My Talk, Their Work
RELATE education research group

Applied and Practical **Learning Analytics**

$\text{Learning} = \text{Knowledge}_{post} - \text{Knowledge}_{pre}$

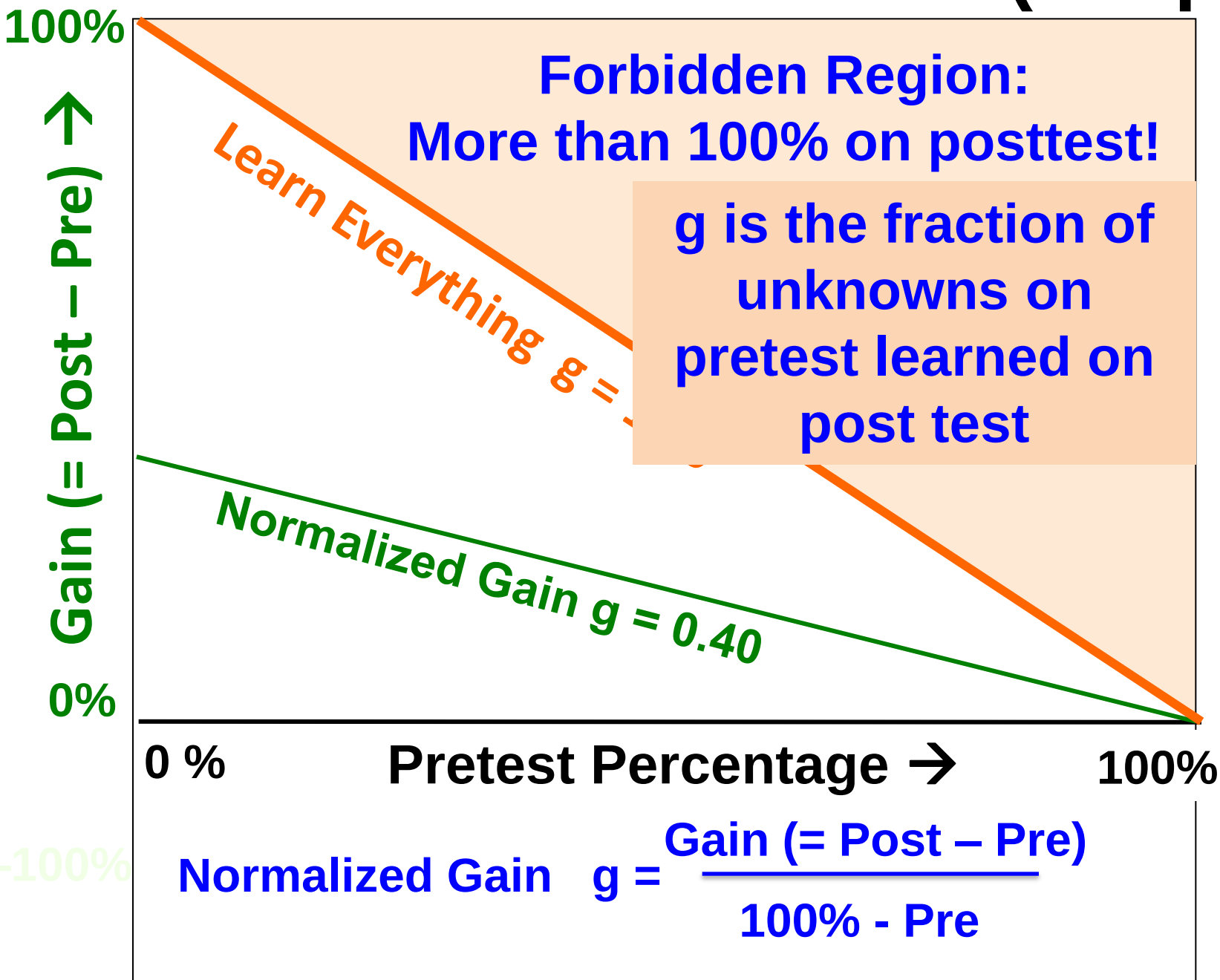
Prof. Dave Pritchard

http://RELATE.MIT.edu

Simple Way to Measure Learning ?

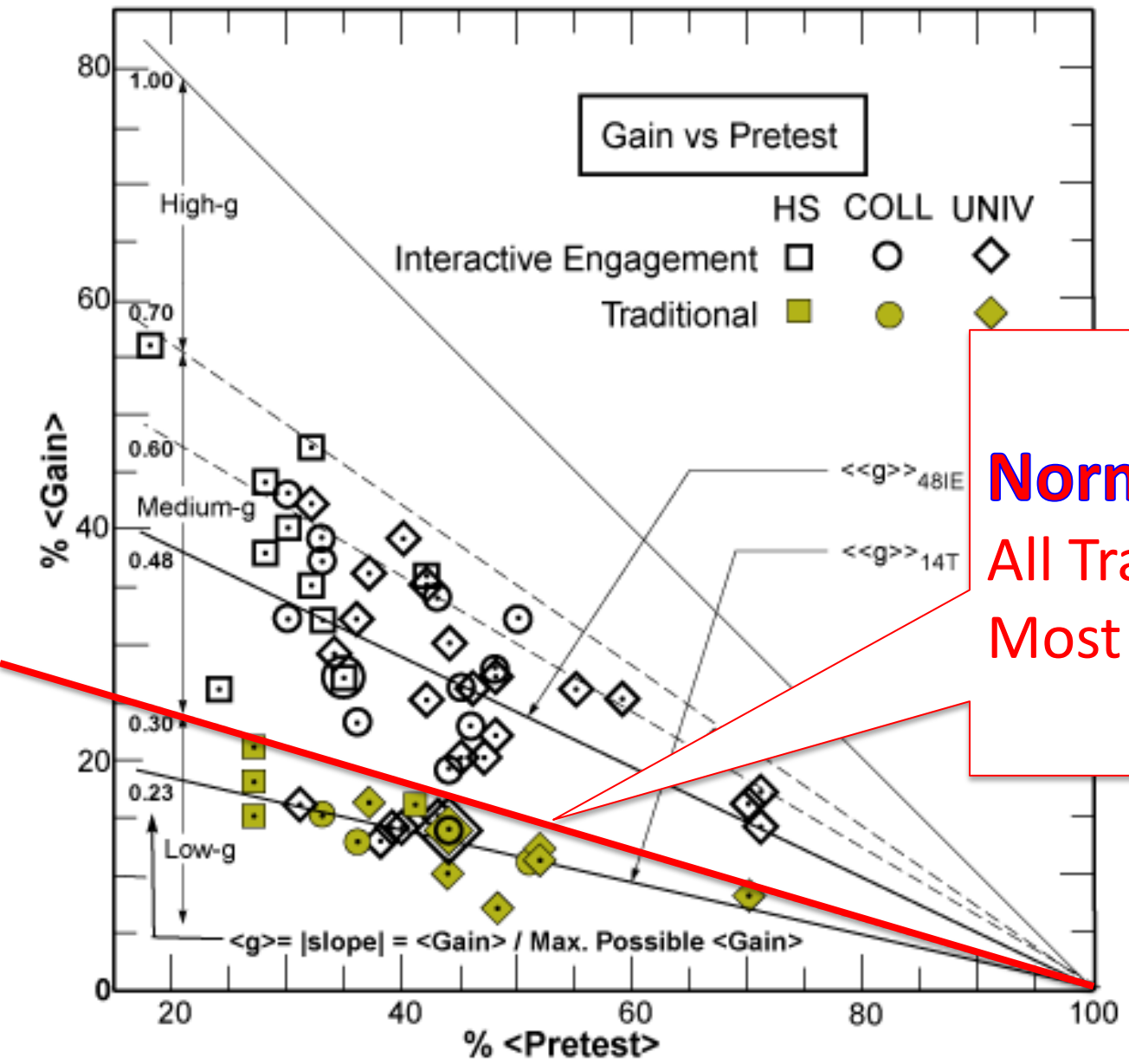
- Give Same Test before and after instruction
- Learning = (post-pre)
- Plot Learning vs. Pre:

Gain and Normalized Gain (-slope)



$$\text{Normalized Gain } g = \frac{\text{Gain (= Post – Pre)}}{\text{100\% - Pre}}$$

Gain (posttest – pretest) vs Pretest



From R. Hake's study of 6545 students in 62 classes. HS→Top College

Normalized Gain =0.3

All Traditional Below

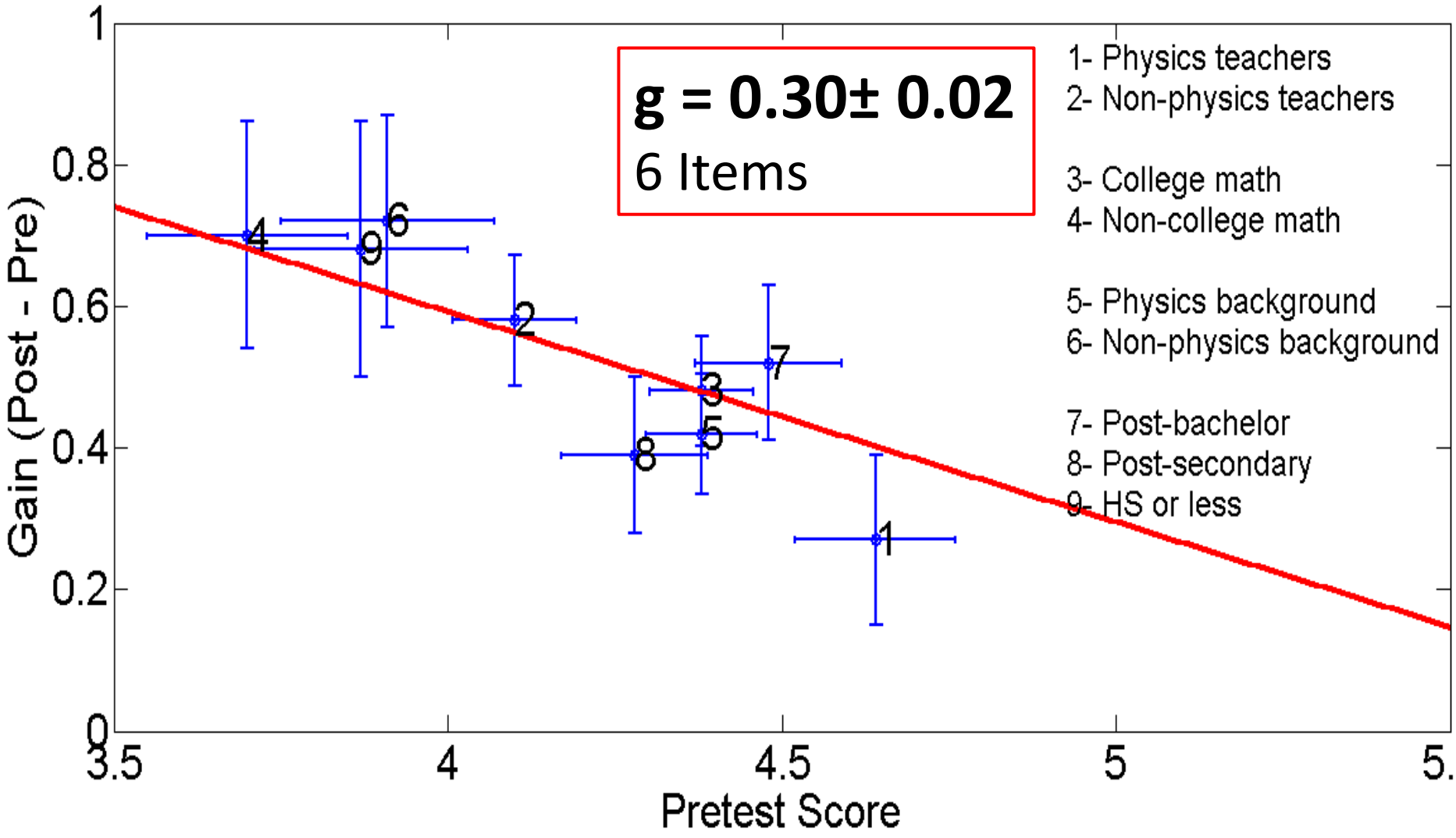
Most Interactive Above

Fig. 1. %<Gain> vs %<Pretest> score on the conceptual Mechanics Diagnostic (MD) or Force Concept

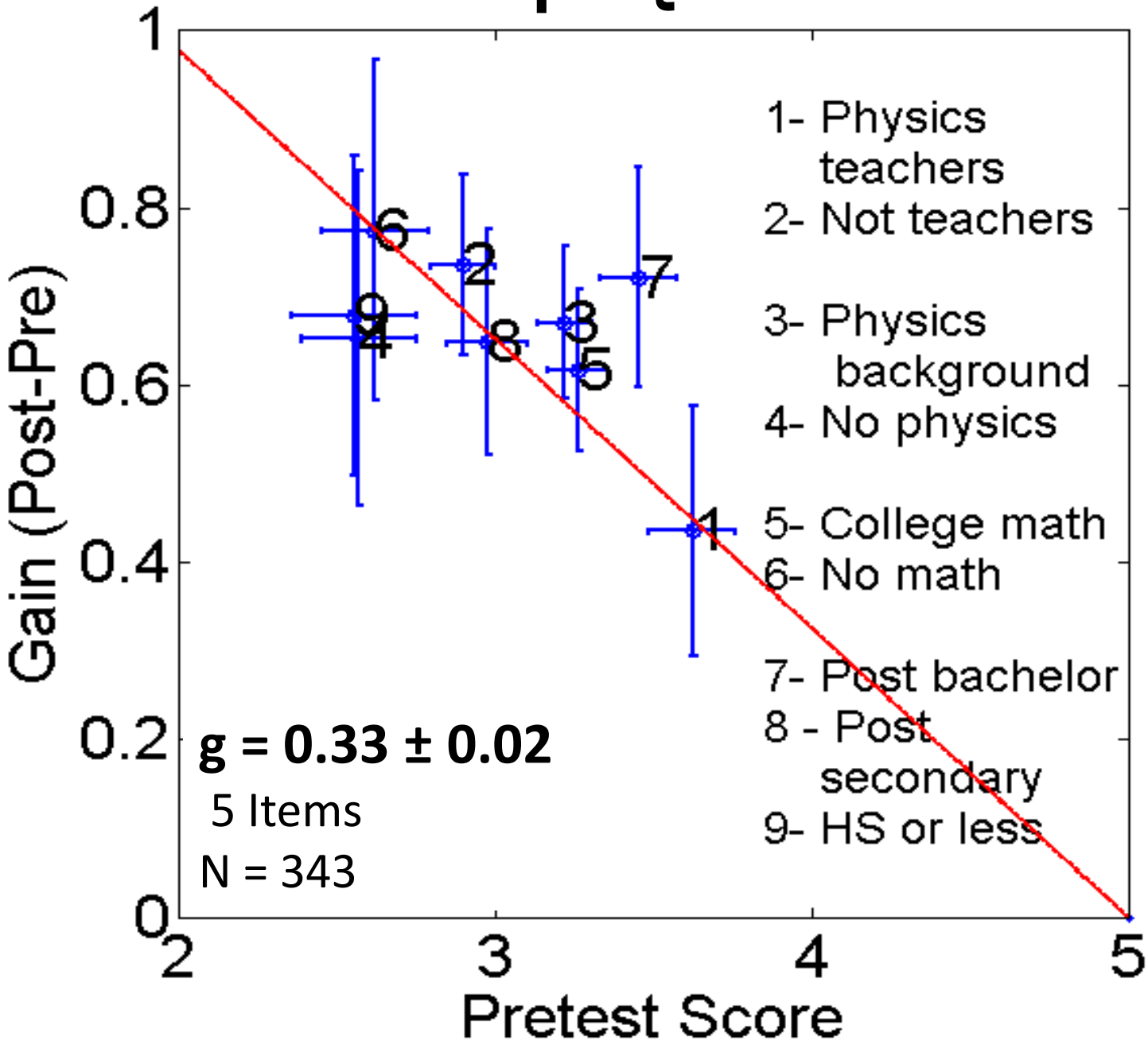
Is There Much Learning in MOOCs?

