Wading Through the Pedagogy Alphabet Soup

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Workshop Objectives

At the completion of this session, participants will make progress toward:

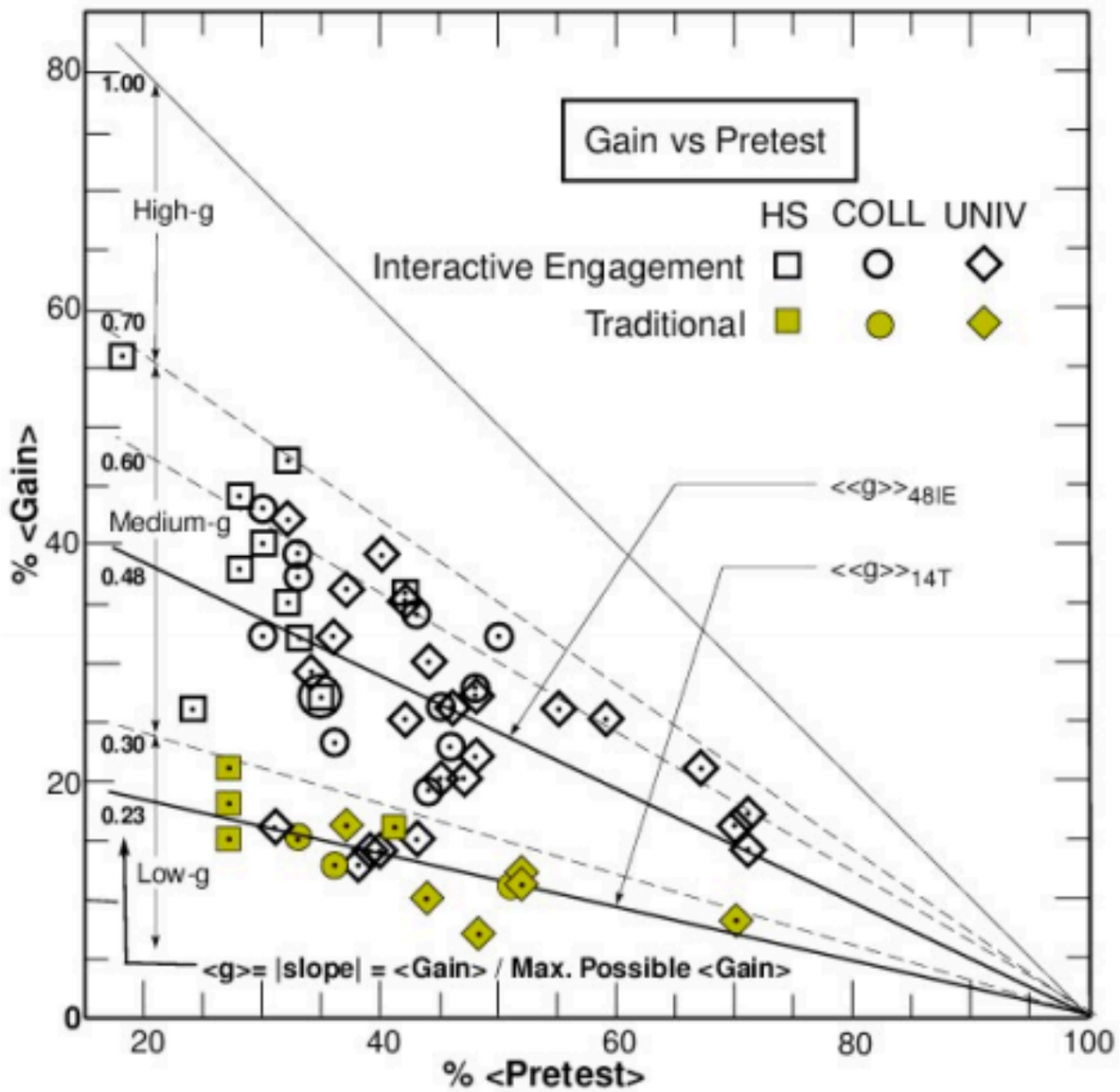
- Distinguishing the techniques used in various active learning pedagogies
- Evaluating each pedagogy for alignment with instructional objectives
- Identifying practical strategies to integrate active learning techniques into current practices

Agenda

- Introductions and welcome
- What the literature on active learning says
- JiTT and PI
- POGIL and TBL
- PLTL and PBL
- Reflection and exit ticket

"Adopting instructional practices that **<u>engage students in the learning process</u>** is the defining feature of active learning."
-Michael Prince

Benefits Illustrated



Measure of performance gain

- Mechanics Diagnostic (MD) or Force Concept Inventory (FCI)
- 62 courses (14 trad.) at multiple institutions
- 6542 students (2084)

