

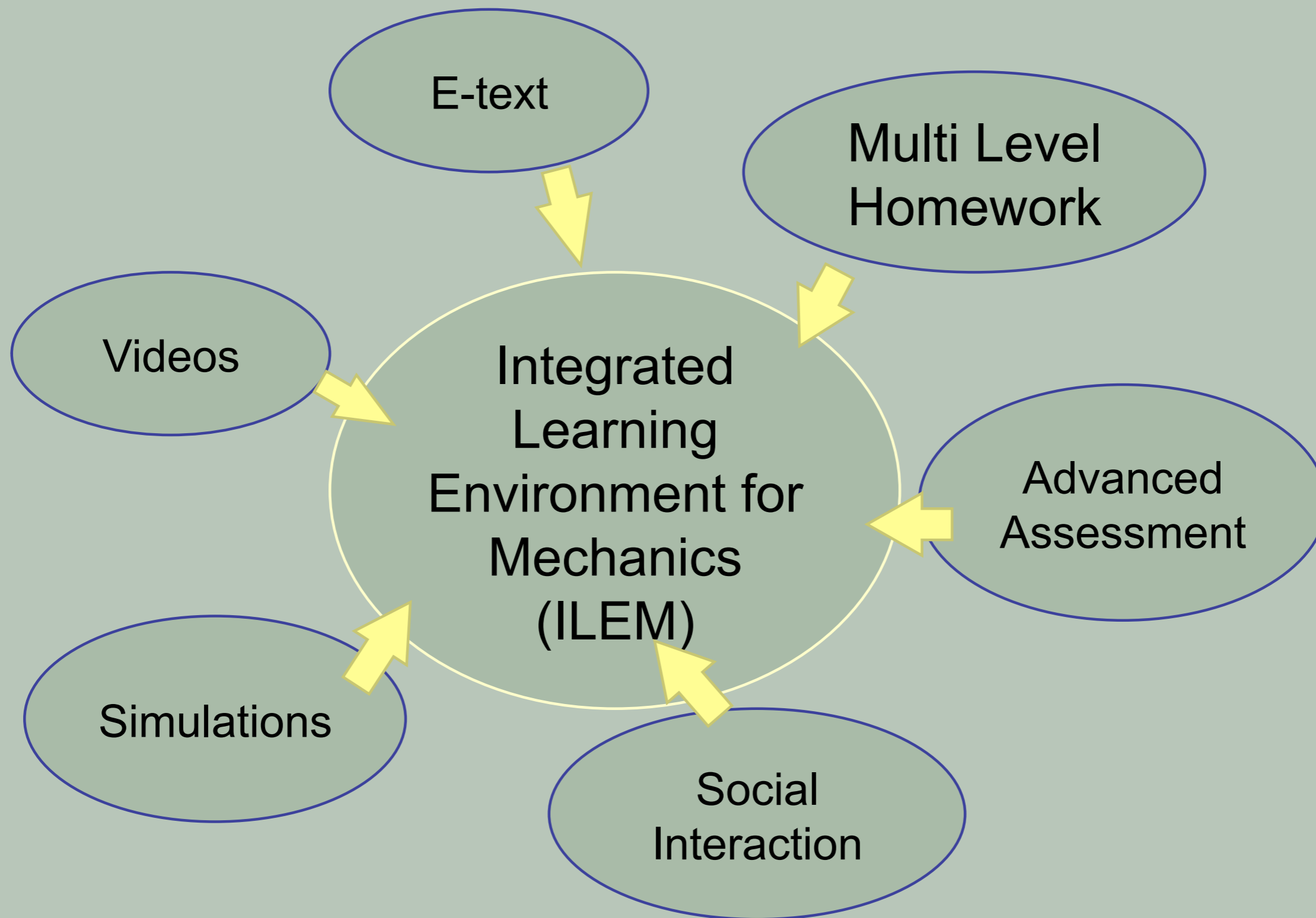
# ILEM - *Integrated Learning Environment for Mechanics*

- Principal Investigator:
  - Dave Pritchard
- Postdocs:
  - Analia Barrantes
  - Carie Cardamone
  - Saif Rayyan
  - Daniel Seaton
  - Raluca Teodorescu

- Collaborators:
  - Gerd Kortemeyer
  - Andrew Pawl
  - Sara Julin



# ILEM



# ILEM @ loncapa.mit.edu

Currently being hosted on LON-CAPA

**ILEM** LON-CAPA

integrated Learning Environment for Mechanics

**Log in**

Username:

Password:

Domain:  
MIT

Log in

[Log-in Help](#)  
[Forgot password?](#)  
[Contact Helpdesk](#)  
[Course/Community Catalog](#)

Domain: MIT  
Server: MIT11 (library)  
Server Load: 0.0 percent  
User Load: --- percent  
2.10.0.RC2-2011011515

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Made possible by grants from  
NSF NATIONAL INSTITUTES OF HEALTH

Teodorescu, R., Pawl, A., Rayyan, S., Barrantes, A. , and Pritchard, D. E.. Physics Education Research Conference 2010 Portland Oregon, AIP Conf. Proc. 1289, 321(2010).

