

Skipping the First Step: Physical Process Understanding in Problem Solving

Katie Ansell

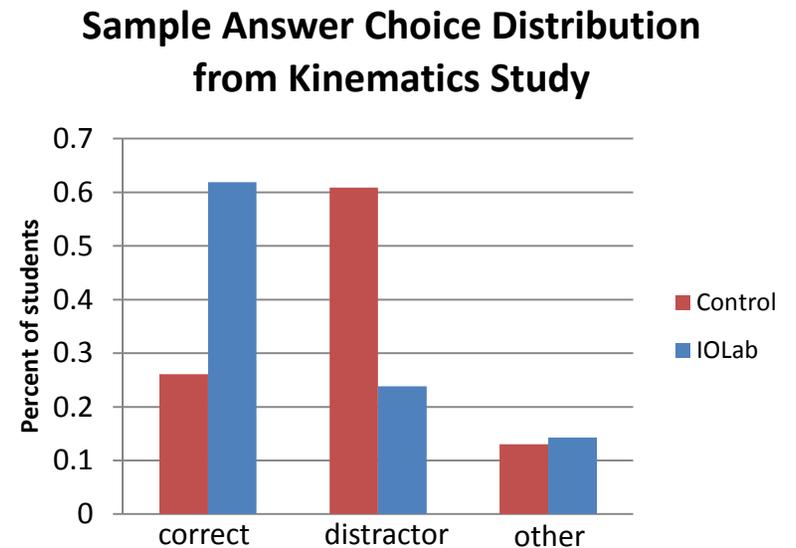


New Conceptual Assessment at Illinois

In previous clinical studies:

Hands-on experiences weaken the attractiveness of distractor answers in conceptual assessments

New assessment for longer-term hands-on programs



Conceptual Assessment - Goals

For Introductory Calculus-based Mechanics:

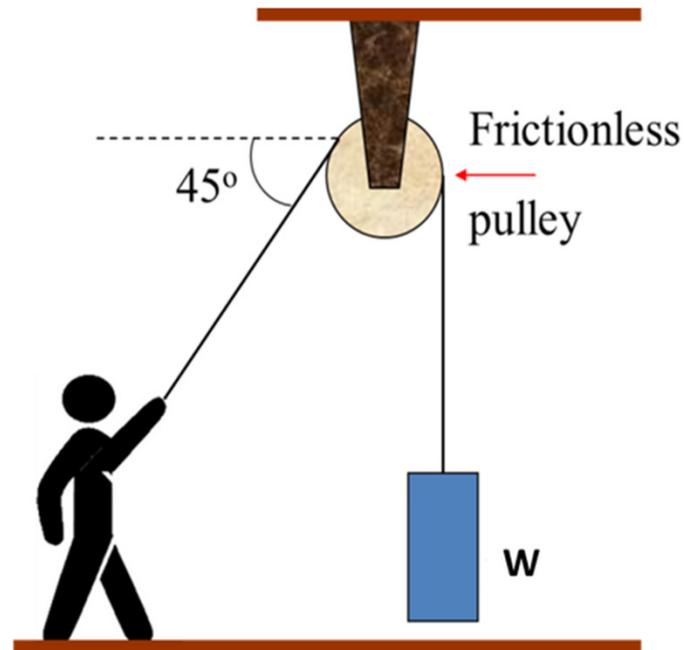
- Cover full scope of course
- Challenging conceptual questions
- No math*
- Strong distractors

Conceptual Assessment - Implementation

- 4 sets of 20 questions chosen based on observed student difficulties
- Given as exam review online homework in Physics 211
- Data collected in Fall 2013 (N = 919) and Spring 2014 (N = 1211)

Data from the Fall 2013 semester will be presented.

