# Context and Gender in 

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## Women's Education

Somen receive
© about half of all high school diplomas,

8 about half of all bachelor's degrees (56\%),
8. $57 \%$ of master's degrees, and
8) $42 \%$ of doctorates

8 What about physics?

## High School Physics



## High School Physics

$850 \%$ of high school physics students are women! ( $28 \%$ of students take HS physics)
\& But...
E. Women are still not found in the AP courses which are better preparation for college coursework

## Undergraduate Physics



## Undergraduate Physics

3. Women make up $31 \%$ of two-year college physics students
4. 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
8. 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
8 Need to be doing research on how to keep women
8. Women and physics education

## Gender and Physics Education

3 Are physics classes contributing to the under-representation?
\& Yes! (Seymour \& Hewitt, 1997)
8 What parts of physics classes might be?

8 Instruction; curriculum; assessment
8. Early analysis of one assessment suggested an issue

# Gender and Physics Assessment 

3 In two different assessments, women in undergraduate physics classes do more poorly than men:
8 Grades
8 Conceptual Questionnaires

8 Is there gender bias in physics assessments?

## The Force Concept Inventory

8 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

8 Study with 8 different higher education institutions

8 Men and women took FCI
8 Collected data on pre-test score, post-test score, gender, and where possible, previous physics background

## The Problem: Gender

 gap?|  | Pre \% | Post \% | \% Gain |
| :---: | :---: | :---: | :---: |
| Women | 35.6 | 57.4 | 21.8 |
| $(\mathrm{~N}=780)$ | $(\mathrm{se}=.5)$ | $(\mathrm{se}=.7)$ | $(\mathrm{se}=.6)$ |
| Men <br> $(\mathrm{N}=1997)$ | 50.3 | 68.6 | 18.4 |
| $(\mathrm{se}=.4)$ | $(\mathrm{se}=.5)$ | $(\mathrm{se}=.4)$ |  |

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<g> Relative Gain
Women $(\mathrm{N}=780)$
.34 ( $\mathrm{se}=.01$ )
Men ( $\mathrm{N}=1997$ )
.39 ( $\mathrm{se}=.01$ )

## Women <br> Men



## Why the gender gap?

8 What's up with this test?
8. The men, the women, or the test?

8 Possible test bias?
8. An examination of the contexts of the FCI questions reveals an interesting pattern:

## FCI contexts

## hockey puck




## Test by males, for males?

3 Stereotypically male contexts
8. Almost every person is a male

8 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

3 Students preferred real-life context questions

8 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

8 Context affects performance!

## How to test context?

8 Change the context!
\& New version of FCI with stereotypically female contexts
\& As far towards a female bias as possible

B Also more daily-life situations

## New FCI contexts



# Trial-testing in non-physics context 

8 Test with students at UW-Stout
3 Use students in English and sociology classes - non-physics context

8 Other concern: male culture of physics classrooms

## Overall comparison

\% correct UW-Stout

|  | Original | Revised |
| :---: | :---: | :---: |
| Women | 21.7 <br> $(N=106)$ | 22.3 <br> $(N=79)$ |
| Men | 33.7 <br> $(N=56)$ | 28.5 <br> $(N=71)$ |

## Comparisons

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

8 Women $\rightarrow 13$ questions show increase in percent correct, 17 show decrease
(8) Men $\rightarrow 5$ questions show increase, 25 show decrease

## Item by Item

\& Look at particular questions:
\& Cannonball $\rightarrow$ baby bowl
82 males in chairs $\rightarrow 2$ female figure skaters
8) Steel balls on table $\rightarrow$ 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

| \% correct <br> by gender | Original | Revised |
| :---: | :---: | :---: |
| Women | 34 | 51 |
| Men | 66 | 66 |

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 Stbaent "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) $a=b$

## Results-skaters

| \% correct | Original | Revised |
| :---: | :---: | :---: |
| Women | 5 | 10 |
| Men | 23 | 17 |

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

## Original Question

8 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:
8
(a) both balls hit the floor at approximately the same horizontal distance.
8 (b) the heavier ball hits the floor at about half the horizontal distance than does the lighter ball.
8. (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.
8) (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,
(3) both oranges hit the floor at approximately the same horizontal distance.
(3) (b) the heavier orange hits the floor at about half the horizontal distance than does the lighter orange.
B. (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

| \% correct | Original | Revised |
| :---: | :---: | :---: |
| Women | 25 | 18 |
| Men | 25 | 37 |

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

## Research Conclusions

Context does affect performance
8 No consistent gender changes-yet!
8. Need to optimize test by question

## Related gender research

\& M. Dancy \& A. Elby (Davidson C. \& UMD)
8 Give FCI asking to choose their own beliefs
\& Give test again asking to choose scientific answers

8 Males mostly had no differences
\& About $1 / 3$ of females chose different answers; scientific answers increased score and reduced gender gap

## Future Research

8 More testing of the newest version of the test

8 Interview students while taking the test to see how context affects their thinking

3 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
8. FCI may have gender bias in favor of males
\& Need further research
© Trying to ensure gender equity in physics classrooms

