

The Missing Women: Physics and Gender



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Physics For All

Need scientifically literate public

Need technologically/scientifically trained workers

Foundation of science is physics

Need to be encouraging all interested people

Who is doing physics?

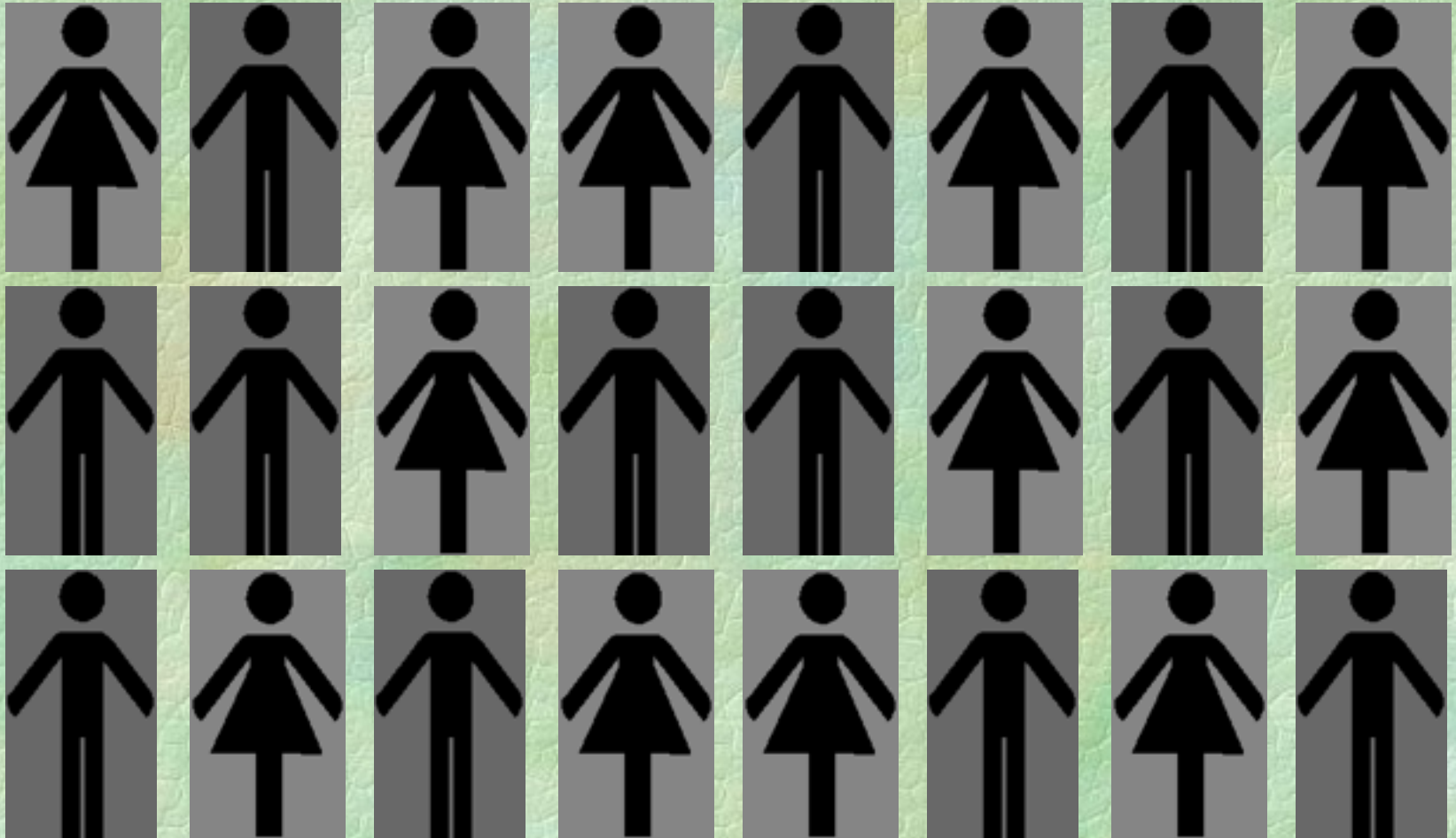
Overview

Is there a problem with the numbers of women in physics?

Is there a problem with women and physics classes?