# Pedagogy

## Modeling Applied to Problem Solving (MAPS).

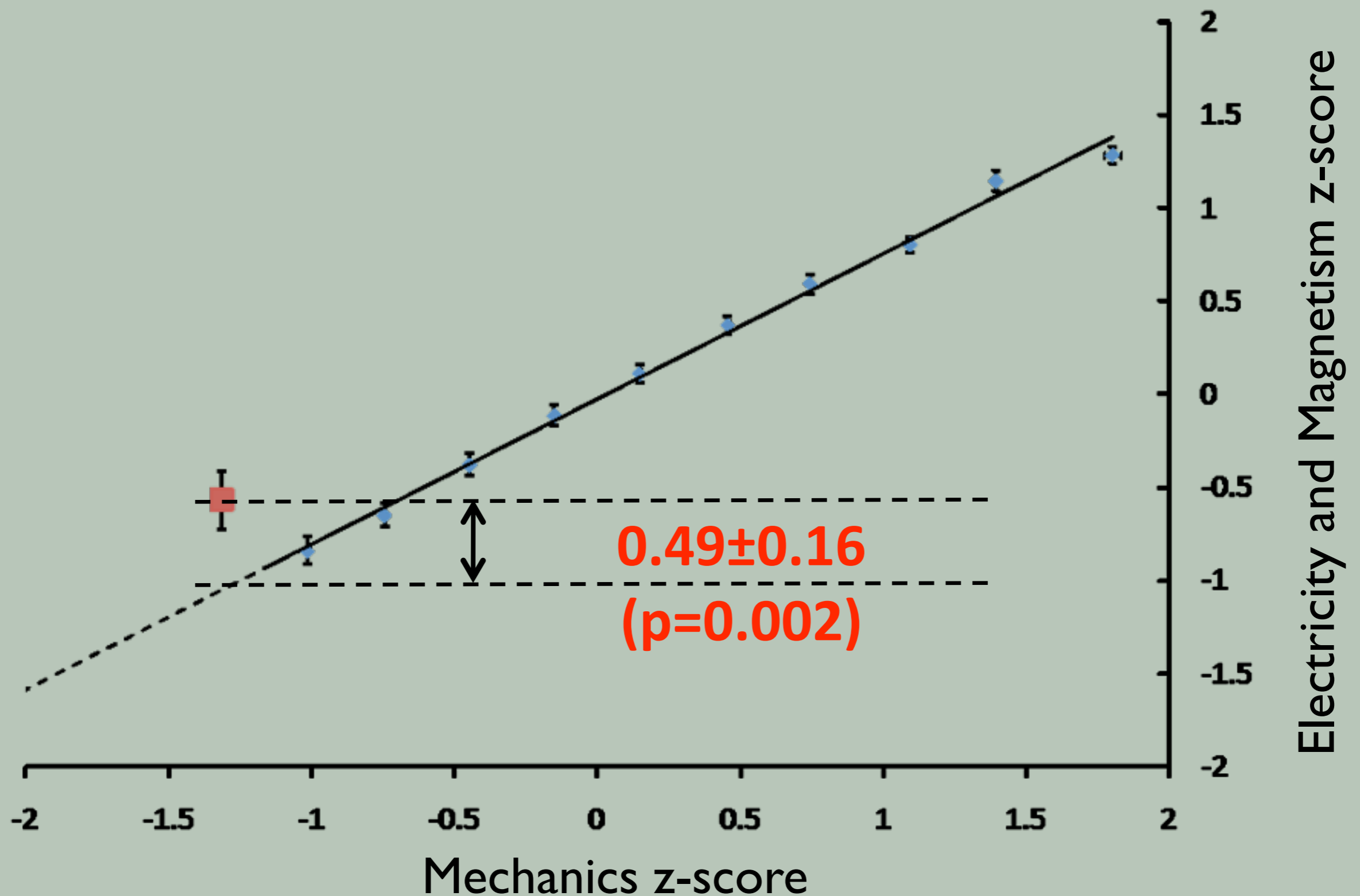
- Students learn how to plan for solving problems in Mechanics.
- Start with specifying the **System** and the **Interactions**, and then Choose a **Model**.
- Collaborative problem solving: groups of 2-3 students working on white boards.
- First implemented in a short ReView for students who failed the fall course



