

# Problem solving strategies in an online homework environment: “Student Choice and Analytics”

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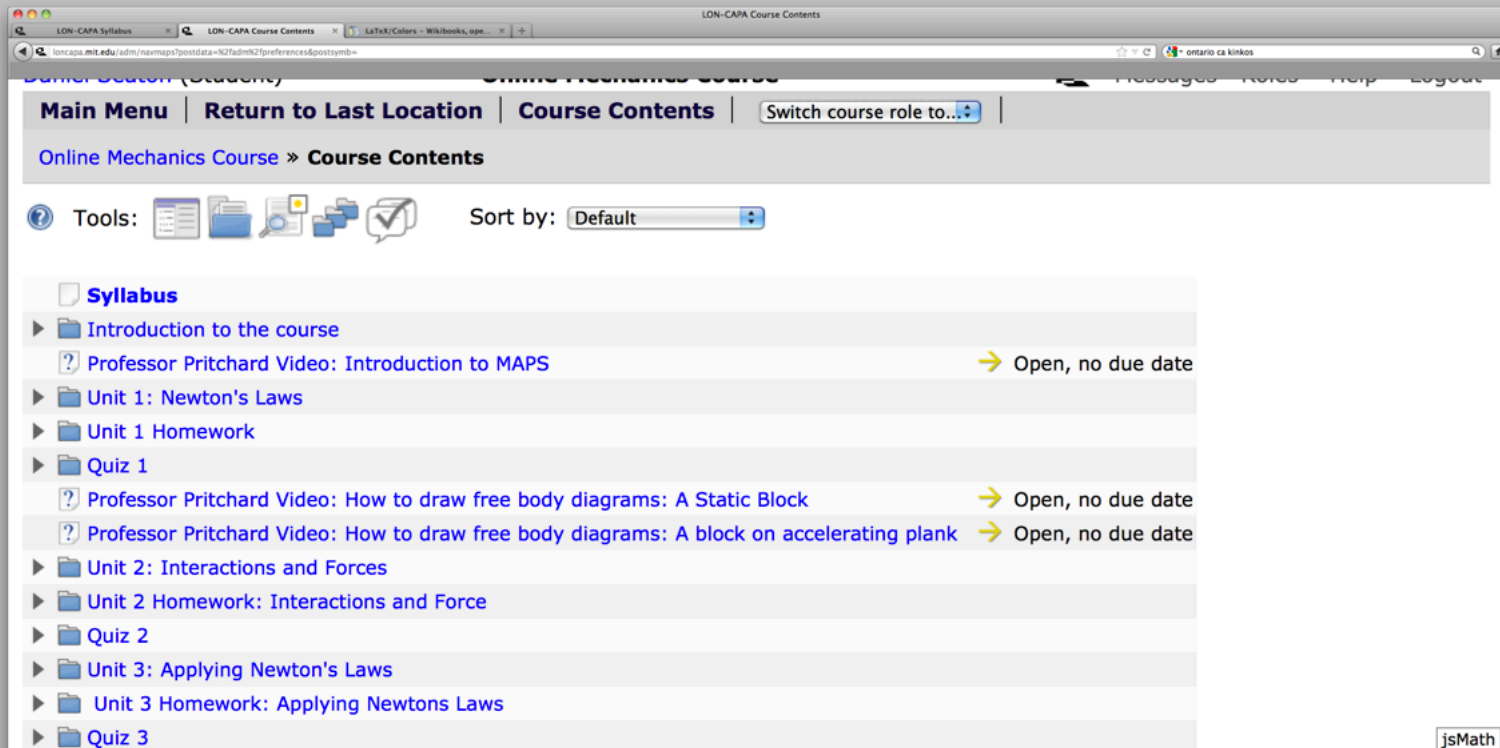


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# Online Environment using LON-CAPA

- Integrated Learning Environment for Mechanics
  - Built within LON-CAPA
  - E-text with instructor videos
  - Concept questions
  - Easy, Medium, Hard homework problems



