

Predicting Exam Performance from Mastery Homework

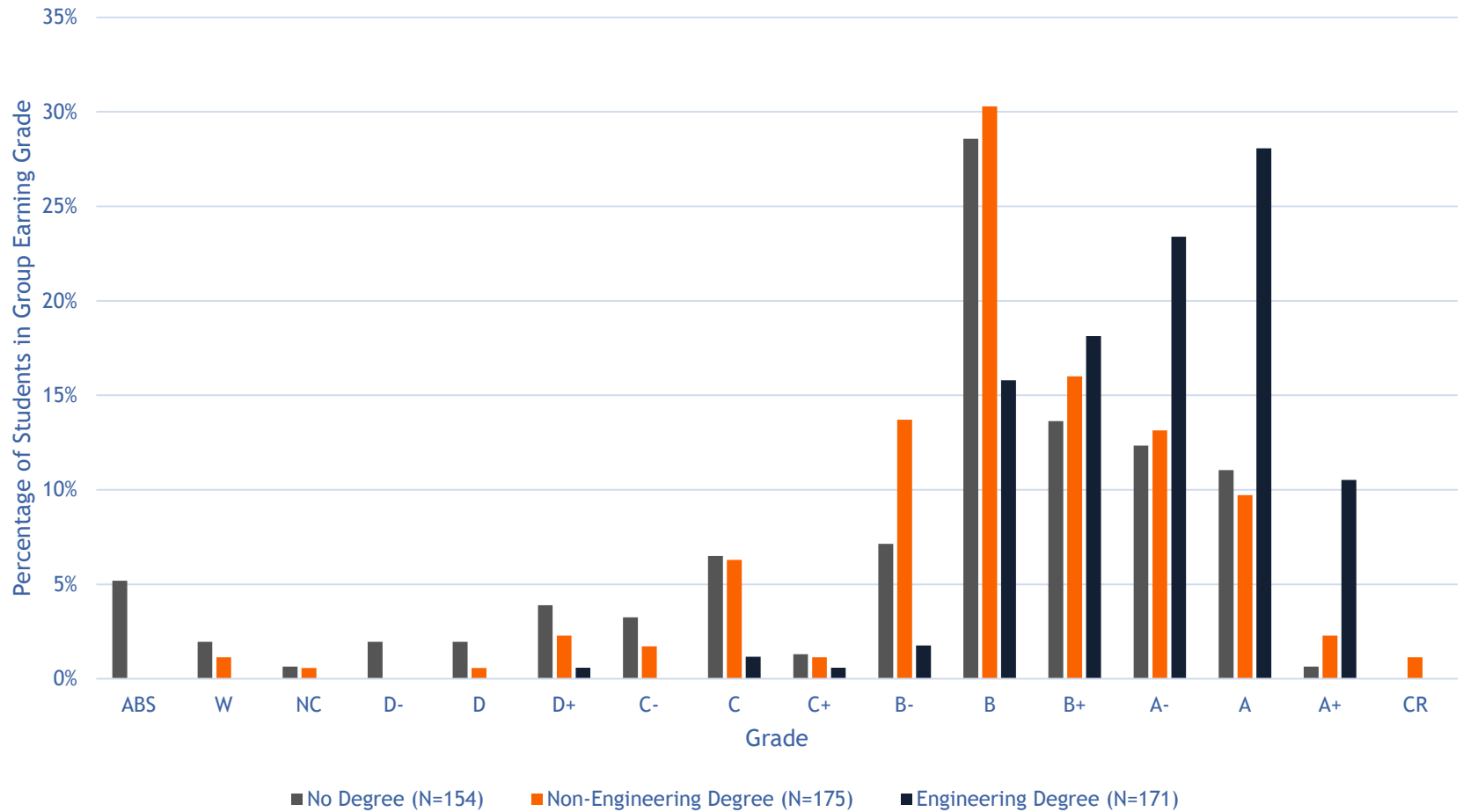
Devyn Shafer and Tim Stelzer

I ILLINOIS

The background of the slide is a photograph of the Alma Mater statue at the University of Illinois, which depicts a woman in a long dress with her arms outstretched. The entire image is overlaid with a semi-transparent red filter. In the foreground, the silhouettes of several people are visible, looking towards the statue.

