

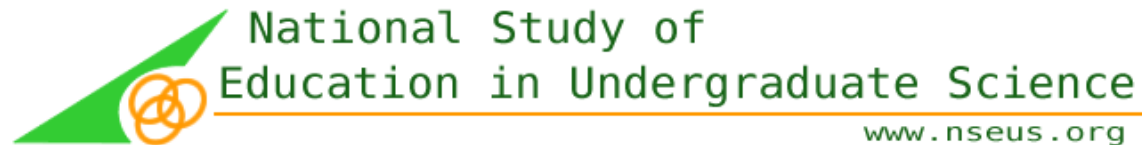
# You can Learn a Lot about Teaching Undergraduates from Preschoolers

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# Purpose of Current Study

- Explores if students' explanation of problem solutions will result in later improved performance on a final exam
- Applies neuroscience research to the teaching of Introductory Astronomy

# Breadth of this Paradigm

- The benefit of pre-test verbal report of problem solution can be seen in cognitive testing of two different age populations on two different types of tasks.

# Importance of a Motivated Sample

- Regardless on what aspect of learning you wish to explore you need an age appropriate, well tested, challenging, complex task and well motivated participants

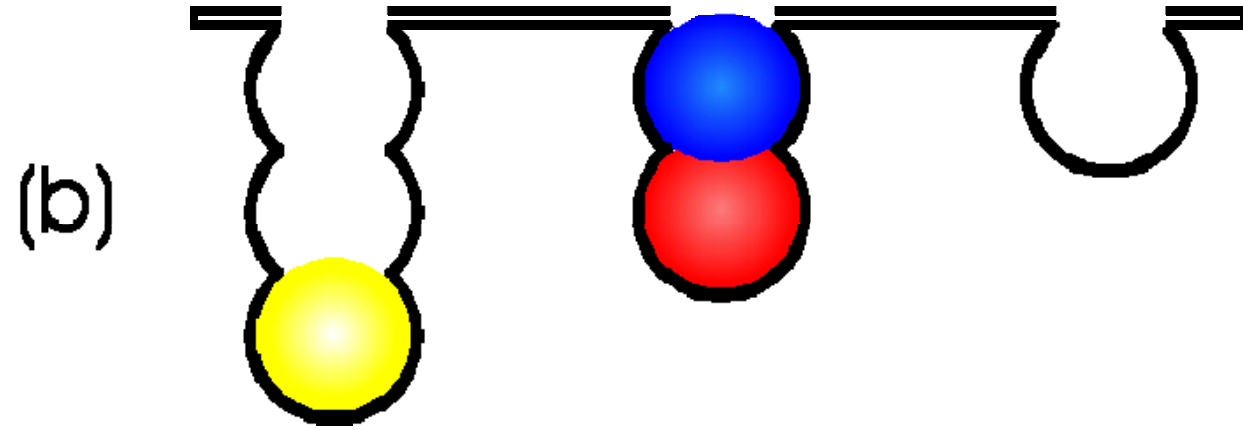
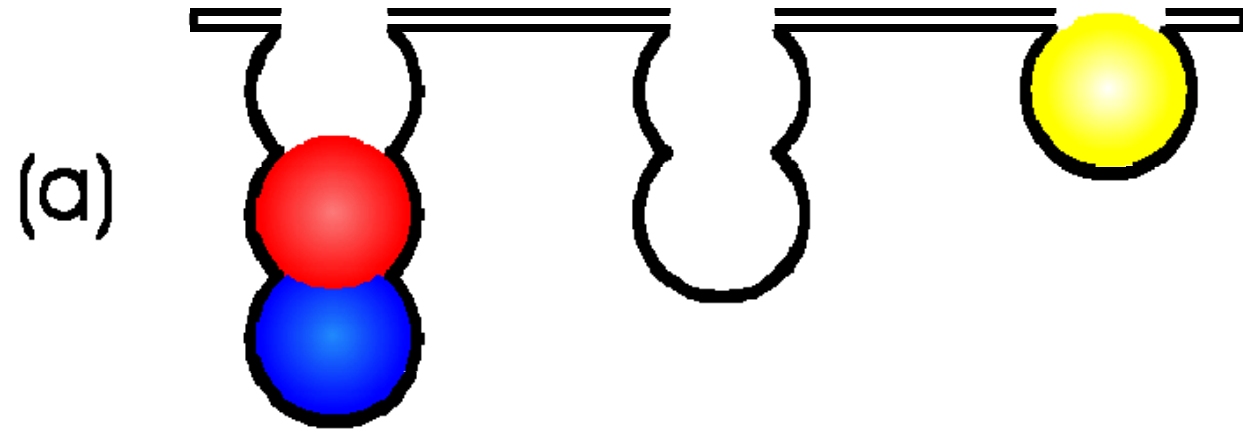
# Neuroscience: Problem Solving Task

