

Studio Physics for Life-Science Majors at Boston University

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6 January 2014

AAPT Winter Meeting, Orlando, FL

Studio outperforms lecture

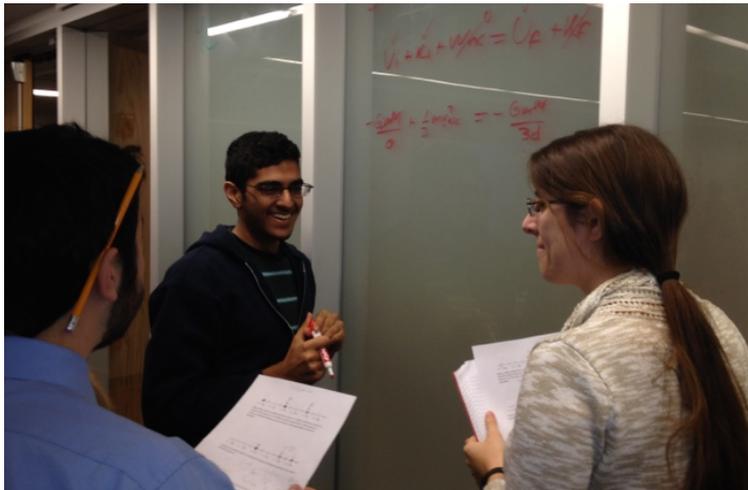
- Better CLASS and FMCE outcomes
- Considerably lower DFW rate
- Better grades on tests and in the course overall
- A gender gap consistent with recent research:

Gender gap on concept inventories in physics, A. Madsen, S. B. McKagan, and E. C. Sayre
PHYS. REV. ST PHYS. EDUC. RES. 9, 020121 (2013)



Studio pedagogy

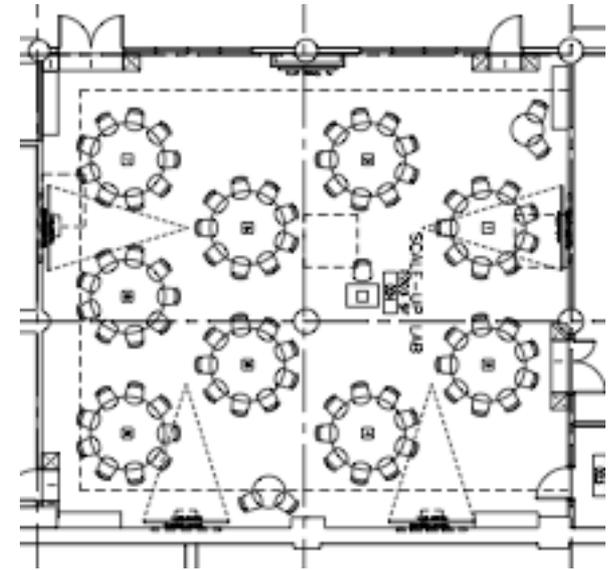
Teamwork and active engagement



- Students in teams of 3; at tables of 9 and at the boards around the room
- 81 students supported by one instructor, 2 TA's, and 2 LA's
- Clicker questions are first answered individually. Following small-group discussion, students answer the question again.

Studio physics at BU

- 1st year of large-scale studio implementation.
- Algebra-based intro physics



3 Studio sections of
81 = 240;
three 2-hour sessions
per week.

2 Lecture sections = 198
three 1-hour classes + 1 hour
recitation + 3-hour lab (not every
week).

- **All students** do the same tests, homework, pre-class quizzes, pre/post tests, and use the same book (Duffy, *Essential Physics*).

DFW rates

Students who have dropped, failed (received D's or F's), or withdrawn

Section	N	DFW #	Rate
studio	240	8	3.3%
lecture	198	19	9.6%

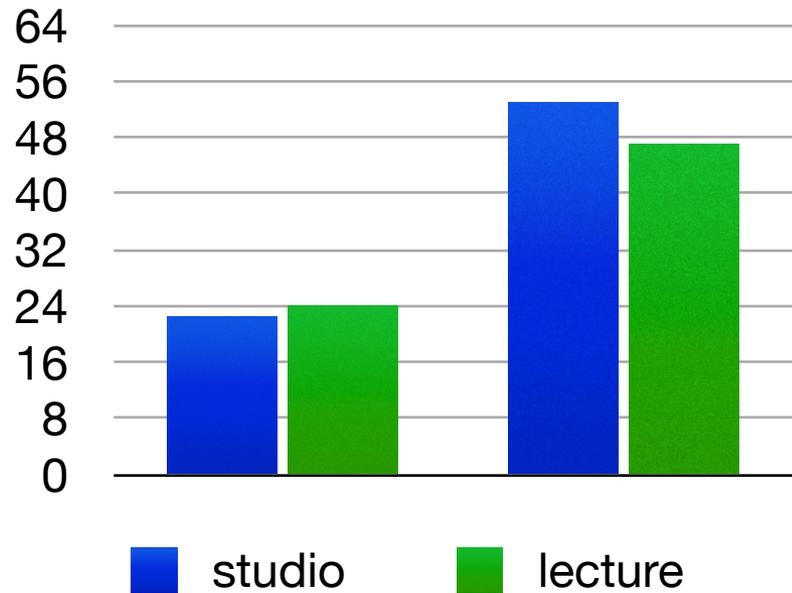
Statistically significant difference, $p = 0.01$