Motivation

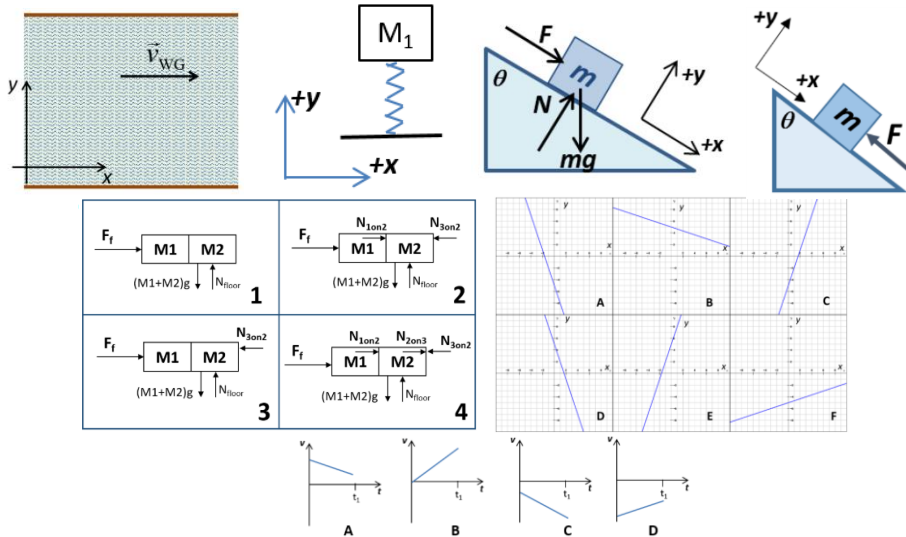
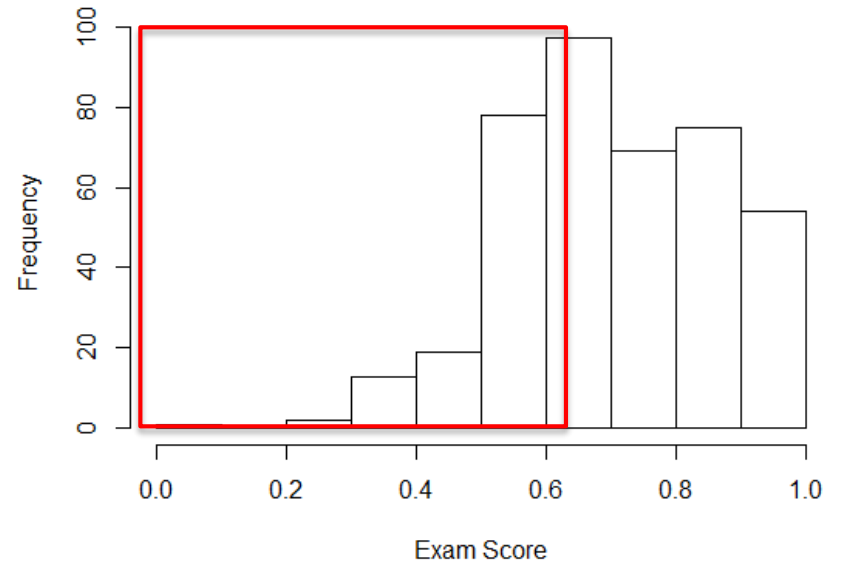
Physics 100 Grades and Outcomes



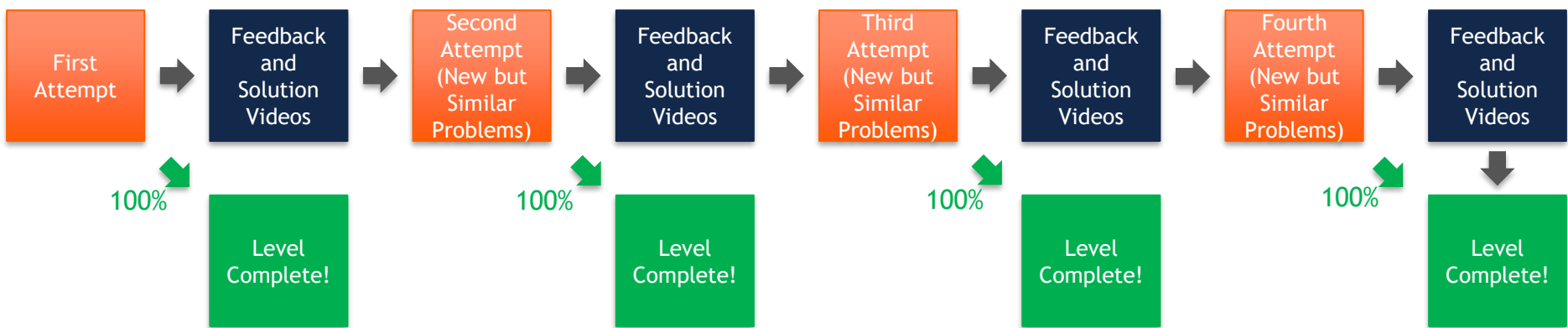
Our Data



Physics 100 Midterm Exam Scores, Fall 2016 (N=408)