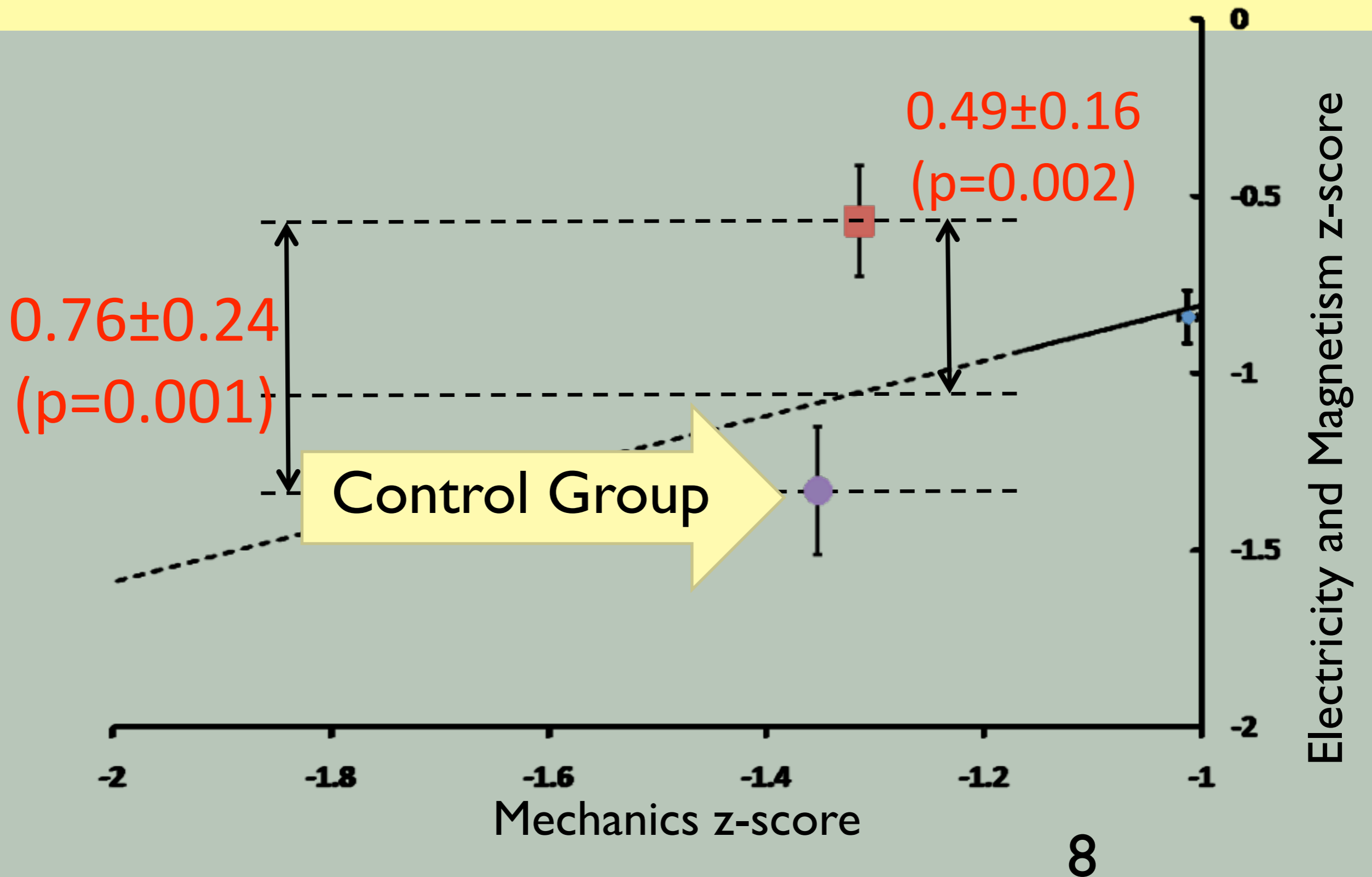
# Performance

- More than 1 standard deviations on a final retest.
- Positive shift in Attitudes towards Science and Problem Solving
- **About one letter grade improvement in the following EM course**

# Performance



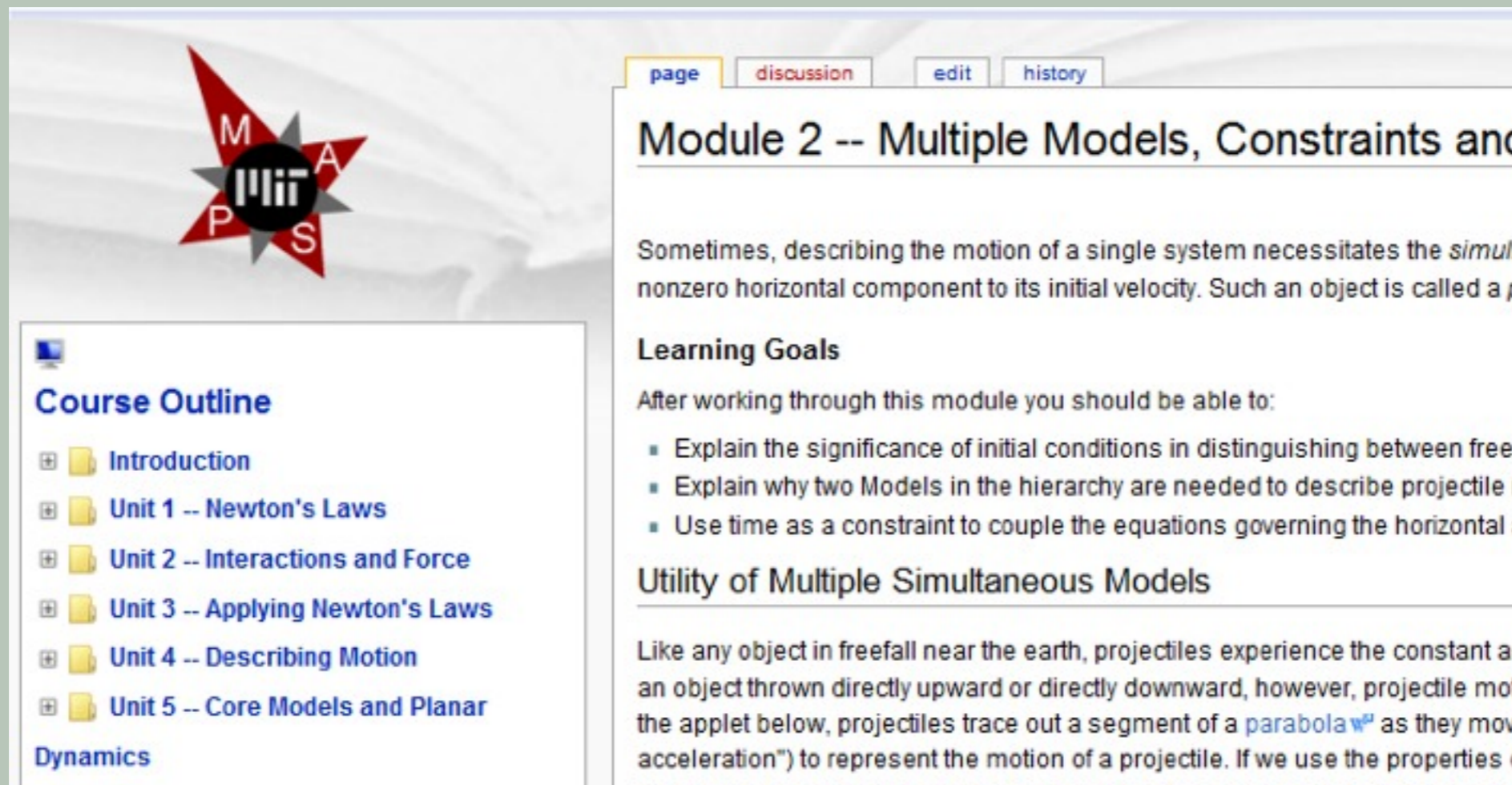
# Performance





# Wiki Text

- <http://scripts.mit.edu/~srayyan/PERwiki/>
- MAPS instructional material + Research based online resources

