

Impact of Peer Instruction on underrepresented groups

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Diversity and Peer Instruction

Key question: Does Peer Instruction serve underrepresented groups well?

- Conceptual inventories
- Grades*
- Retention*

Many other questions could be asked!



Pedagogical best practices for girls

Research (both K-12 and higher ed) suggests:

- Actively involve students
- Promote cooperative learning/decrease competitiveness
- Emphasize deep understanding
- Build on prior knowledge and experiences
- Provide real-world examples/social context

... These practices generally benefit *all* students



For a review see Brotman and Moore (J. Res. Sci. Teach, 2008).



Best practices for URM

- ❑ Many of the same strategies as for girls
- ❑ Combat isolation: provide structured opportunities for group work
- ❑ Provide active academic mentoring



See for example Treisman (Coll. Math. J., 1992); Maton et al (J. Res. Sci. Teach, 2000).



Do female students achieve at the level of male students with Peer Instruction?



Pedagogy and gender

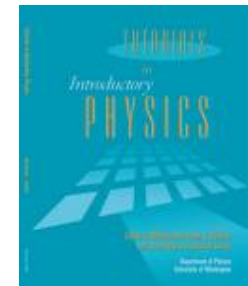
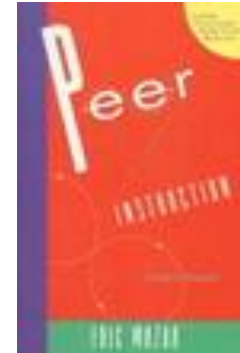
- Calculus-based introductory mechanics for non-majors at Harvard University, 1990 - 1997
- 150-200 students each year, 30-40% women
- Administered Force Concept Inventory as pre- and post-test



First study: pedagogy and gender

Three pedagogies:

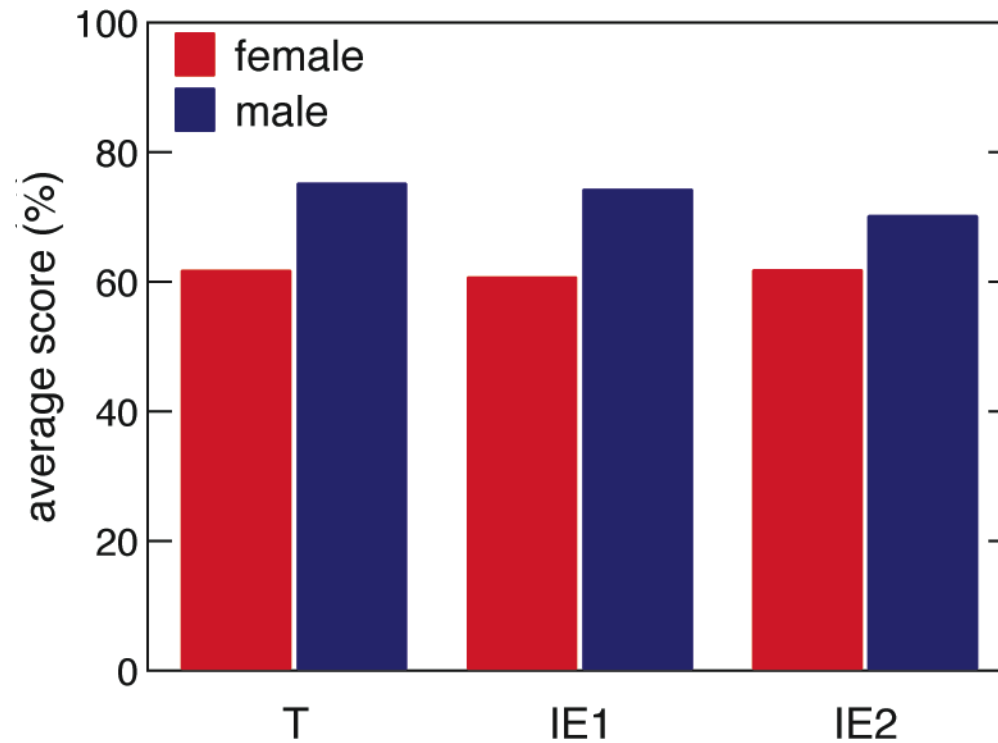
- ❑ Traditional (passive lecturing)
- ❑ Partially interactive (IE1):
Peer Instruction in class
traditional discussion section
- ❑ Fully interactive (IE2):
Peer Instruction in class
Tutorials and cooperative groups in section



How does male and female performance compare?