Example Question



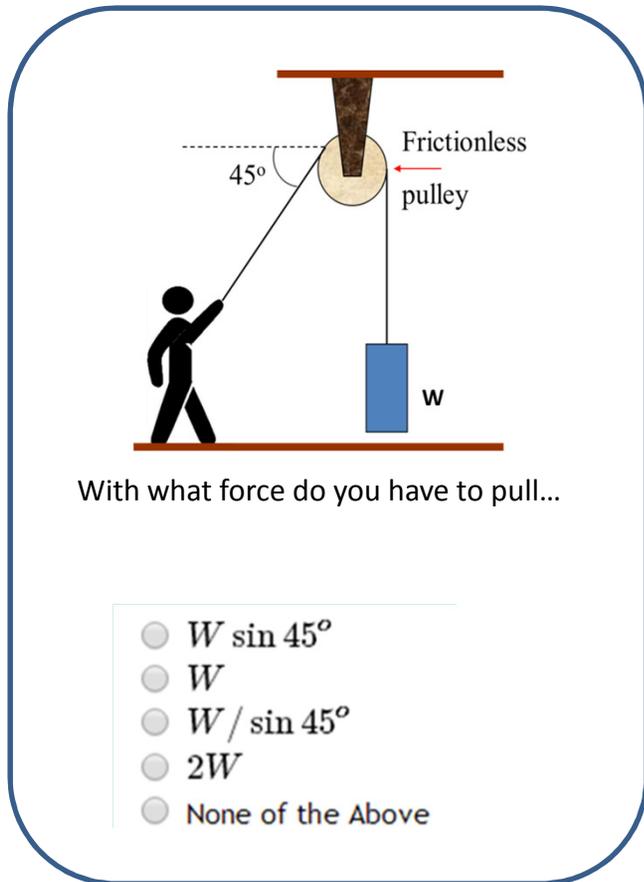
A block with weight W hangs from a rope attached to a frictionless pulley. You pull the rope at a 45° angle.



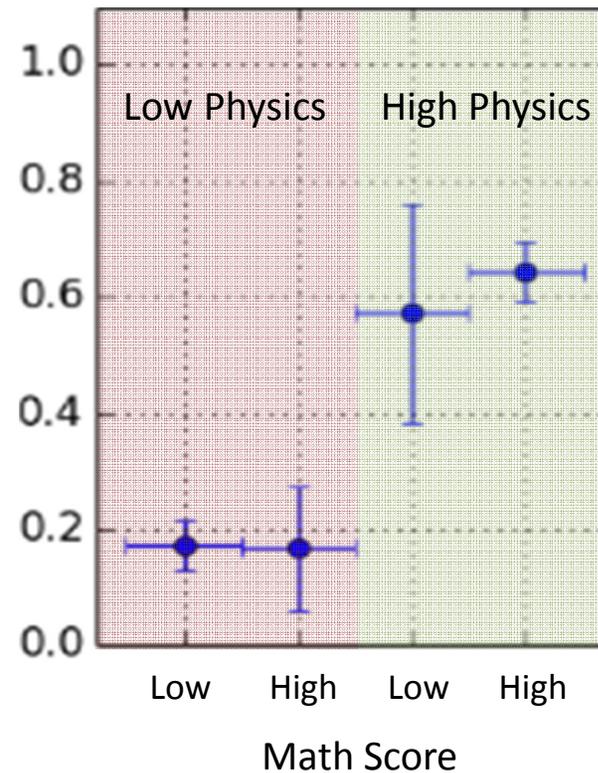
1) With what force do you have to pull on the rope to hold the box off the ground?