FMCE - matched results

$$\text{Gain} = \frac{\text{Post} - \text{Pre}}{\text{Max} - \text{Pre}}$$

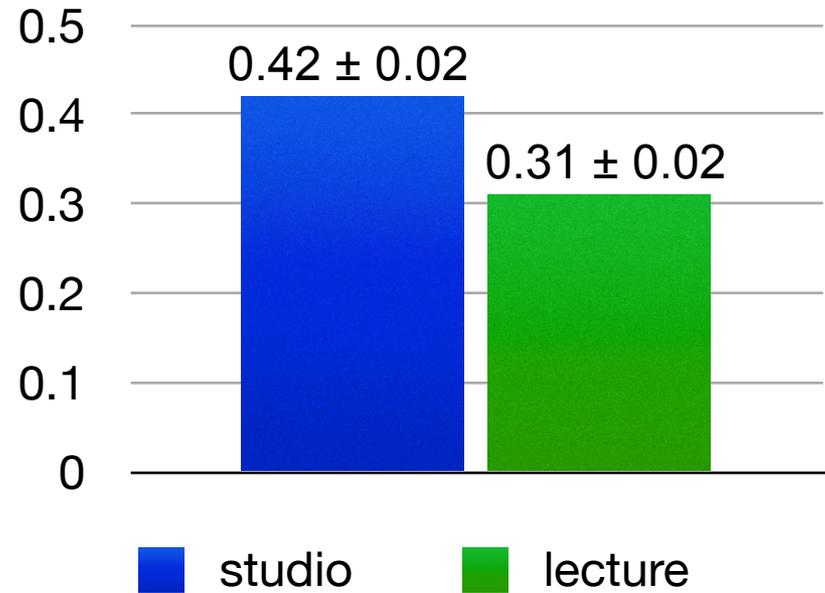
Force and Motion Conceptual Evaluation

Average pre and post scores (%)



N: 211 115

Average normalized gain



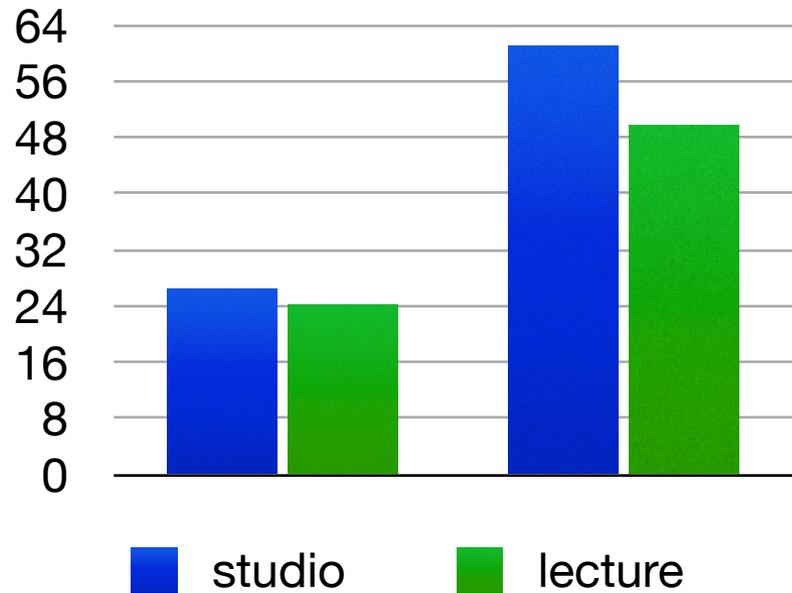
Omitted students with pre scores ≥ 30 (4 studio, 11 lecture)
 Omitted cases with post more than 2 below pre (3 studio, 4 lecture)

FMCE - male students

$$\text{Gain} = \frac{\text{Post} - \text{Pre}}{\text{Max} - \text{Pre}}$$

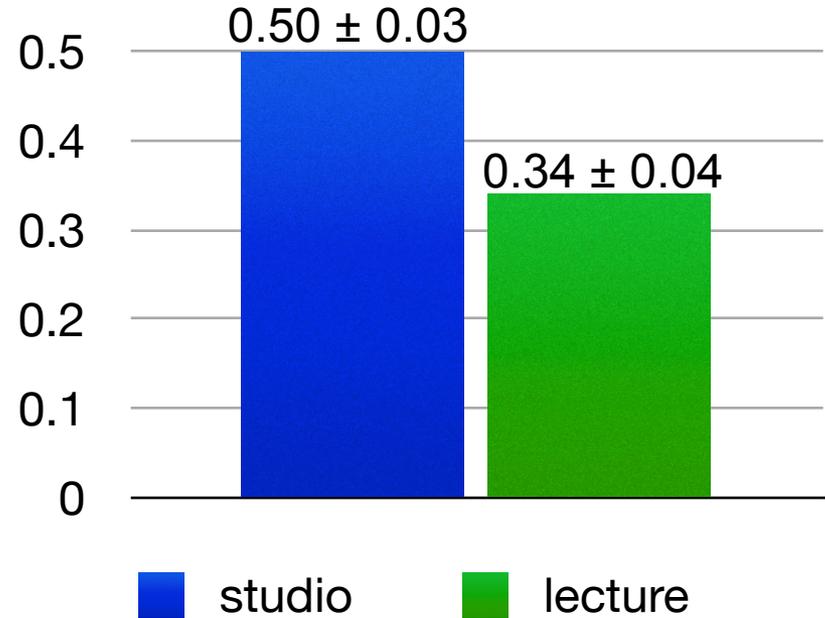
Force and Motion Conceptual Evaluation

Average pre and post scores (%)



