Modeling Applied to Problem Solving (MAPS)

Saif Rayyan, Andrew Pawl, Analia Barrantes, Raluca Teodorescu and David E. Pritchard, Physics Department, MIT
srayyan@mit.edu, aepawl@mit.edu, analiab@mit.edu, rteodore@mit.edu, dpritch@mit.edu *http://relate.mit.edu*

MAPS: A Pedagogy To Teach Problem Solving

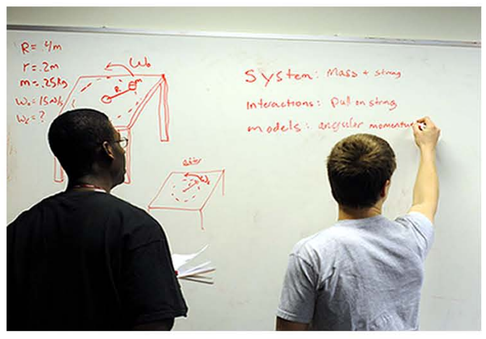
System, Interactions, Model (S.I.M.) Rubric
Teaches students to Understand and Plan

Students required to begin all problems using the same *problem-solving rubric* that contains three elements:

System: What collection of objects are you considering?

Interactions: Indicate the interactions that might change the state of that system.

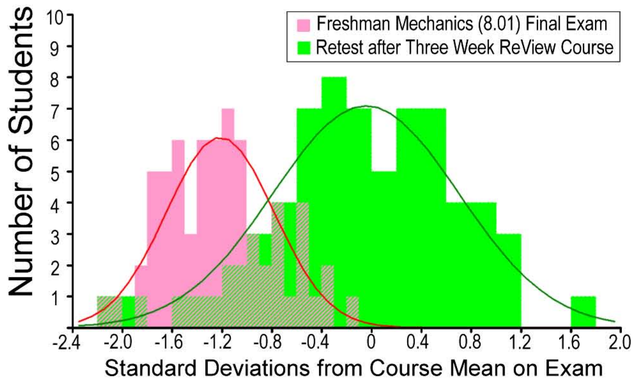
Model: Selection of one or more Models from the hierarchy to apply to the problem in order to plan the solution and set up the equations.



Assessment of Pedagogy: Year Two

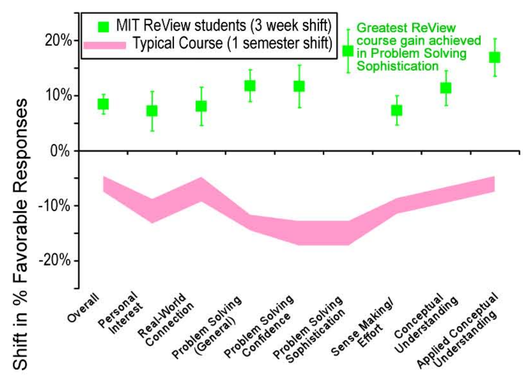
A ReView for D Students
We implemented these ideas in a three week ReView course in January 2009 for 30 students and in January 2010 for 40 students who received D's in freshman mechanics (MIT 8.01) at MIT during the fall. Students who passed a retest of the final exam were granted a C for MIT 8.01 and allowed to move on to the second semester.

Improved Performance



The students entering the ReView scored 1.2 standard deviations below the class average on their final exam in the fall course, but had risen over one standard deviation on the final exam questions they answered after its completion.

More Favorable Attitudes toward Physics



Student attitudes toward physics underwent a shift toward the attitudes of experts in all categories of the CLASS survey. This is a marked contrast with typical mechanics courses, including MIT 8.01, which produce shifts away from expertlike attitudes in all categories (Adams, *et al.*, 2006).

References
Andrew Pawl, Analia Barrantes and David E. Pritchard ,*"Modeling Applied to Problem Solving " Proceedings of the 2009 Physics Education Research Conference, pp. 51-54*

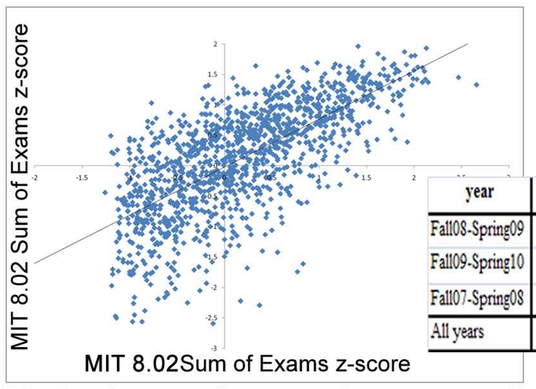
W.K. Adams, K.K. Perkins, N.S. Podolefsky, M. Dubson, N.D. Finkelstein and C.E. Wieman, "*New instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey*", *Phys. Rev. ST-PER* 2, 010101 (2006).

Benefit in Electricity and Magnetism Following The Mechanics ReView Course

Goal
To investigate whether the improvement in the ReView course transfers to performance in subsequent Introductory Electricity and Magnetism (MIT 8.02).

Methodology
We compare the performance of ReView students in the following MIT 8.02 compared to a control group in the year prior to implementing the ReView. Performance of all students taking MIT 8.02 following Mechanics over three years is used as a Baseline for the comparison.

Performance in Electricity and Magnetism Correlates with Performance in Mechanics



year	Regression line	R^2
Fall08-Spring09	y = 0.80x - 0.03 (N=410)	0.5
Fall09-Spring10	y = 0.74x + 0.03 (N=440)	0.41
Fall07-Spring08	y = 0.83x - 0.07 (N=448)	0.51
All years	y = 0.79x - 0.02 (N=1298)	0.47

Student sum of exams in MIT 8.02 (in standard deviations from the mean) plotted against their sum of exams in MIT 8.01.