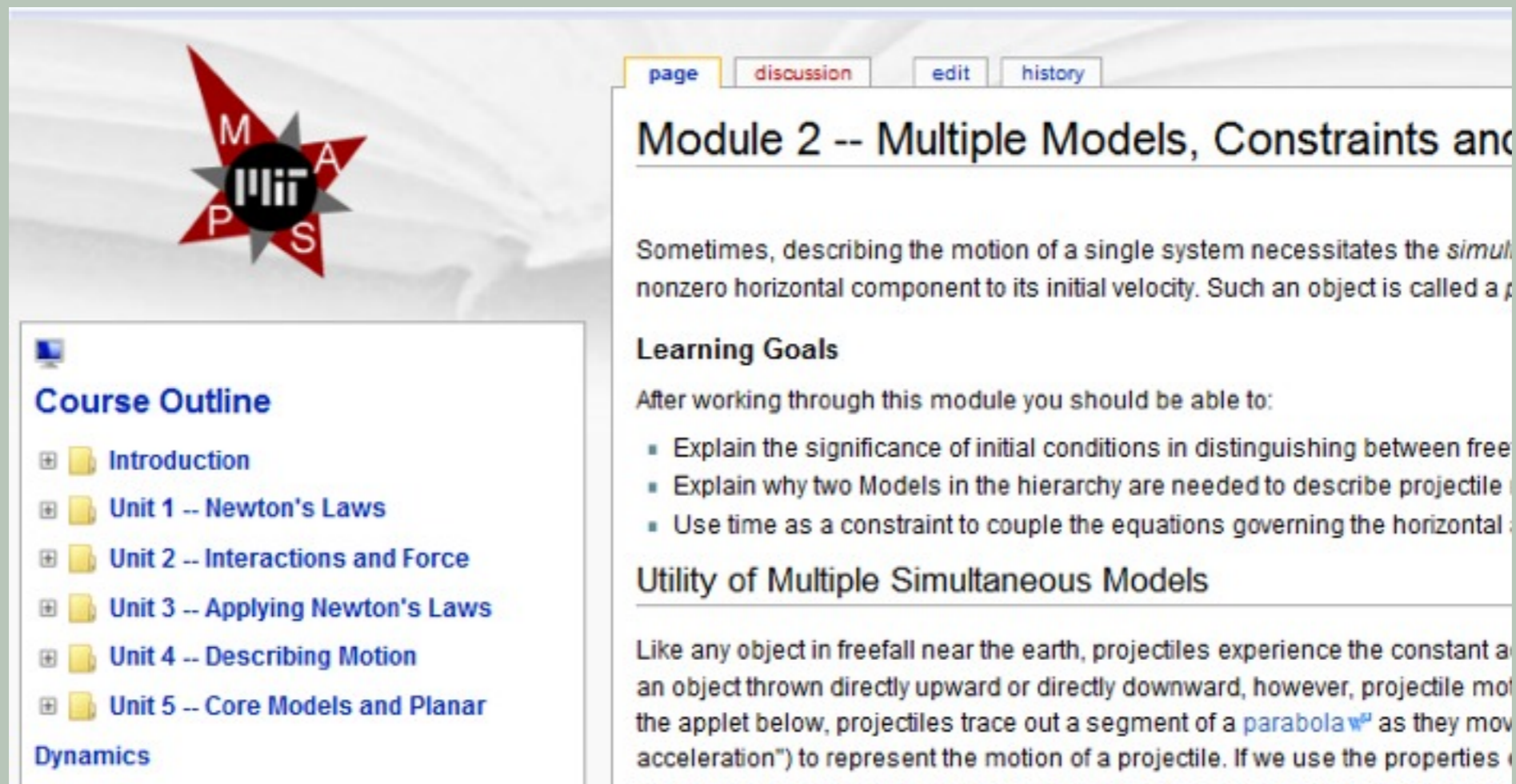


The screenshot displays the PERwiki website interface. At the top left is a red star logo with the letters M, A, P, S and the MIT logo. Below it is a 'Course Outline' sidebar with a tree view of units: Introduction, Unit 1 -- Newton's Laws, Unit 2 -- Interactions and Force, Unit 3 -- Applying Newton's Laws, Unit 4 -- Describing Motion, and Unit 5 -- Core Models and Planar Dynamics. The main content area shows the 'Module 2 -- Multiple Models, Constraints and...' page. It includes navigation tabs for 'page', 'discussion', 'edit', and 'history'. The text discusses projectile motion, mentioning 'Sometimes, describing the motion of a single system necessitates the *simultaneous* use of multiple models' and 'nonzero horizontal component to its initial velocity. Such an object is called a projectile'. It lists 'Learning Goals' such as explaining initial conditions, why two models are needed, and using time as a constraint. A section titled 'Utility of Multiple Simultaneous Models' begins with 'Like any object in freefall near the earth, projectiles experience the constant acceleration of gravity. Unlike an object thrown directly upward or directly downward, however, projectile motion is more complex. In the applet below, projectiles trace out a segment of a parabola as they move through the air (ignoring air resistance and assuming a constant acceleration) to represent the motion of a projectile. If we use the properties of a parabola, we can determine the time of flight, the maximum height, and the range of a projectile.'