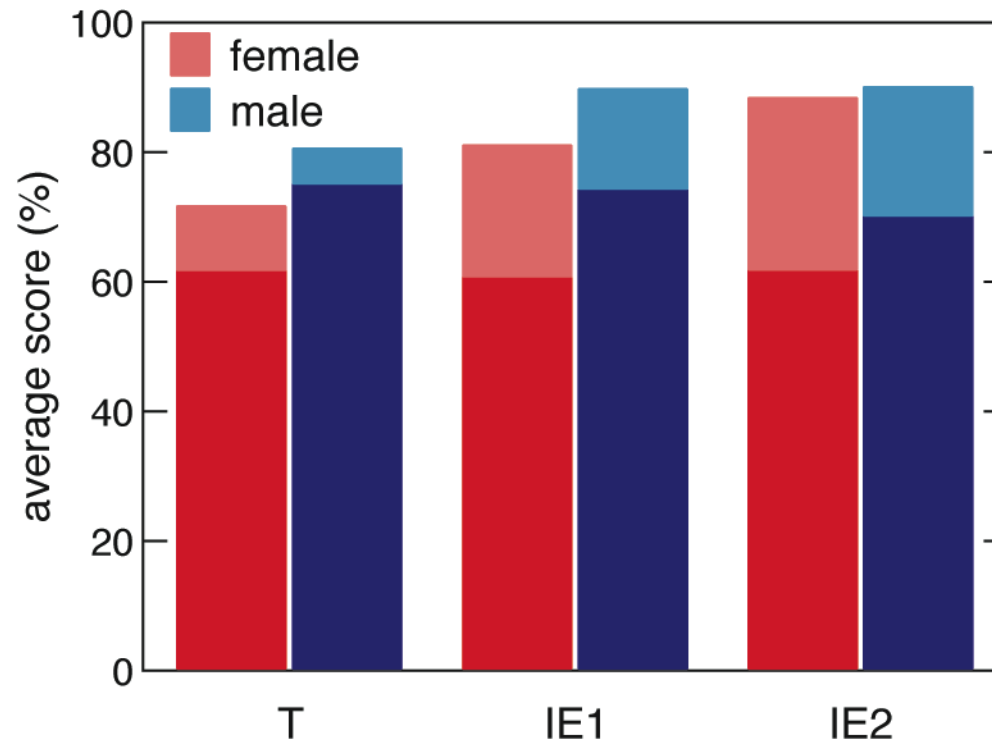
Results: FCI pretest



Female students start out behind



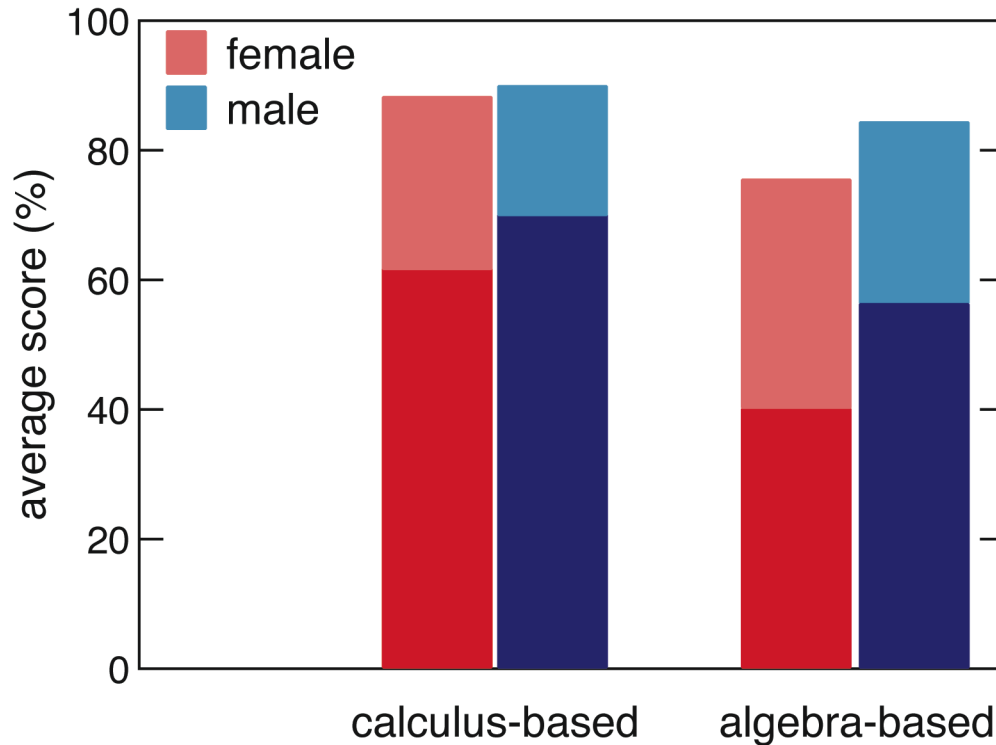
Results: FCI posttest



Fully interactive instruction appears to eliminate gap



Results: algebra-based



Algebra-based (IE2): females gained more BUT lower posttest scores, slightly smaller normalized gains



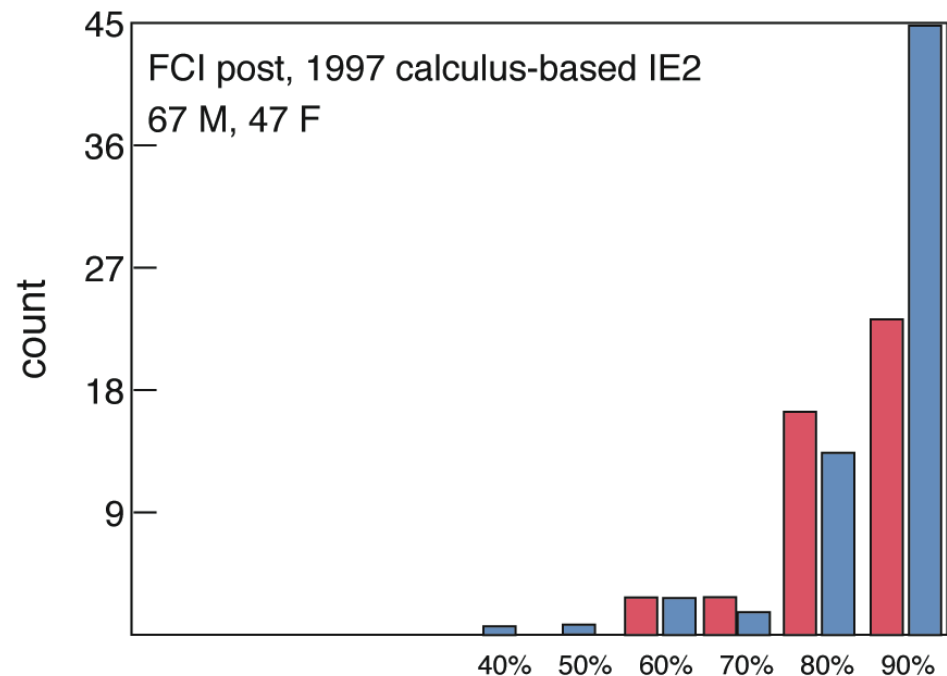
How do we interpret this?