- In neuroscience research, the “Tower of London” puzzle is a well-tested problem-solving task requiring multi-step planning toward a solution.
- Similar to the “Tower of Hanoi” but more flexible

# Neuroscience:

## The Tower of London Task

- The Tower of London task with increased levels of complexity has been used up through older adults for testing higher level cognitive reasoning.
- Preschoolers find simple forms of this task challenging

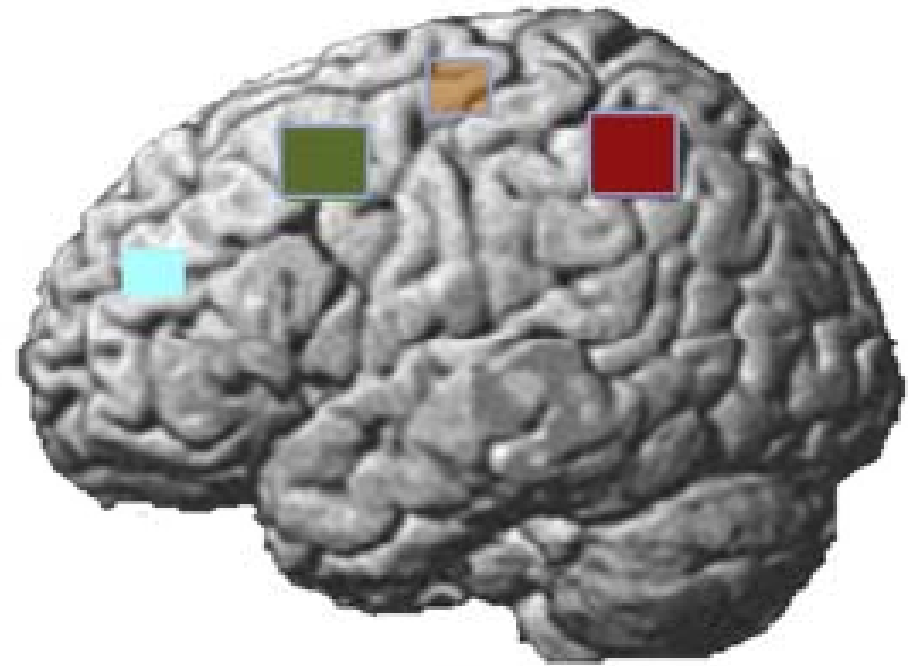


# Neuroscience: Problem Solving Task

- Four and five year-old preschoolers who are beginning to develop multistep reasoning provide good subjects. Rewarded with colorful animations and stickers.
- Two conditions
  - Solve silently
  - Speak aloud solution before solving
- Results
  - Better problem solving when children spoke aloud before solving, less impulsive answers, thinking more steps ahead