Gender and assessment research

High School Physics

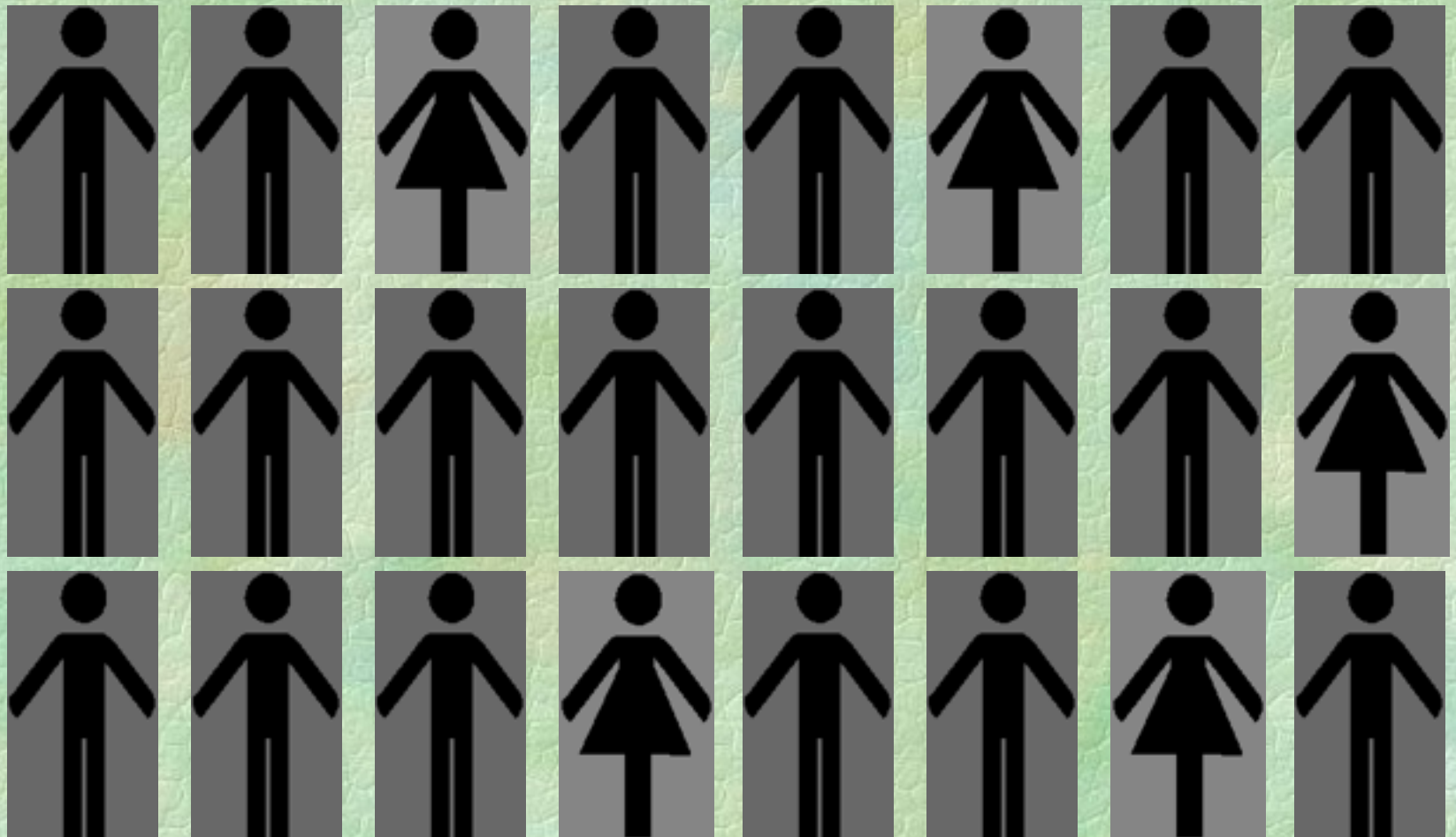


~50 % of high school physics students are women! (28% of students take HS physics)

But...