- Many FCI measures
 - absolute gain
 - normalized gain
 - absolute posttest score
- What do we really want to know?
- Regression analysis: control for background



Problem: high posttest scores

- Non-normal posttest score distribution: ceiling effect, invalidates linear regression

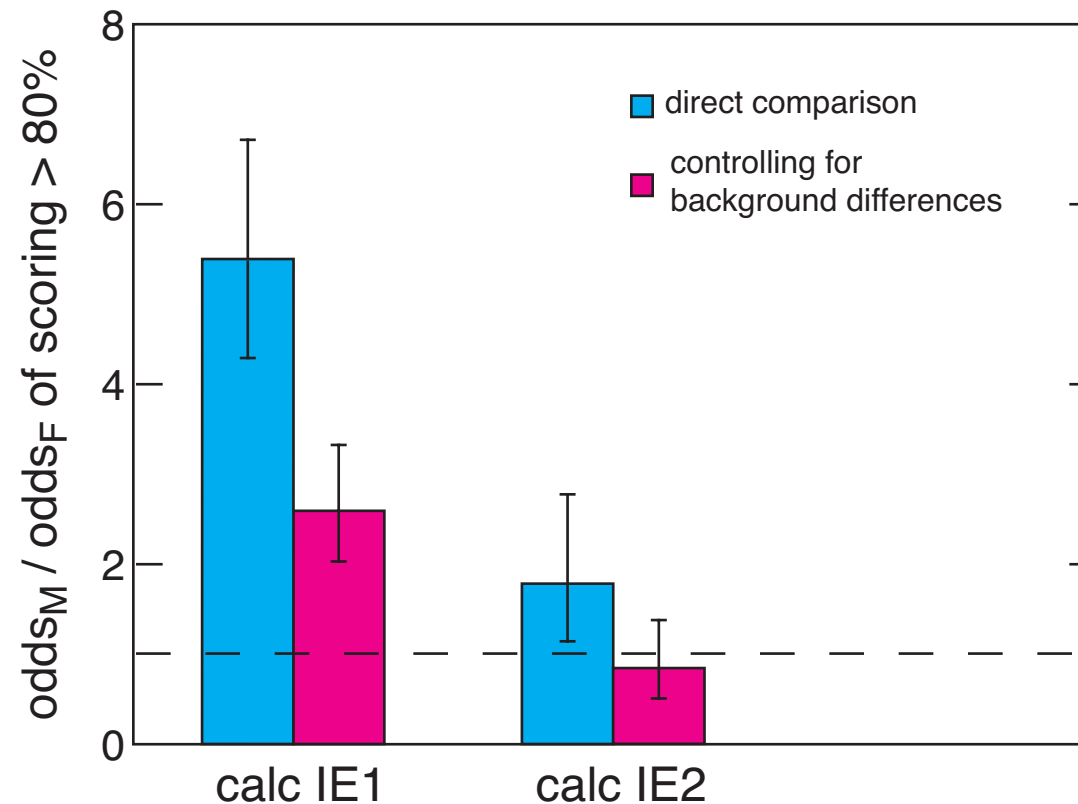


- Solution: divide into high and low scorers



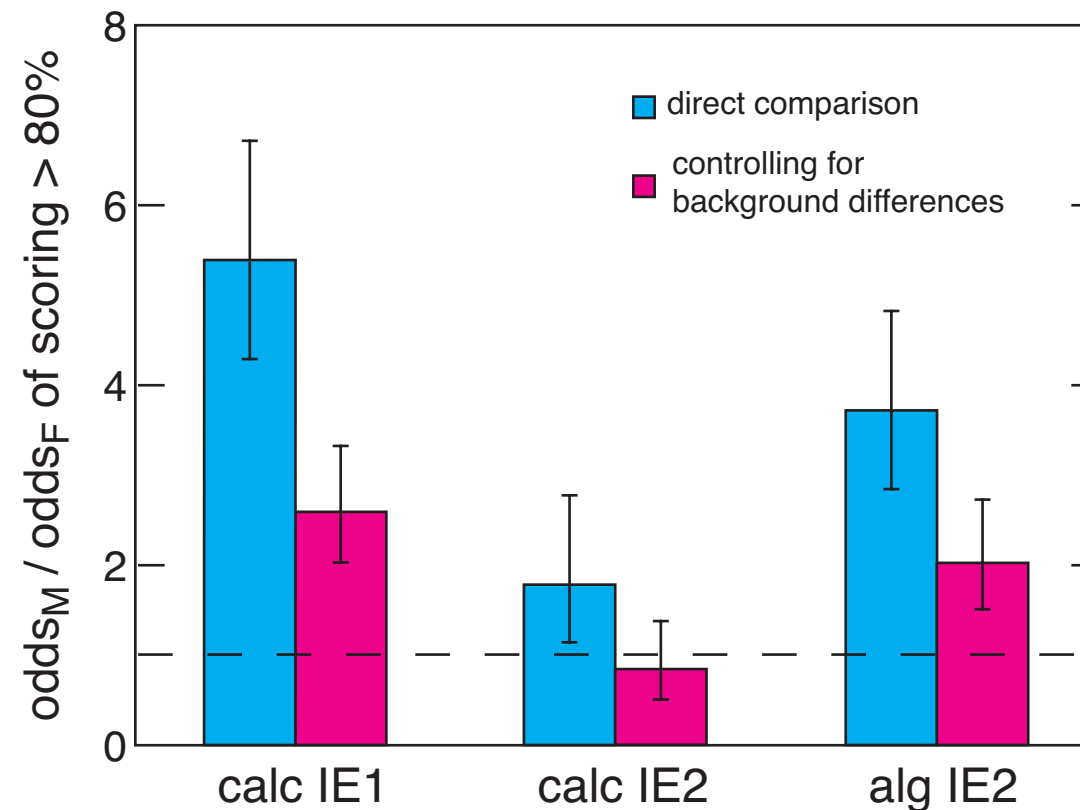
High/low scores: logistic regression

- Find probability of scoring $>80\%$
- IE2: equal male/female odds accounting for background



High/low with algebra-based

- More male high scorers
- Background accounts for much but not all of difference