R.R. Hake, "Interactive-engagement vs traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses," Am. J. Phys. 66, 64- 74 (1998). http://www.physics.indiana.edu/~sdi/ajpv3i.pdf

Collaborative and Cooperative Learning

Reference	Learning Outcome	Effect Size
Johnson, Johnson and Smith [12]	Improved academic achievement	0.64
	Improved quality of interpersonal interactions	0.60
	Improved self-esteem	0.44
	Improved perceptions of greater social support	0.70
Johnson, Johnson and Smith [13]	Improved academic achievement	0.53
	Improved liking among students	0.55
	Improved self-esteem	0.29
	Improved perceptions of greater social support	0.51
Springer et al. [43]	Improved academic achievement	0.51
	Improved student attitudes	0.55
	Improved retention in academic programs	0.46

Reference	Learning Outcome	Effect Size
Johnson, Johnson and Smith [12]	Improved academic achievement	0.67
	Improved interpersonal relationships	0.82
	Improved perceptions of greater social support	0.83
	Improved self-esteem	0.67
Johnson, Johnson and Smith [13]	Improved academic achievement	0.49
	Improved liking among students	0.68
	Improved perceptions of greater social support	0.60
	Improved self-esteem	0.47

M. Prince, "Does active learning work? A review of the research." J. Eng. Education 93(3), 223- 241, 2004.
http://www4.ncsu.edu/unity/lockers/users/f/felder/public/Papers/Prince_AL.pdf

Problem-Based Learning

Characteristic	Effect Size
(a) Individualized	0.23
(b) Cooperative	0.54
(c) Small group	0.31
(d) With non-expert tutors	-0.74
(e) Self-paced	-0.07
(f) Self-directed	-0.05
(g) Using problems	0.20
(h) Inquiry based	0.16
(i) Instruction in problem solving	0.54
(j) Inductive	0.06

M. Prince, "Does active learning work? A review of the research." J. Eng. Education 93(3), 223- 241, 2004.
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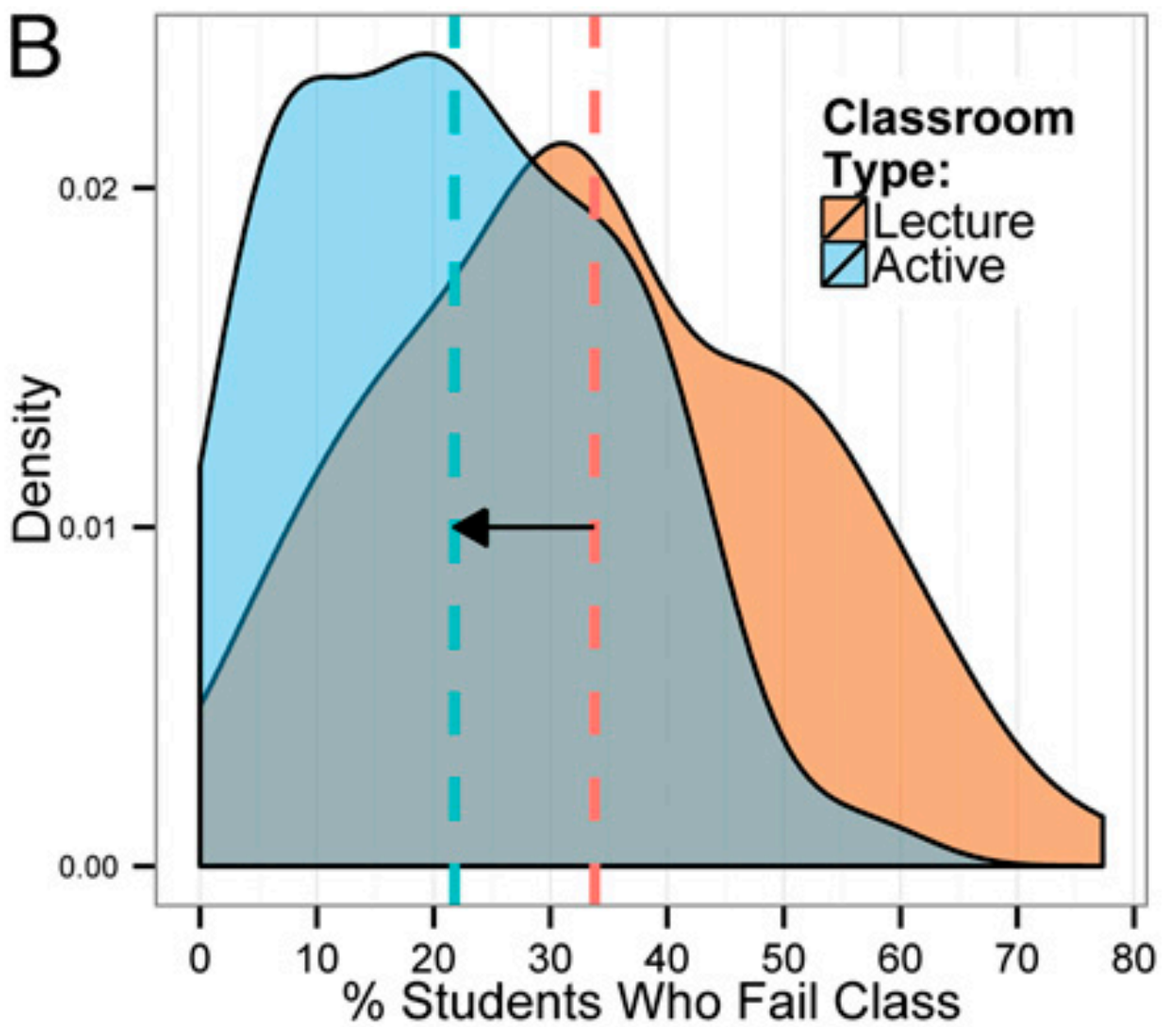
Active Learning in STEM