- $W \sin 45^\circ$
- W
- $W / \sin 45^\circ$
- $2W$
- None of the Above

Example Question

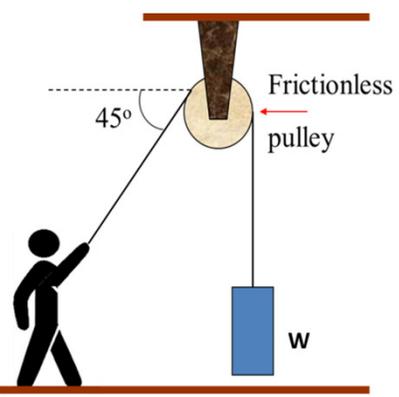


Question Scores by Math and Physics Ability



For more on math skills analysis: William Evans, session GA04

Example Question



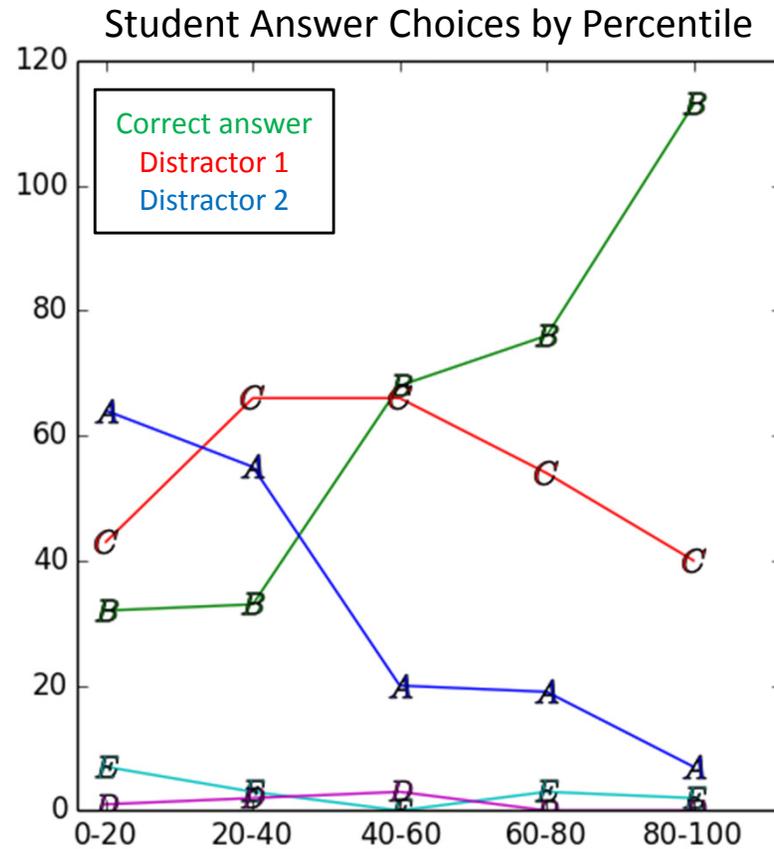
Frictionless pulley

45°

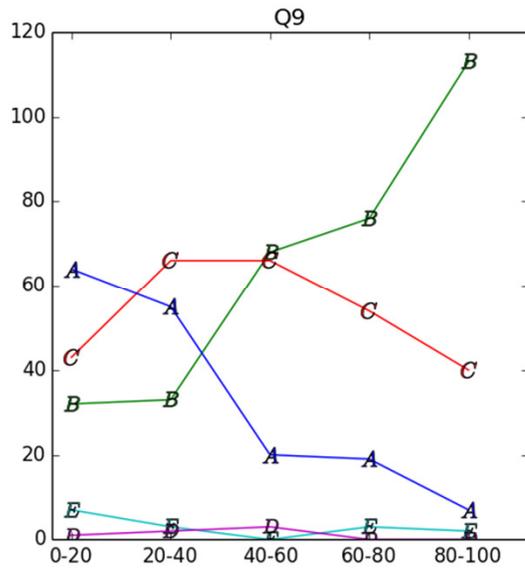
w

With what force do you have to pull...

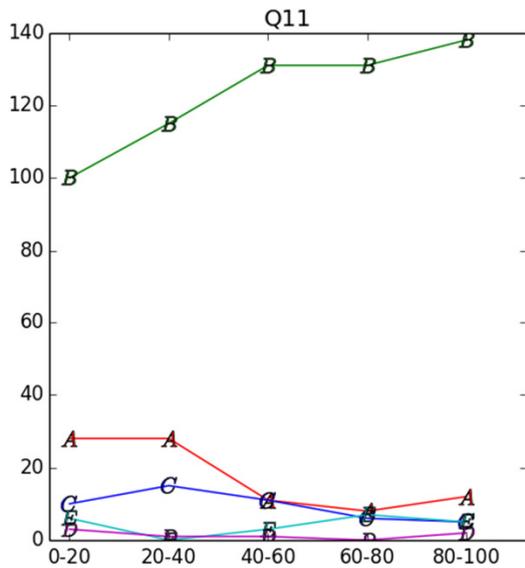
- $W \sin 45^\circ$
- W
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- None of the Above



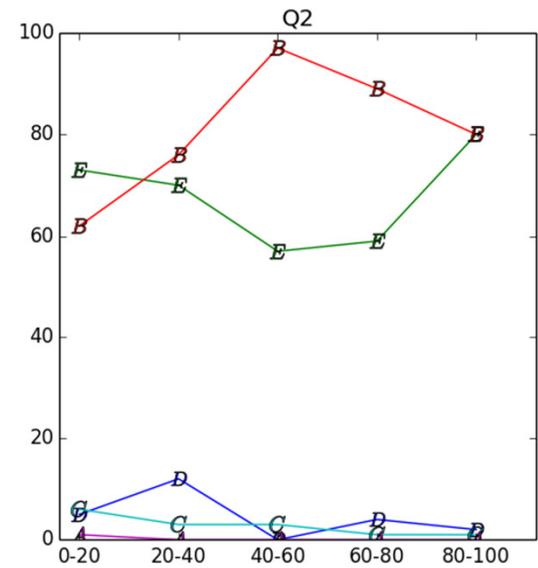
Evaluation of Questions by Distractor Strength