N: 76 36

Average normalized gain



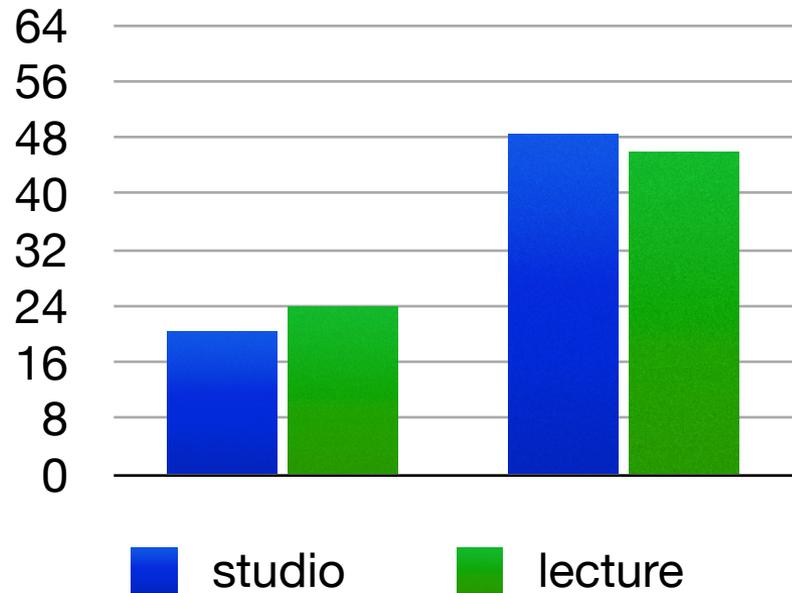
Omitted students with pre scores ≥ 30 (4 studio, 7 lecture)
 Omitted cases with post more than 2 below pre (2 studio, 1 lecture)

FMCE - female students

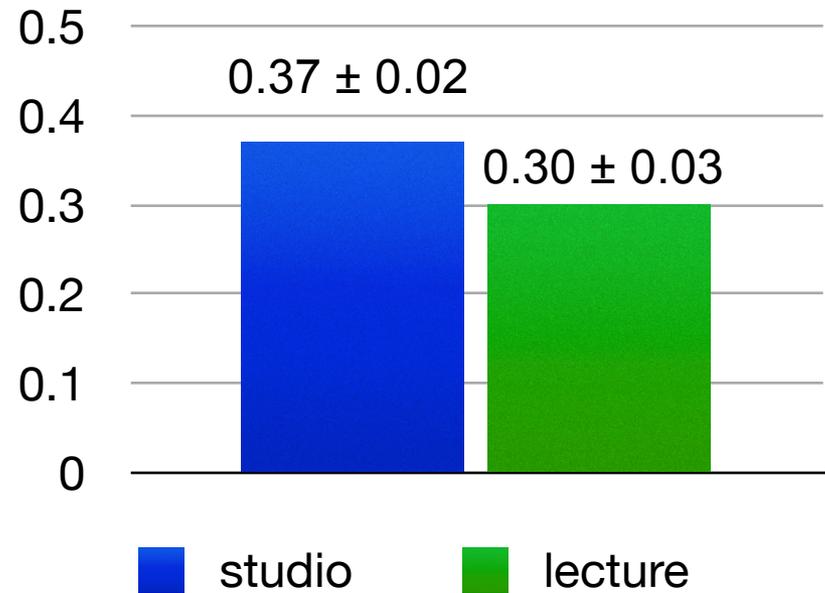
$$\text{Gain} = \frac{\text{Post} - \text{Pre}}{\text{Max} - \text{Pre}}$$

Force and Motion Conceptual Evaluation

Average pre and post scores (%)



Average normalized gain



N: 135 79



Omitted students with pre scores ≥ 30 (0 studio, 4 lecture)
 Omitted cases with post more than 2 below pre (1 studio, 3 lecture)

FMCE - matched results

$$\text{Gain} = \frac{\text{Post} - \text{Pre}}{\text{Max} - \text{Pre}}$$

Force and Motion Conceptual Evaluation

Section	N	Pre %	Post %	Gain / 1
studio - all	211	22.5 (0.8)	53.0 (1.6)	0.42 (0.02)
studio - male	76	26.4 (1.6)	61.0 (2.9)	0.50 (0.03)
studio - female	135	20.4 (0.7)	48.5 (1.9)	0.37 (0.02)
lecture - all	115	24.0 (1.1)	47.1 (2.0)	0.31 (0.02)
lecture - male	36	24.2 (1.8)	49.8 (3.5)	0.34 (0.04)
lecture - female	79	23.9 (1.3)	45.9 (2.4)	0.30 (0.03)



The gain reported above is the average of the gains calculated individually for each student.