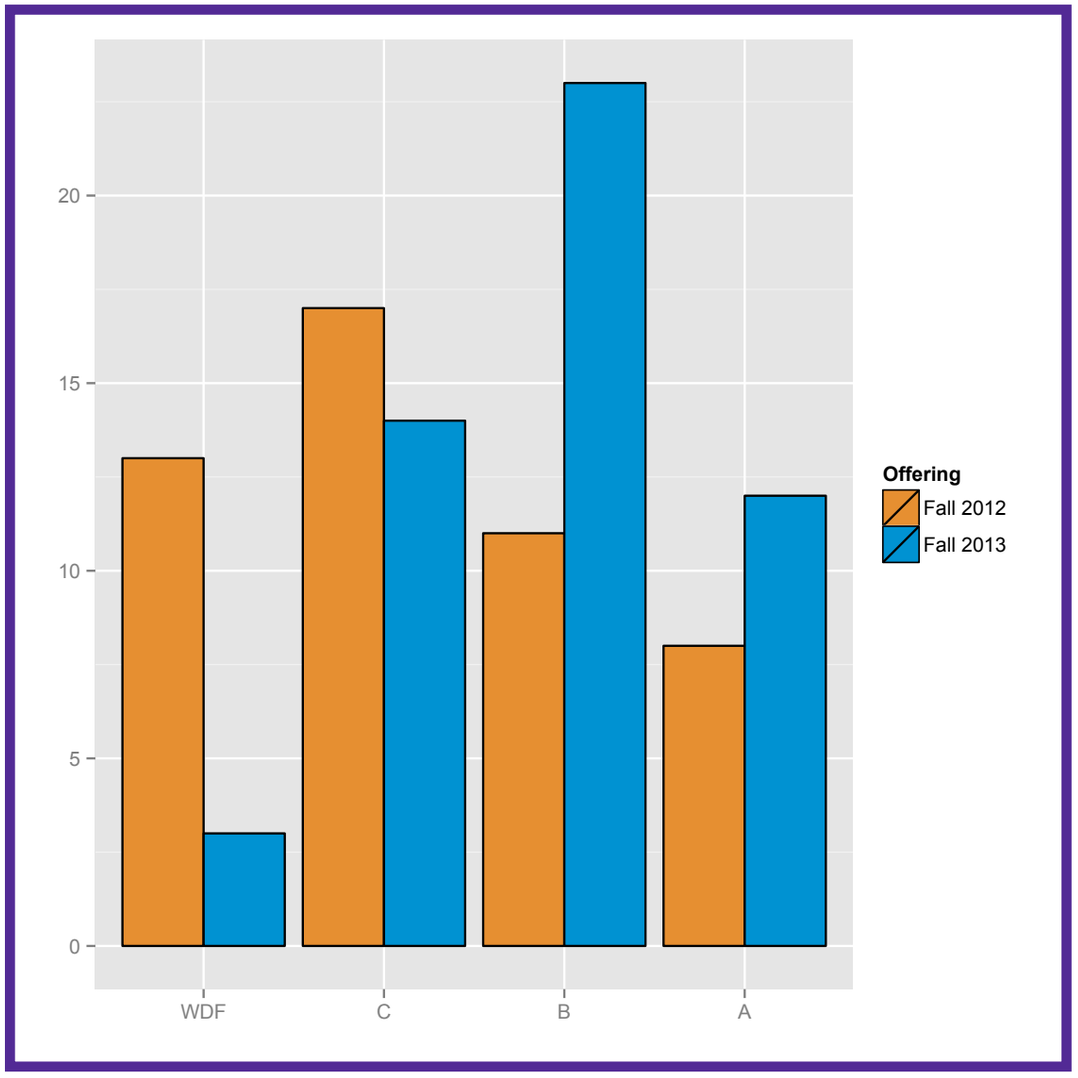


Metaanalysis of 225 studies

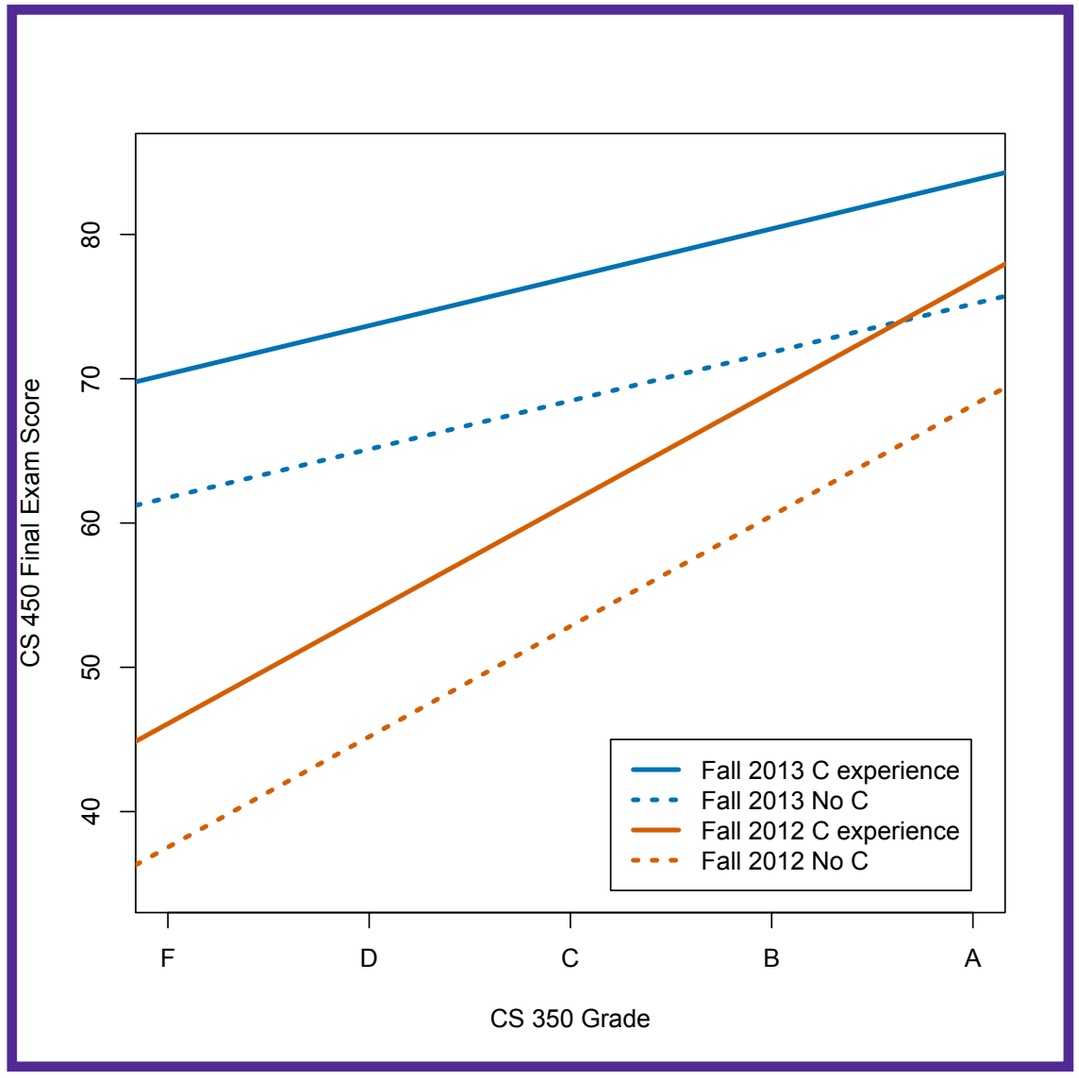
- 158 studies: average 0.47 SDs better on CIs/exams
- 67 studies: average failure rate dropped from 33.8% to 21.8% with active learning

S. Freeman *et al.*, "Active learning increases student performance in science, engineering, and mathematics," Proceedings of the National Academy of Sciences 111(23), 8410- 8415, 2014. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4060654/pdf/pnas.201319030.pdf

Active Learning in CS 450



Course grades in CS 450 for Fall 2012 vs. Fall 2013



Final exam performance for Fall 2012 vs. Fall 2013

M. Kirkpatrick and S. Prins, "Using the Readiness Assurance Process and metacognition in an Operating Systems course," ITiCSE, 2015.