Mastery Homework



An Example

Springs

Limited Attempt Cluster Item

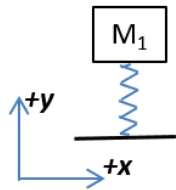
Grade cluster

1 2 3 4

Level 4 Competencies:

i) To be able to determine direction and magnitude of net force exerted on object (including the force exerted by a spring) when that object is in equilibrium or at any position after released from a non-equilibrium position.

A block of mass $M_1 = 5$ kg sits on top of a vertical spring, which has a relaxed length $L_0 = 160$ cm and a spring constant $k = 75$ N/m. The system is let go reaches equilibrium.

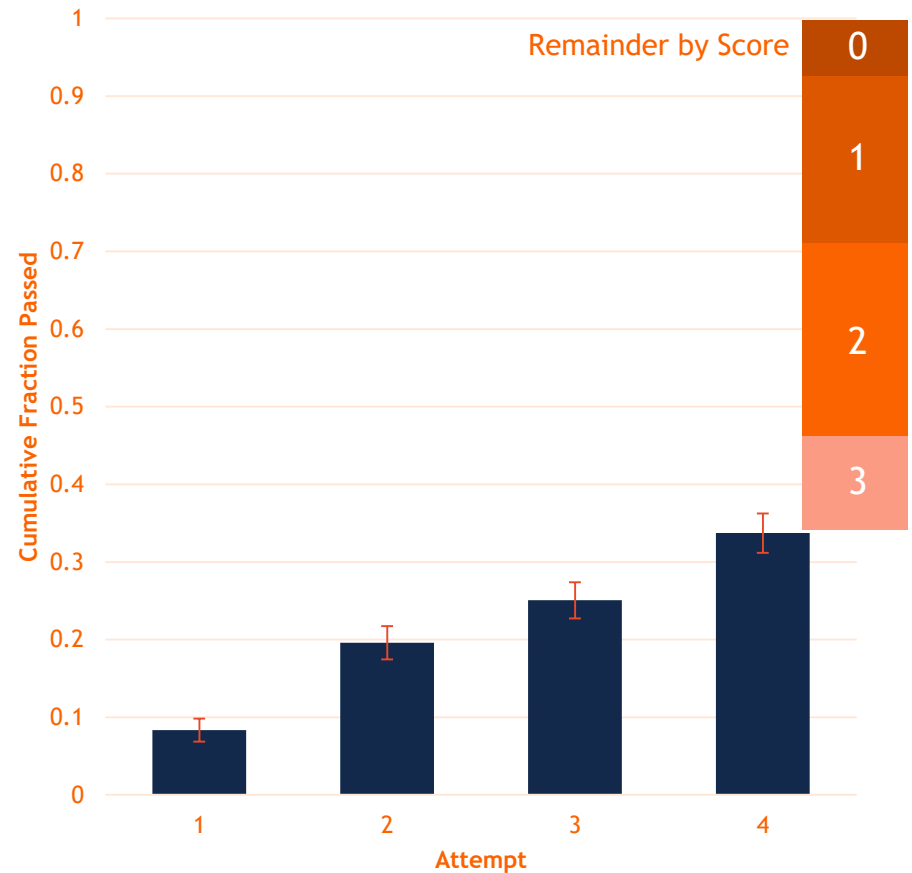


1) What is the direction of the of the spring force acting on M in equilibrium?