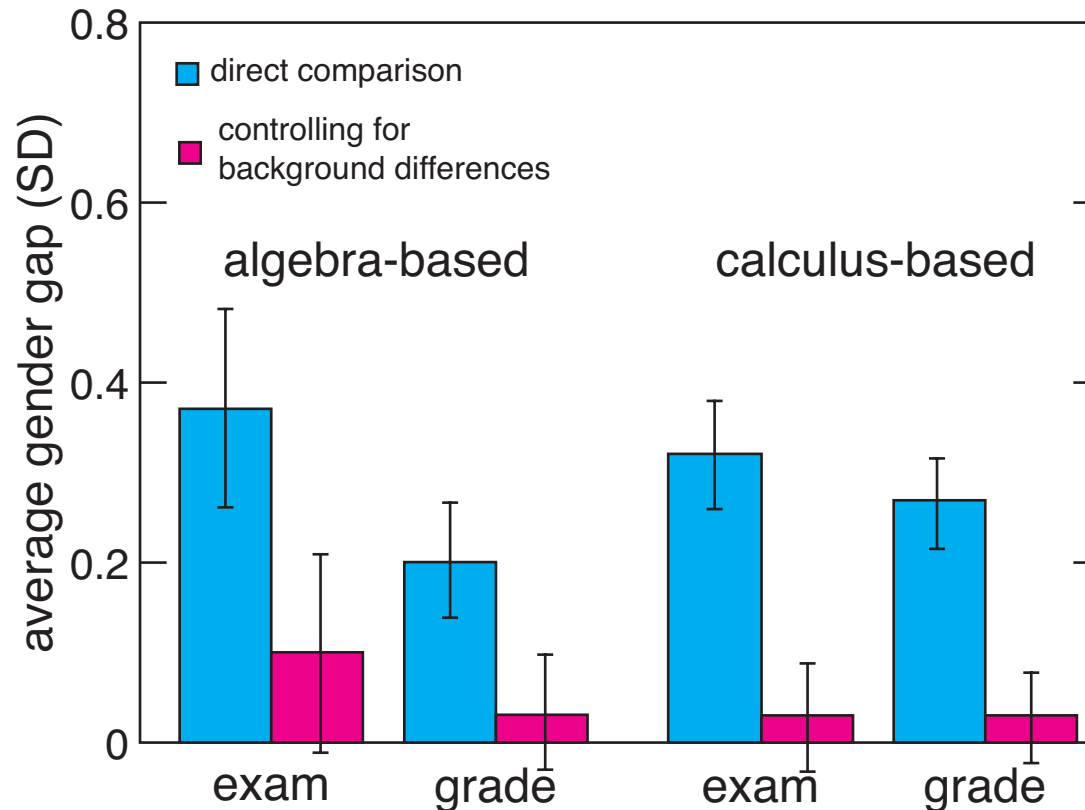


Exam scores and grades

- ❑ FCI analysis still murky (ceiling effect)
- ❑ Exam scores and grades matter!
- ❑ Normally distributed; can use linear regression



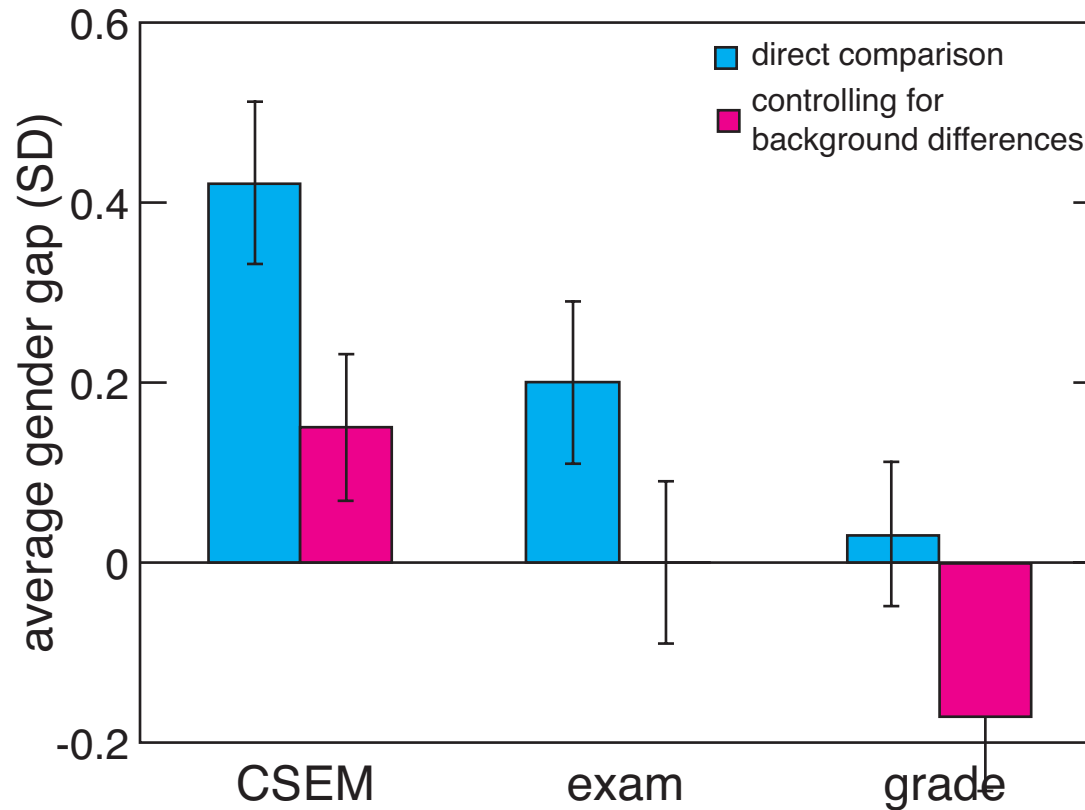
Exam scores and grades: gender



Males earn slightly higher exam scores (~4-5%) and course grades (~2-3%) than females
Gap is entirely attributable to background



Electricity and magnetism: gender



Exam, grade gaps attributable to background
Females earn *better* grades by background!
Small CSEM gap (2 points out of 32)



Gender and Peer Instruction

- ❑ Females have weaker average preparation (FCI pretest)
- ❑ *All* students show greatest FCI gains from PI/IE2
- ❑ Females do as well on exams, grades, and CSEM as males with the same background (FCI murky)



University of Colorado results

- Also use PI (both with and without other innovations)
- Larger class (400-600), smaller fraction female
- Average pretest score is lower
- Broadly consistent conclusions about gender effects in mechanics

Pollock *et al*, PRST-PER 3, 010107 (2007)