Terminology Detour

Active learning
- Requires students to engage in meaningful activities

Collaborative learning
- Students work together toward common goal

Cooperative learning
- Like collaborative, but individual assessment

Flipped classroom
- Delivers content outside of classroom

Problem-based learning
- Relevant problems used to provide context

Team-based learning
- A specific teaching strategy designed by Larry Michaelsen

Survey

On a scrap of paper, respond to the following question:

What is your biggest concern about adopting an active learning pedagogy in your course(s)?

First reading

Question

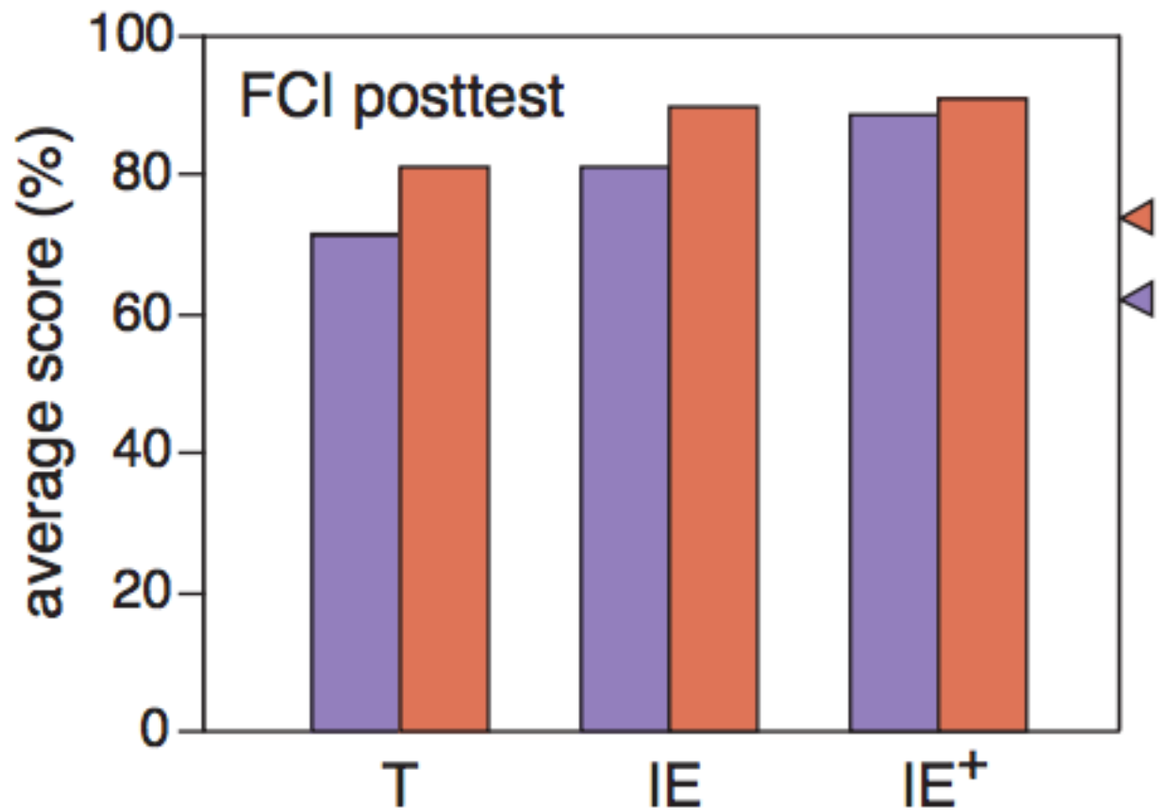
Which of the following statements best summarizes the relationship between pedagogy and the gender gap in physics?

A. There is a small gender gap on the pretest, and the performance gap increases in traditional lecture.
B. Courses with interactive structures yield greater performance gains from the pretest to the posttest among women than men.
C. Cooperative learning courses improve women students' confidence, but show equal performance gains from pretest to posttest among men and women.

Closing the Gender Gap

Cooperative learning closes the gender gap

- Pretest scores were 10% points higher for men
- Gap persisted with lecture alone
- Posttest results for cooperative classes were almost equal



PI can eliminate gender gap in physics

- T: traditional lectures
- IE: interactive lectures
- IE+: interactive assignments, lectures, tutorials

E. Mazur, "The scientific approach to teaching: Research as a basis for course design," keynote/plenary talk at the International Computing Education Research Conference (ICER), 2011. http://mazur.harvard.edu/search-talks.php?function=display&rowid=1712