The screenshot shows a web browser window displaying the LON-CAPA Course Contents page for an Online Mechanics Course. The page features a navigation bar with links for 'Main Menu', 'Return to Last Location', 'Course Contents', and a 'Switch course role to...' dropdown. Below the navigation bar, the course title 'Online Mechanics Course » Course Contents' is displayed. A 'Tools' section includes icons for a help page, folders, a search icon, a document, and a checkmark, along with a 'Sort by: Default' dropdown menu. The main content area is a tree view of course materials, including a 'Syllabus' folder, an 'Introduction to the course' folder with a video link, and three units (Unit 1, Unit 2, and Unit 3). Each unit contains sub-items for 'Homework' and 'Quiz', and Unit 1 includes two video links. A 'jsMath' logo is visible in the bottom right corner of the page.

# Problem Categorization in Homework

Difficulty	Cognitive Processes	Declarative Knowledge	Mental Procedures	Examples
Easy	recall, execution, representation, ranking, analyzing errors	definitions, vocabulary terms, basic facts, simple time sequences	single rules and basic algorithms	evaluate definitions, identify appropriate systems, perform simple calculations, match basic graphs with verbal descriptions, match arrows with relevant forces
Medium	same as Easy + integration	complex facts and time sequences	complex algorithms and tactics	choose an appropriate problem solving strategy, perform two-step calculations, compare physical quantities and outcomes, over-informed scenarios
Hard	same as Easy + integration	more complex facts and time sequences, principles and generalizations	complex procedures	evaluate solutions, match complex diagrams with verbal descriptions, match problems with their strategies, perform multi-step and limiting case calculations, multiple object scenarios

- Problems categorized by Raluca Teodorescu based on her thesis work.
- Categorization provides opportunity to explore problem difficulty and student choice.

[1] R. Teodorescu, D. T. Seaton, et. al, PERC (2011).

[2] R. Teodorescu, Thesis, George Washing University (2009).

# Course Implementation at MIT

- ILEM / LON-CAPA homework
  - Easy (+1), Medium (+2), Hard (+3)
  - Students must attain 15 points per assignment
  - Students generally have to work in at least two folders
- Spring 2011, MIT 8.011 ( ~60 Students)
  - Reform course for students needing to re-take introductory physics at MIT
  - ILEM / LON-CAPA used to prep students each week, only required for 5 units
  - Class time used for highly interactive group problem solving sessions (minimal lecture)
- [Data Mining LON-CAPA Activity Logs!!!](#)