# Wiki Text

- In LONCAPA:
- [/res/MIT/RELATE/MAPS\\_8011/](/res/MIT/RELATE/MAPS_8011/)



The screenshot shows a LONCAPA wiki page. At the top left is a red star logo with 'MIT' in the center and 'MAPS' around it. Below the logo is a 'Course Outline' sidebar with a tree view containing: Introduction, Unit 1 -- Newton's Laws, Unit 2 -- Interactions and Force, Unit 3 -- Applying Newton's Laws, Unit 4 -- Describing Motion, and Unit 5 -- Core Models and Planar Dynamics. The main content area has tabs for 'page', 'discussion', 'edit', and 'history'. The title is 'Module 2 -- Multiple Models, Constraints and Dynamics'. The text begins with 'Sometimes, describing the motion of a single system necessitates the simultaneous use of multiple models. For example, an object with a nonzero horizontal component to its initial velocity. Such an object is called a projectile.' It then lists 'Learning Goals' and 'Utility of Multiple Simultaneous Models'.

page discussion edit history

## Module 2 -- Multiple Models, Constraints and Dynamics

Sometimes, describing the motion of a single system necessitates the simultaneous use of multiple models. For example, an object with a nonzero horizontal component to its initial velocity. Such an object is called a projectile.

### Learning Goals

After working through this module you should be able to:

- Explain the significance of initial conditions in distinguishing between free fall and projectile motion.
- Explain why two Models in the hierarchy are needed to describe projectile motion.
- Use time as a constraint to couple the equations governing the horizontal and vertical motions of a projectile.

### Utility of Multiple Simultaneous Models

Like any object in freefall near the earth, projectiles experience the constant acceleration of gravity. However, unlike an object thrown directly upward or directly downward, however, projectile motion is more complex. In the applet below, projectiles trace out a segment of a parabola as they move through the air. The applet uses the "multiple models" approach (i.e., "multiple models" to represent the motion of a projectile. If we use the properties of the projectile model, we can describe the motion of a projectile as a combination of free fall and constant velocity motion.




# Multi Level Homework

Raluca Teodorescu  
[rteodore@mit.edu](mailto:rteodore@mit.edu)

Traditional (55%) and research-based problems (45%)

Complexity	Cognitive Processes	Knowledge	
		Declarative	Procedural
Easy	Recalling, Executing	Vocabulary terms, Facts	Single rules
Medium	Recalling, Executing, Integrating, Representing	Facts, Time sequences	Algorithms
Hard	Recalling, Executing, Integrating, Representing Analyzing errors	Facts, Time sequences, Multiple Principles	Algorithms, Tactics

# Multi Level Homework

- ▼  Unit 4 -- Describing Motion Homework 2
  -  Read This Page First
  - ▶  Describing Motion Homework 2 - easy
  - ▶  Describing Motion Homework 2 - medium
  - ▶  Describing Motion Homework 2 - hard

## Choose Your Own Path Homework

---

### Determine your own path:

At what level would you like to begin this homework? (Level 1 = easiest, Level 3 = hardest.)

- Level 1 (Easiest)
- Level 2
- Level 3 (Hardest)

Tries 0/99

# Implementation

- Experimental Course at MIT Fall 2010 (10 students)
- Whatcom Community College : Fall 2010 ,Spring 2011 (60 students)
- University of Wisconsin Platteville: Fall 2010, Spring 2011 (120 students)
- MIT Spring 2011 (70 students).
- Workshops at AAPT winter and summer meetings