Force Questions Gain in 8.MReV MOOC

Gain vs Pre-Score: equal Learning for all cohorts



Non-Force Concept Questions 8.MReV



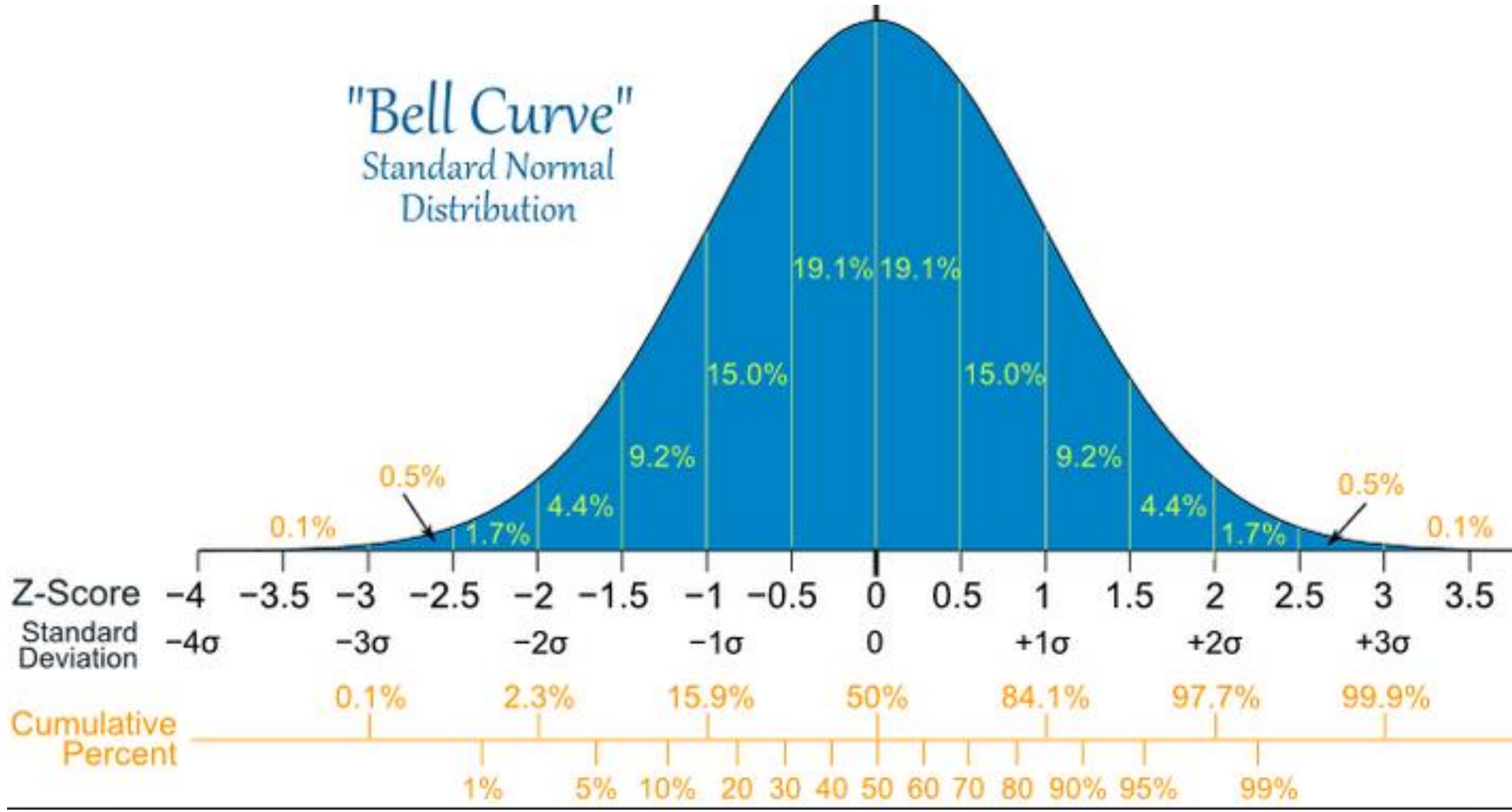
Summary – Conceptual Learning

- Conceptual Learning in 8.MReV **slightly greater than traditional** on-campus course
- **None** of the various cohorts we studied showed significantly less normalized gain
  - HS students vs those with advanced degrees
  - poor prerequisites: math or physics courses
  - Students of low average skill
- Contrary to concerns, **no evidence that unskillful, less educated, or less prepared students learn less** (if they finish)