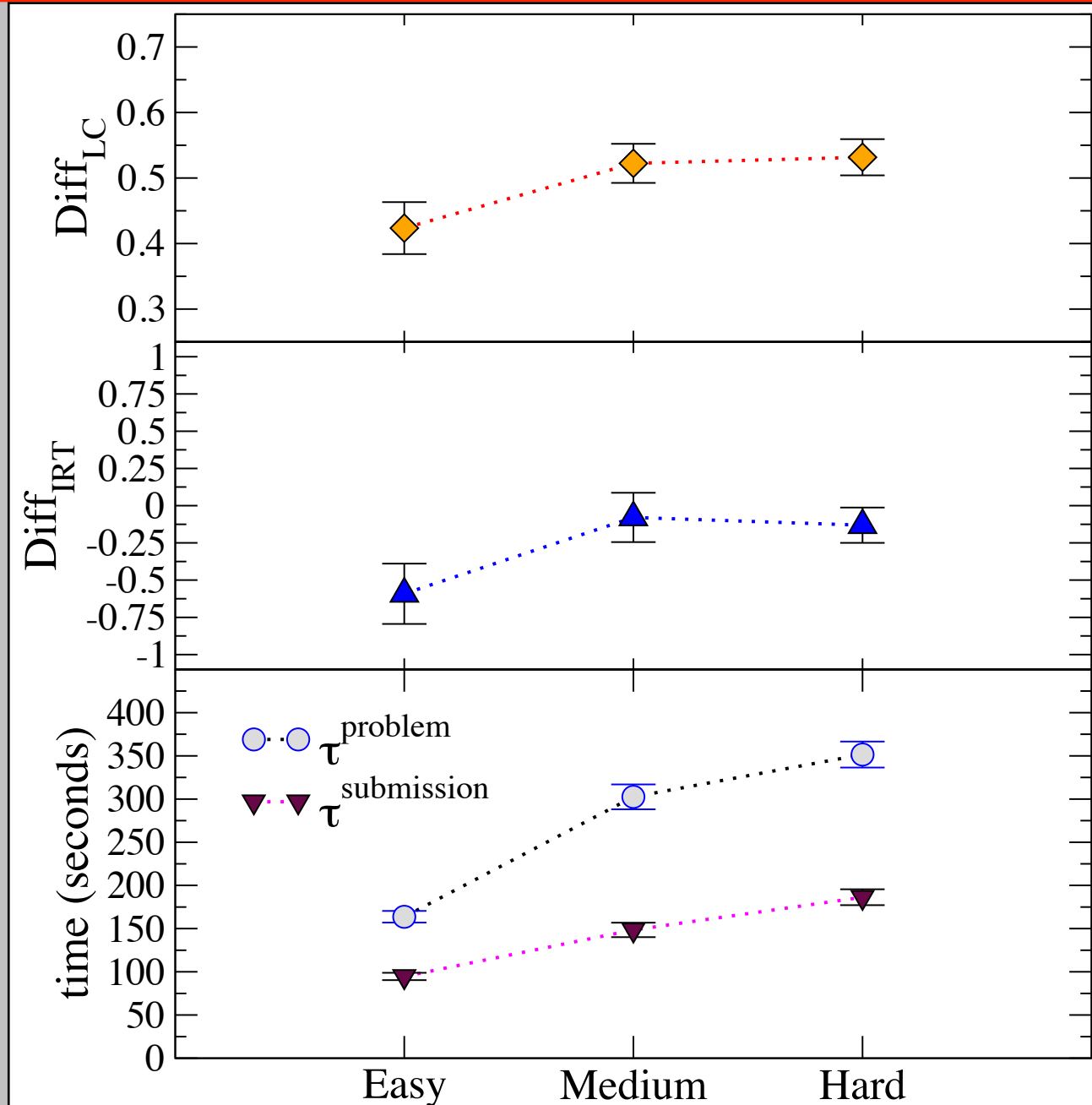
# Problem Categorization

LON-CAPA Difficulty

$$Diff_{LC} = \text{incorrect}/\text{total}$$

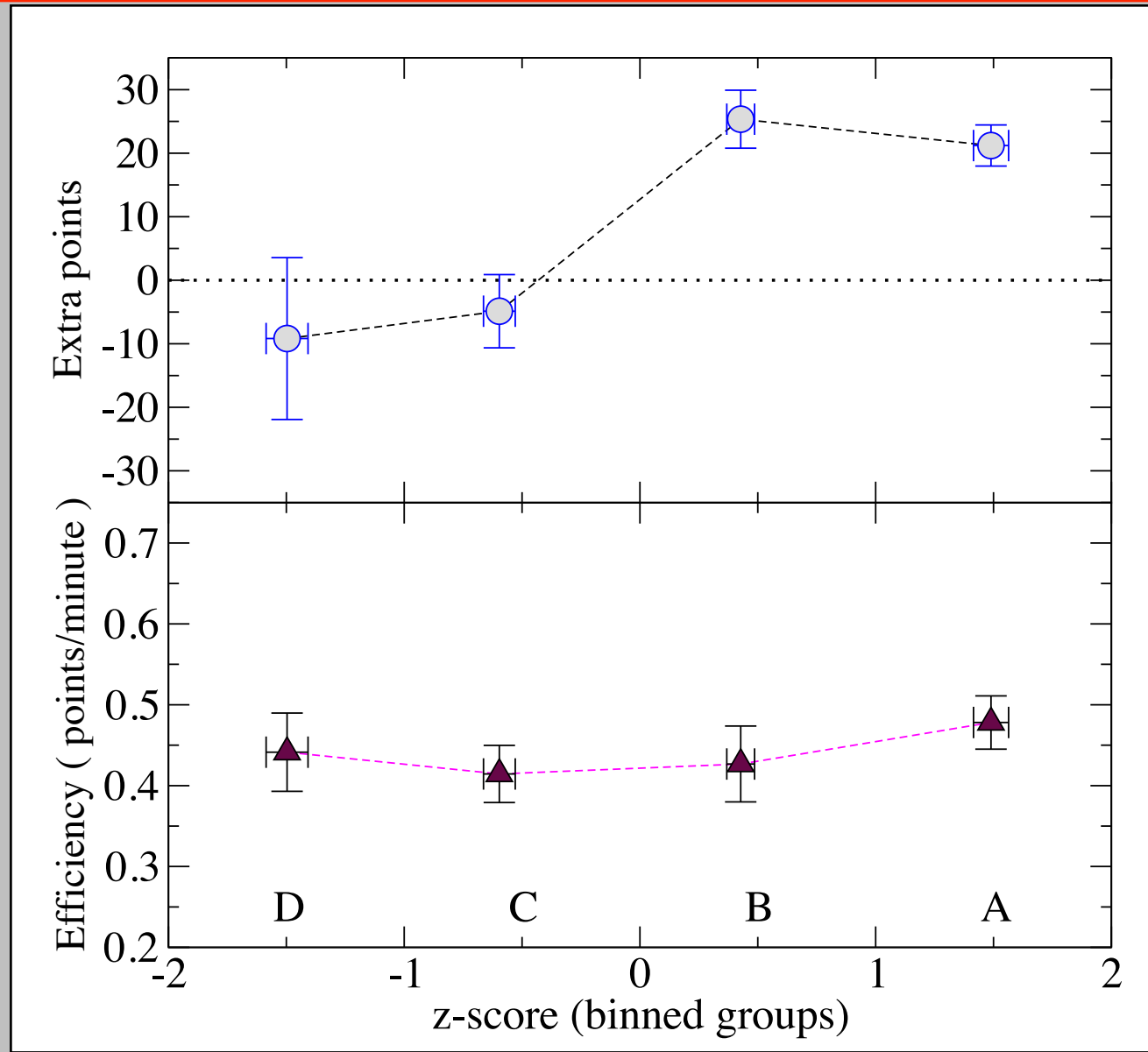
Item Response Theory  
using *Rasche Model*

Time *per problem*  
and time *per submission*



# Student Behavior and Performance

- Z-score student groups based on overall performance
- Motivation
  - ~ 70% students gained more than 15 points on 3 or more assignments
- Efficiency
  - Similar value across all groups