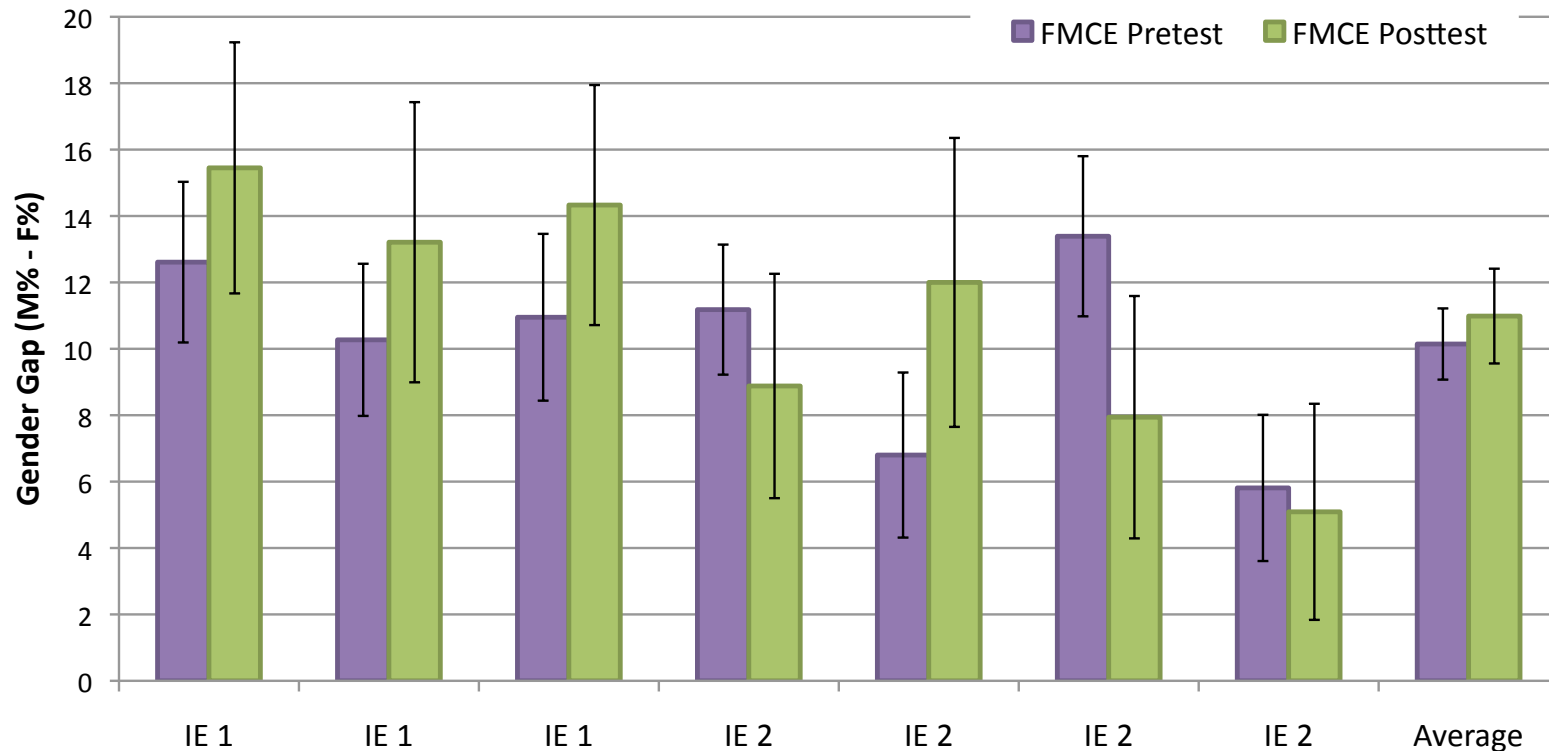
Kost *et al*, PRST-PER 5, 010101 (2009)

Kost *et al*, PERC Proceedings (2009).



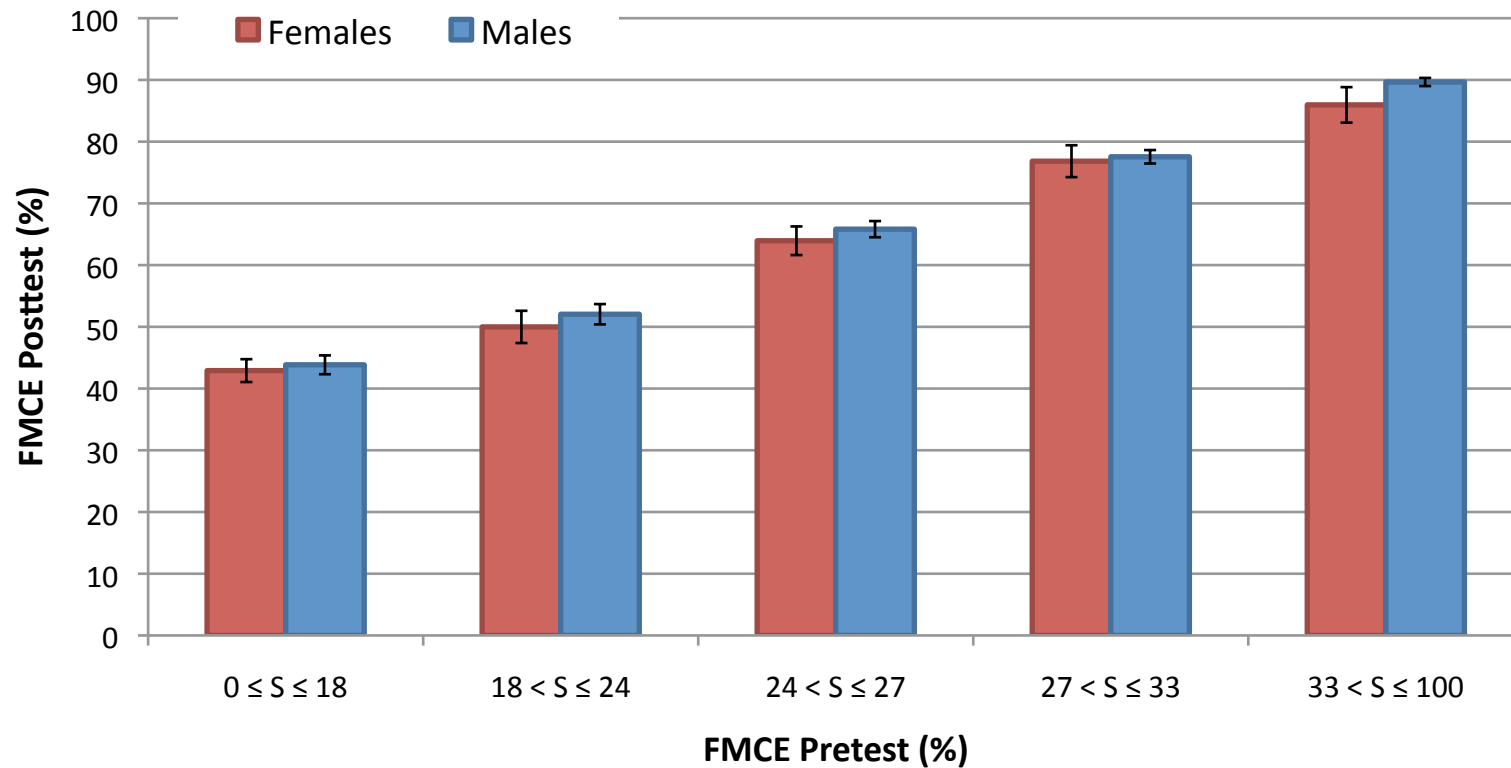
UC: FCME and gender

- Same absolute gains by males and females
- Posttest gender gap often smaller, but never zero
- PI/IE2 implementation probably matters