# What is next?

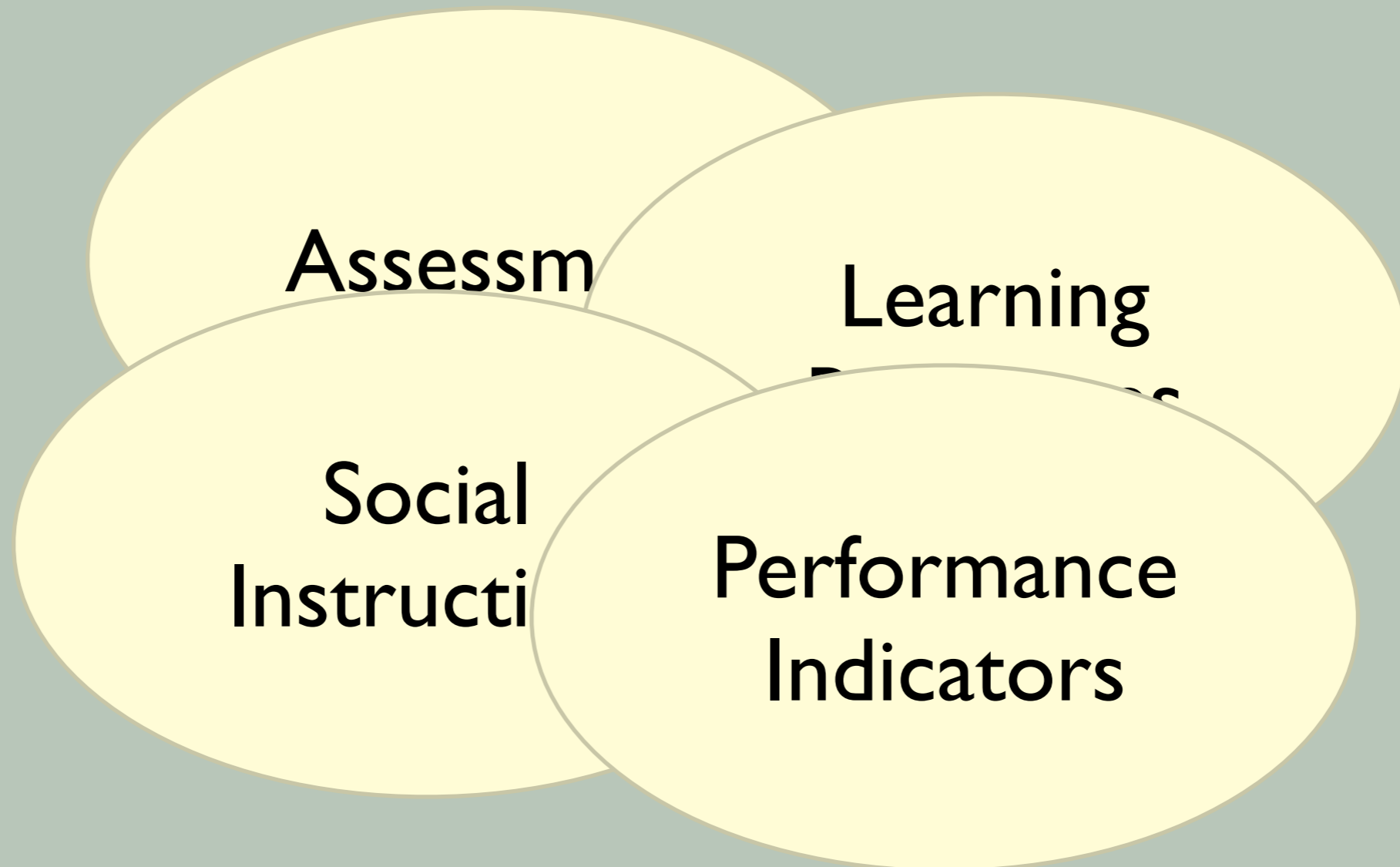
**Assessment**

**Learning  
Resources**

**Social  
Instruction**

**Performance  
Indicators**

# What is next?



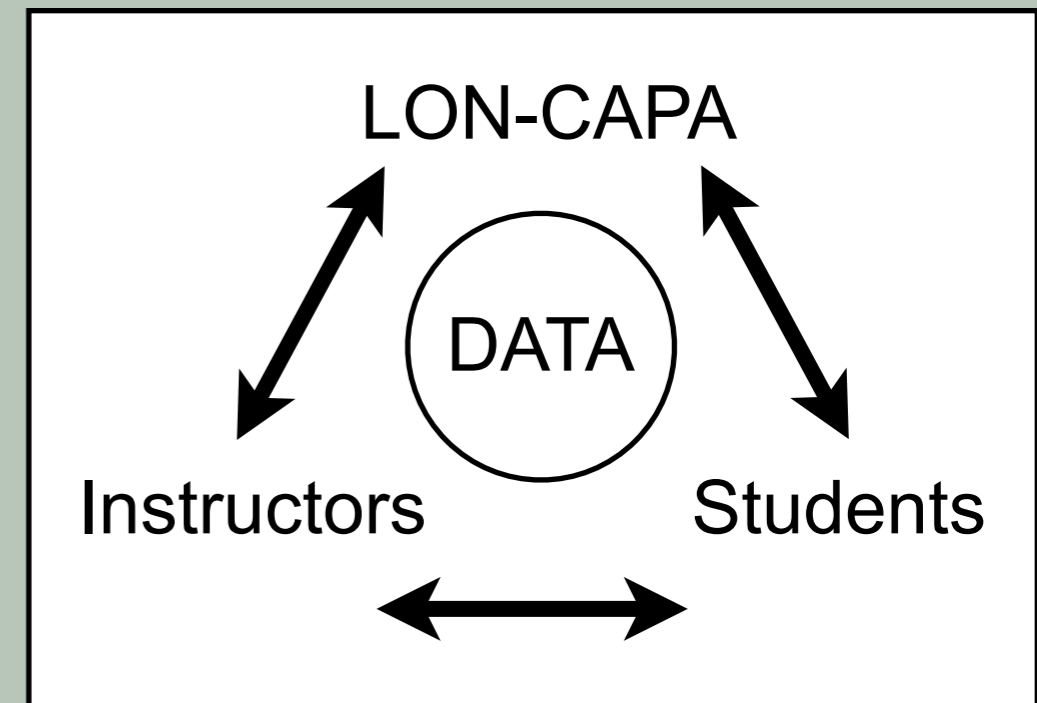


# Assessment

- Our objective is to define measures of learning; subsequently displaying such measures to students and instructors
- Currently we are formulating the basic research to define useful properties and how they should be displayed

## Current Research Efforts

- Analysis of discussion boards
- Item Response Theory
- Time-on-task
- Asset Window