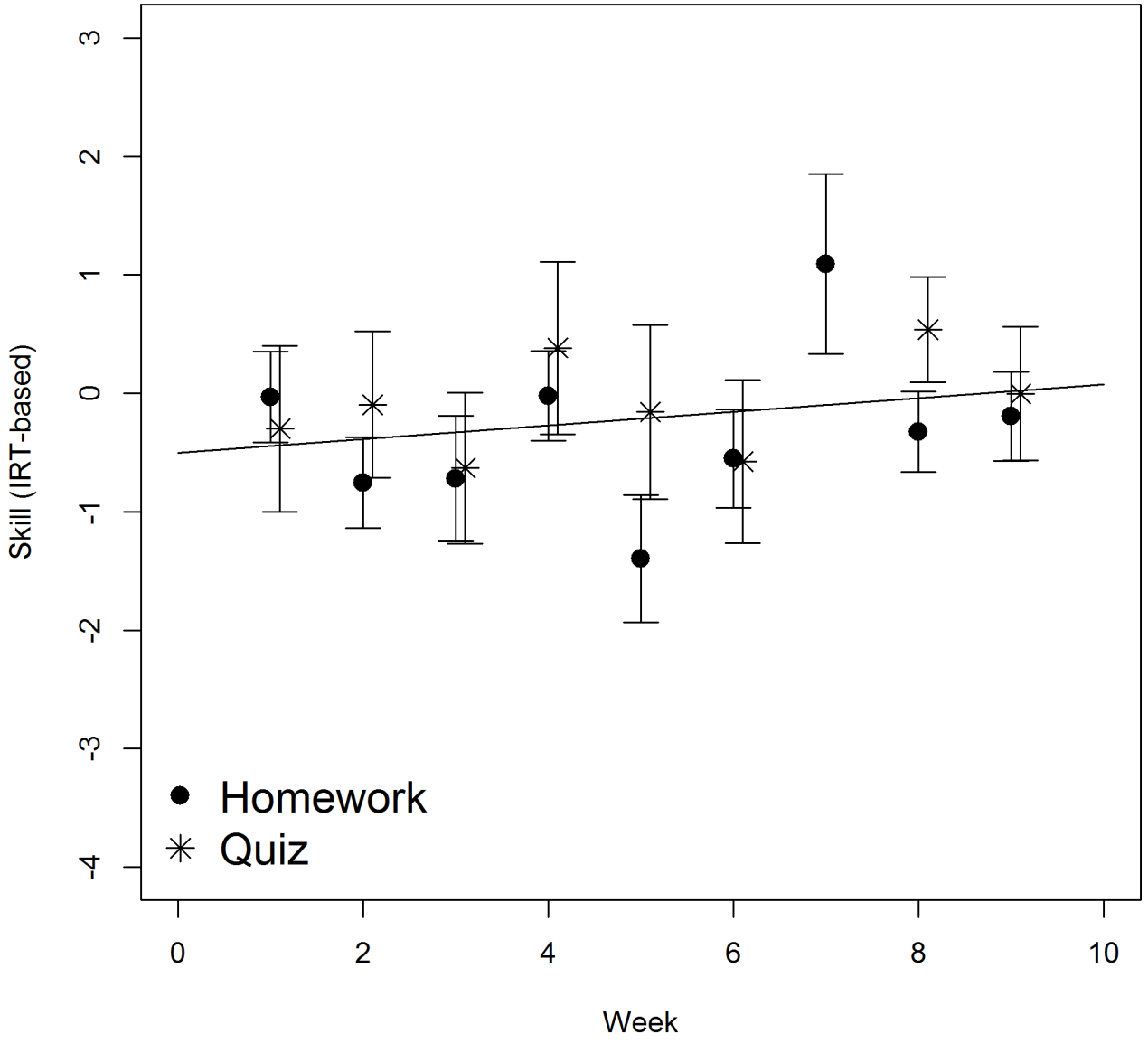
Relative Improvement: Learning More

Weekly Grade on a Curve (using IRT)

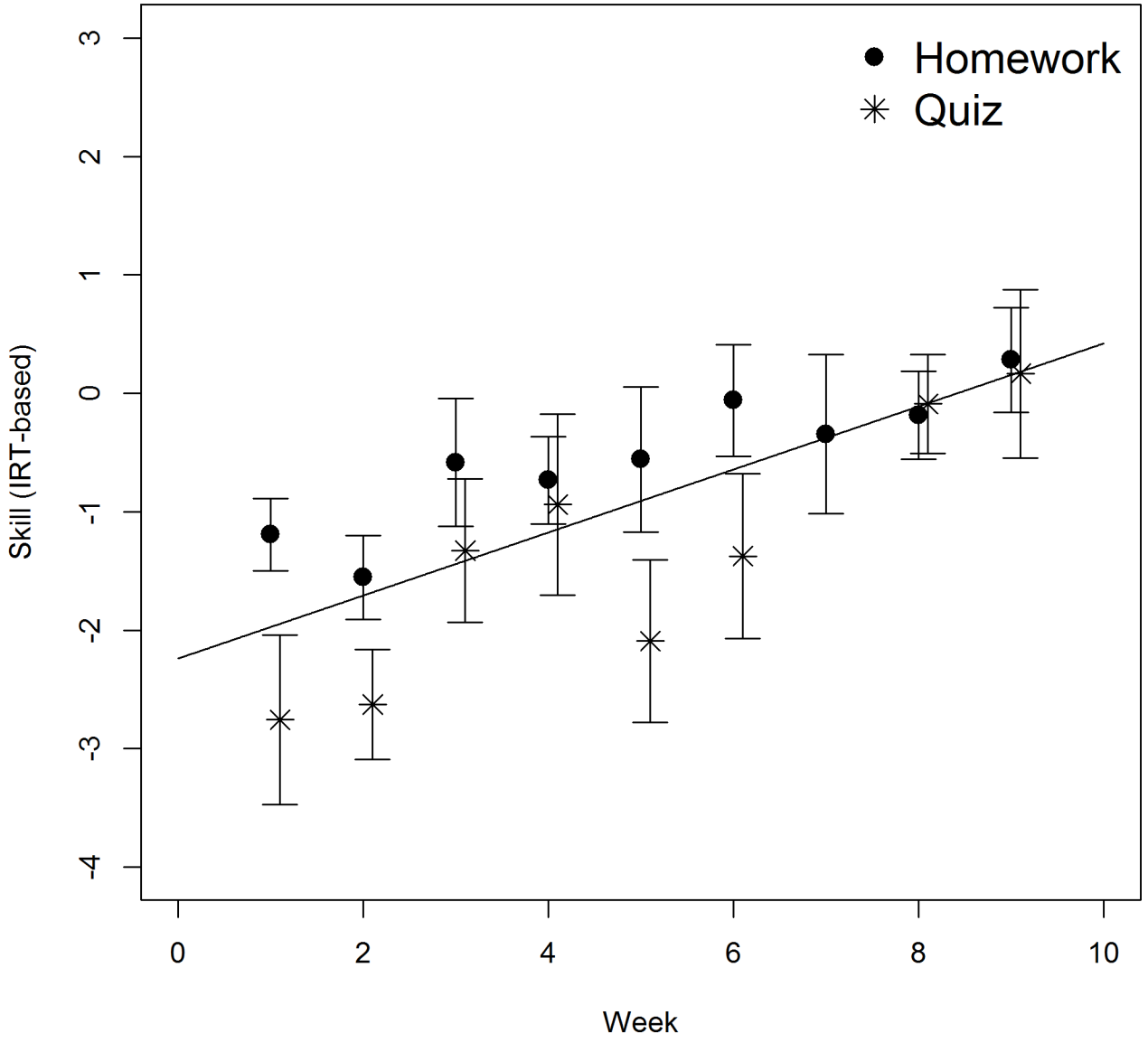
Improvement relative to class as a whole



Skill Average -0.50 Skill Improvement 0.6



Student Skill_avg = -2.24 Skill Improvement = 2.7



There is Learning!

What Resources Help Students Learn?