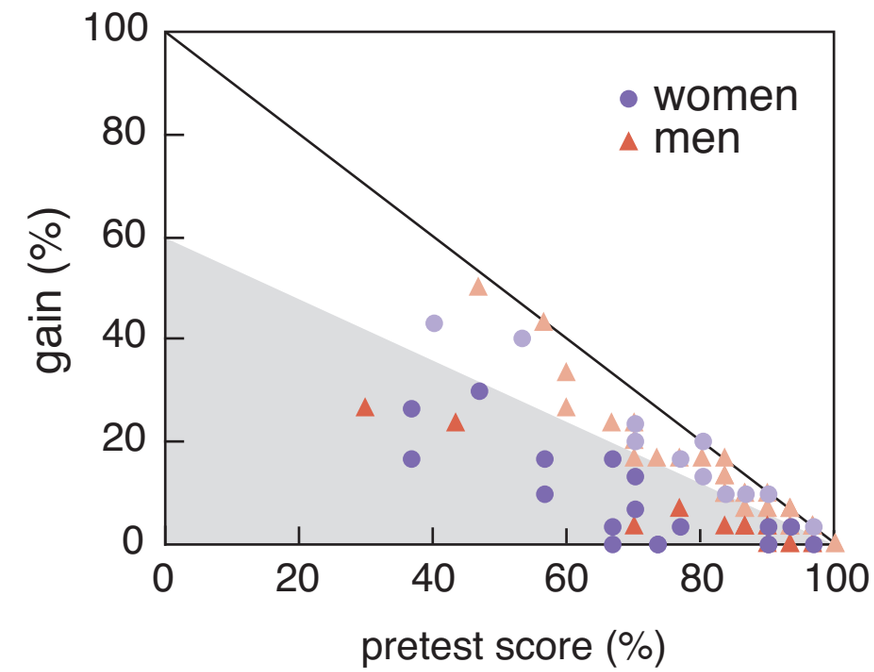
Closing the Gender Gap

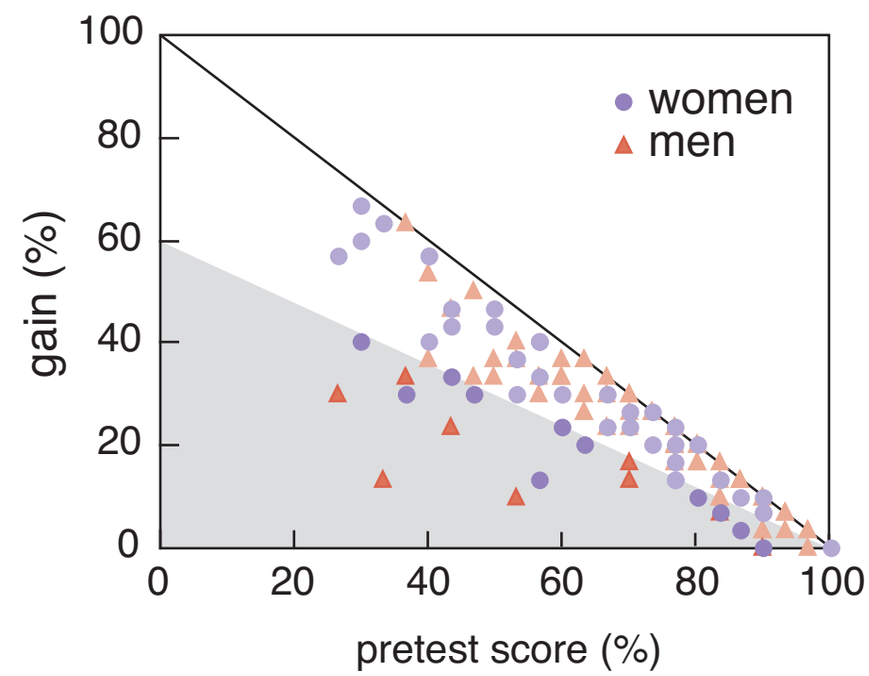
Traditional lectures leave women behind

- Women tend to have smaller performance gains

Cooperative learning improves gains for women

- ...but men improve as well





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Question

When in-class demonstrations were studied, which group of students did the **worst** in the sense that they missed the most points?

A. Students who did not observe a demo
B. Students who only observed a demo
C. Students who predicted the outcome before it occured
D. Students who discussed the outcome afterward

Demos and Engagement

Performance and understanding increase with engagement

- Those who only observe sometimes **<u>learn it wrong</u>**
- Those who discuss show clearer reasoning and provide partially correct answers

mode	correct	incorrect
no demo	30%	70%
observe	18%	82%
predict	29%	71%
discuss	30%	70%

mode	correct	balances torques	no clear reasoning
no demo	31%	53%	42%
observe	42%	55%	42%
predict	41%	65%	32%
discuss	46%	85%	15%

Confusion and Understanding

"Please tell us briefly what points of reading you found most difficult or confusing."