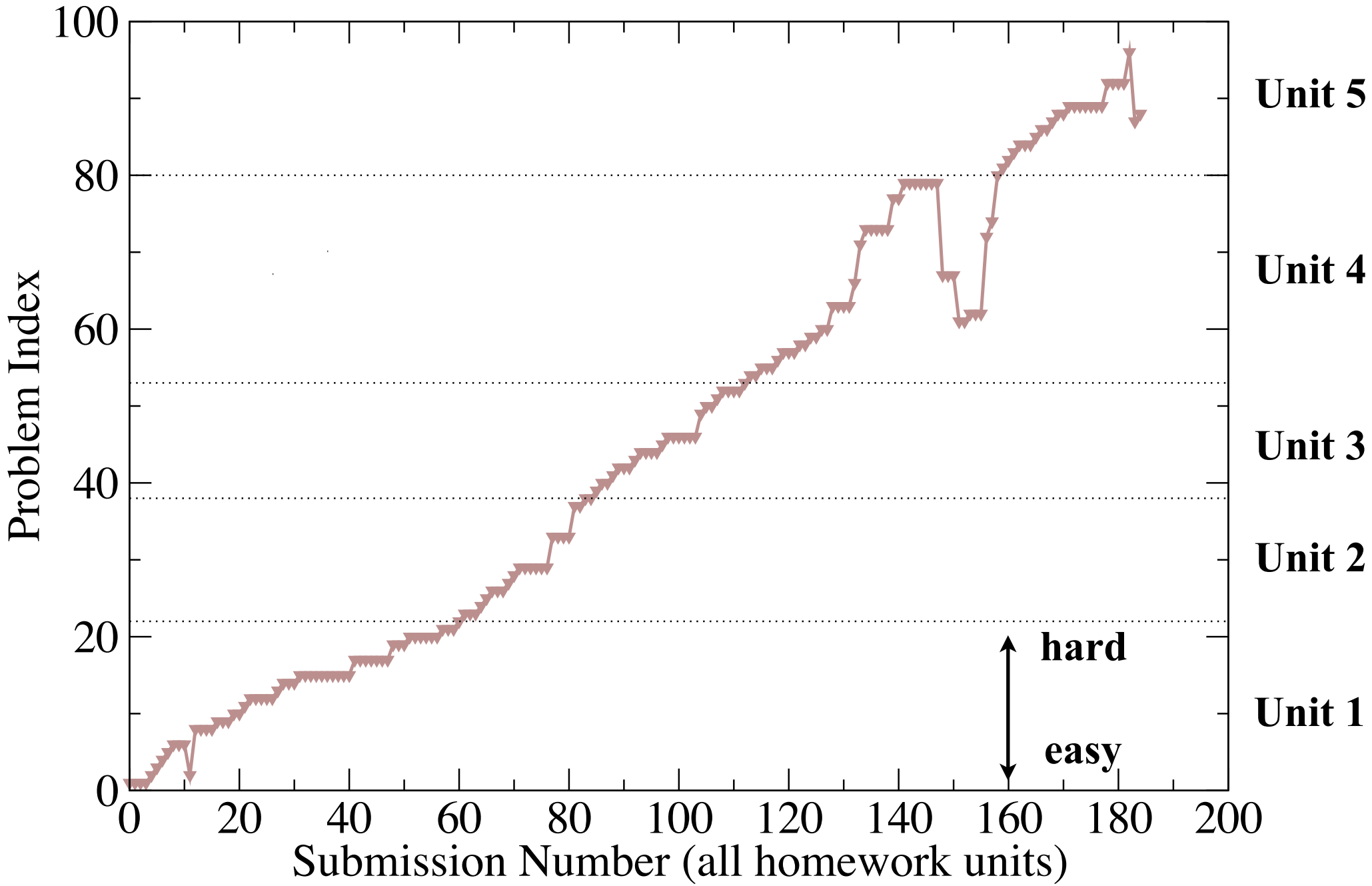
[1] R. Teodorescu, D.T. Seaton, et. al, PERC (2011).