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

Undergraduate Physics

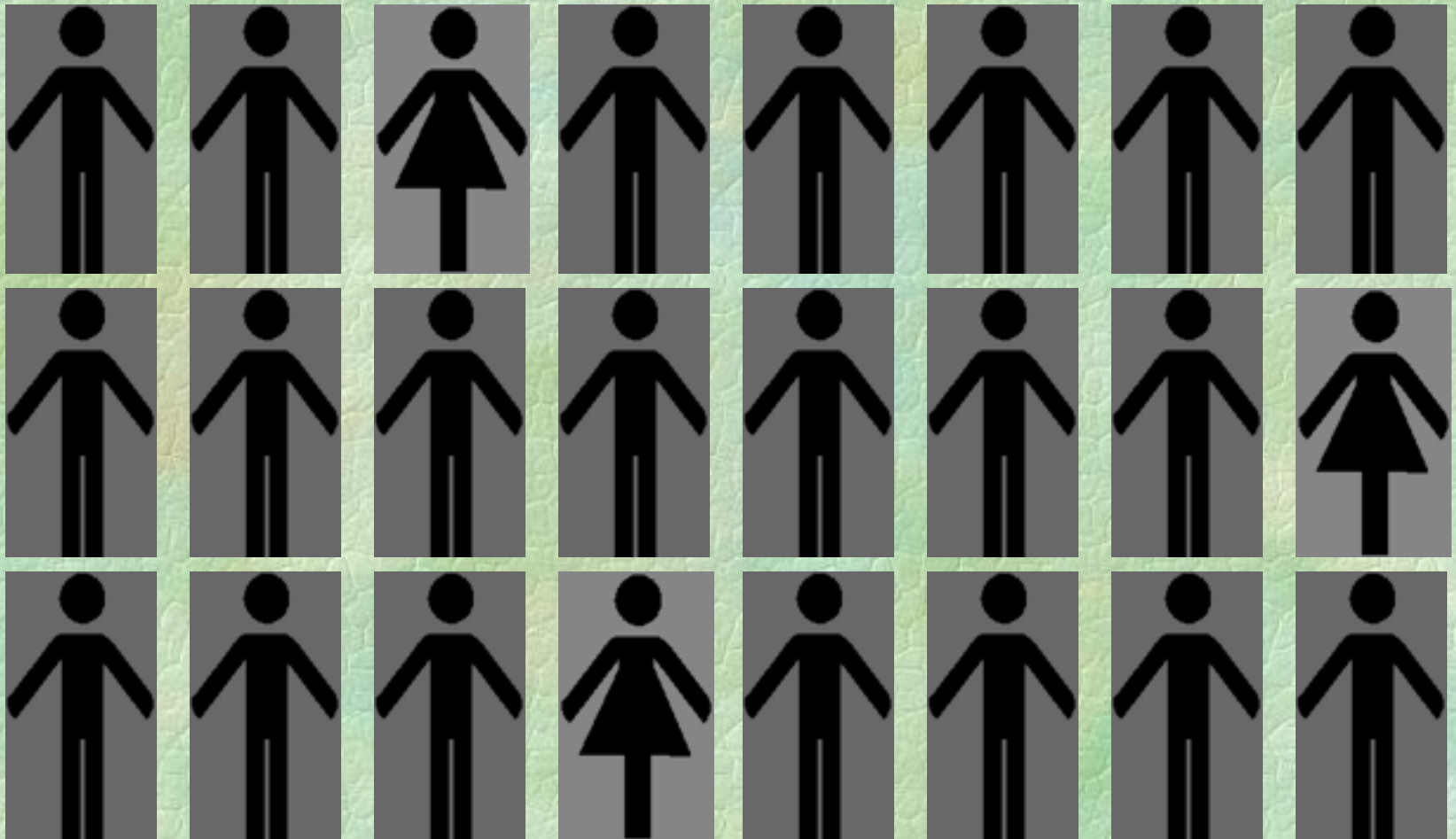


Undergraduate Physics

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

Women receive 19 % of physics bachelors

Graduate physics



Graduate Physics

Women receive 21 % of master's degrees in physics

13% of physics doctorates go to women

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

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?

	Pre %	Post %	% gain
Women (N=780)	35.6 (.5)		
Men (N=1997)	50.3 (.4)		

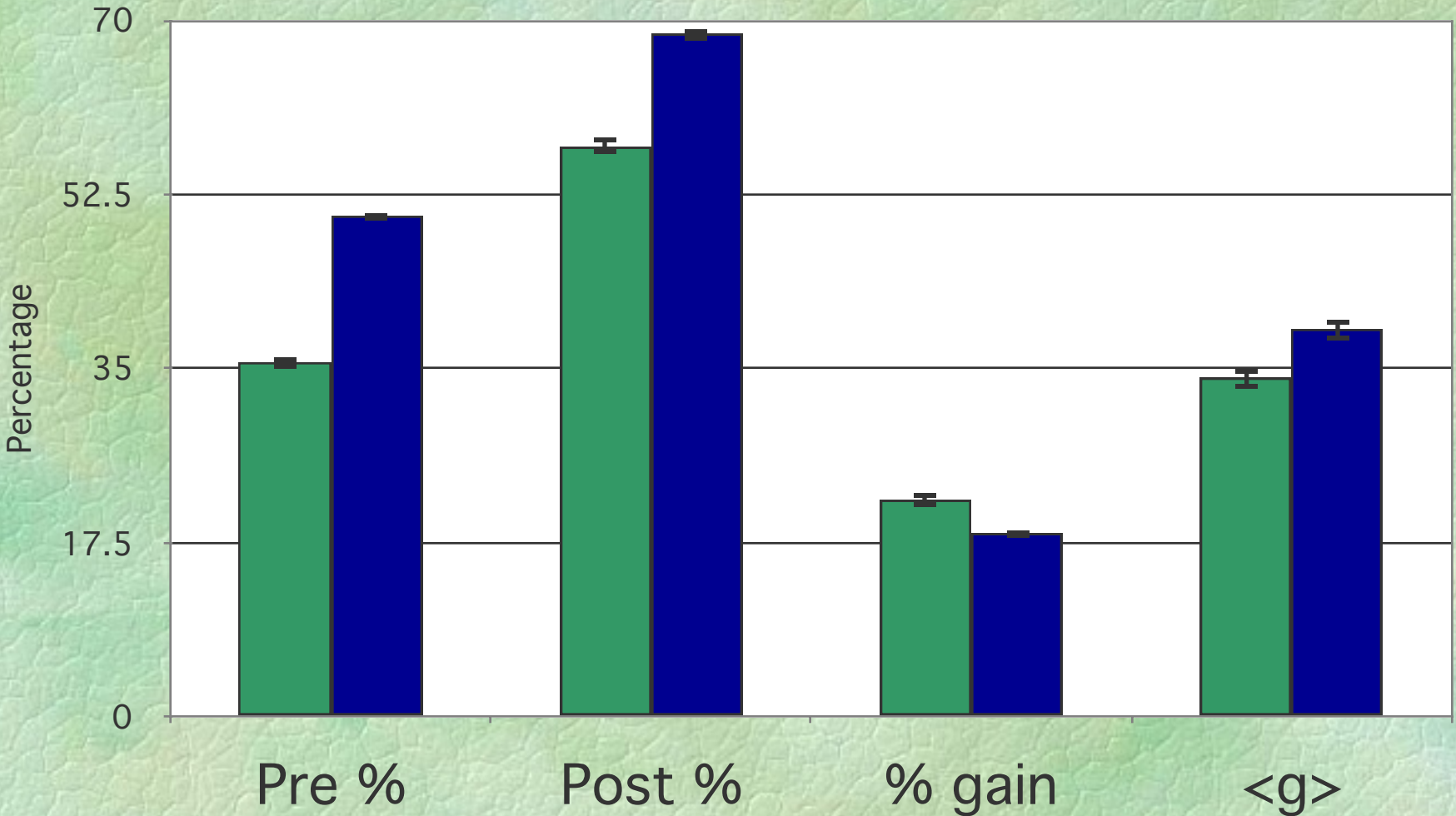
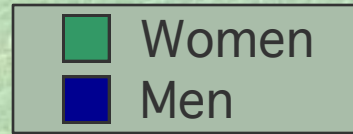
	Pre %	Post %	% gain
Women (N=780)	35.6 (.5)	57.4 (.7)	
Men (N=1997)	50.3 (.4)	68.6 (.5)	