- "Nothing was difficult or confusing."
- "I found the explanation inadequate. I don't understand the reasoning that led to the conclusion."

capillarity	correct	incorrect
confused	44%	56%
not confused	25%	75%

Laplace	correct	incorrect
confused	49%	51%
not confused	21%	79%

JiTT and PI

Just-in-time teaching (JiTT)

- Developed at IUPUI, Davidson College, U.S. Air Force Academy
- Goals: increase learning during class time, enhance motivation, encourage preparation, allow faculty to adapt to student needs
- Key features:
  - Online warm-up quizzes and puzzles (<24 hours before class)
  - Mini-lectures (~10 minutes)
  - Active classroom with exercises, worksheets, discussions, demos
  - Exit tickets

Peer Instruction

- Created by Eric Mazur (Harvard)
- Augment class with *ConcepTests*
  - Expose common misconceptions
  - Think-vote-pair-revote pattern

Question

Which classification(s) best describe JiTT and PI?

A. Active learning
B. Collaborative learning
C. Cooperative learning
D. Flipped classroom
E. Problem-based learning
F. Team-based learning

POGIL and TBL

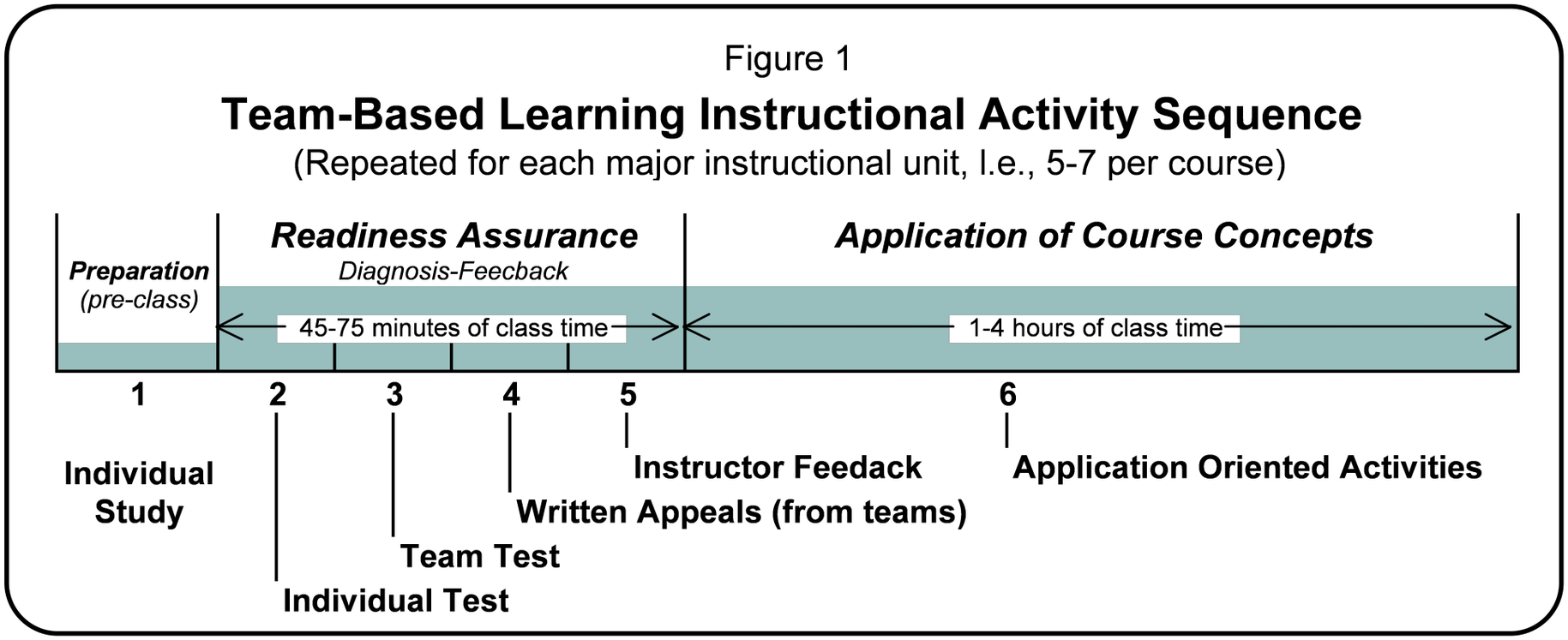
Process-oriented guided inquiry learning (POGIL)

- Developed by Richard S. Moog and colleagues (Franklin & Marshall, Stony Brook)
- Goals: teach **process skills** through inquiry-based learning
- Key features:
  - Teams with assigned roles
  - Carefully structured activities to build up to a concept

Team-based learning (TBL)