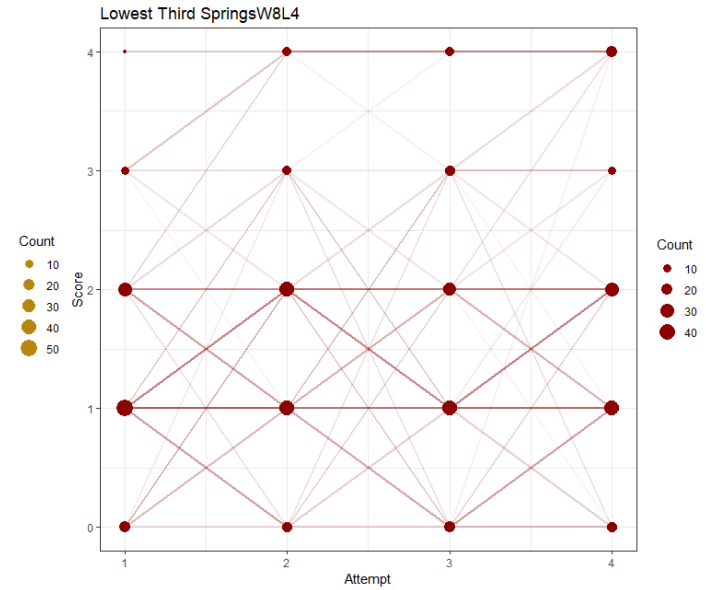
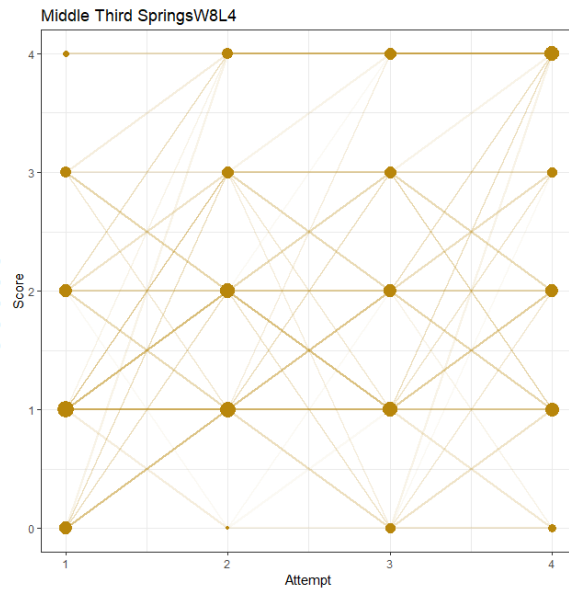
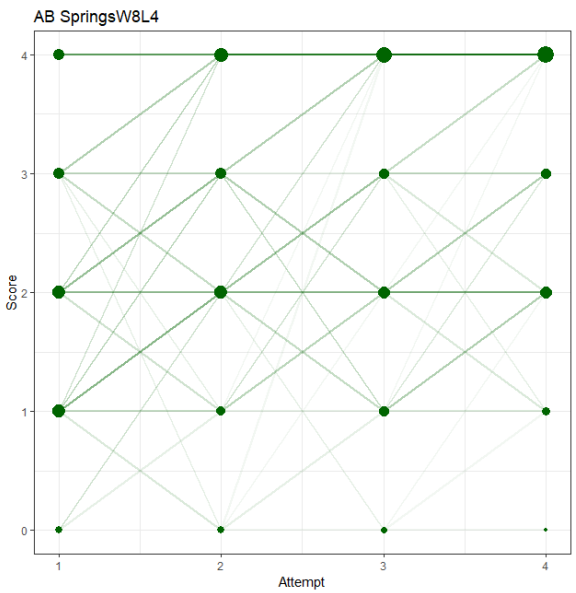
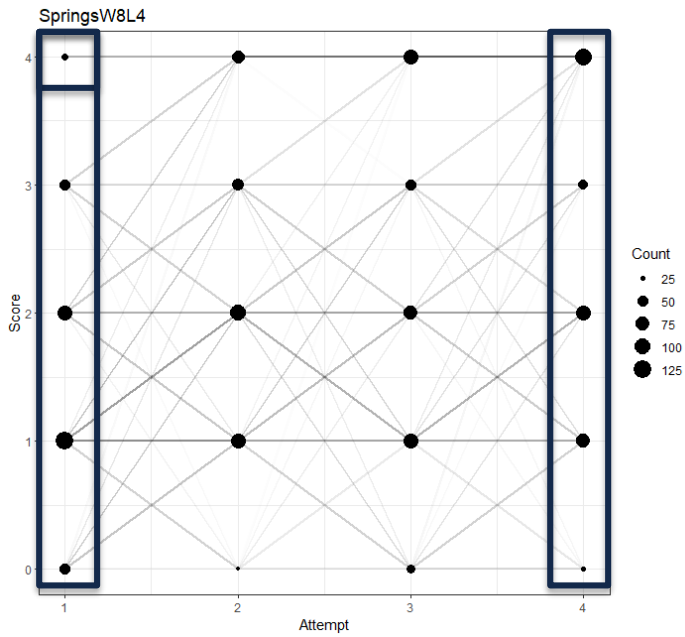
- $+\hat{y}$
- $F_{\text{spring}} = 0$
- $-\hat{y}$