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

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

	<g>
Women (N=780)	.34 (.01)
Men (N=1997)	.39 (.01)

Gender Gap



Pretest scores by preparation

<i>Avg pretest score</i>	Women (N=469)	Men (N=1129)
No HS physics	25.6	41.3
HS physics (reg/AP)	35.5	50.2
College	33.3	58.1
HS & College	34.4	45.9
AP physics	48.7	59.5

Why the gender gap?

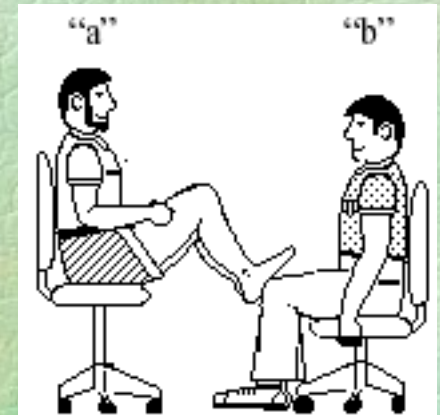
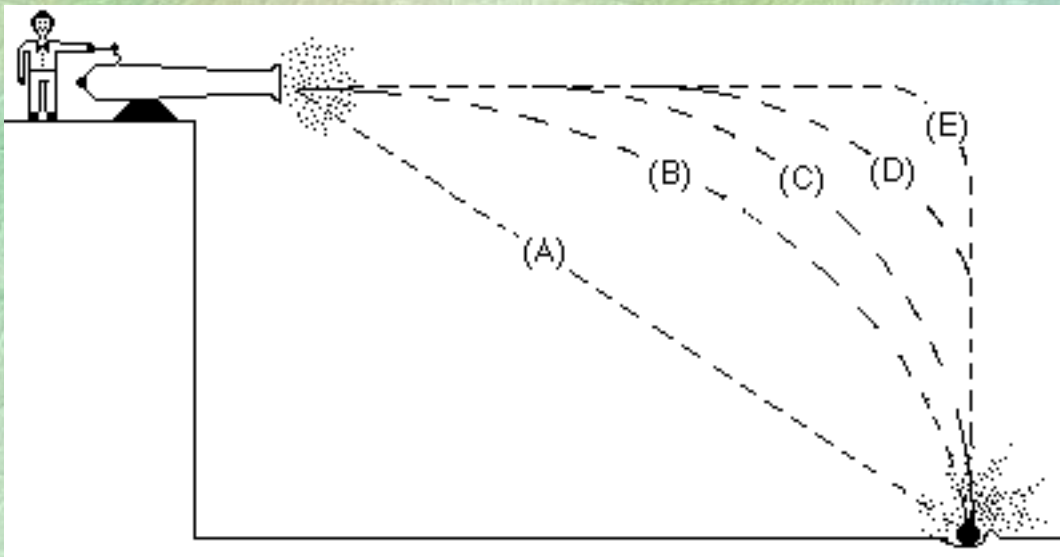
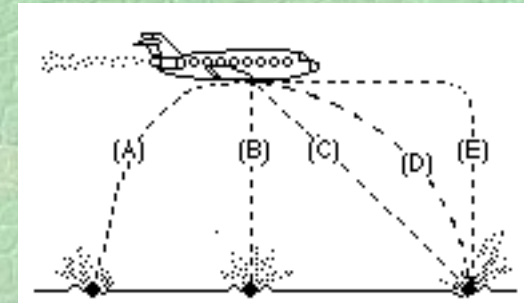
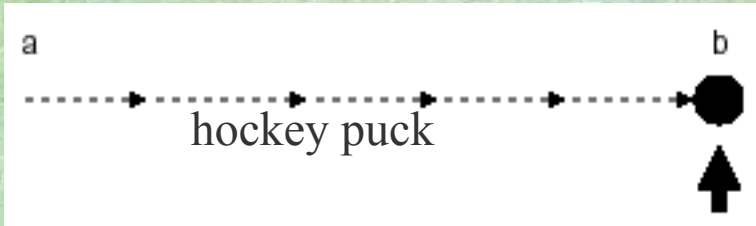
What's up with this test?