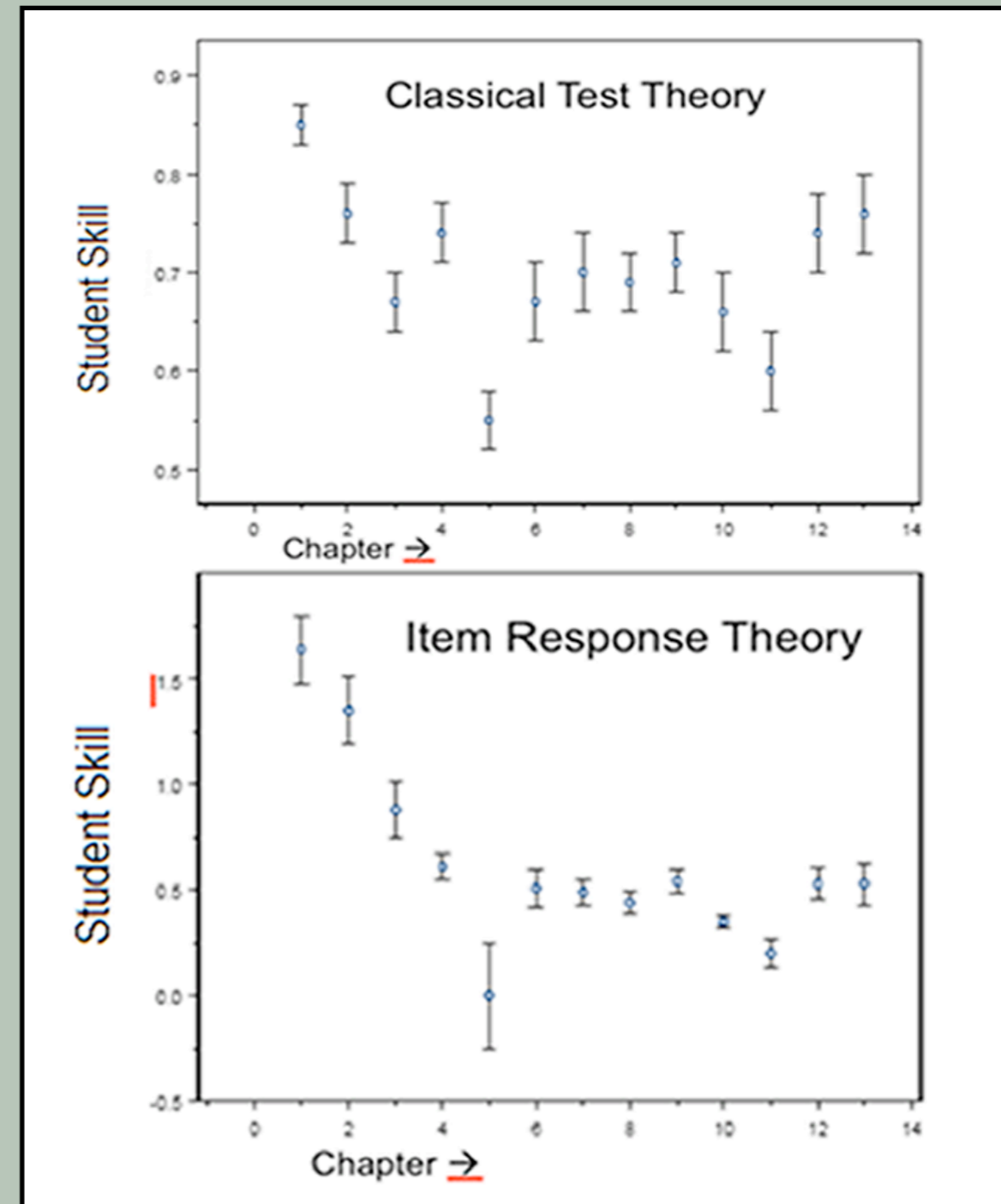
# Item Response Theory

Carie Cardamone

[cnc@mit.edu](mailto:cnc@mit.edu)

Generalized goal of IRT is to provide discrimination of students and resources within LON-CAPA

- Currently testing IRT methods on data outside LON-CAPA
- Multiple Institutions: MIT, MSU, and UGA
- Figure: comparing classical test and item response theories at estimating student skill for an MIT intro mechanics course



# Time-on-task

Daniel Seaton  
[dseaton@mit.edu](mailto:dseaton@mit.edu)

Further discrimination of problems and resources through analysis of time

- Course wide measurements
- Student and resource specific measurements
- Would like to understand effects of displaying “time-based” information to students

