The Current Status of Women in Physics

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http://physics.uwstout.edu/staff/mccullough/physicseduc.htm#Presentations
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Overview

- Current status of women in physics
- Gender gaps in the physics classroom
- Better pedagogy = more women?
Women’s Education

Women make up 50.7% of the US population (2007)

Women receive

- about half of all high school diplomas,
- 62% of associates degrees
- over half of all bachelor’s degrees (58%),
- 60% of master’s degrees, and
- 51% of doctorates

Women in Physics

- Women earn majority of degrees
- What pattern in physics?
High school physics

2008:

47% of high school physics students are women*

37% of males study physics; 33% of females**

4.1% of males and 2.4% of females took AP/IB physics**

Undergraduate Physics

Women make up ~31% of two-year college physics students*

Among 25-year old college attendees who have had physics, 37% are female**

Women receive 20% of physics associates degrees***

Women receive 21% of physics bachelors degrees***


***Data from http://caspar.nsf.gov (NSF and NCES sources) 2007 data
21% of first-year graduate students are women

Women receive 23% of master’s degrees in physics

18% of physics doctorates go to women

Teaching positions

29% of high school physics teachers are women*
14% of 2-yr instructors in physics are women**
19% of adjunct/instructors in physics are women***
17% of assistant professors in physics are women***
14% of associate professors in physics are women***
6% of full professors in physics are women***


Women making progress, but still under-represented in physics

Salary equity at assistant & associate levels; 8% gap for full professors

• Gender Differences at Critical Transitions in the Careers of Science, Engineering and Mathematics Faculty. (2009). Committee on Gender Differences in the Careers of Science, Engineering, and Mathematics Faculty; Committee on Women in Science, Engineering, and Medicine; National Research Council. Available at http://www.nap.edu/catalog.php?record_id=12062.
Issues for women in the field

- Decision to have children
- Decision when to have children
- Trailing spouse
- Caregiver duties for children/spouse/parents
- Work/life balance
- Lack of family-friendly policies
The two-body problem

Women in physics more likely to have physicist spouse:

- 43% married female physicists are married to physicists
- 6% of married male physicists are married to physicists

More issues

- Subtle harassment
- Subtle discrimination
Women’s Physics Education

- Lack of women in physics classes & jobs
- What’s a physics educator to do?
- How do women interact with physics classes?
Gender gap in the physics classroom

How do women fare in the physics classroom?

In high school, girls tend to get higher grades than boys

In high school science class, girls receive higher grades than boys

• Hazari, Z., Sadler, P., Tai, R. Gender differences in the high school and affective experiences of introductory college physics students. Phys. Teach. 46, 423-427
# K-12 NAEP Science Assessment

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<tr>
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</table>

Data from [http://www.nsf.gov/statistics/seind08/c1/c1s1.htm](http://www.nsf.gov/statistics/seind08/c1/c1s1.htm)
Women in college tend to earn higher grades than their male counterparts.

Women’s SAT/ACT scores tend to under-predict their college GPA.


Women earn lower grades than men in college physics

College physics grades

Women more likely to do better than men among students who had HS physics

In university-level (calculus-based) physics, women receive lower grades than men

Professor of same gender ➔ higher grade in college physics course

Conceptual testing

Many multiple-choice conceptual tests are available for introductory physics courses; how do women fare on these tests?
Women average lower scores on the FCI at all class levels; this gap does not seem to be dependent on previous physics background*

Gender gap on FMCE present with or without high school physics; gap is worse with no high school physics**


Test of Understanding Graphs-Kinematics

21 question test on kinematics graphs

From the test author:

Males averaged 9.5/21 (45%)

Females averaged 7.2/21 (34%)

Statistically significant gap favoring males

The DIRECT conceptual test on direct current circuits shows a gender difference at the university and high school levels; both differences were found to be statistically significant.

<table>
<thead>
<tr>
<th></th>
<th>University mean score</th>
<th>High school mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>16</td>
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<tr>
<td>Women</td>
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</tbody>
</table>

Gender gaps exist

- Lower rates of participation of women in physics
- Conceptual tests show gap favoring males
Do interactive pedagogies help women in physics?

Belief that IE courses are better at recruiting and retaining women

Many, many publications recommend IE as a strategy for promoting women’s participation

What is the evidence for this?
Bad pedagogy

“Reports of poor teaching in S.M.E. classes were by far the most common complaint of all switchers and non-switchers.”

Pedagogy was third-highest rated reason for leaving science

Science teachers less likely to use active learning techniques; more likely to grade on curve

Good pedagogy: Harvard IE implementation

FCI gender gap (pre, post, norm. gain)
IE1: reduced gender gap
IE2: reduced gap to statistical insignificance

CU-Boulder implementation

Three stages: traditional, IE₁, IE₂

IE₁ and IE₂ did not necessarily reduce the gender gap: no average reduction in gap

Teacher effects?

U of Minnesota implementation

- Examine IE courses (differing implementation)
- No significant instructor effect on reducing gender gap
- Higher pre-test scores more likely to reduce gap (like Harvard)
- Lower pre-test scores less likely to reduce gap (like CU-Boulder)

Avila implementation

- Workshop Physics style course with CGPS
- FMCE gender gap not reduced with IE
- FMCE <g> connect with MPEX for females?

Rutgers program

Extended Analytical Physics: alternative course to Analytical Physics; medium IE course

EAP course has significantly higher pass rate for women and URM than regular AP course

Curricular effects

Workshop Physics:
Younger college women $\rightarrow$ positive experience
More senior college women $\rightarrow$ more likely to feel negative about the interactive course structure

SCALE-UP:
Women were almost five times as likely to pass a SCALE-UP course than a traditional course

Other recent gender research


Issues with the Field

- Belief that we know what the problem is
- Belief that IE strategies will help women
- Belief that the problem is solved
- Lack of funding for replication studies
Issues in the future?

- Generational changes (X-ers, Millennials vs. Boomers)
- LGBTQ issues (gender & science vs. women & science)
- Continued lack of support for replication studies
Conclusions

- Women still under-represented in physics
- Gender disparities in physics classrooms
- Better pedagogy, while helping raise all students’ achievement, may be particularly helpful to women; much more research needed
Thank you!