Strong distractor(s)

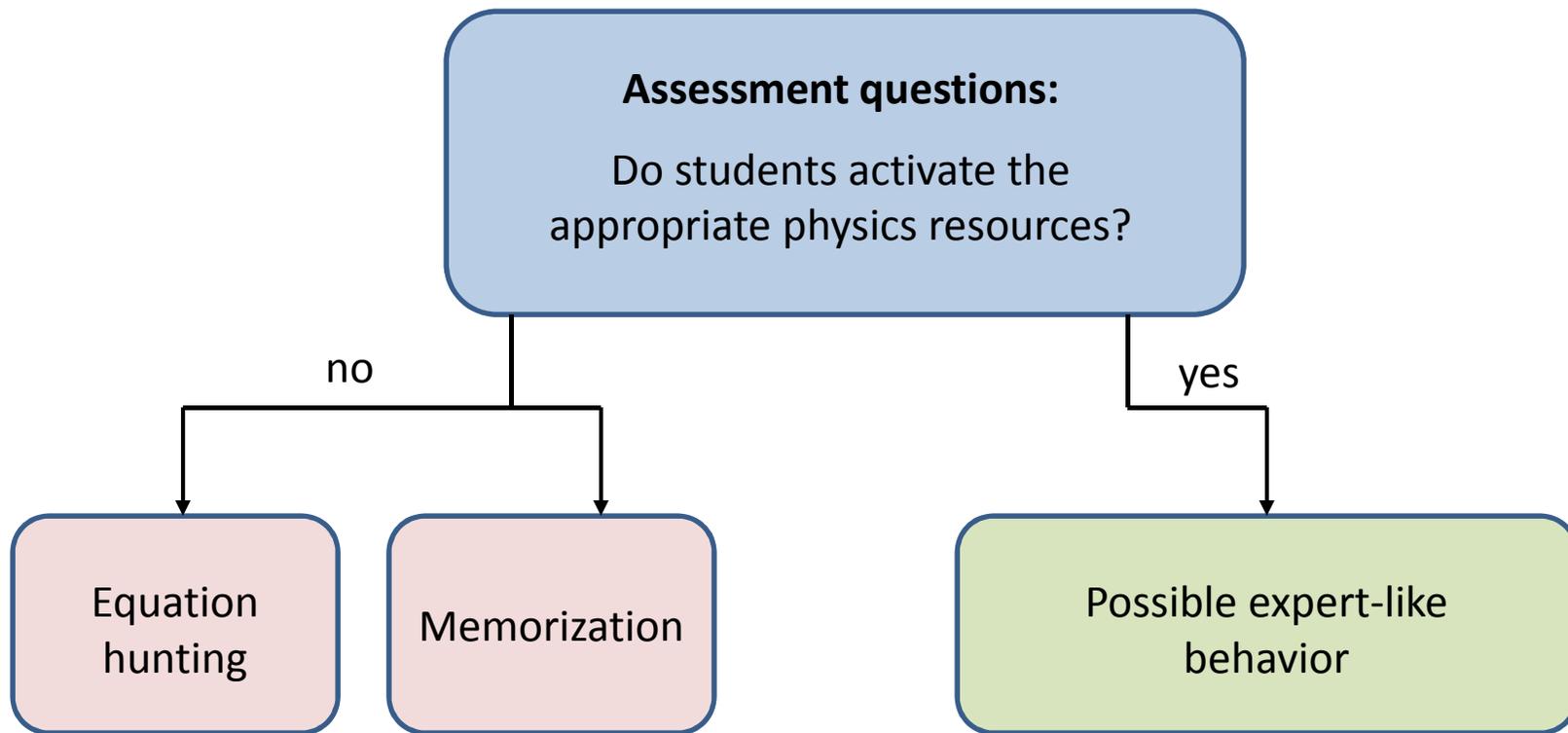


Weak/no distractor(s)