Submit

Cumulative Mastery



Student Performance on a Tough Problem Set



There seems to be a difference... but how do we quantify it?

$$\sum_{\text{Problem Sets}} \text{Final Score}$$

$$\sum_{\text{Problem Sets}} \text{First Attempt}$$

$$\sum_{\text{Problem Sets}} \left(\sum_1^4 \text{Attempt}_n \right)$$

Odds Ratio

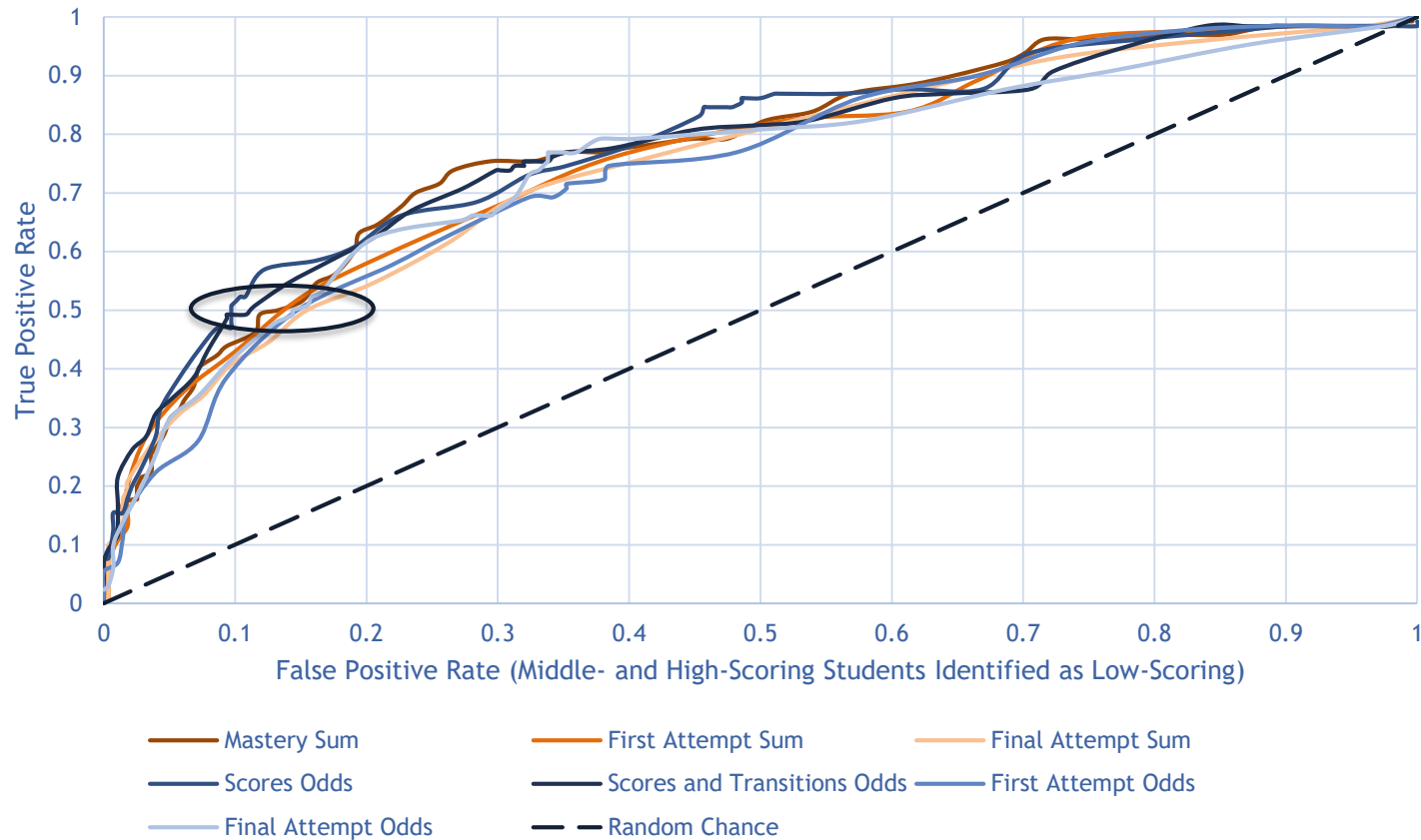
For each score on each problem, calculate an odds ratio:

$$r_i = \frac{\# \textit{Students with bottom third of exam scores}}{\# \textit{Students with top third of exam scores}}$$