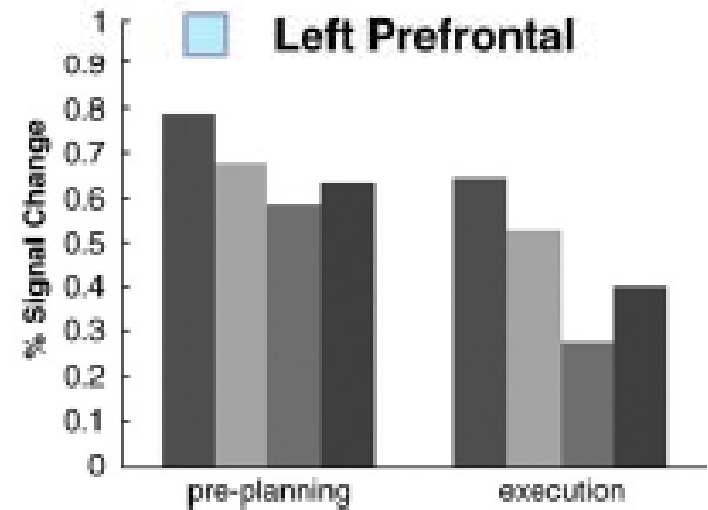


# Brain Activity During Tower of London Task



- In adults pre-planning tower moves activates frontal lobes of the brain, the regions used for higher level thinking

Notice increased activation  
In pre-planning period.  
fMRI study.



# Would pre-solving explanation benefit undergraduate science teaching?

- Two classes of Online Introductory Astronomy Laboratory students– Motivated to achieve a higher grade
- Both classes receive credit for in-class discussion, 12 modules with open-book multiple choice assessments, plus an observational notebook.
- Evaluated on a cumulative multiple-choice final exam

# Research Question

- Can pre-solving explanation, in this case working through major concepts before answering exam questions, improve later final exam performance?

# Study Design

- All students had Learning Objectives (used in writing the course) available prior to the final exam
- Control group: Given learning objectives for reading. No extra credit directly connected with the reading.
- Experimental group: Also given Learning Objective discursive questions. The students were encouraged to write and submit answers as an extra credit assignment prior to the final.
  - This would correspond to the preschoolers' "talking to themselves" about moves in the Tower of London problem.