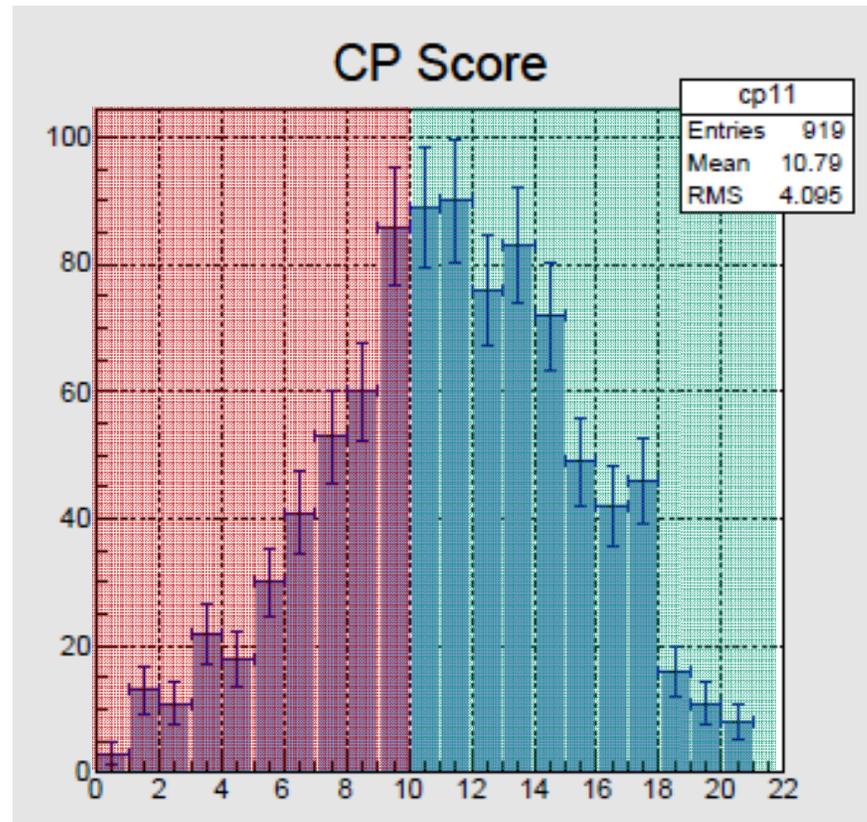
Weak question

Conceptual Questions as diagnosis of student problem-solving behavior

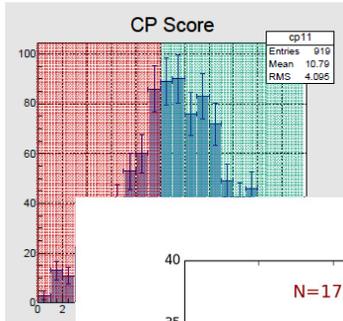


These approaches break down for more difficult problems

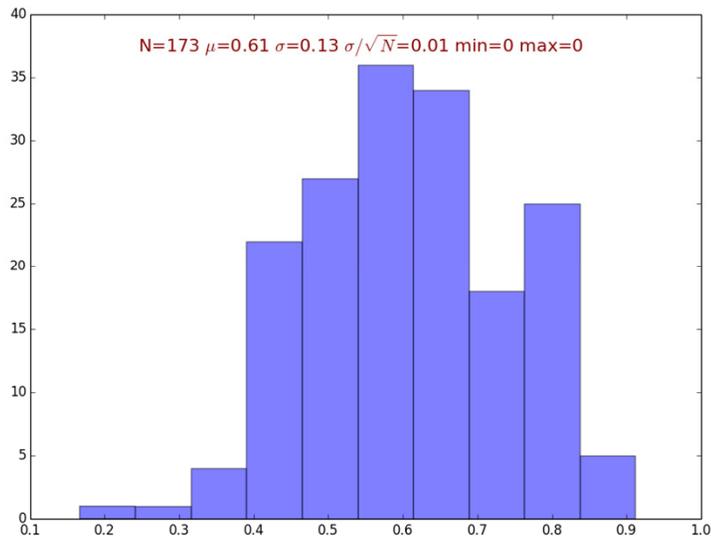
Conceptual Assessment to characterize student problem-solving behavior