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



FCI for males, by males

Stereotypically male contexts

Almost every person is a male

Written by a team of male physics education researchers

Male contexts → female disadvantage?

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

How to test context?

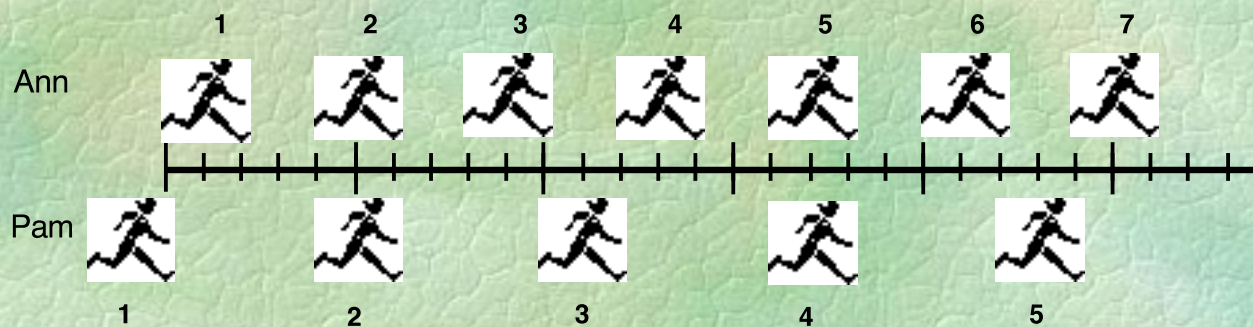
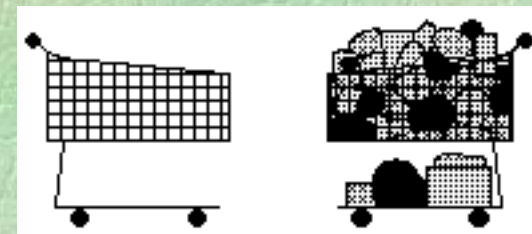
Change the context!

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

<i>FCI score UW-Stout</i>	Original	Revised
Women	21.7 (N=79)	22.4 (N=106)
Men	33.7 (N=71)	28.5 (N=56)

What's up?

Overall, no difference in scores, no change in gap

No effect or no overall effect?

Changes in individual questions

What do we see?

Look at particular questions:

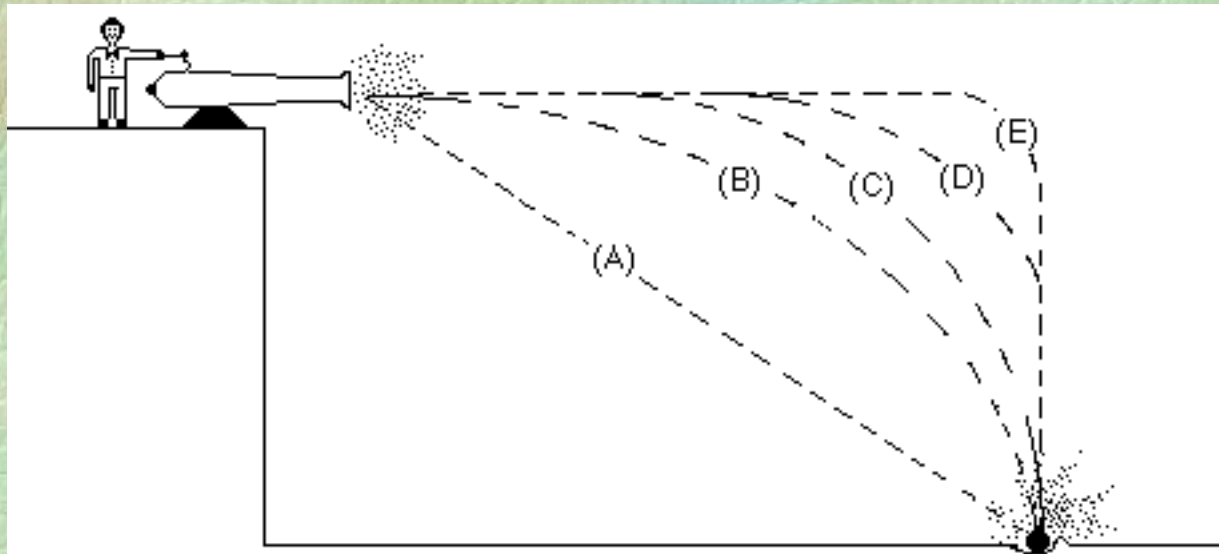
Cannonball to baby bowl

Students in chairs to ice skaters

Moving blocks to joggers

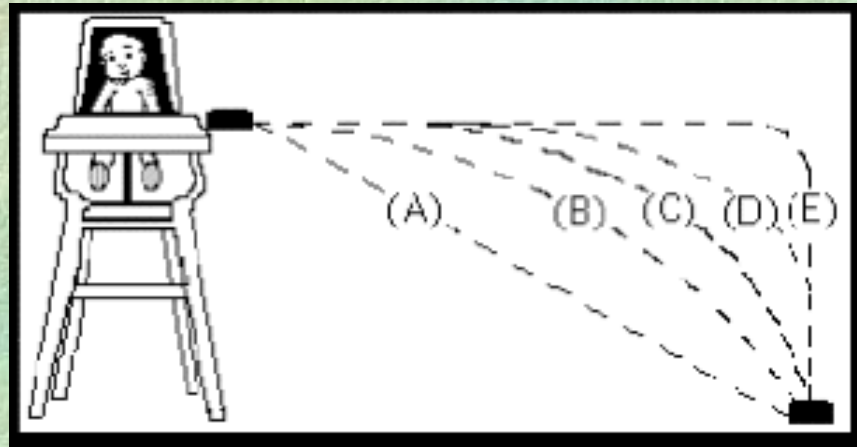
Original Question

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

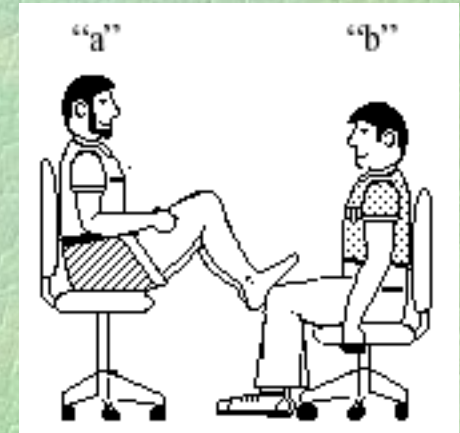
<i>% correct (B)</i>	Original	Revised
Women	34	51
Men	66	66

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

Original Question

(Thailand example)

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.



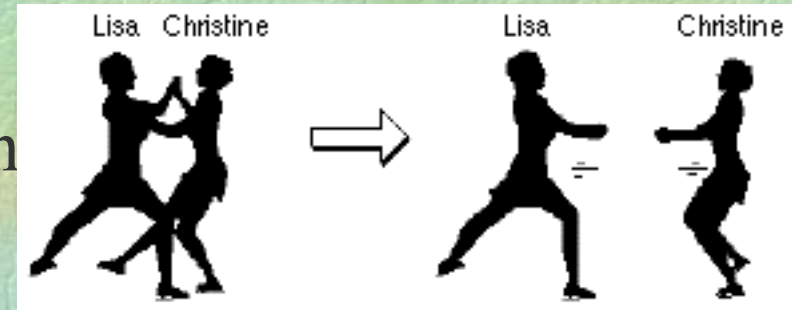
Student “a” places his bare feet on the knees of student “b”, as shown. Student “a” then suddenly pushes outward with his feet, causing both chairs to move.

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) $a = b$

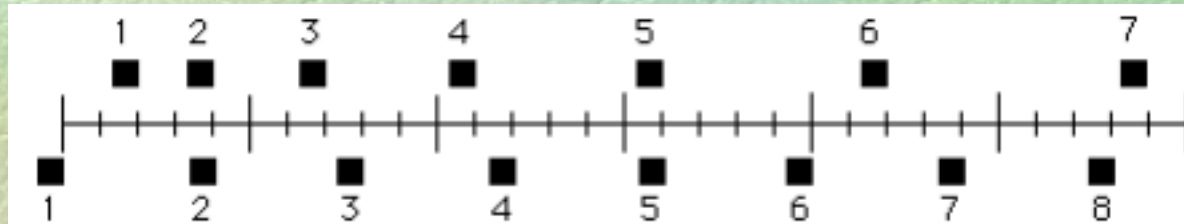
Results-skaters

<i>% correct (E)</i>	Original	Revised
Women	5	10
Men	23	17

Women did better on the revised version, men did worse on the revised version.

Original Question

The position of two blocks at successive 0.20-second time intervals are represented by the numbered squares in the figure below. The blocks are moving toward the right.

