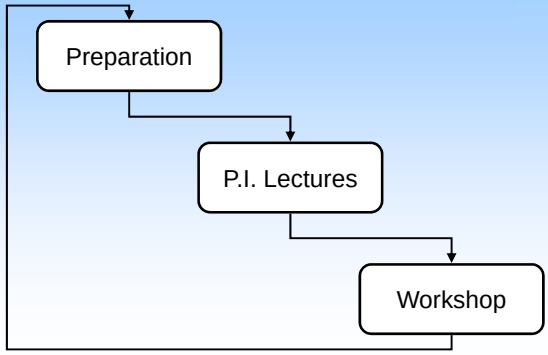

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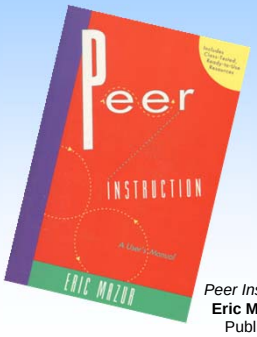
Peer Instruction



Peer Instruction: A User's Manual
Eric Mazur, Harvard University
Publisher: Addison-Wesley

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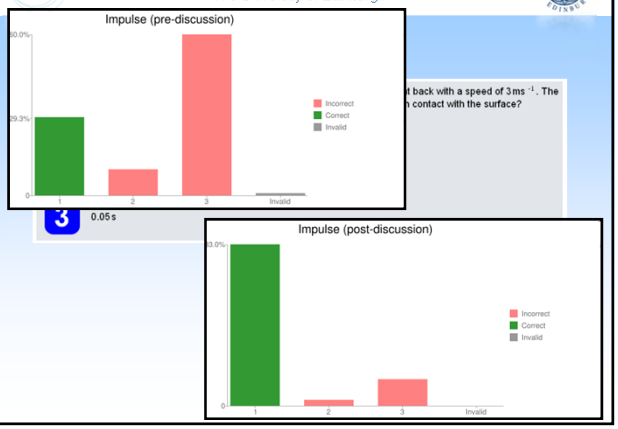

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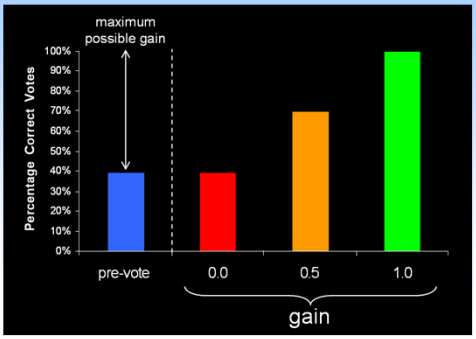
Evaluation: Gain



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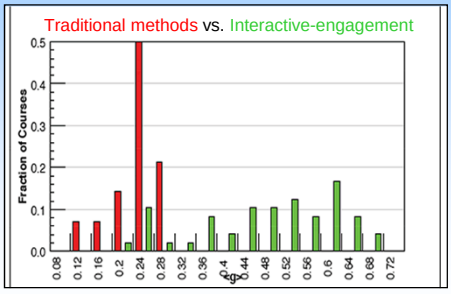
Force Concept Inventory gains

Traditional methods vs. Interactive-engagement



Adapted from R.R. Hake, *Am. J. Phys.* **66** 1, (1998)

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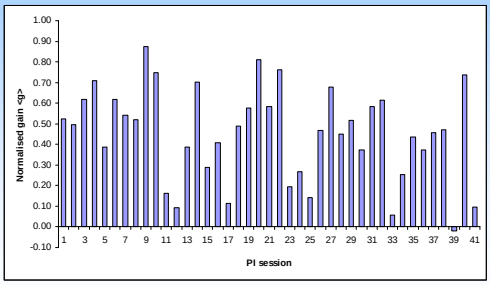
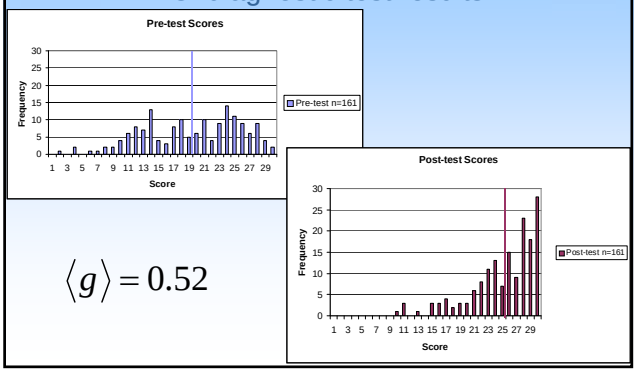
P.I. sessions: gain



$$\langle g \rangle = 0.45$$

FCI diagnostic test results



$$\langle g \rangle = 0.52$$

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Repeatability

Course	Average P.I. gain	Diagnostic test gain
Sem 1, 2011-12	0.45	0.52
Sem 2, 2011-12	0.42	-
Sem 1, 2012-13	0.50	0.51
Sem 2, 2012-13	0.47	-

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Smart pen

Ballpoint pen with integral digitiser and microphone.
Captures penstrokes and audio recording in sync.