Grouping by Assessment Score

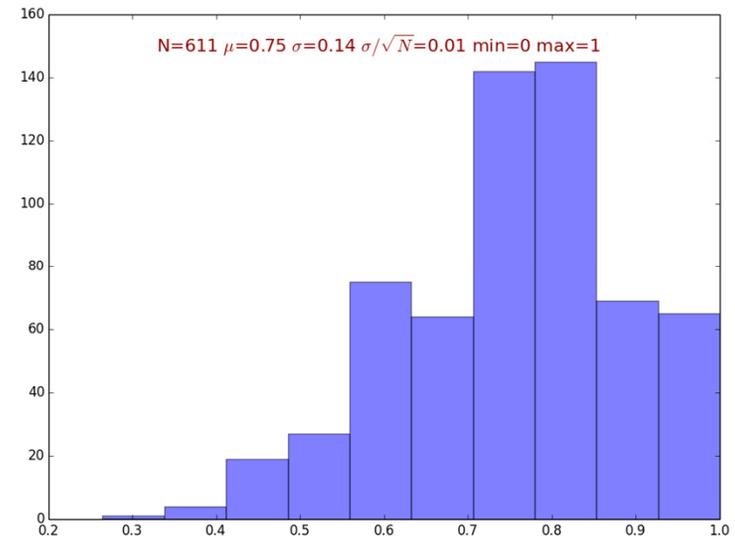


Total Exam (Low Conceptual)



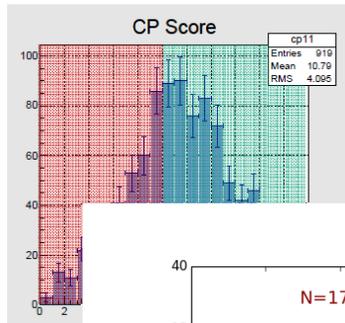
Average = 61 ± 1 %

Total Exam (High Conceptual)

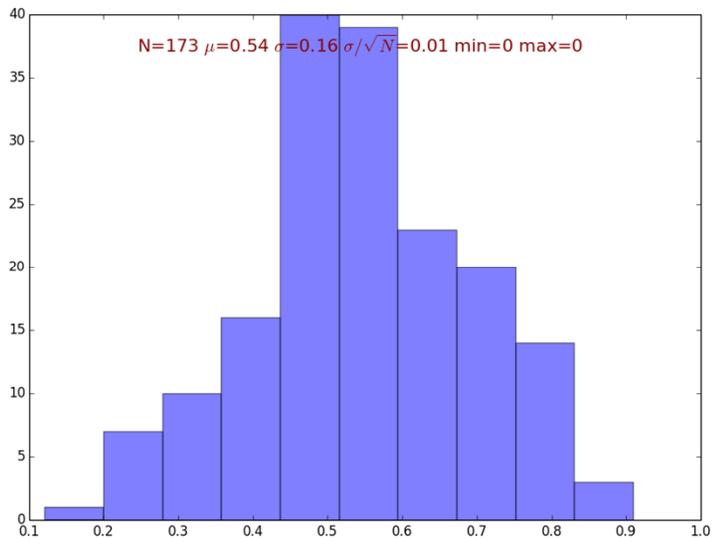


Average = 75 ± 1 %

Relationship to Calculation Problems

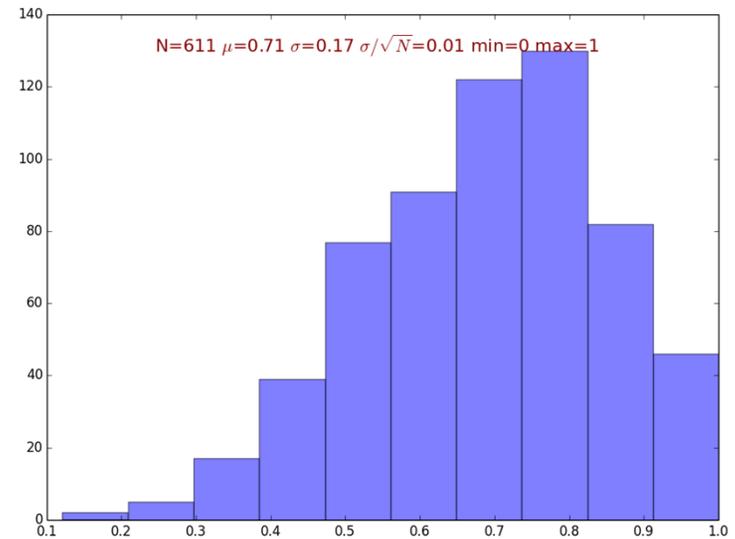


Calculational Exam (Low Conceptual)



Average = 54 ± 1 %

Calculational Exam (High Conceptual)



Average = 71 ± 1 %

Next Steps

- Further examine relationship between student answer choices and exam performance
- Apply questions as long-term assessment for Hands-on Prelecture supplement program (in development)



smartPhysics

For more on the pilot program,
see PERC poster P1-53