- Created by Larry Michaelsen
- Goals: work cooperatively to **apply** concepts to solve significant problems
- Very specific structure for course with 5-7 modules
  - Permanent, instructor-assigned groups
  - iRAT/tRAT - preparatory tests of reading understanding
  - 4 S's - Significant problem, same problem, specific choice, simultaneous reporting

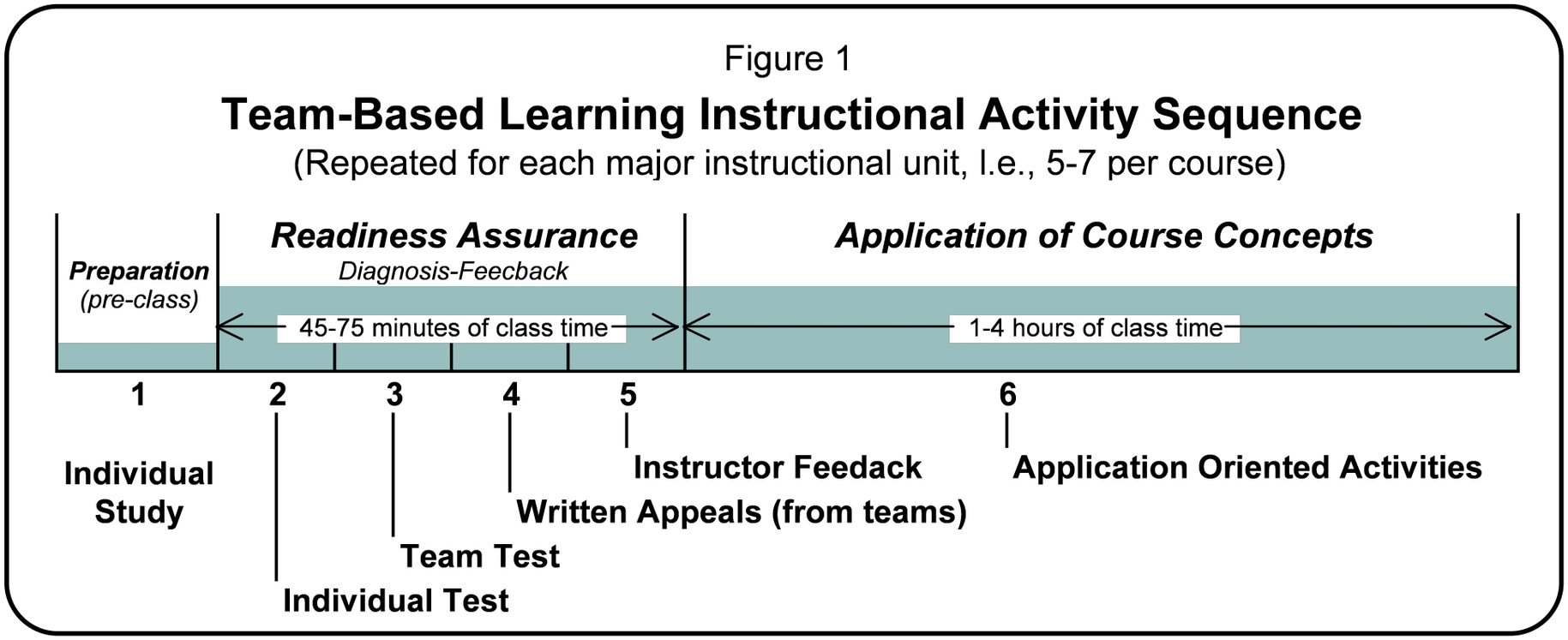
TBL Module Structure



POGIL Handout

iRAT and tRAT

TBL Module Structure



TBL Handout

PLTL and PBL

Peer-led team learning (PLTL)

- Developed by David K. Gosser (CUNY) and others
- Recruit **and train** peers from recent classes
- Course instructors design materials used during weekly peer workshops
- Goals: build community of practitioners, identify and address misconceptions quickly, give advanced students practice

Problem-based learning (PBL)

- Use relevant problems to provide context for learning
- No clear instructional pattern or strategy
- Literature is inconsistent in use
  - Evidence is dependent on definition, which varies

Reflection and Exit Ticket

Resources

Process-oriented guided inquiry learning (POGIL)

- http://pogil.org/

Team-based learning (TBL)

- L. Michaelsen, A.B. Knight, L.D. Fink, *Team-Based Learning: A Transformative Use of Small Groups in College Teaching*, 2004.
- http://learntbl.ca/

Peer Instruction (PI)

- E. Mazur, *Peer Instruction: A User's Manual*, 1996.
- http://mazur.harvard.edu/research/detailspage.php?rowid=8

Just-in-Time Teaching (JiTT)

- G. Novak and A. Gavrin, *Just-In-Time Teaching: Blending Active Learning with Web Technology*, 1999.
- http://jittdl.physics.iupui.edu/jitt/