Test, final exam, and overall results

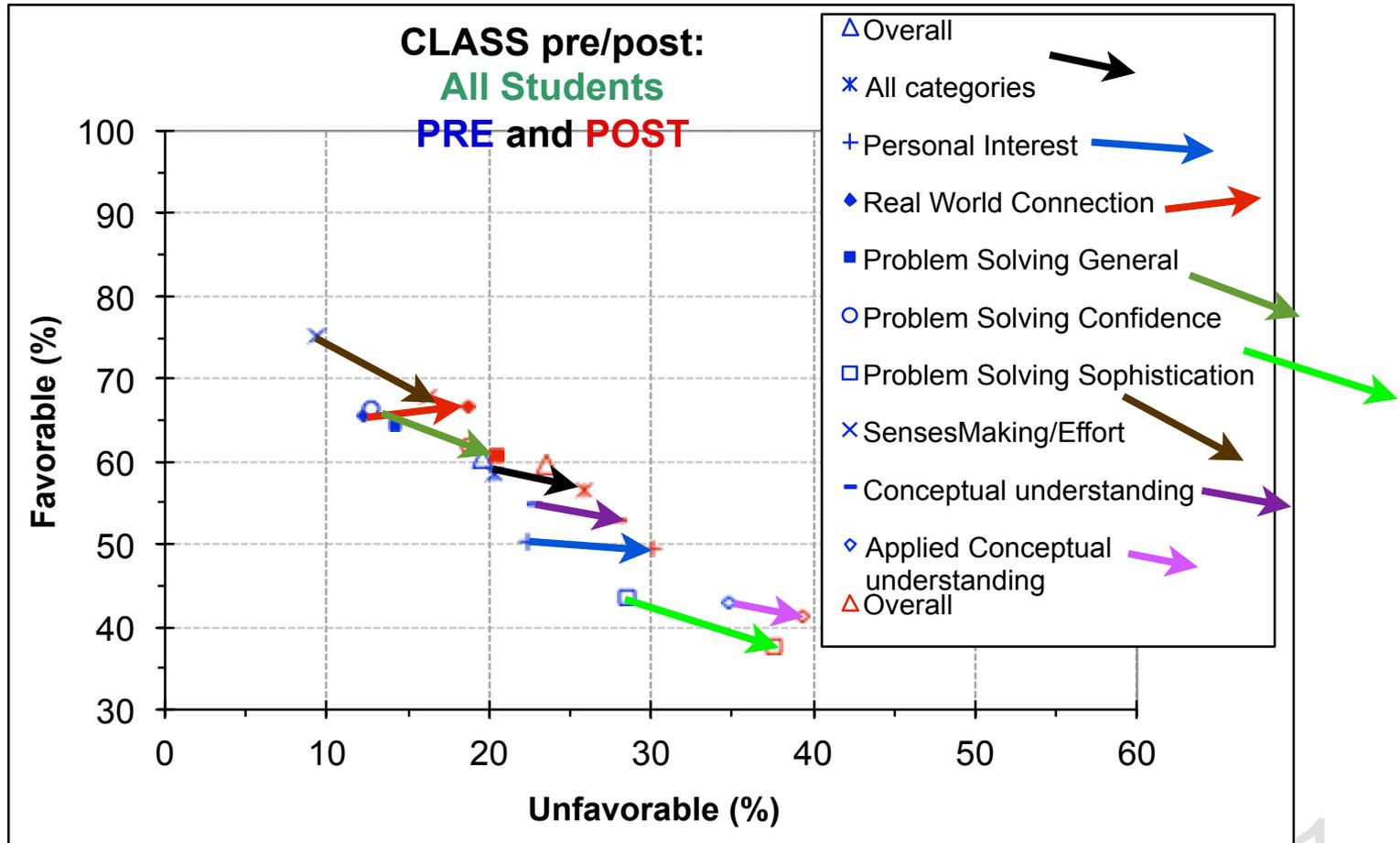
Section	N	Test 1	Test 2	Final	Overall
studio - all	211	68.8	73.2	69.0	79.4
studio - male	76	71.6	75.3	73.0	81.3
studio - female	135	67.2	72.0	66.7	78.4
lecture - all	115	65.9	68.5	67.4	78.0
lecture - male	36	70.1	72.0	70.8	80.0
lecture - female	79	64.0	66.8	65.9	77.1



This is the same set of students compared with the FMCE.