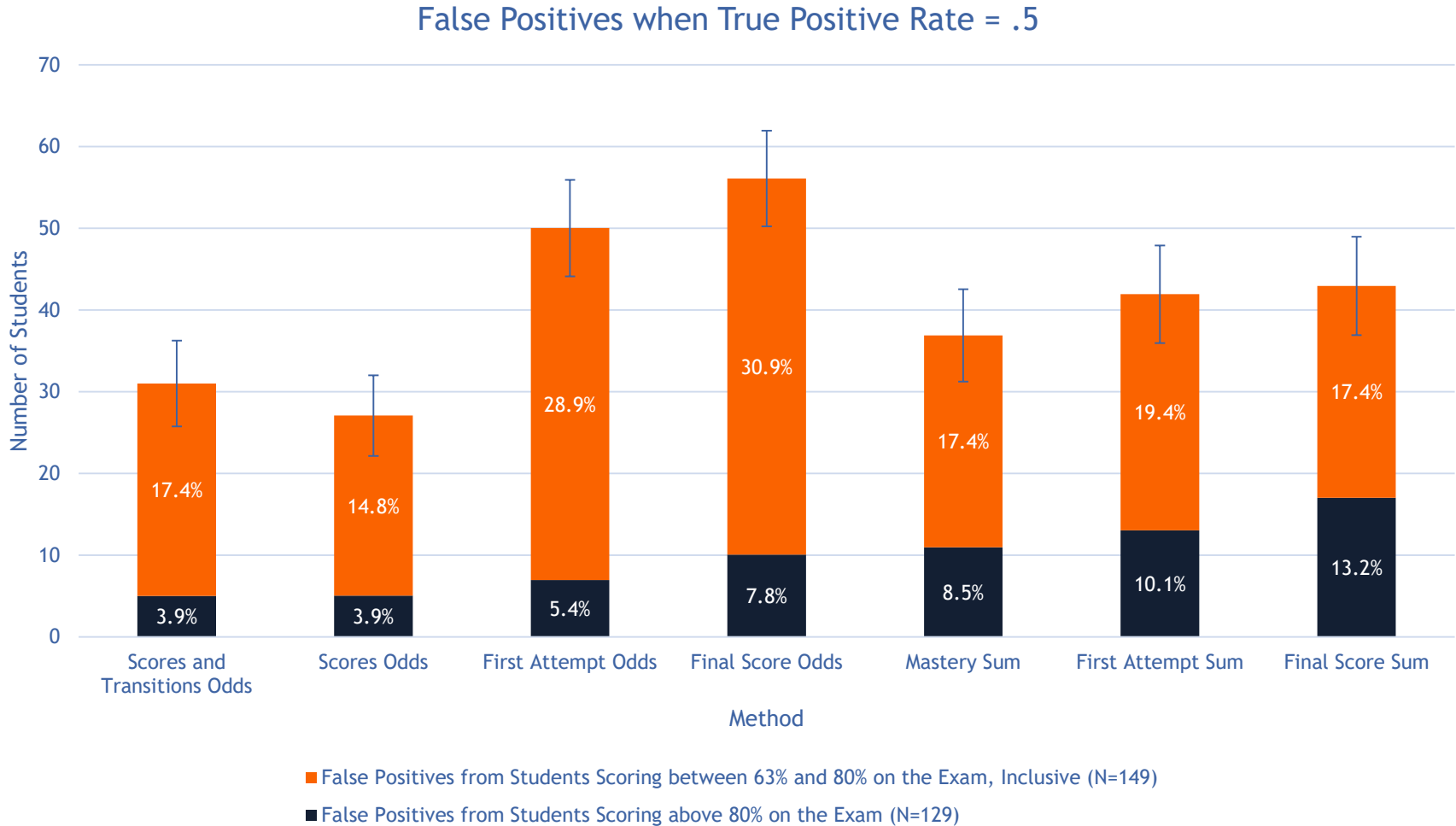
$$\text{Likelihood Score} = \prod r_i$$

Method Comparison

ROC Curve for Identifying Low-Performing Students



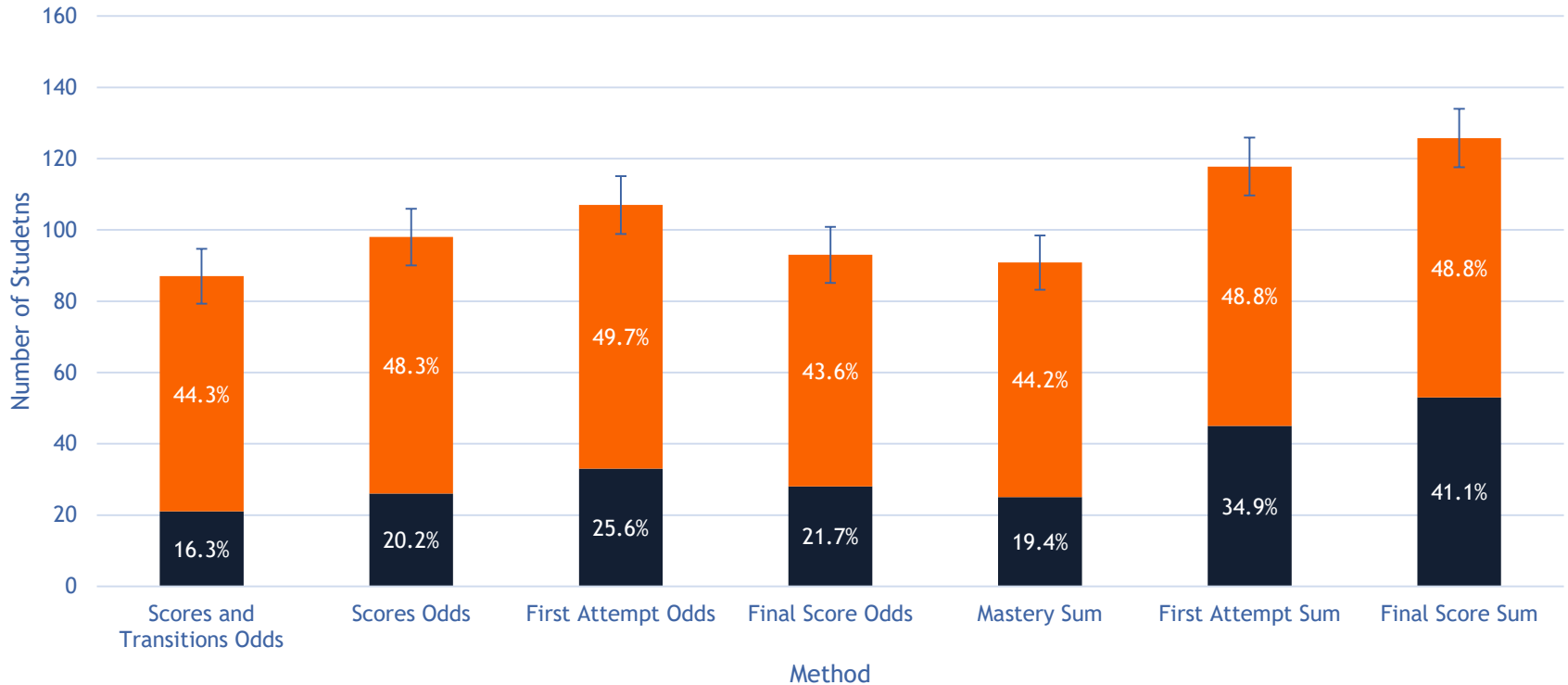
Comparison: What if we want to identify just half of the at-risk students?



Note: Labels represent percentage of high- or middle-scoring group identified as at risk

What about three-quarters?

False Positives when True Positive Rate = .75



- False Positives from Students Scoring above 80% on the Exam (N=129)
- False Positives from Students Scoring between 63% and 80% on the Exam, Inclusive (N=149)



Takeaways

- Student responses to mastery problems have information for identifying at-risk students.
- The odds ratio using all mastery score information provided better discrimination than simply using the sums of first or final attempts.
- Even in a class of 408 students, the odds ratio is limited by the sample size.