UC: FCME, gender, and background

Posttest gap is accounted for by background



UC: grades and gender

- ❑ Over seven semesters, females earn very slightly lower grades (0.11 points on 4 point scale)
- ❑ This difference can be accounted for by background (Kost, personal communication)
- ❑ Differences in individual semesters range from 0.04 to 0.17 points (not significant)
- ❑ Males' exam scores are higher by $\sim 5\%$; females' homework scores are higher by $\sim 5\%$



Gender and Peer Instruction

Bottom line: PI appears to serve female students as well as male students, but does not overcome starting gaps

Implementation is probably important!

Consistent with University of Minnesota study of FCI and grades

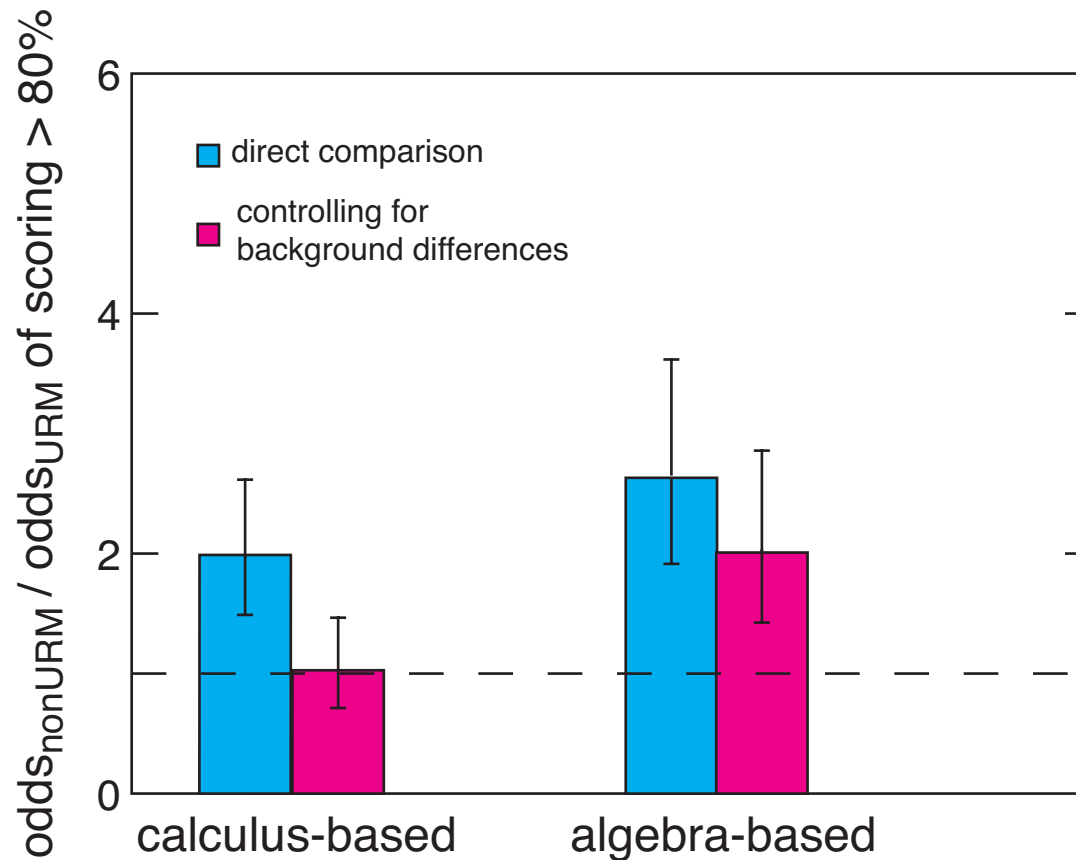


Do underrepresented minorities achieve at the level of majority students with Peer Instruction?