CLASS - lecture, females

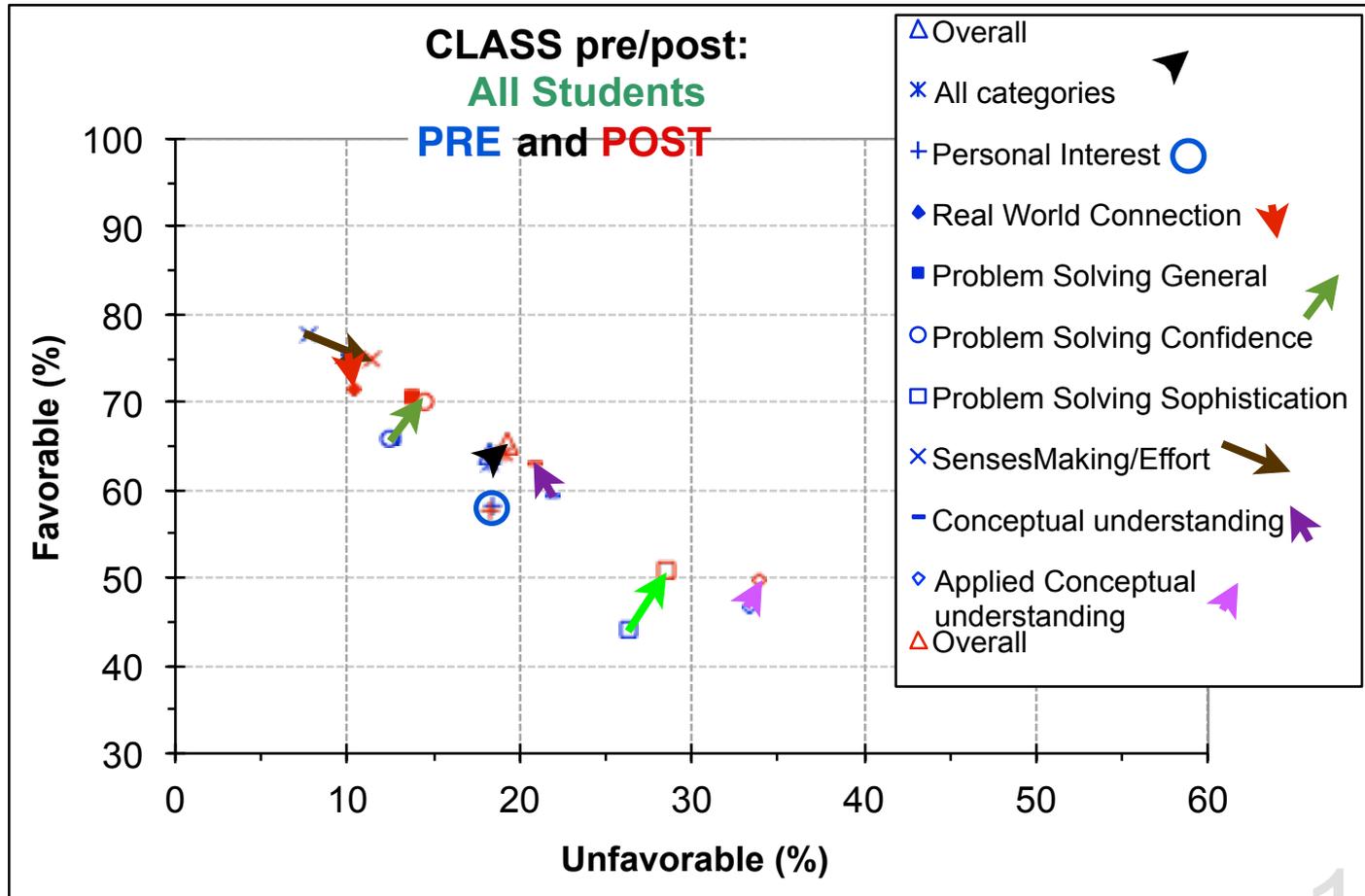
Colorado Learning Attitudes about Science Survey



Shifts down and right – more unfavorable

CLASS - studio, females

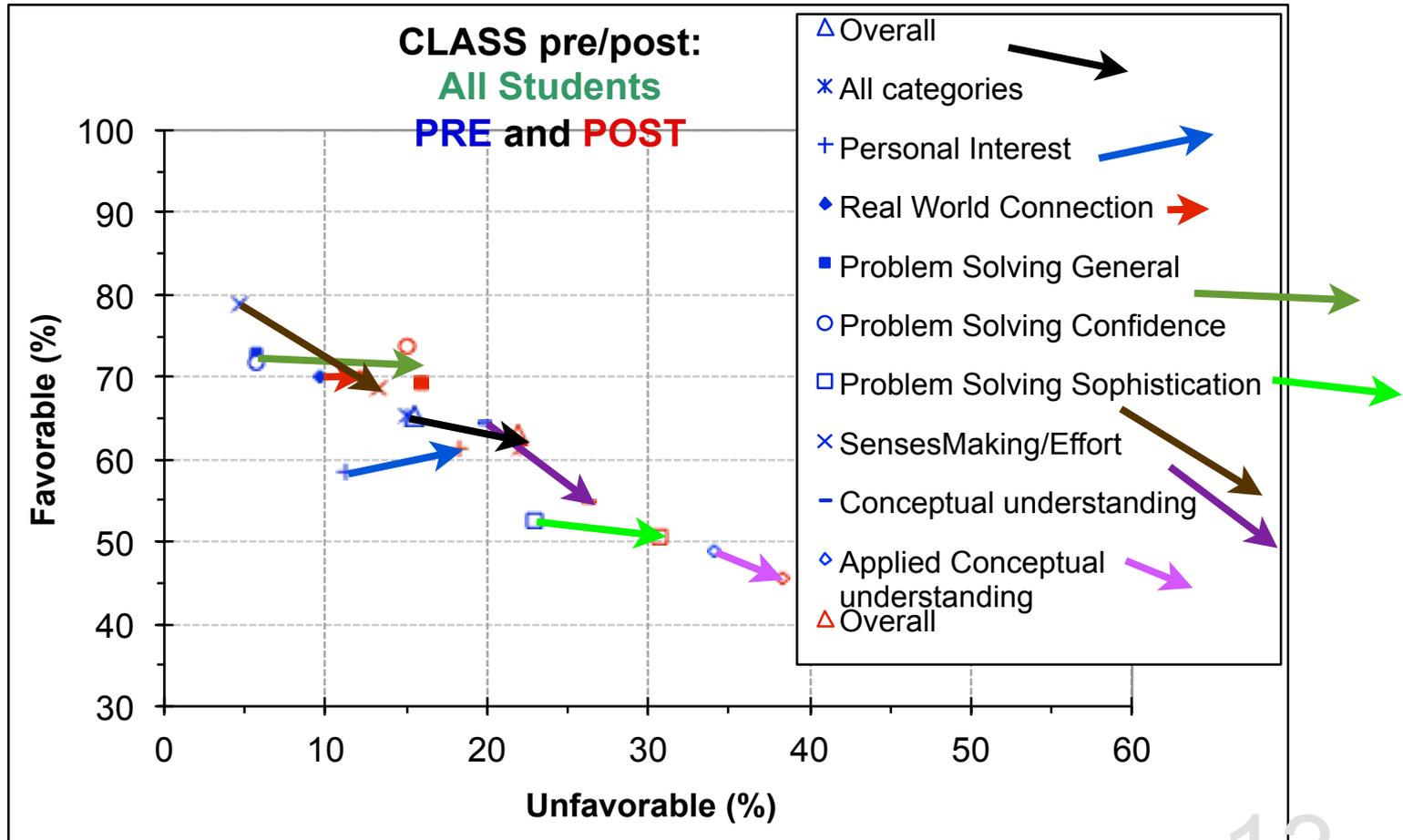
Colorado Learning Attitudes about Science Survey