- Measures of Student Learning:
  - Post-Pre Gain
  - Relative Improvement (over course)

- Correlate with time on various *Resources*
  - Instructional: eText, Video, Discussion
  - Assessment: Checkpoint questions, Homework

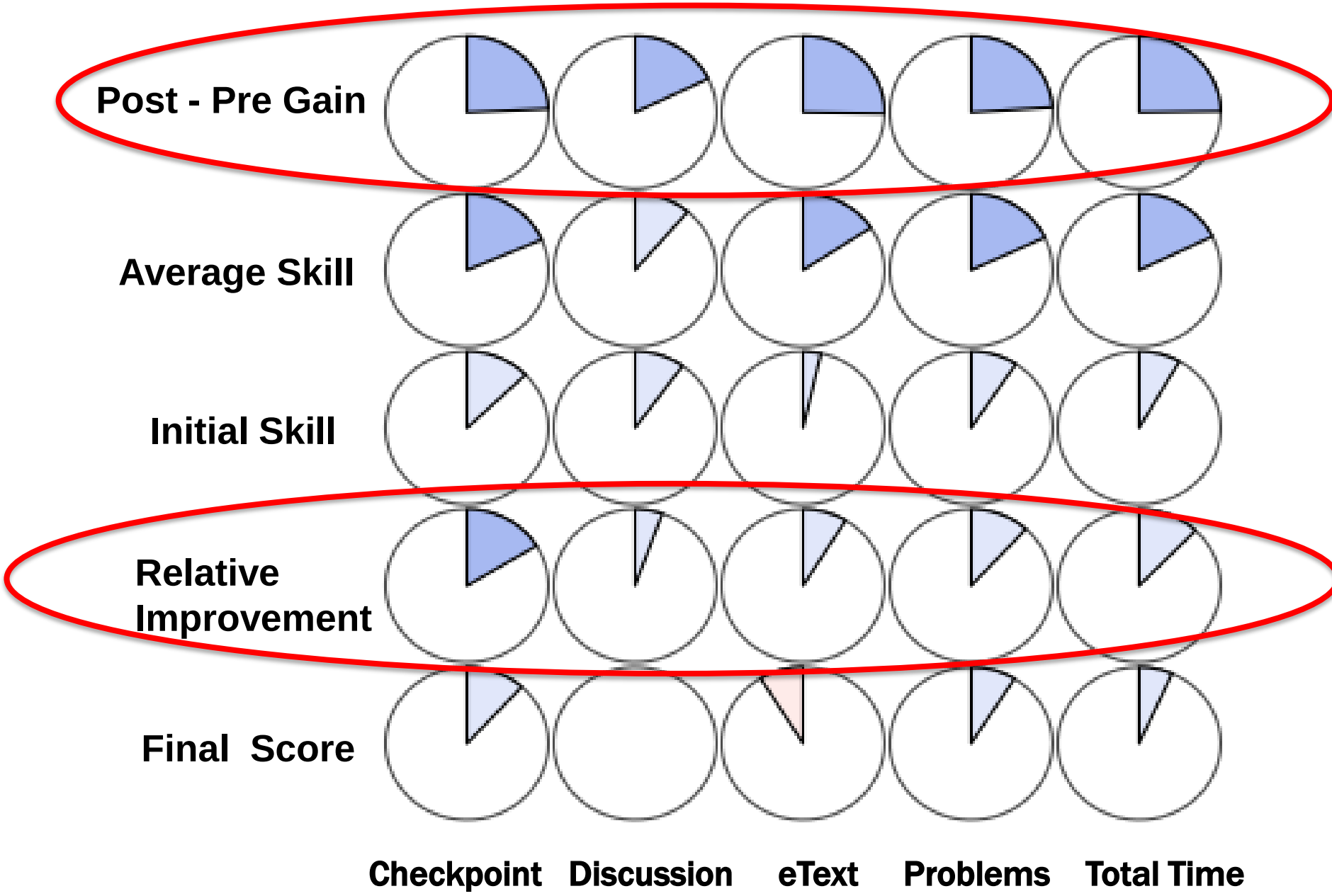
Correlation Coefficients Visualized

-0.62 +0.30

Color ←→Sign

Fraction←→Number

8.MReV Measures of Skills and Log of Time on Tasks (N = 292)



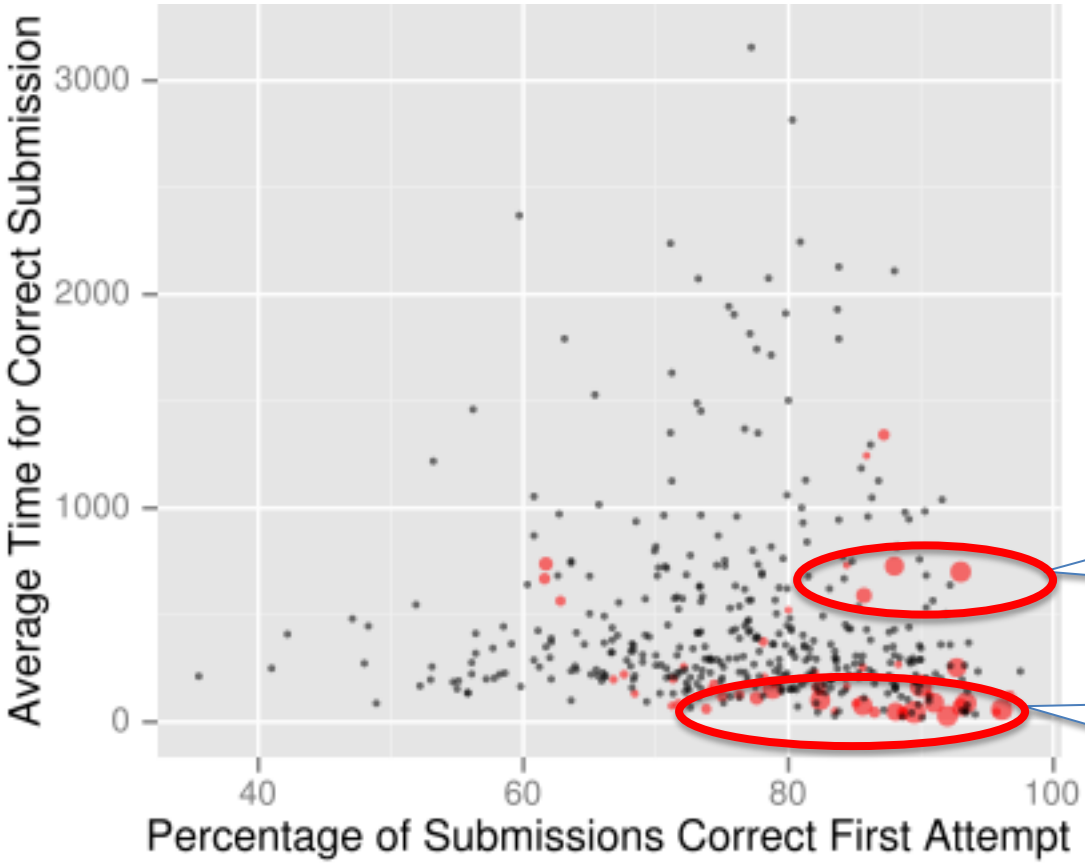
Applied and **Practical** Learning Analytics

Academic Dishonesty (Cheating)