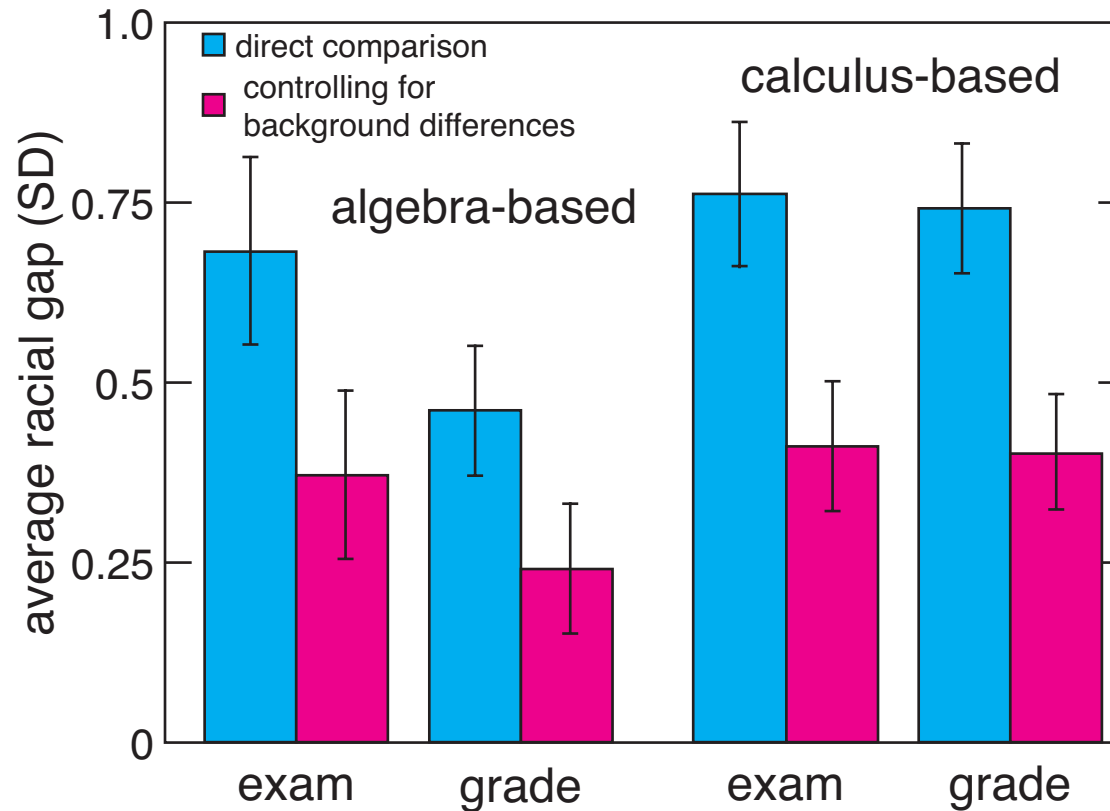


FCI high/low with URM

- Calc-based shows no gap after controlling for background, slight gap persists in alg-based



Exam scores and grades: URM

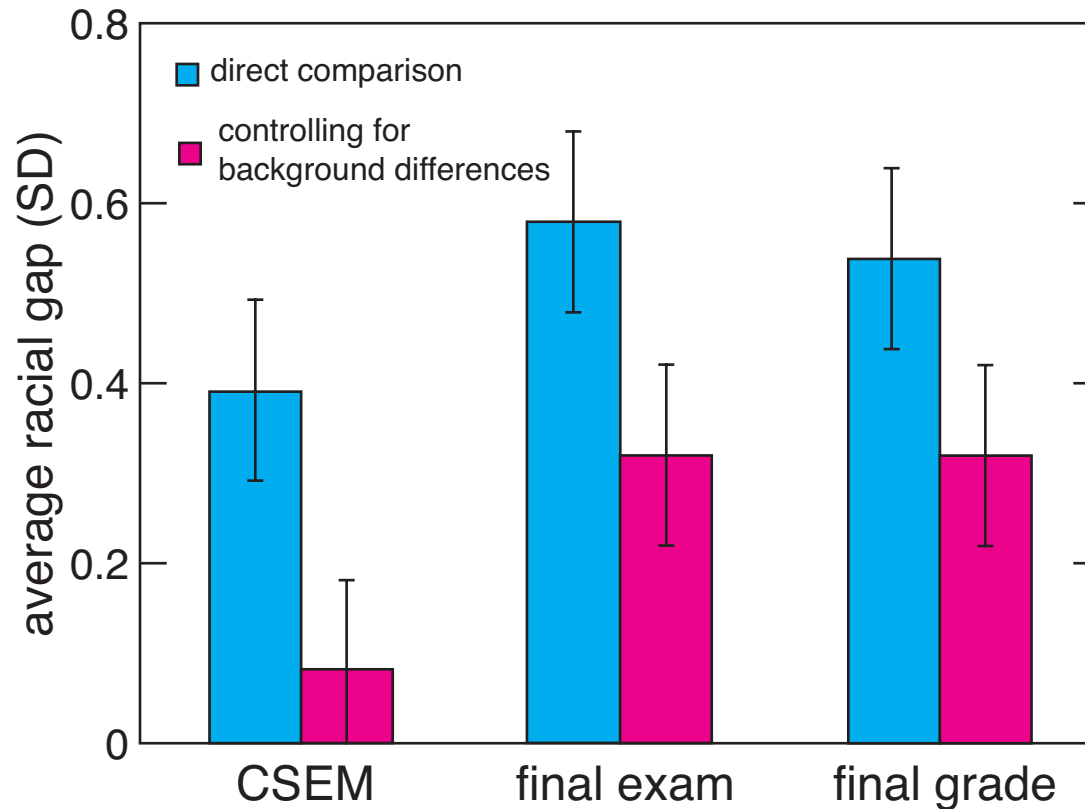


URM earn appreciably lower exam scores (8-13%) and grades (3-8%)

Gap is greater than background predicts



Electricity and magnetism: URM



CSEM gaps attributable to background, but not exams (~5-7%) or grades (~2-4%)!



URM and Peer Instruction

Key findings:

- ❑ Females and URM have weaker average preparation (FCI pretest)
- ❑ *All* students show greater FCI gains from PI
- ❑ Females do as well on exams, grades, and CSEM as males with the same background (FCI murky)
- ❑ In this population, URM do as well on CSEM, but underperform on exams and grades



Why the URM grade gap?