More mixed results

CLASS - lecture, males

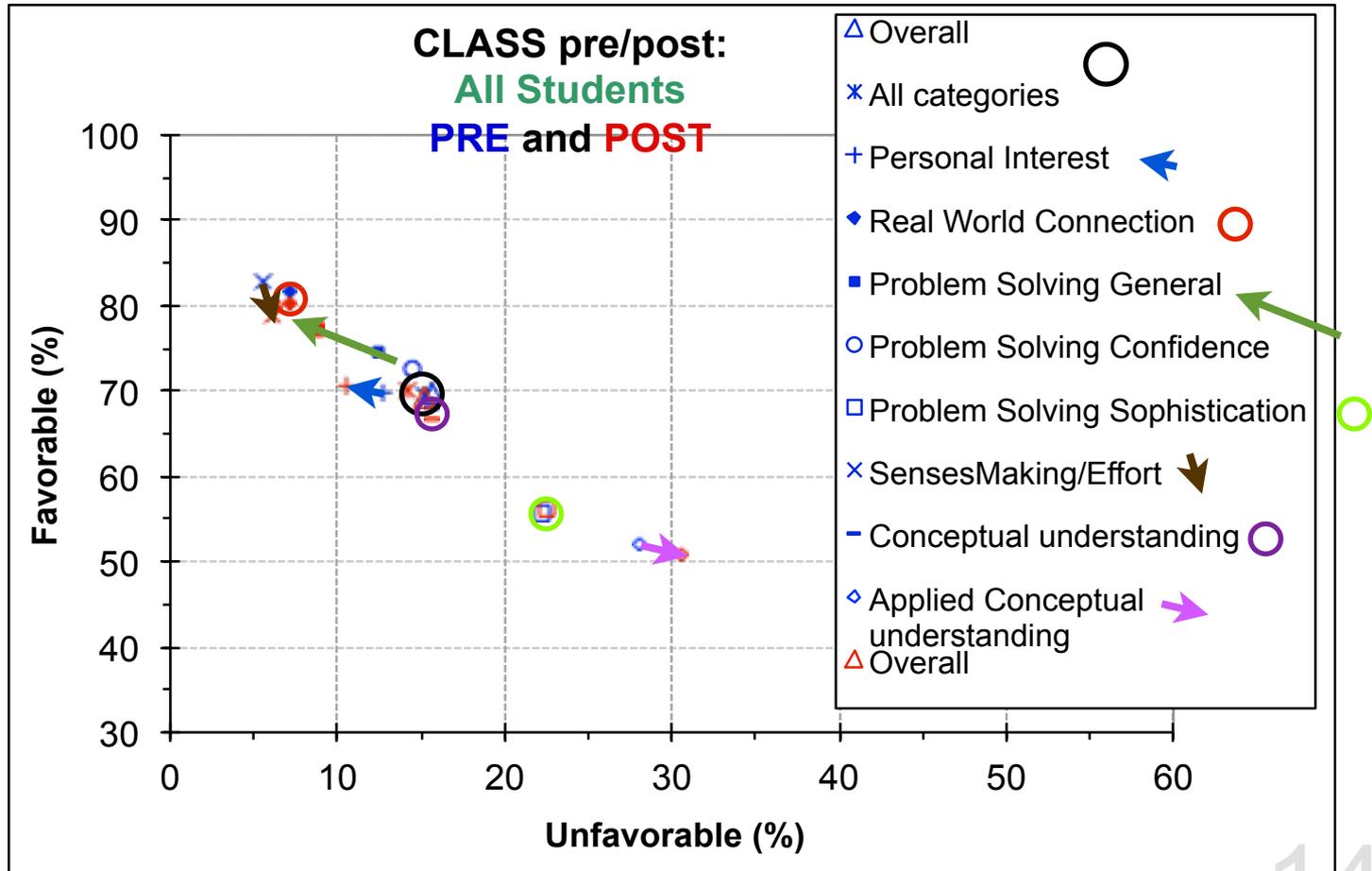
Colorado Learning Attitudes about Science Survey



Shifts down and right – more unfavorable

CLASS - studio, males

Colorado Learning Attitudes about Science Survey



Essentially no change - a good result!