On-Campus
Copying Homework
from
Other Students

MOOCs
Getting Answers
From
a Harvester account

Copying MOOC Answers from "Harvester" accounts into "Master" account



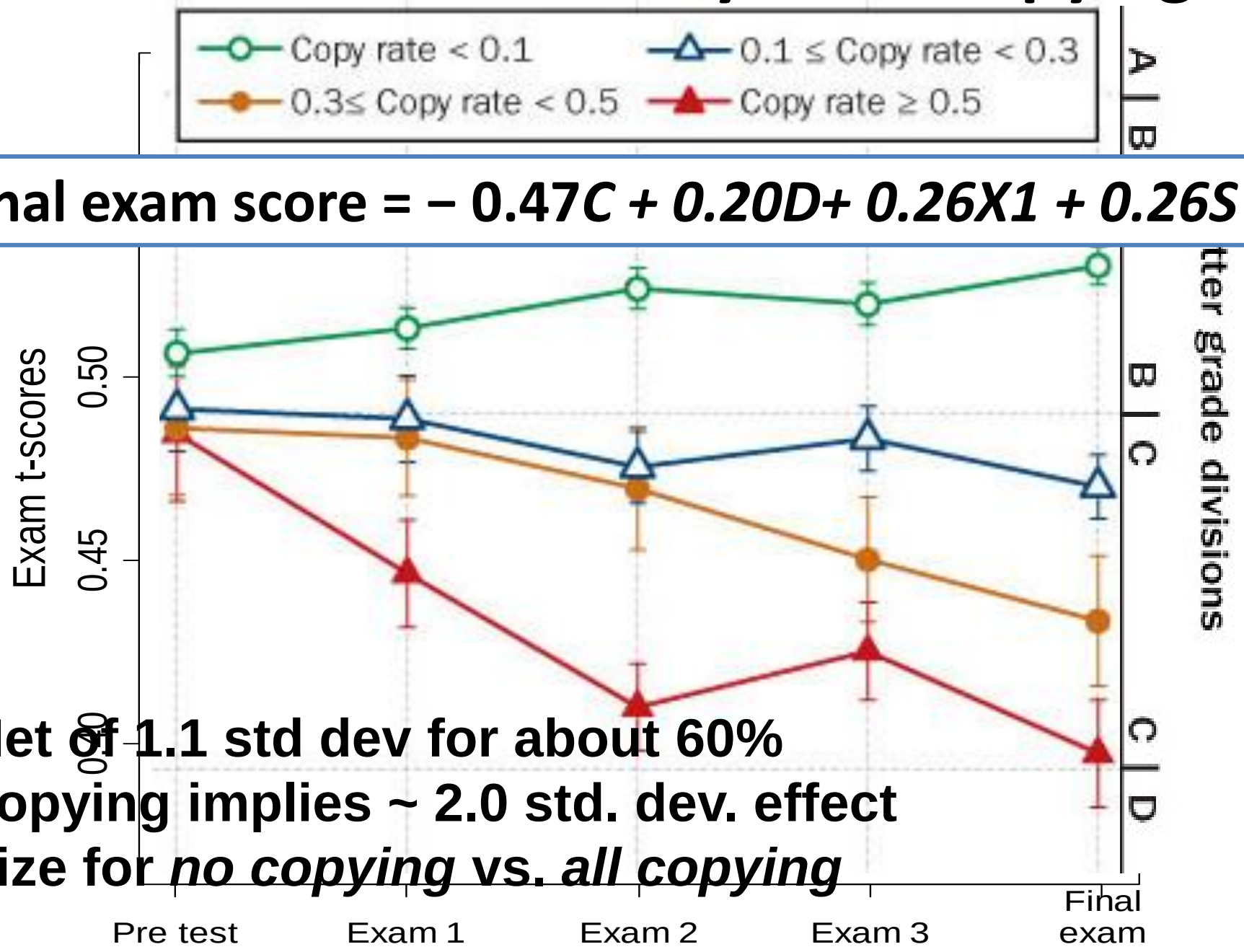
These Students use Harvester account to avoid making errors

These Students answer before they've had time to read the problem

Red Students are "Master" accounts

Black Students don't have "Harvester" accounts

MIT Exam Scores Vary With Copying



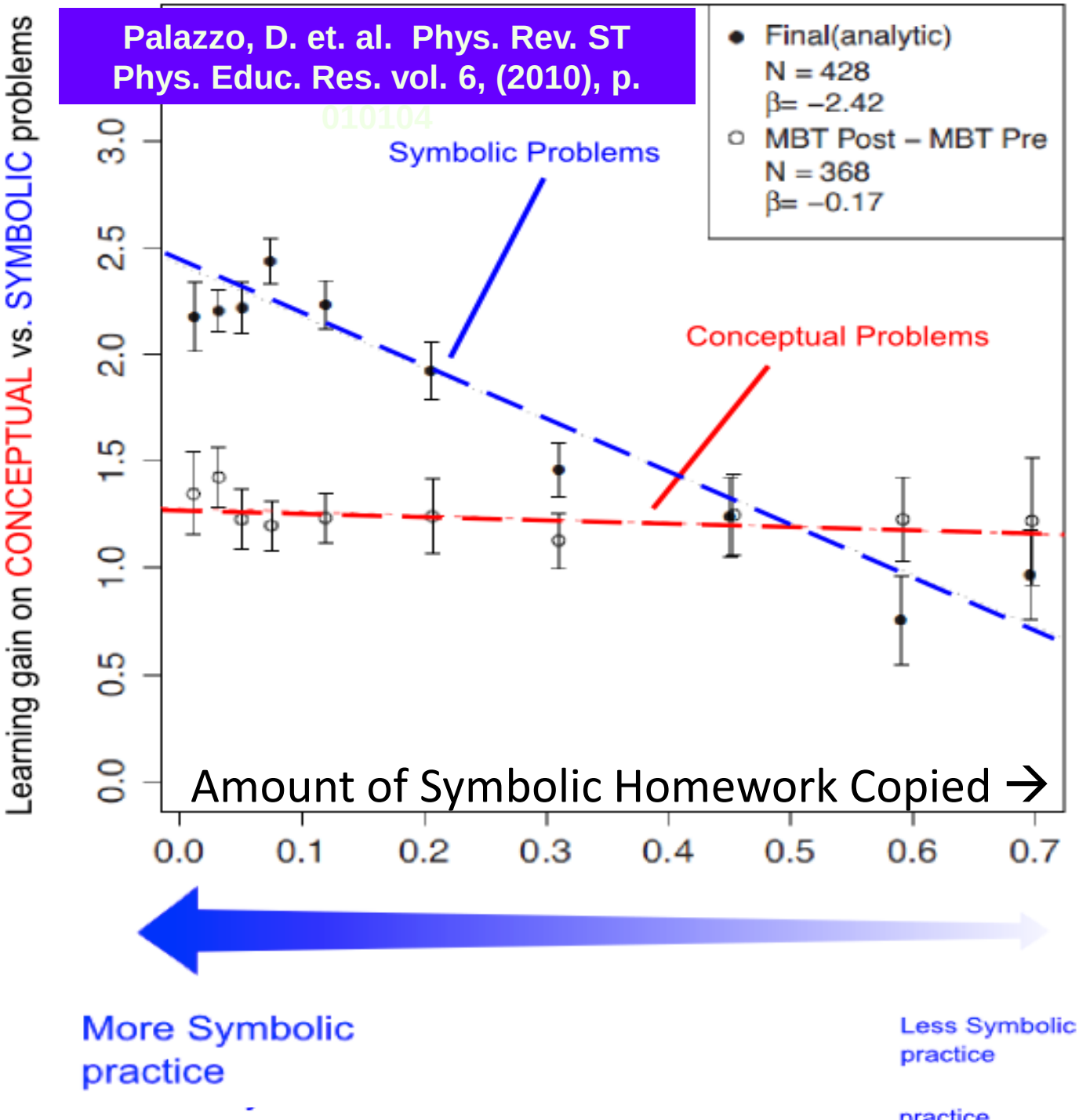
final exam score = − 0.47*C* + 0.20*D*+ 0.26*X1* + 0.26*S*

Net of 1.1 std dev for about 60% copying implies ~ 2.0 std. dev. effect size for *no copying* vs. *all copying*

Closer Look At Homework Copying

Mastering gives
- 2.4 Sigma on Symbolic!