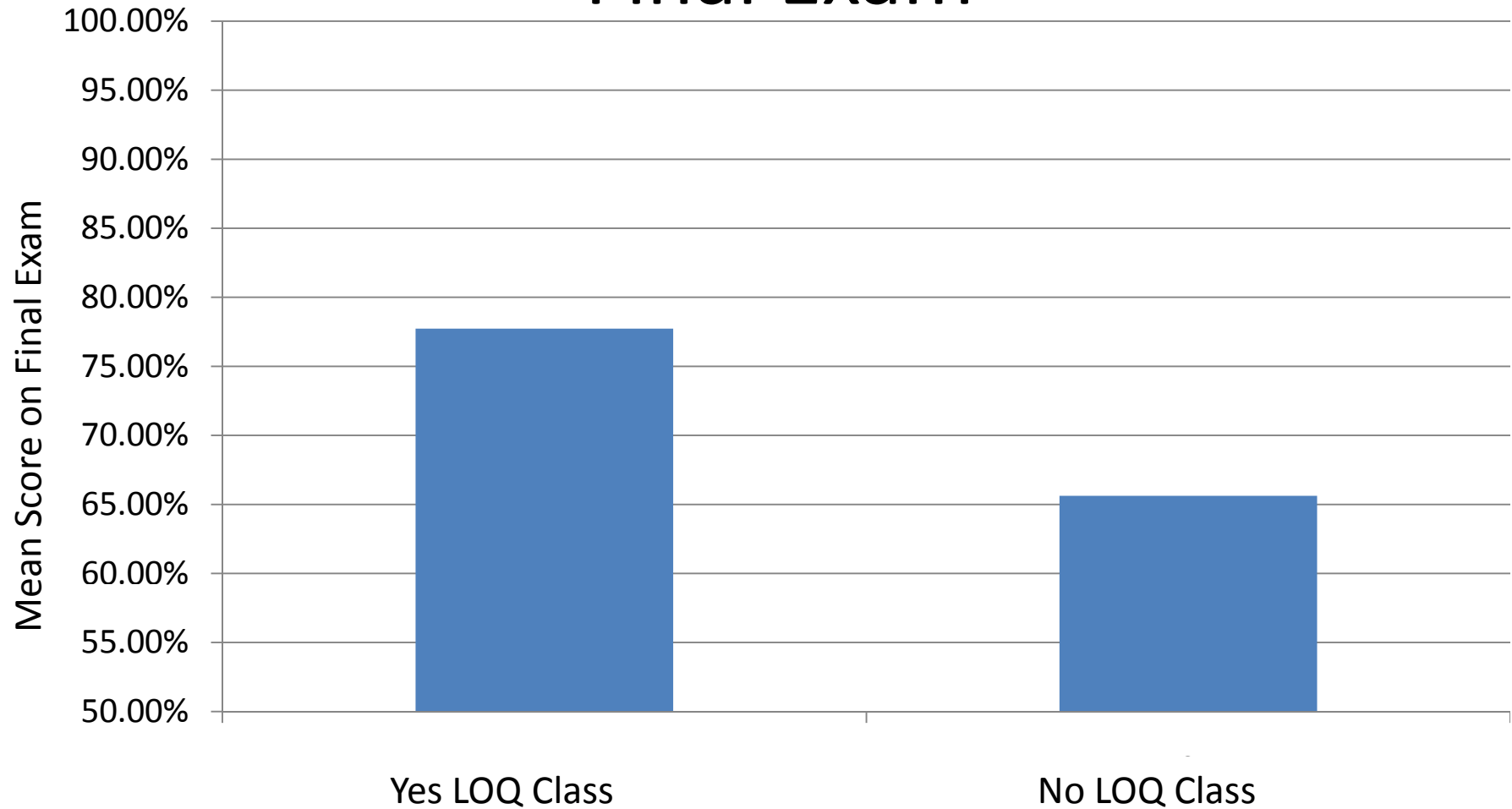
# Astronomy Online Lab Course Study Design

- Students were college age or older. There was no prerequisite for the course.
- Twelve modules with open book multiple choice assessments.
- Modules prepared according to Learning Objectives for each.
- N=41
  - n = 17 NO Learning Objective Questions
  - n = 24 YES Learning Objective Questions

# Study Question

- Both groups of students listened to lectures, read modules containing the Learning Objectives, constructed equipment which was used to make observations which they reported.
- Questions relevant to learning objectives were available to be answered discursively by one group for extra credit. The other was not provided questions.
- Across the two classes, did the group who had the opportunity to answer the Learning Objective Questions perform better on the final exam than those who did not?