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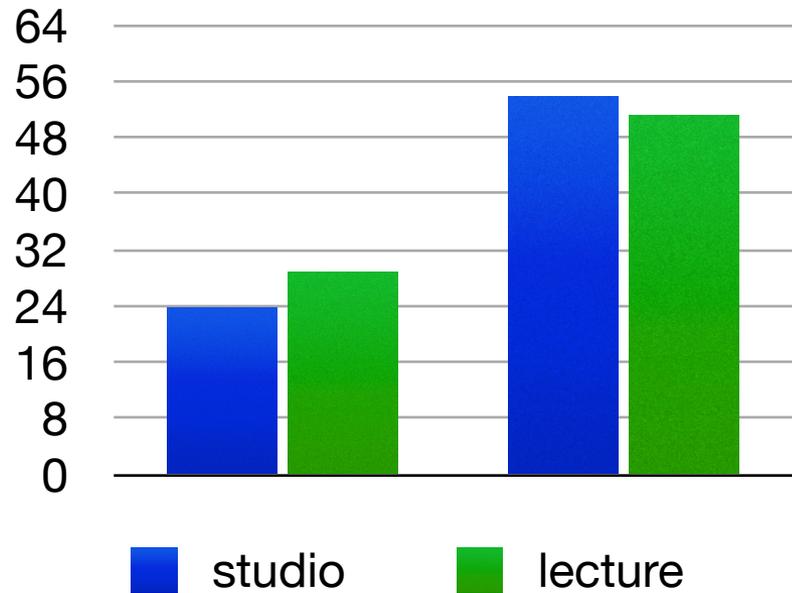
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FMCE - matched results

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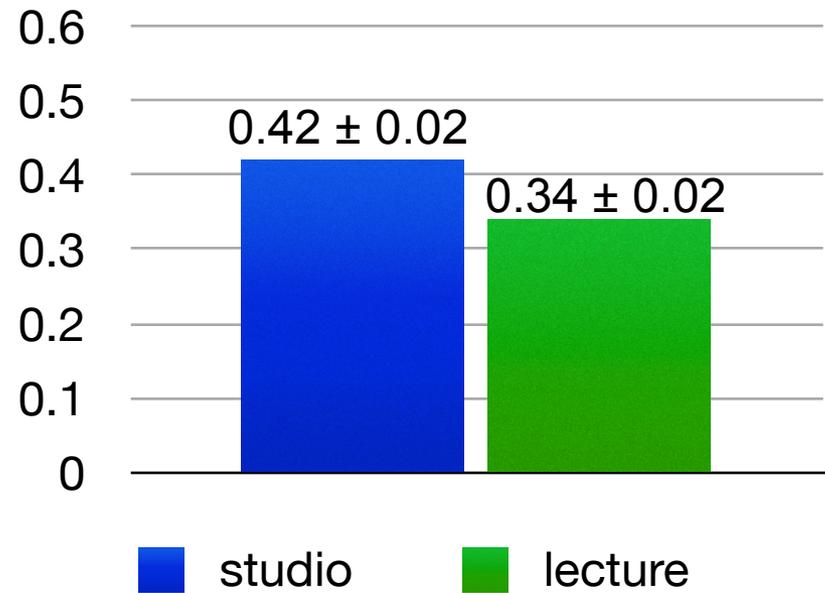
Force and Motion Conceptual Evaluation

Average pre and post scores (%)



N: 215 126

Average normalized gain



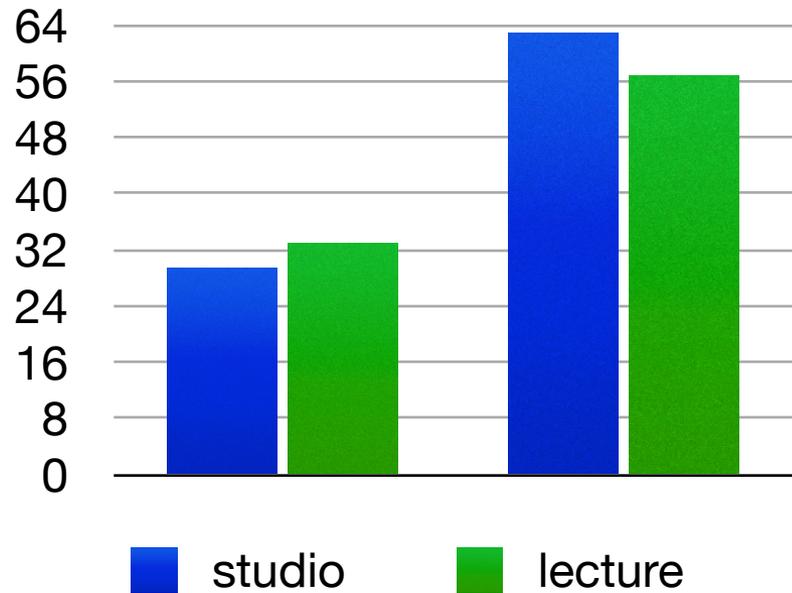
Omitted cases with post more than 2 below pre (3 studio, 7 lecture)

FMCE - male students

$$\text{Gain} = \frac{\text{Post} - \text{Pre}}{\text{Max} - \text{Pre}}$$

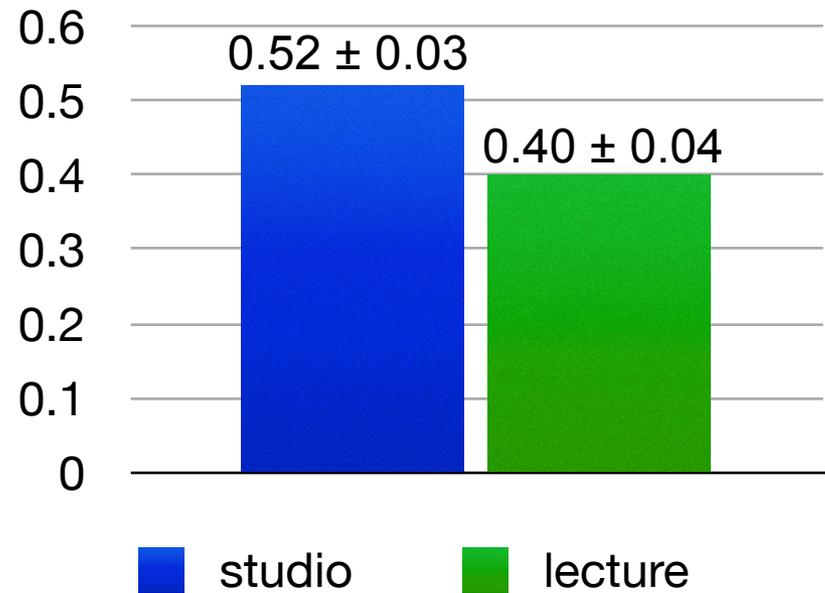
Force and Motion Conceptual Evaluation

Average pre and post scores (%)