But no help on Conceptual



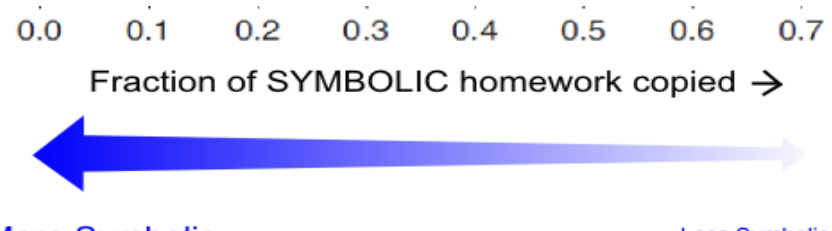
How to Explain Disparity?

Expert Expectation

1. **We teach them only to answer our examinations! ?**
2. **Careful thought on Symbolic**

Quick Response on concept

D. Kahneman



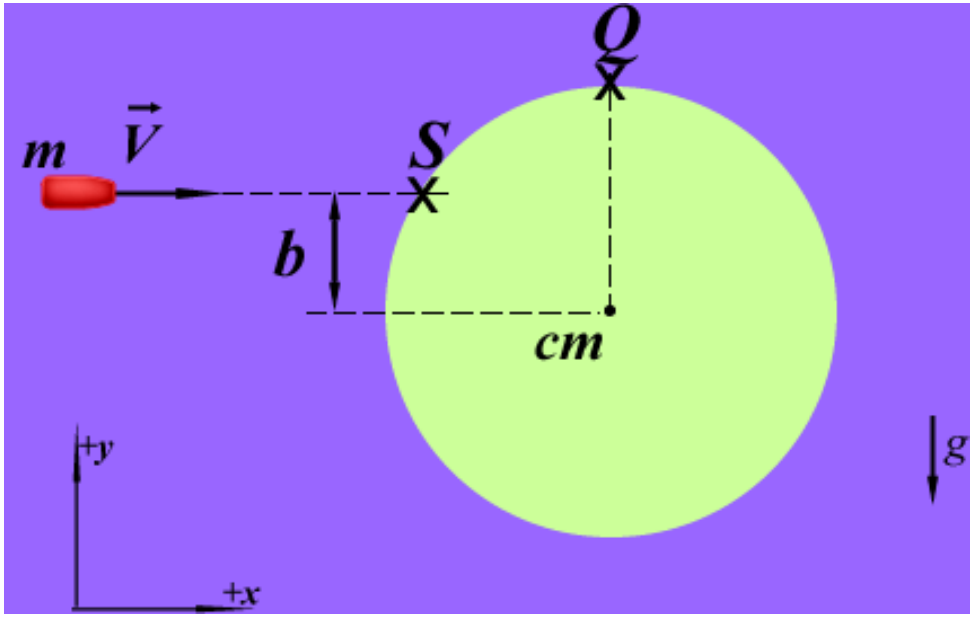
Diagrams in Problem: Help/Matter?

- Active Analytics: To Analyze A-B Experiments in MOOC
- Previous work:
  - Diagram Reduces % correct
  - Metacognitive Value?

- Zhongzhou Chen, Neset Demirci, Saif Rayyan, Christopher Chudzicki, Qian Zhou, and David E. Pritchard

Does Diagram Help Students; if so When?

A disk of mass M and radius R rotates about the horizontal z-axis which passes through its center. A bullet of mass m moving with speed V hits the disk a distance b above its center of mass and sticks at point S on the edge of the initially non-rotating disk.



What is the minimum speed for the bullet such that the embedded bullet will overcome gravity and rotate over the axle?

Does Diagram Help Students; if so When?

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No Diagram Condition:

Now student must draw

→More Time to Solve?

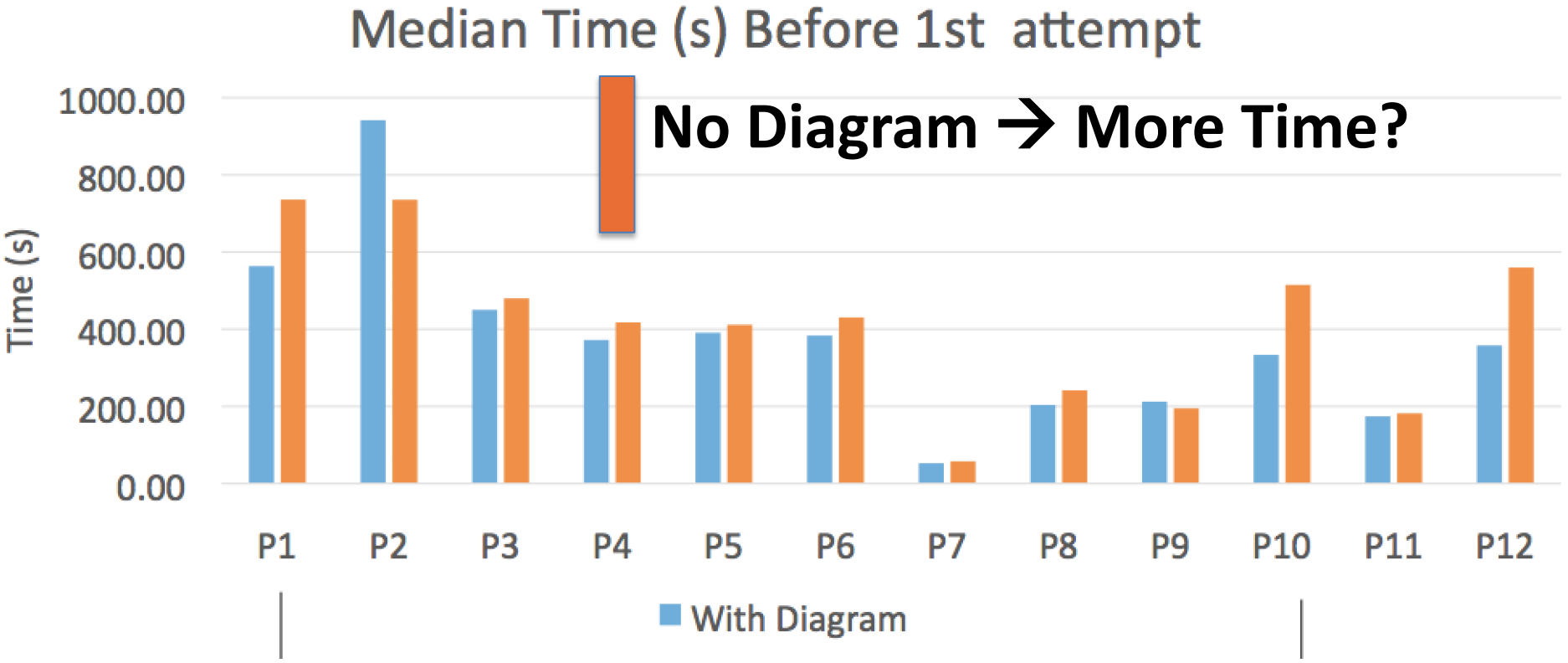
Or omit altogether

→Reduce % Correct?

→Is Drawing Helpful?

What is the minimum speed for the bullet such that the embedded bullet will overcome gravity and rotate over the axle?

Does No-Diagram Increase Time?