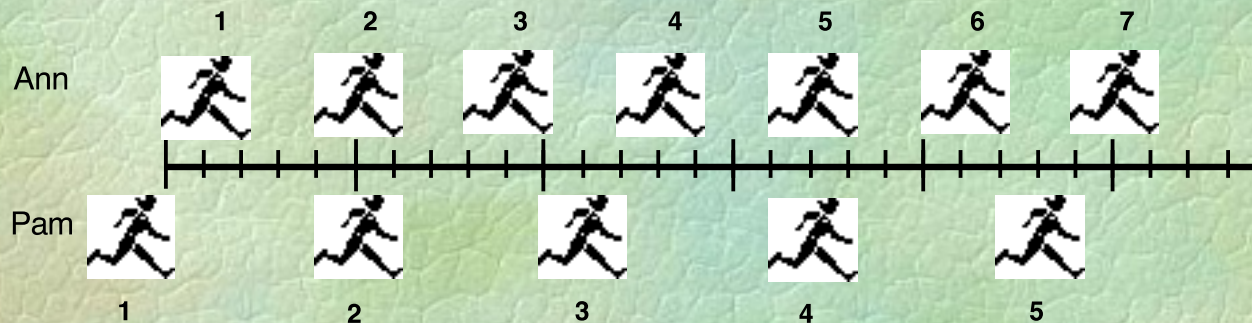


Do the blocks ever have the same speed?

- (A) No
- (B) Yes, at instant 2.
- (C) Yes, at instant 5.
- (D) Yes, at instants 2 and 5.
- (E) Yes, at some time during the interval 3 to 4.

Revised Question

The position of two joggers, Ann and Pam, are shown below. The joggers are shown at successive 0.20-second time intervals, and they are moving toward the right. (Use the forward arm or foot as a reference point.)



Do the joggers ever have the same speed?

- (A) No
- (B) Yes, at instant 2.
- (C) Yes, at instant 5.
- (D) Yes, at instants 2 and 5.
- (E) Yes, at some time during the interval 3 to 4.

Results-joggers

<i>% correct (E)</i>	Original	Revised
Women	20	12
Men	36	19

On this question, both men and women did worse on the revised version.

