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

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High School Physics

50 % of high school physics students are women! (28% of students take HS physics)



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

Undergraduate Physics

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Undergraduate Physics



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

Women receive 19% of physics bachelors degrees

Graduate Physics



Graduate Physics

Women receive 21% of master's degrees in physics



13% of physics doctorates go to women

Is this a problem? Yes!

The Problem: Underrepresentation

- 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?
- 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 postinstruction

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

	Pre %	Post %	% Gain
Women	35.6	57.4	21.8
(N=780)	(se=.5)	(se=.7)	(se=.6)
Men	50.3	68.6	18.4
(N=1997)	(se=.4)	(se=.5)	(se=.4)

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		<g> Relative Gain</g>		
Women (N=780)		.34 (se=.01)		
Men (N=1997)		.39 (se=.01)		

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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:

FCI contexts

b

hockey puck

а



"b"



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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











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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Comparisons

Overall, the scores did not show statistically significant difference between the versions

 \sim Women \rightarrow 13 questions show increase in percent correct, 17 show decrease



 \checkmark Men \rightarrow 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

Original Question

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?



Results-cannon/baby



Women did much better, men did the same on the revised version.

Original Question

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



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) <u>a = b</u>

Results-skaters



Women did better on the revised version, men did worse on the revised version. This revision decreased the gender gap.

Original Question

- 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.

Revised Question

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.

Results-oranges

Women did worse on the revised version, men did better on the revised version. <u>This revision increased the gender gap!</u>

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 <u>scientific</u> 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