Context and Gender in Science Assessment

Laura McCullough
Physics Department
UW-Stout
Women’s Education

- Women receive about half of all high school diplomas,
- about half of all bachelor’s degrees (56%),
- 57% of master’s degrees, and
- 42% of doctorates

What about physics?
High School Physics
50% of high school physics students are women! (28% of students take HS physics)

But...

Women are still not found in the AP courses which are better preparation for college coursework
Undergraduate Physics

- Women make up 31% of two-year college physics students
- Women receive 19% of physics bachelors degrees
Women receive 21% of master’s degrees in physics

13% of physics doctorates go to women

Is this a problem? Yes!
The Problem: Under-representation

- Severe under-representation of women in physics
- Need scientifically literate public and technological/scientific workers
- Need to be working to keep women
- Need to be doing research on how to keep women
- Women and physics education
Gender and Physics Education

Are physics classes contributing to the under-representation?

Yes! (Seymour & Hewitt, 1997)

What parts of physics classes might be?

Instruction; curriculum; assessment

Early analysis of one assessment suggested an issue
Gender and Physics Assessment

In two different assessments, women in undergraduate physics classes do more poorly than men:

- Grades
- Conceptual Questionnaires

Is there gender bias in physics assessments?
The Force Concept Inventory

The FCI is commonly used across the country in high schools and colleges.

30 question test covers topics usually taught in first term introductory physics.

Women routinely do worse than men on the FCI both pre- and post-instruction.
Gender and the FCI

- Study with 8 different higher education institutions
- Men and women took FCI
- Collected data on pre-test score, post-test score, gender, and where possible, previous physics background
## The Problem: Gender gap?

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<thead>
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<th>Post %</th>
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<g> Relative Gain

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<td>Women (N=780)</td>
<td>.34 (se=.01)</td>
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Why the gender gap?

What’s up with this test?
The men, the women, or the test?
Possible test bias?

An examination of the contexts of the FCI questions reveals an interesting pattern:
Test by males, for males?

- Stereotypically male contexts
- Almost every person is a male
- Written by a team of male physics education researchers
- Tested on mostly male high school students
Context & Response?

Rennie & Parker: changing context affected student response

Students preferred real-life context questions

More girls than boys preferred contextual questions (found the questions easier)

Enderstein & Spargo: changing context from native to urban changed responses
Evidence for Contextual Interaction

- Translated version of the test in Thailand
- Students wouldn’t answer this question!
- Cultural context completely blocked the science of the question
- Context affects performance!
How to test context?

- Change the context!
- New version of FCI with stereotypically female contexts
- As far towards a female bias as possible
- Also more daily-life situations
New FCI contexts

Thursday, October 21, 2010
Trial-testing in non-physics context

- Test with students at UW-Stout
- Use students in English and sociology classes – non-physics context
- Other concern: male culture of physics classrooms
## Overall comparison

### % correct UW-Stout

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<td>22.3 (N=79)</td>
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<tr>
<td>Men</td>
<td>33.7 (N=56)</td>
<td>28.5 (N=71)</td>
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Comparisons

- Overall, the scores did not show statistically significant difference between the versions.
- Women → 13 questions show increase in percent correct, 17 show decrease.
- Men → 5 questions show increase, 25 show decrease.
Item by Item

Look at particular questions:

- Cannonball ➔ baby bowl
- 2 males in chairs ➔ 2 female figure skaters
- Steel balls on table ➔ oranges on table
A ball is fired by a cannon from the top of a cliff as shown in the figure below. Which of the paths would the cannonball most closely follow?
Revised Question

A baby in a high chair slides her bowl of food horizontally off the side of her flat tray with a quick push. Which path below best represents the path of the bowl?
Women did much better, men did the same on the revised version.

<table>
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<td>34</td>
<td>51</td>
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<td>66</td>
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In the figure at right, student “a” has a mass of 95 kg and student “b” has a mass of 77 kg. They sit in identical office chairs facing each other. Student “a” places his bare feet on the knees of student “b”, as shown. Student “a” then suddenly pushes outward with his feet, causing both chairs to move.

During the push and while the students are still touching one another:

(a) 0 force
(b) a on b but not b on a
(c) b > a
(d) a > b
(e) a = b
Revised Question

Two figure skaters, Lisa who has a mass of 95 kg and Christine who has a mass of 77 kg, are standing on the ice with Lisa’s hands braced against Christine. Lisa suddenly pushes off of Christine, causing them both to move.

During the push and while the skaters are still touching one another:
(a) 0 force
(b) a on b but not b on a
(c) b > a
(d) a > b
(e) a = b
Women did better on the revised version, men did worse on the revised version. This revision decreased the gender gap.

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<td>5</td>
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Two metal balls are the same size but one weighs twice as much as the other. The balls roll off a horizontal table with the same speed. In this situation:

(a) both balls hit the floor at approximately the same horizontal distance.

(b) the heavier ball hits the floor at about half the horizontal distance than does the lighter ball.

(c) the lighter ball hits the floor at about half the horizontal distance than does the heavier ball.

(d) the heavier ball hits the floor considerably closer to the table than the lighter ball, but not necessarily at half the horizontal distance.

(e) the lighter ball hits the floor considerably closer to the table than the heavier ball, but not necessarily at half the horizontal distance.
Two oranges, one of which weighs twice as much as the other, roll off of a kitchen table with the same speeds. In this situation,

(a) both oranges hit the floor at approximately the same horizontal distance.
(b) the heavier orange hits the floor at about half the horizontal distance than does the lighter orange.
(c) the lighter orange hits the floor at about half the horizontal distance than does the heavier orange.
(d) the heavier orange hits the floor considerably closer to the table than the lighter orange, but not necessarily at half the horizontal distance.
(e) the lighter orange hits the floor considerably closer to the table than the heavier orange, but not necessarily at half the horizontal distance.
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Research Conclusions

- Context does affect performance
- No consistent gender changes—yet!
- Need to optimize test by question
Related gender research

M. Dancy & A. Elby (Davidson C. & UMD)

Give FCI asking to choose their own beliefs

Give test again asking to choose scientific answers

Males mostly had no differences

About 1/3 of females chose different answers; scientific answers increased score and reduced gender gap
Future Research

- More testing of the newest version of the test
- Interview students while taking the test to see how context affects their thinking
- Develop a test that is gender-neutral (may not eliminate gender gap, though)
- Give revised version; ask for personal and scientific answers
Conclusions

- Definite interaction between gender, context and score
- FCI may have gender bias in favor of males
- Need further research
- Trying to ensure gender equity in physics classrooms