N: 80 43

Average normalized gain



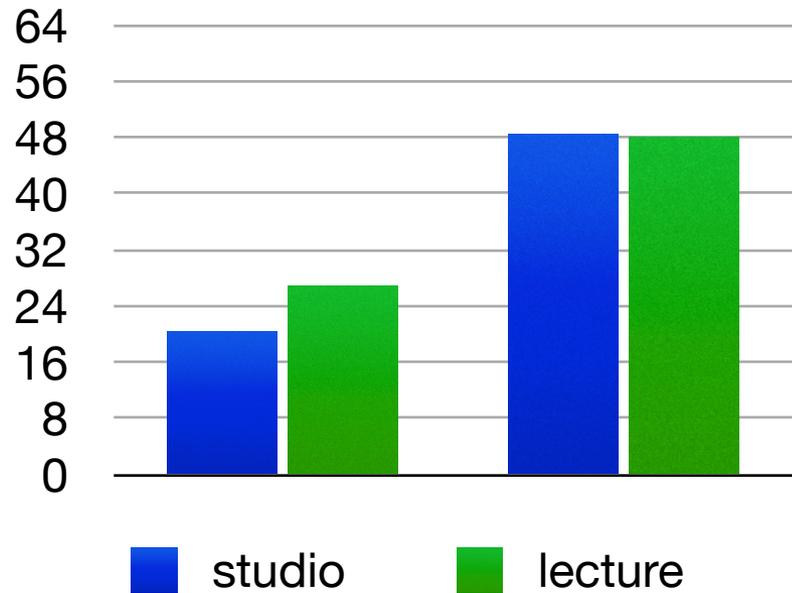
Omitted cases with post more than 2 below pre (2 studio, 1 lecture)

FMCE - female students

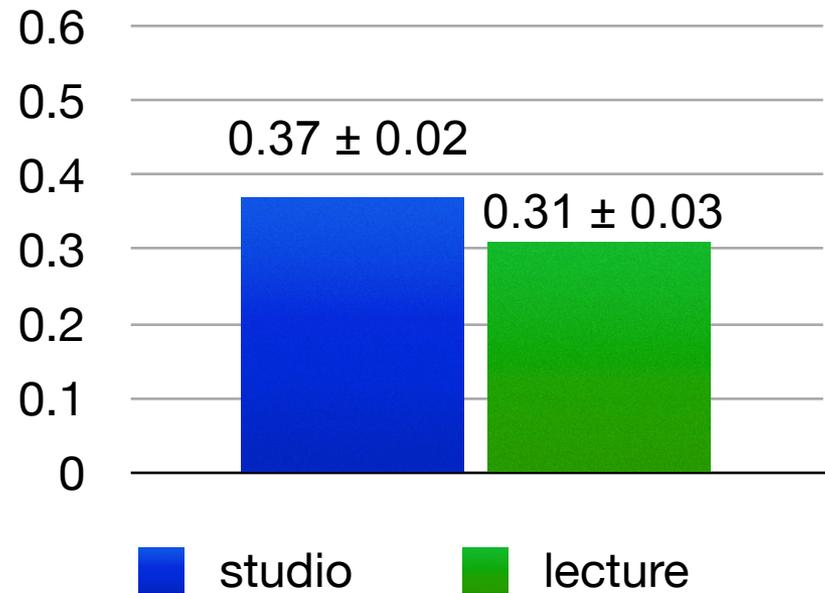
$$\text{Gain} = \frac{\text{Post} - \text{Pre}}{\text{Max} - \text{Pre}}$$

Force and Motion Conceptual Evaluation

Average pre and post scores (%)



Average normalized gain



N: 135

83



Omitted cases with post more than 2 below pre (1 studio, 6 lecture)

FMCE - matched results

$$\text{Gain} = \frac{\text{Post} - \text{Pre}}{\text{Max} - \text{Pre}}$$

Force and Motion Conceptual Evaluation

Section	N	Pre %	Post %	Gain / 1
studio - all	215	23.7 (1.0)	53.9 (1.7)	0.42 (0.02)
studio - male	80	29.4 (2.1)	62.9 (2.9)	0.52 (0.03)
studio - female	135	20.4 (0.7)	48.5 (1.9)	0.37 (0.02)
lecture - all	126	28.9 (1.7)	51.1 (2.2)	0.34 (0.02)
lecture - male	43	32.9 (3.4)	56.8 (3.8)	0.40 (0.04)
lecture - female	83	26.8 (1.9)	48.1 (2.6)	0.31 (0.03)



The gain reported above is the average of the gains calculated individually for each student.

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studio - male	80	72.5	76.2	73.9	81.8
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lecture - all	126	67.8	70.1	68.9	79.0
lecture - male	43	72.7	74.5	72.8	81.4
lecture - female	83	65.3	67.8	66.9	77.8



This is the same set of students compared with the FMCE.