# Student Choice - Initial / Final Categories

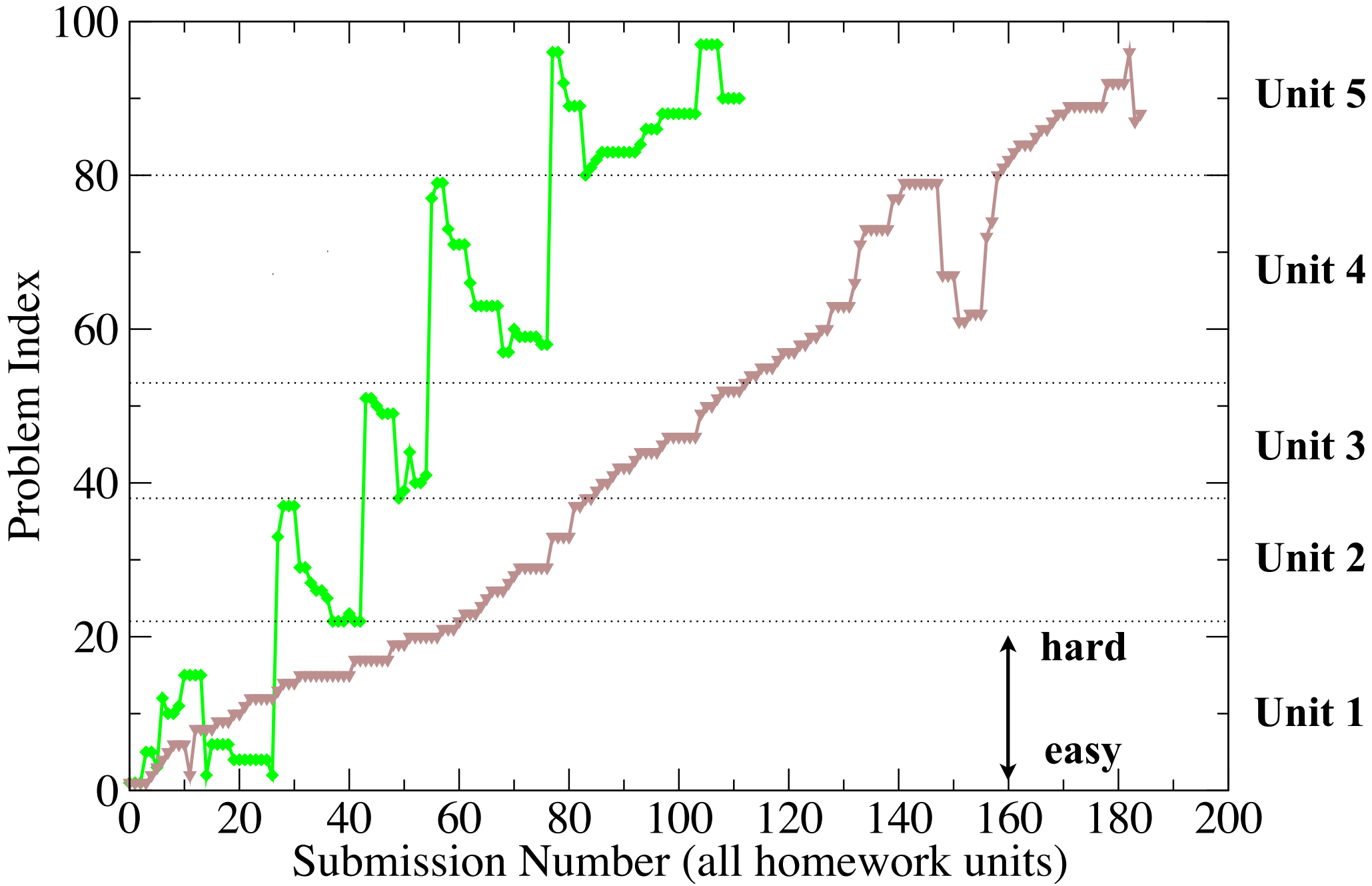
- What categories do students start with? End with?