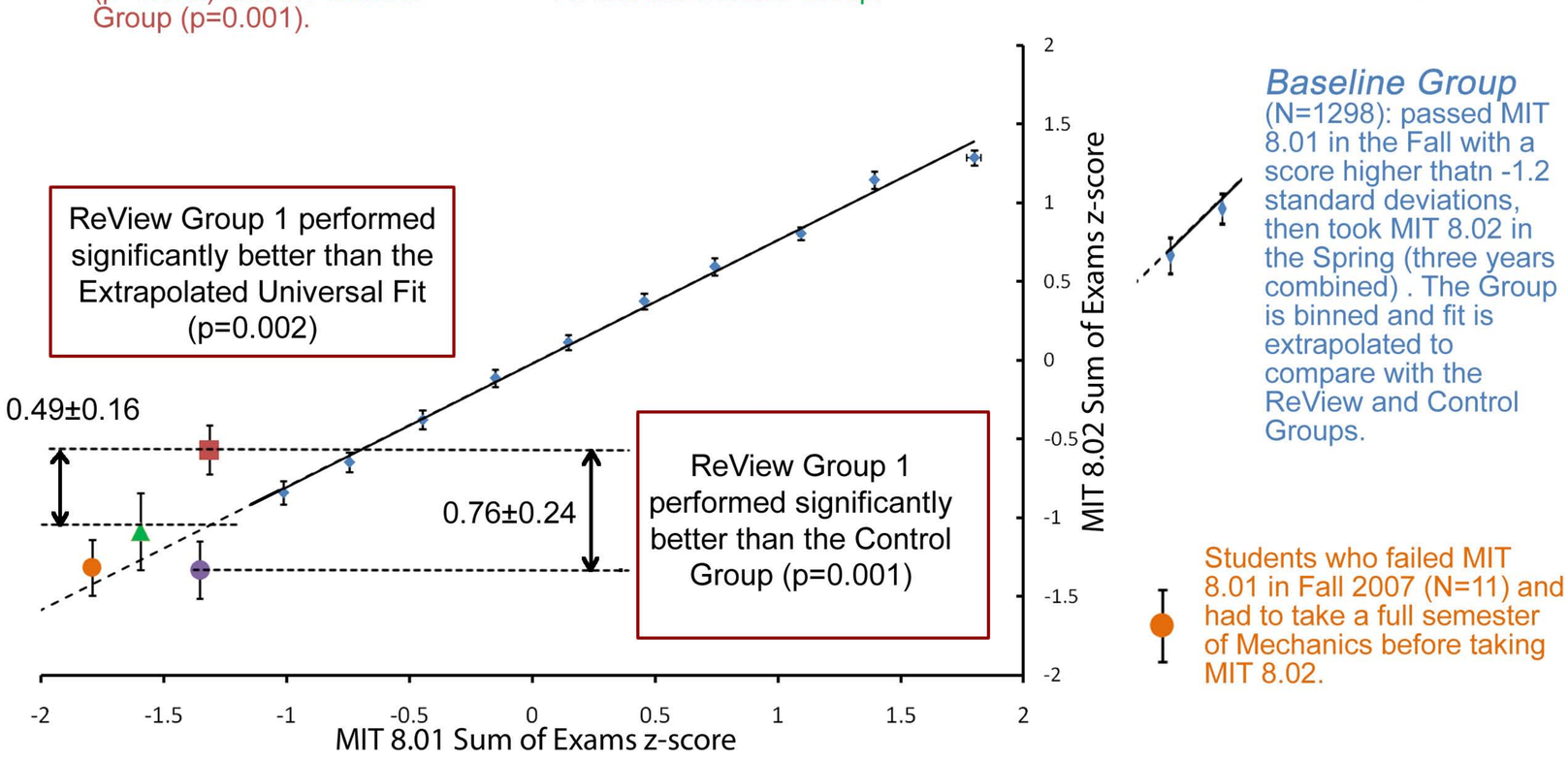
Performance of ReView Students in Electricity and Magnetism Compared to A Control Group and a Universal Fit

ReView students with MIT 8.01 above -1.5 standard deviations performed significantly better than the Control Group and the extrapolated Universal Fit. ReView students below that cutoff did not show a significant shift from the Fit.

ReView Group 1. (N=34) with MIT 8.01 score between -1.5 and -1.2 standard deviations from the mean. This group's performance is significantly higher than the extrapolated Universal Fit (p=0.002) and the Control Group (p=0.001).

ReView Group 2 (N=15) with MIT 8.01scores between -1.8 and -1.5 standard deviations from the mean. This group's performance is slightly higher, but not significantly from the extrapolated Universal Fit and the Control Group.

Control Group (N=18) took MIT 8.01 in Fall 2007 and scored in the same range as ReView Group 1 (-1.5 to -1.2 standard deviations from teh mean). They continued to take MIT 8.02 in Spring 2008 without taking the ReView (or any other Mechanics course).



Baseline Group (N=1298): passed MIT 8.01 in the Fall with a score higher thatn -1.2 standard deviations, then took MIT 8.02 in the Spring (three years combined) . The Group is binned and fit is extrapolated to compare with the ReView and Control Groups.

Students who failed MIT 8.01 in Fall 2007 (N=11) and had to take a full semester of Mechanics before taking MIT 8.02.

We are looking for collaborators!

To test and use our Integrated Learning Environment for Mechanics (ILEM)
http:/loncapa.mit.edu/ilem

To use our assessment of problem solving skills
Mechanics Reasoning Inventory

To use MAPS pdagogy and inspired WIKI-text
https://wikis.mit.edu/confluence/display/RELATE/