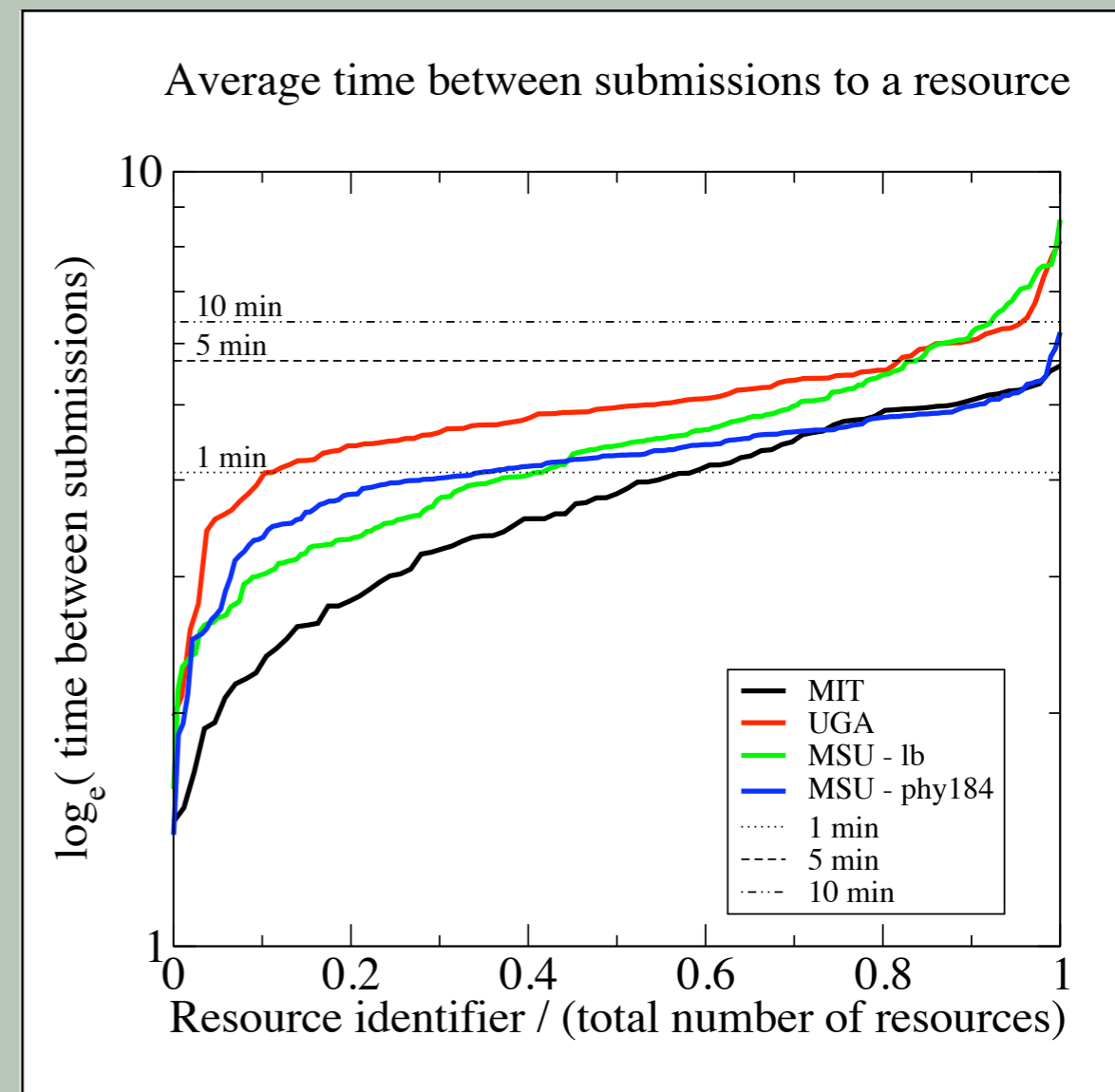


Figure: measuring the time between submissions for all resources from 3 physics courses: MIT, MSU, UGA

# Discussion Board Analysis

Spring 2011: Required students to post to discussion throughout the course

- Analysis is underway, with the aim of classifying posts and measuring utility
- Homework where students posted their plans for solving difficult multi-concept problems
- Would like to more greatly facilitate such activities in LON-CAPA

Raluca Teodorescu  
[rteodore@mit.edu](mailto:rteodore@mit.edu)

The screenshot shows an Excel spreadsheet with the following data structure:

	Week Feb 1			Week Feb 7			Week Feb 14	
	Novice	Expert	Total	Novice	Expert	Total	Novice	Expert
1								
2								
3								
4								
5	ns,	4	0	4	1	2	3	3
6	nac	0	0	0	0	0	0	0
7	Xut	3	0	3	1	1	4	3
8	ob,	4	2	6	5	0	5	1
9	cha	0	0	0	0	0	0	0
10	ev,	2	0	2	3	0	3	1
11	s, J	1	2	3	3	0	3	1
12	oy,	5	5	10	6	3	9	1
13	ha,	3	0	3	0	0	0	2
14	, C	3	0	3	1	0	1	3
15	ha,	8	0	8	5	0	5	0
16	y, C	3	0	3	0	0	0	0
17	, At	4	0	4	0	0	0	0
18	Jo	0	0	0	0	0	0	0
19	asc	3	1	4	5	0	5	1
20	Ve	0	0	0	0	0	0	0
21	n, C	2	1	3	1	2	3	2
22	zo,	7	2	9	2	1	3	3
23	s, t	10	0	10	7	0	7	2
24	rzb	1	0	1	3	0	3	1
25	s, v	0	0	0	0	0	0	0
26	Cal	7	3	10	8	3	11	5
27	in	0	0	0	0	0	0	0
28	lau	0	0	0	0	0	0	0
29	ess	3	0	3	2	0	2	2
30	chn	1	2	3	5	0	5	4
31	la,	3	0	3	0	0	0	0
32	ren,	5	2	7	8	0	8	3
33	ale	0	0	0	0	0	0	0
34	ale	2	1	3	2	0	2	1
35	nbt	0	0	0	0	0	0	2
36	ko,	4	0	4	8	0	8	3
37	rer	4	0	4	3	0	3	1
38	arz	6	0	6	6	0	6	1
39	ssel	3	1	4	4	0	4	2
40	rrc	2	0	2	4	0	4	4
41	ito	1	0	1	3	0	3	3
42	non	5	2	7	9	0	9	3
43	y, V	5	1	6	6	0	6	0
44	t, S	3	0	3	2	0	2	0
45	hyc	3	0	3	0	0	0	0
46	son	3	1	4	2	1	3	0
47	i, R	2	1	3	4	0	4	4
48	Br	6	2	8	4	0	4	1
49	, J,	0	0	0	0	0	0	2
50	za,	3	0	3	2	0	2	3
51	ry,	0	0	0	3	0	3	2
52	, J,	3	0	3	3	0	3	4
53	Mi	4	0	4	3	0	3	3
54	, A	0	0	0	2	2	4	0
55	ta	3	0	3	3	0	3	1

# Asset Window

How do we recommend “educational resources” to students based on material and problems?

Saif Rayyan  
[srayyan@mit.edu](mailto:srayyan@mit.edu)

- Provides links to other resources: *previously worked problems, videos, online text, etc...*
- Relies heavily on associations and mappings of relationships between content/resources

Many students at MIT take the T (subway) to campus each day. Suppose a 50kg student boards a resting subway car, and departs at a constant acceleration of 4 m/s. If the student remains at rest, with their only contact being their feet with the car floor, calculate the friction force if  $\mu = 0.4$ . Assume traveling toward campus to be the positive direction.

Submit Answer Tries 0

## Asset Window

Resource	Description	Rating
<a href="#">MIT - OCW</a>	Walter Lewin Video - Friction	5.0
<a href="#">Problem</a>	Related Problem	4.0
<a href="#">Wiki text</a>	Course or outside content	3.0

# Asset Window

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- Provides links to other resources: *previously worked problems, videos, online text, etc...*
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Can we apply such a recommender to other elements in LON-CAPA?

- We think yes, e.g., Content pages in our Wiki
- Such a recommender may also facilitate other aspects of LON-CAPA

# Conclusions

We are excited to be working within the LON-CAPA community, and we welcome collaborations.

Thank you for your attention!