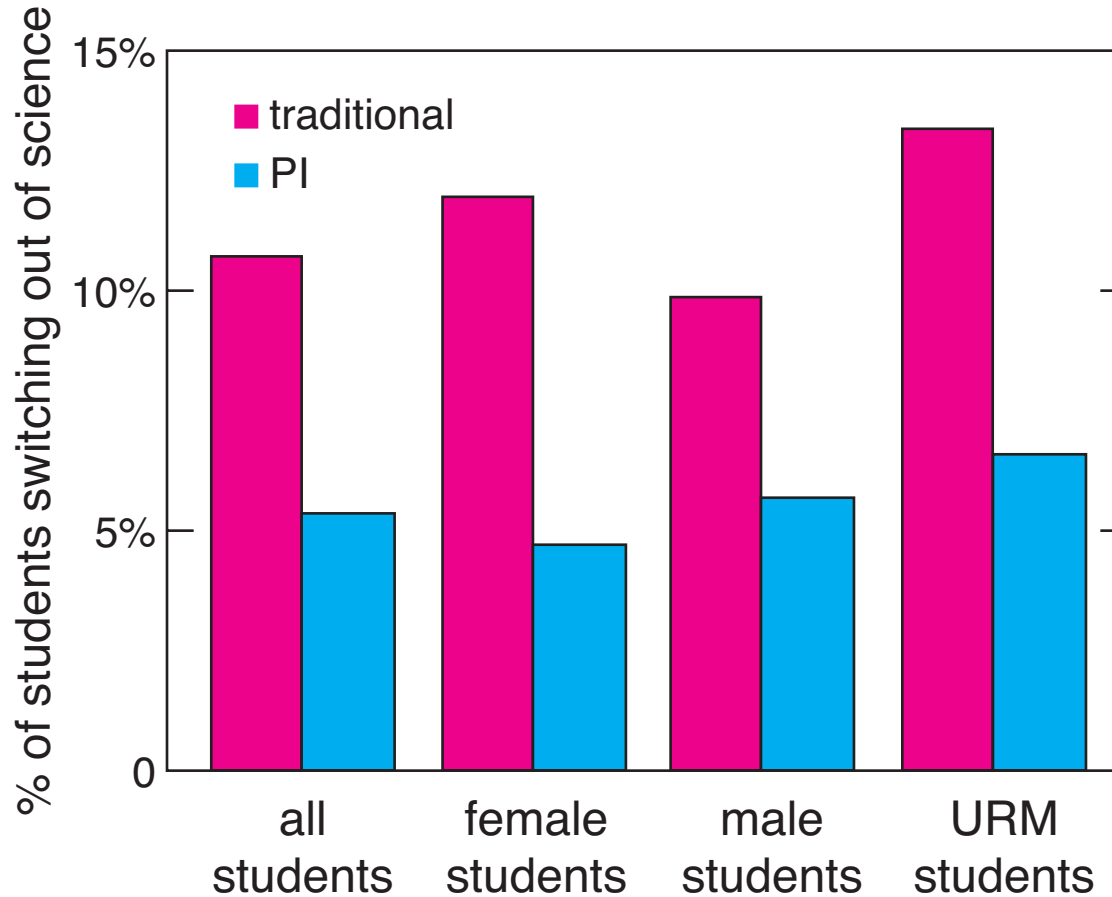
- ❑ URM homework scores (quantitative problem solving) are lower
- ❑ URM students may not be collaborating as much
- ❑ Stereotype threat on high-stakes assessments?



Does Peer Instruction affect retention of
underrepresented groups in science majors?



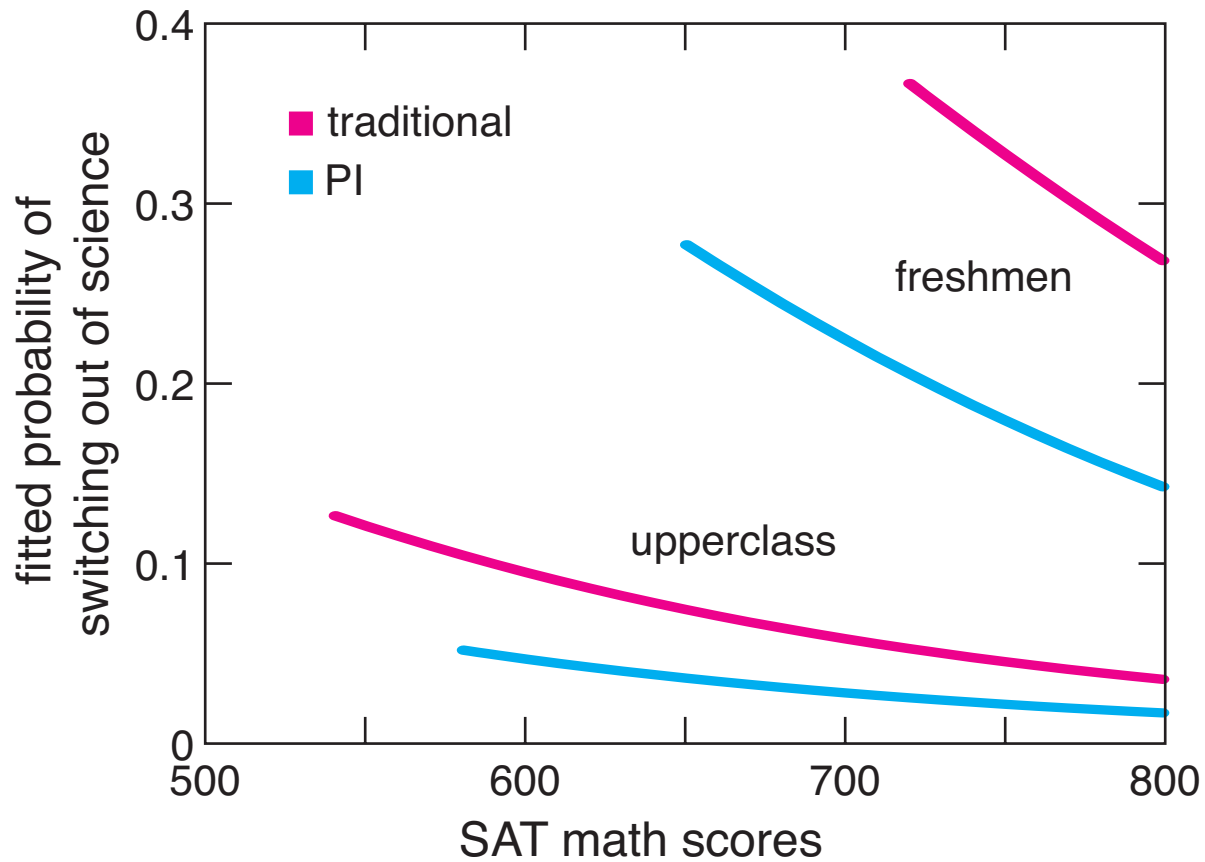
Retention: Harvard calc-based



PI halves the rate of switching out of science for all groups



Retention



PI halves the rate of switching out of science for all groups



Retention

Study of prospective engineers: one good early course confirmed choice to pursue engineering

PI course might play that role?



Lichtenstein, ASEE Annual Conference, 2007.



Other questions for other talks

How does implementation affect underrepresented groups?

Does PI affect attitudes and confidence differently for males and females?



Conclusions

- ❑ Females/URM have weaker preparation
- ❑ Although PI/IE2 produces greater gains for all students, differences persist
- ❑ Gender gaps attributable to background
 - > PI appears to serve females as well as males
 - > pay attention to implementation
- ❑ URM students underperform in grades even accounting for background
 - > requires further study
- ❑ PI courses improve retention for all groups



Thanks to....

Jessica Watkins

PER@Colorado (especially Lauren Kost, Noah Finkelstein, and Steven Pollock)

University of Minnesota PER (especially Jen Docktor and Ken Heller)

NSF for funding

New results from Kost and Watkins: Session DH,
Pavilion West, 5:40 – 6 p.m. today!