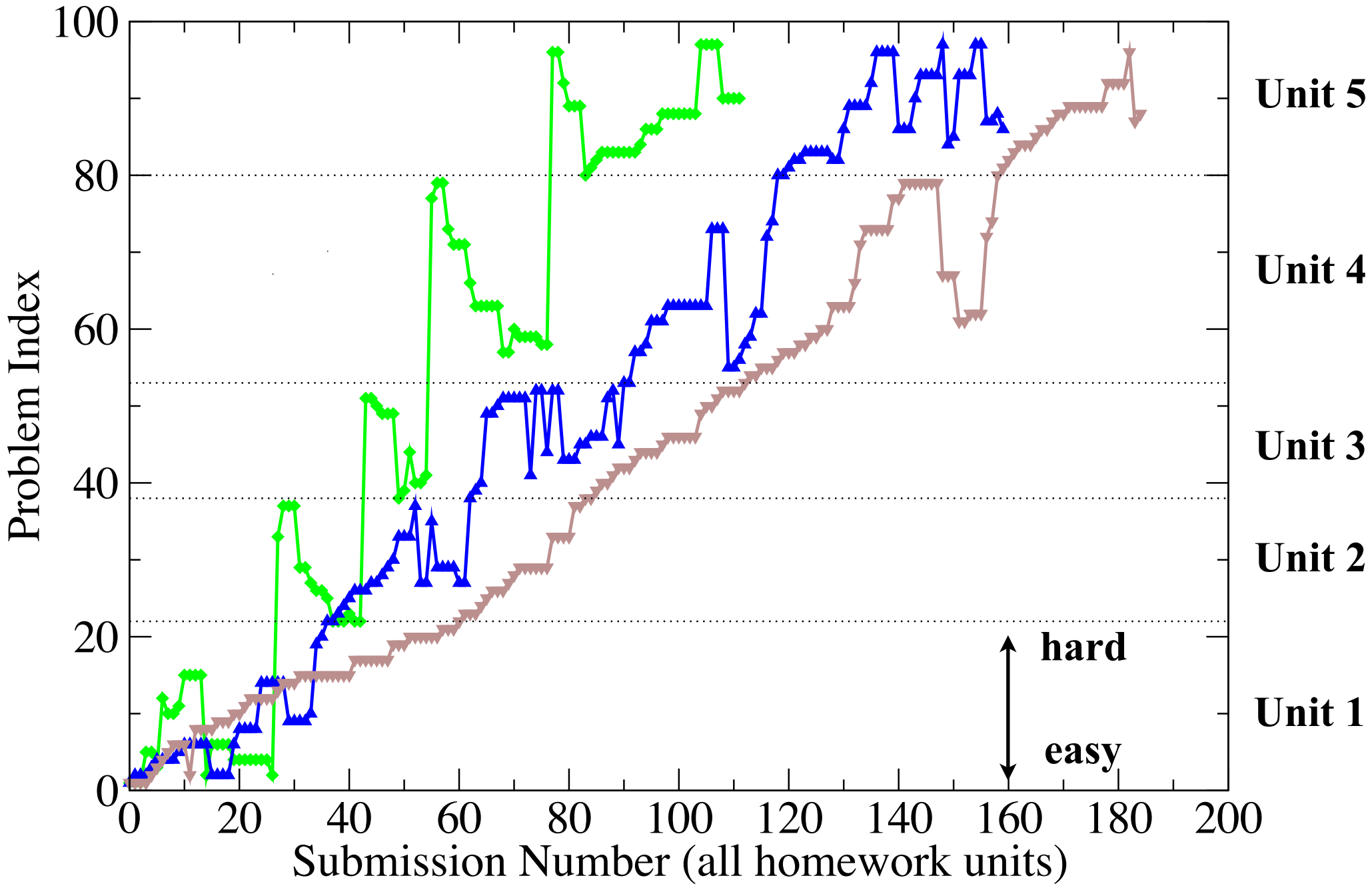
Unit	Initial Category				Final Category		
	Easy	Med	Hard		Easy	Med	Hard
Newton's Laws	50	1	5		3	19	34
Dynamics & Modeling	43	2	7		4	13	35
Momentum	45	0	6		7	21	23
Mechanical Energy	45	4	8		12	27	18
Torque & Rotation	48	2	7		7	28	22

- Survey information being analyzed from January course.
- Student number conserved between initial and final state, but not necessarily between units.









# Comparison with Traditional Homework

- Future work:
  - We have built some nice tools for analyzing student interactions with homework in LON-CAPA
  - Now we need to assess traditional homework with these tools, then compare / contrast with our easy, medium, hard homework method
  - Will be looking at data sets from MSU, UGA, and MIT

# Thanks for your time!

- Collaborators

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Stefan Dröschler

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Plattville  
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- Free-online mechanics course!!! Enrollment starts now!!!

- [relate.mit.edu/physicscourse](http://relate.mit.edu/physicscourse)