# Comparison Across Classes: LOQ (24 students) vs NoLOQ (17) on Final Exam



# Conclusion 1

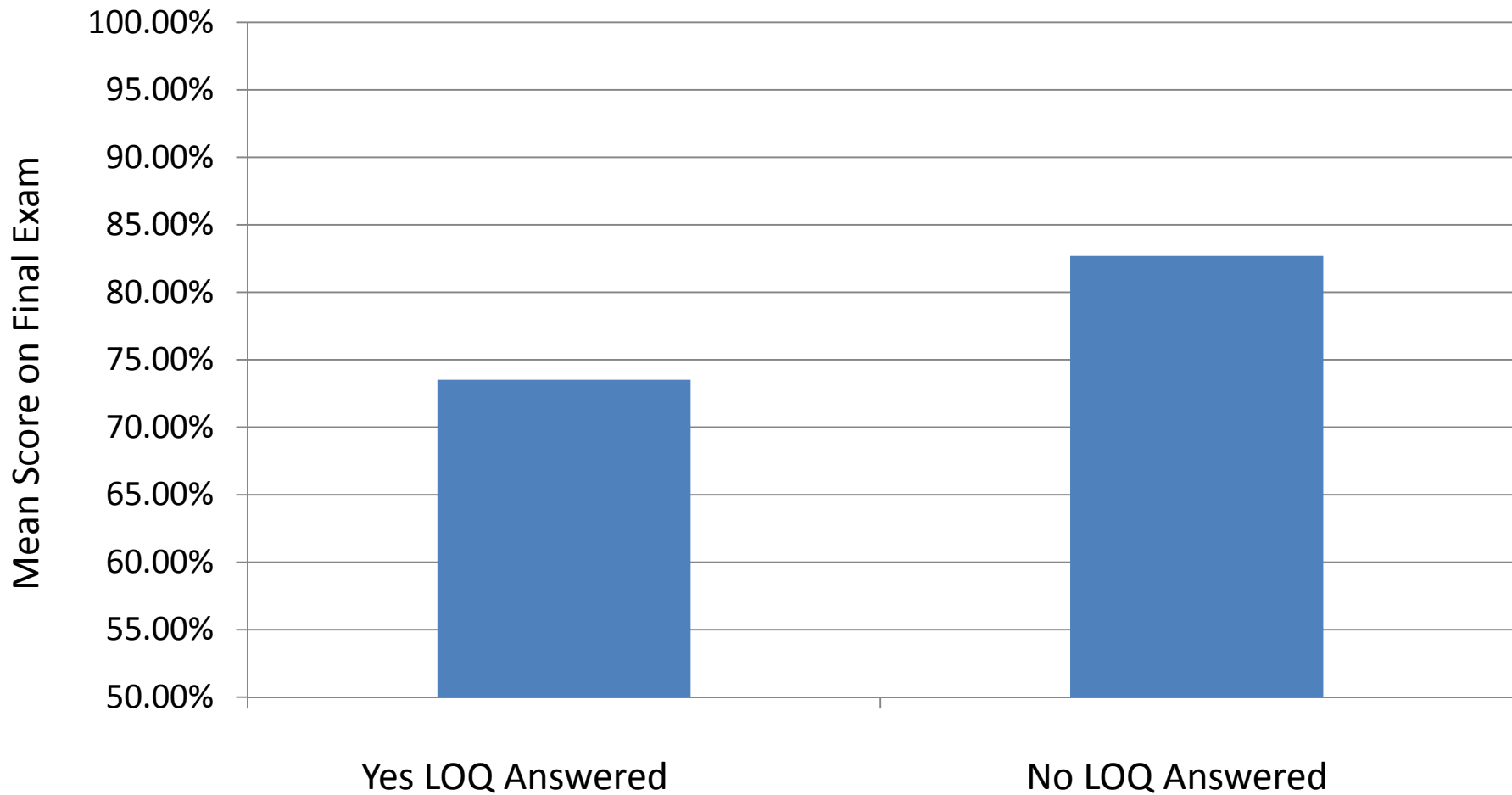
- Classes given the extra credit opportunity to answer Learning Objective Questions performed better than classes who were not given the opportunity.
- T test  $p=0.02$