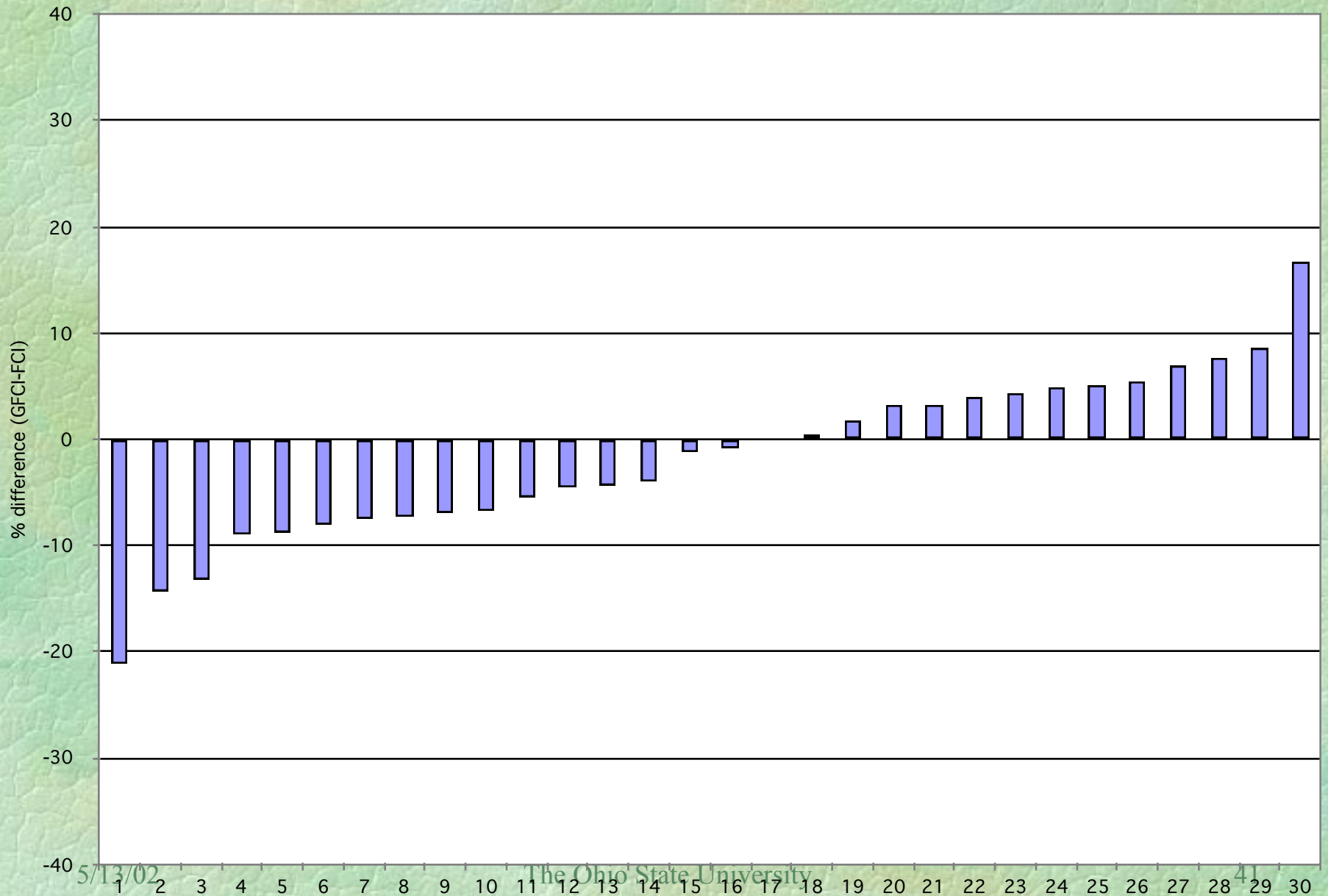
Comparisons

Overall, the scores did not change significantly between the versions

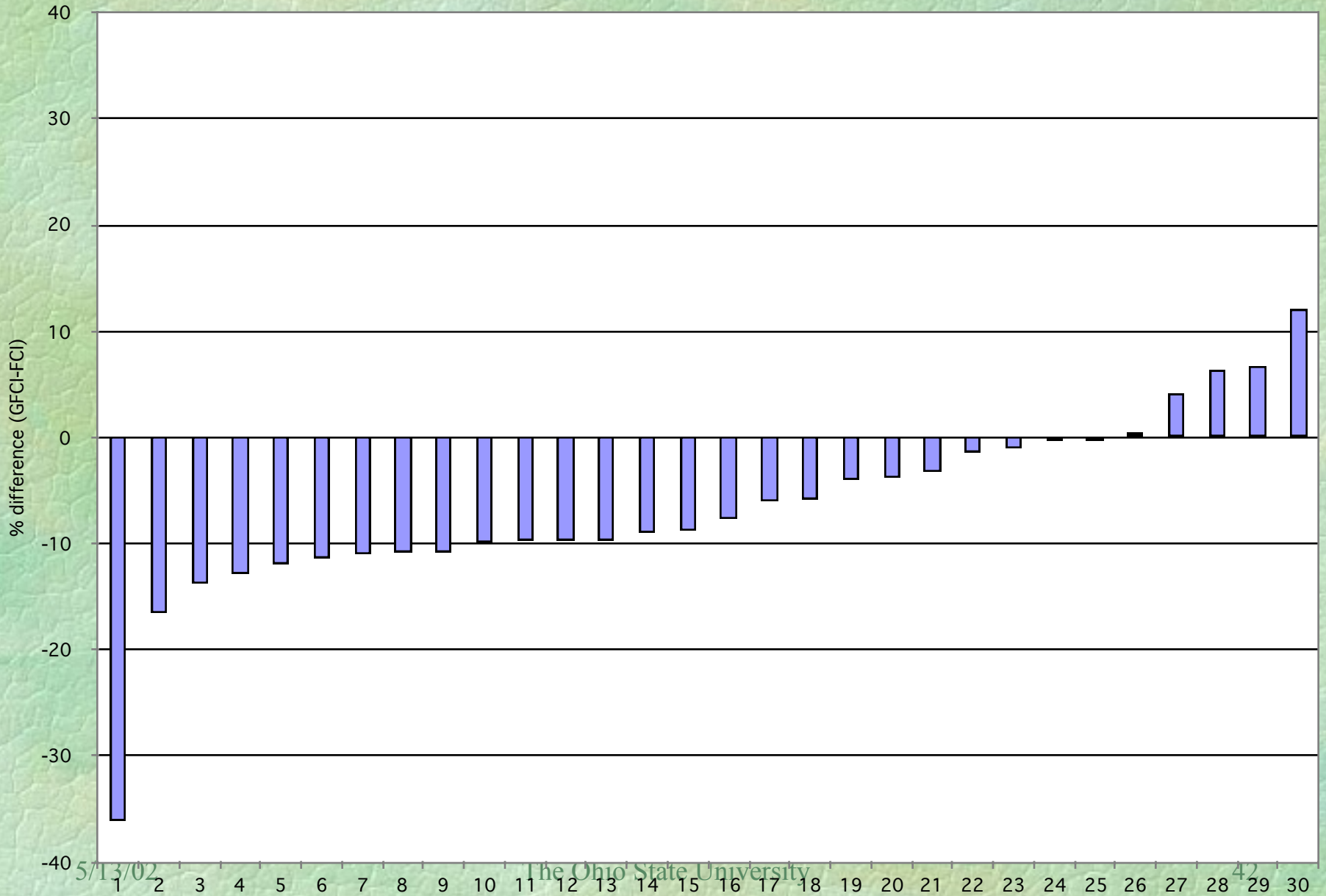
There is an interaction between gender and context

Males and females responded differently to the two versions of the test

Women-Difference between versions



Men-Difference between versions



5/13/02

The Ohio State University

42

Gender bias?

Interaction between gender and context

Males seemed to do better on original; females equally well

Physics GRE: mis-representing ability; exacerbating gender gap

Other issues:

- Culture
- Cartoons
- Prior experiences

Next steps

Getting more data

Comparing non-physics students with physics students

Interview students taking the FCI/GFCI

Deeper statistical analysis (DIF?)

Examination of particular answers

Hybrid version

Non-Stout students

Other conceptual tests

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