Reducing the gender gap in the physics classroom

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Why be concerned?

- Boys outperform girls on K-12 standardized science tests (NAEP, TIMSS)
- K-12 science gender disparities increase with age
- In AP physics only 36% (AP-B) or 27% (AP-C) of students are girls
- Only 22% of bachelor’s degrees in physics are earned by women
Pedagogy and gender

Some proposed sources of K-12 gender gap:

- Girls have less hands-on experience with science
- Science perceived as a male activity: girls are less confident and encouraged less
- Girls perceive (physical) science as less beneficial to society
- Teachers often interact less with girls than with boys
- Boys often dominate classroom activities
Pedagogy and gender

Some teaching practices that appear to help:

- Placing science in a wider context
- Hands-on experiences
- Non-competitive environment
- Opportunities for all students to ask and explain
- Frequent feedback (praise and constructive criticism) to all students
Interactive engagement

Research-based pedagogies:
- Involve all students actively in learning
- Require students to articulate their ideas
- Frequently involve collaborative or cooperative activities
- Frequently involve hands-on activities

Student learning gains demonstrated thoroughly

Do these pedagogies help female students?
Study: effect of pedagogy

- 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
Study: effect of pedagogy

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
Study: effect of pedagogy

*Peer Instruction*:  
- Lectures interspersed with conceptual questions  
- All students given time to think, respond, and discuss  
- Students gain conceptual understanding  
- Quantitative problem-solving skills remain strong

Study: effect of pedagogy

*Tutorials*: (Univ. of Washington PERG)
- Students work in small groups through guided exercises
- Exercises focus on research-identified student difficulties
- Exercise require students to explain their ideas

*Cooperative group problem solving*: (Heller group)
- Students instructed in problem-solving strategies
- Groups of three work on challenging problems
Results: FCI pretest

Female students start out behind
Results: FCI posttest

Fully interactive instruction eliminates gap!
Results: FCI posttest

IE2: similar numbers of male and female high scorers
Results: FCI normalized gain

\[ g = \frac{\text{post} - \text{pre}}{100 - \text{pre}} \]
Results: grades

More comparable grade distributions with IE2
Why IE2?

- Consistent emphasis on concepts and understanding
- Provides more practice articulating ideas
- May increase female students’ confidence and comfort with interaction
- Research required to understand this!
Does it always work?

- Algebra-based: females gained more, but didn’t catch up
- Calculus-based: may be saturating the test
Does it always work?

- Reformed methods often help, but not always .... (Finkelstein A21.003)
Conclusions

In the Harvard calculus-based course:
- All students benefit from interactive instruction (IE1 and IE2)
- FCI gender gap eliminated in IE2 course
- Comparable number of male and female high scorers in IE2
- Grade distributions become more balanced

Talk posted at http://mazur-www.harvard.edu
# Data tables: FCI and FBT

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<th>Group</th>
<th>Year</th>
<th>$N^M$</th>
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<th>FCI Posttest score (%)</th>
<th>FCI Pretest score (%)</th>
<th>MBT (%)</th>
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## Data tables: FCI gains

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** These $p$-values are calculated from the distributions of individualized normalized gain for males and for females. No $p$-values are calculated for the $T$ group because of the lack of a pretest; the gains are calculated using the average IE pretest.
IE1 grade distribution

traditional

IE1
Both male and female low posttest scores eliminated
Comparable numbers of male and female high scorers