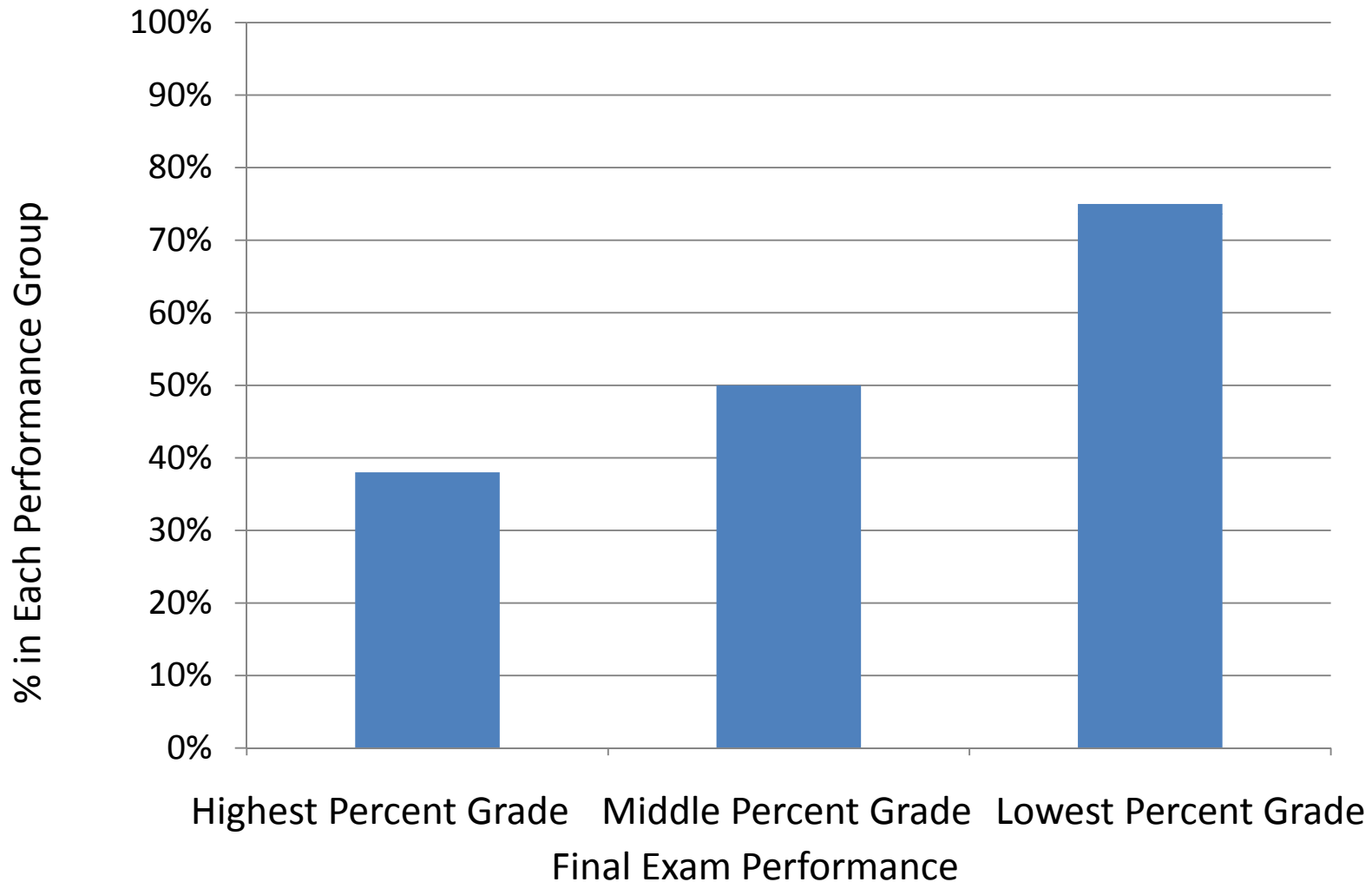
Within the class offered LOQs did those who answered extra credit do better?

- We investigate this in two ways.

# Comparison within LOQ Option Class: Score on Final Exam



Within LOQ Option Class:  
% of Highest, Middle, and Lowest 3<sup>rd</sup> on  
final exam who chose to answer LOQs



## Conclusion 2

- Students who chose to perform this learning objective question extra credit assignment were the poorer performing students. A paradox?
- No! Students who needed the extra credit answered the LOQs but also did better on the final exam. They thus improved the class average.

# Summary

- This project was only an initial application of a strategy based on neuroscience “Tower of London” results.
- However, pre-explanation strategies do improve class final exam averages, particularly for those students who most need help.
- Shows efficacy of highly relevant extra credit work completed *before* final exam.

Thank you