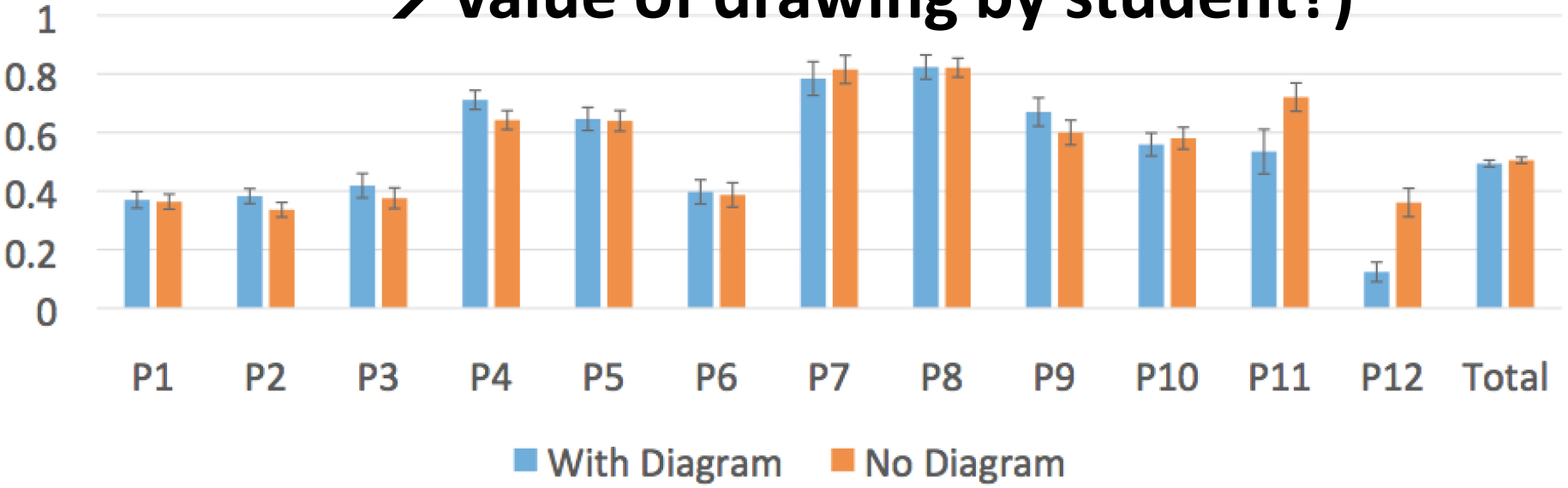
- **Only on 1, 10, and probably 12.**

Does Diagram Reduce % Correct?

No Diagram → More Often Correct?

(as previously found

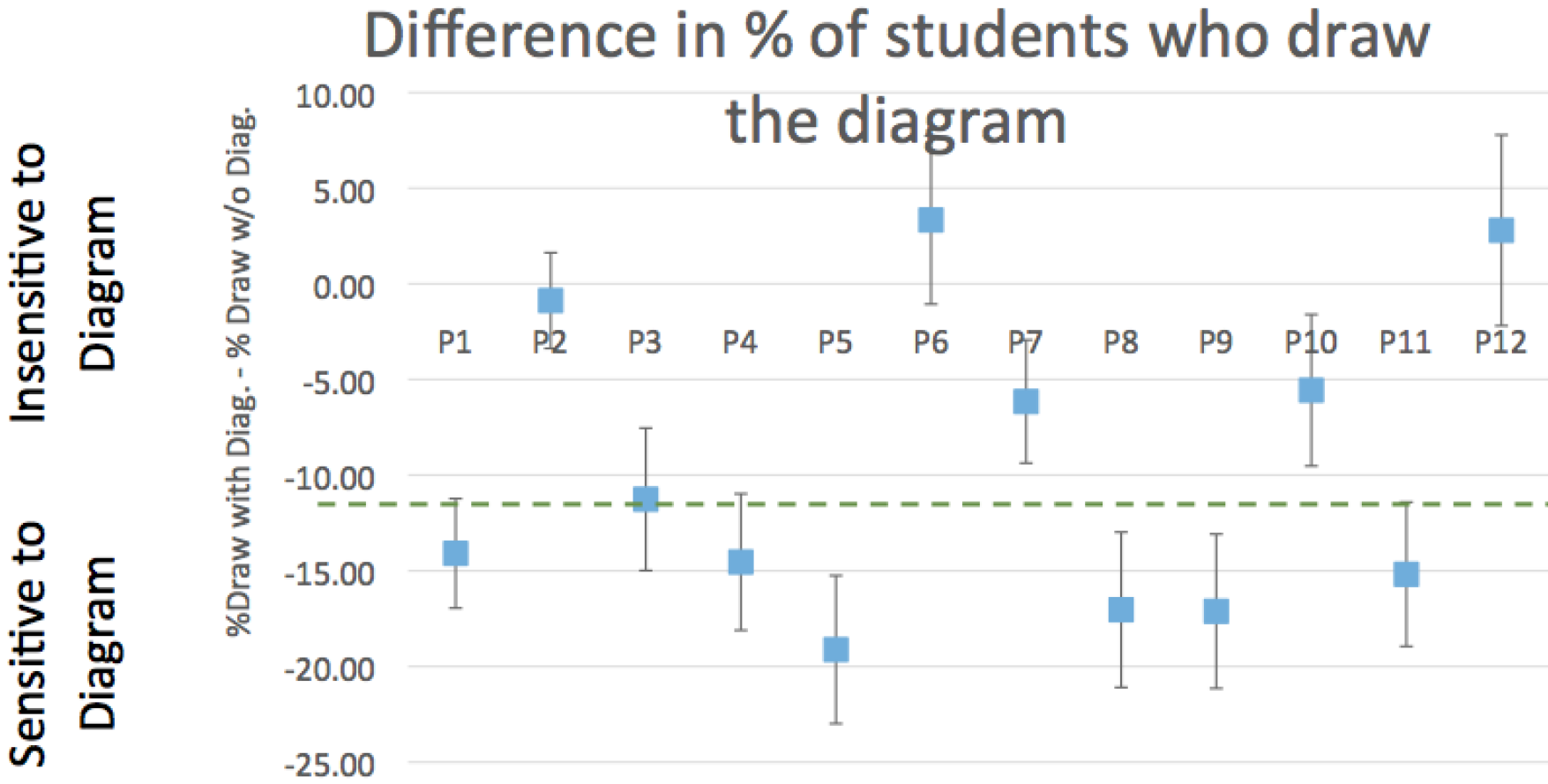
→ value of drawing by student?)



In only one case (#12) – no overall effect

Does Diagram Reduce Diagram Drawing?

Surprise: 50% draw diagram when one given!



- **Very significantly (<0.001) on about half, insignificantly on the others.**

Diagrams for your Students?

- **> 50% of students draw a diagram *even if given one***
- **No Diagram very slightly (< 5%) increases time**
- **Diagram neither helps/hinders Correct**
- **BOTTOM LINE: Adding a diagram to your problem helps very very little. If you think it's helpful, ask students to draw diagram themselves.**

Summary

- There is Learning in MOOCs
- All Cohorts Learn Equally
- Every Resource Helps – especially for concepts
- Practical – People Cheat
  - It has very strong effect!
- Diagrams in Physics Problems
- Many Ways to Analyze Learning
- http://RELATE.MIT.edu

Skill Average 1.38 Skill Improvement -1.9