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Smart pens

Advantages
- Easy to use
- Portable and convenient
- Relatively unobtrusive
- Capture speech and writing

Disadvantages
- No video
- Can be hard to identify speakers

Student conversations

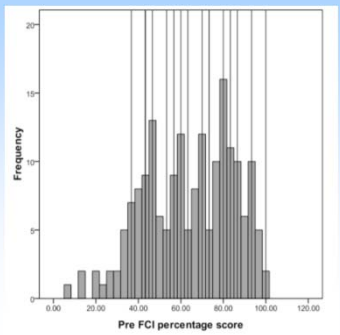
19 student volunteers

Retained smart pens throughout semester

41 Peer Instruction questions posed

162 distinct Peer Instruction episodes captured

Volunteer student characteristics



Vertical lines show volunteer students

No significant differences to rest of cohort in:
- FCI results
- course exam results

Volunteer students representative of whole class

Student conversations

"learning is culturally shaped and defined: people develop their understandings of any enterprise from their participation in the 'community of practice' within which that enterprise is practised"

Schoenfeld (1992)

Previous studies, e.g. Nielsen & Stav (2012) and James & Willoughby (2011), find many P.I. discussions not aligned with expectations.

Student conversations

James et al. (2008):
- Discourse bias study.
- Categorised student ideas and conversation dynamics.
- Simple word counting was most reliable indicator.

Student conversations

Our data set:

Full-cycle P.I. episodes

and

Student discussion recordings

and

Matched student voting records

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Methodology

Examine recordings

Identify technical words (spoken & written)

Determine:

- Total number of technical words uttered
- Number of different technical words used
- Technical word 'h-index'

Double-coding to check for inter-rater reliability

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Methodology

Match student recordings to clicker votes

Determine correctness of pre- and post-votes

Classify discussions as

- right-right (RR) √
- wrong-right (WR) √
- wrong-wrong (WW) –
- right-wrong (RW) ×
- …etc.

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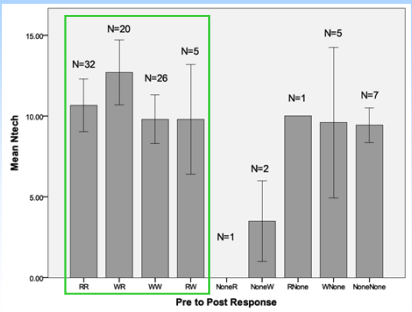
Number of technical words uttered



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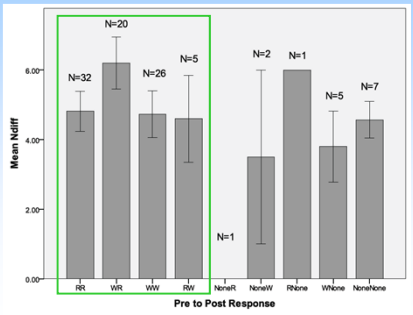
Number of different technical words



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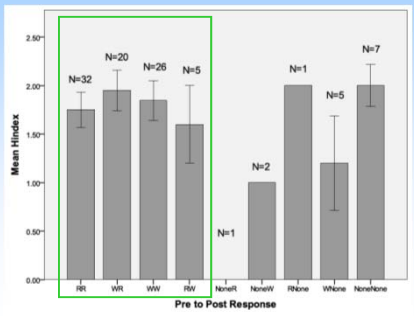
Technical words h-index



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Summary

No significant differences between numbers of conversations in each correctness category for:

- Total number of technical words uttered
- Number of different technical words used
- Technical word 'h-index'

Success of P.I. episode **not** dependent on technical fluency of discussion.

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From the instructor's perspective: Closing the loop

Which one of the following is NOT a true statement about the frictional force acting on a block on a rough surface?

1. The frictional force is given by $\mu_k F_N$ if the block is accelerating
2. The frictional force is given by $\mu_s F_N$ if the block is stationary
3. The frictional force can be less than either $\mu_s F_N$ or $\mu_k F_N$

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$\langle g \rangle = 0.09$

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Problems with the question

Which one of the following is NOT a true statement about the frictional force acting on a block on a rough surface?

1. The frictional force is given by $\mu_k F_N$ if the block is accelerating
2. The frictional force is given by $\mu_s F_N$ if the block is stationary
3. The frictional force can be less than either $\mu_s F_N$ or $\mu_k F_N$

- Negative question
- Confusion over symbols
- Focus on static vs. kinetic friction
- Focus on stationary vs. moving block
- Symbols activate formula-based approach

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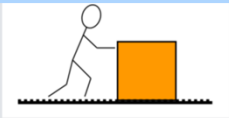
Revised question



A box of weight 100 N rests on a rough surface. The coefficient of static friction between the box and surface is 0.5. I push on the box with a force of 20 N. What is the magnitude of the force of friction exerted on the box by the surface?

1. 20 N
2. 30 N
3. 50 N

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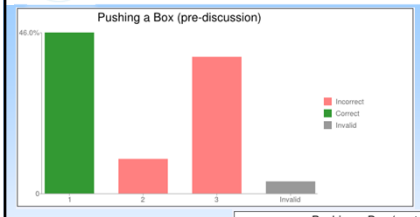
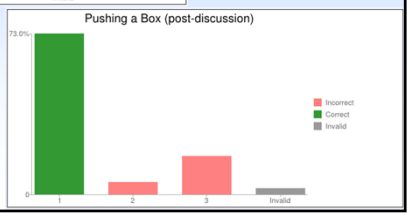
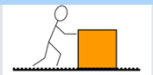




~~$\langle g \rangle = 0.09$~~

$\langle g \rangle = 0.51$

Revised question



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1. 20 N
2. 30 N
3. 50 N

Still not perfect:

- Numerical values activate formula-based approach

But a big improvement

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Summary

- Smart pen technology is highly effective for observing Peer Instruction ‘in the wild’
- Success (or otherwise) of P.I. episodes apparently independent of technical fluency of student discourse
- Smart pen recordings can give insight into impact of question characteristics on P.I. discussion
- Allows successful refinement of teaching materials