



# Work Together, Fight Alone: How Does Presenting Problems in Groups Improve the Robustness of an Individual's Problem-Solving Process?

Alison Huff

School of Natural Sciences, Assessment as Pedagogy and Planning Project Fall 2015  
University of California, Merced; Merced, CA 95343

## Abstract

In academia, a common goal among educators is to develop students into critical thinkers; in Physics 08 at UC Merced, this is often monitored through the robustness of homework and exam solutions. Students have shown to retain and advance to high orders of knowledge through the process of active learning, which can be promoted through group work. Using an expanded form of a pre-existing rubric for homework, students were placed into groups of three, where each member was assigned a role, and together would develop a solution to present to their peers. These were then scored based on the robustness of the problem-solving process by both the teaching assistant and their classmates. Through these presentations, the average homework score improved at a higher rate than with purely feedback alone. These results indicate that this method can help students start to develop a robust solution with individual work; however, due to the short-term application of these presentations, further testing must be conducted to fully assess the improvements in student work.

## Motivation

- Creating
- Evaluating
- Analyzing
- Applying
- Understanding
- Remembering

- Develop students into critical thinkers, addressing higher orders of Bloom's taxonomy<sup>1</sup>
- Students create solid base of fundamental knowledge by actively learning<sup>2</sup>
- Active learning best conducted when embedded in curriculum, such as working in small groups<sup>3</sup>
- In Physics 008: Introductory Physics I for Physical Sciences, method used to assess such thinking is examining robustness of student work

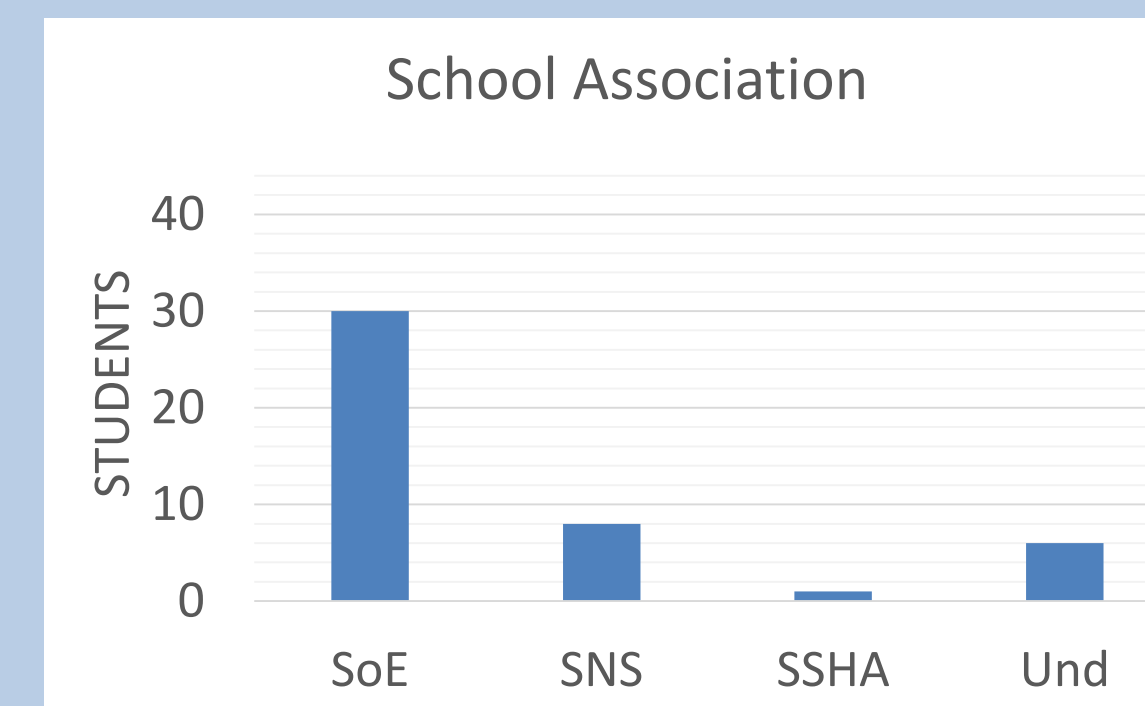
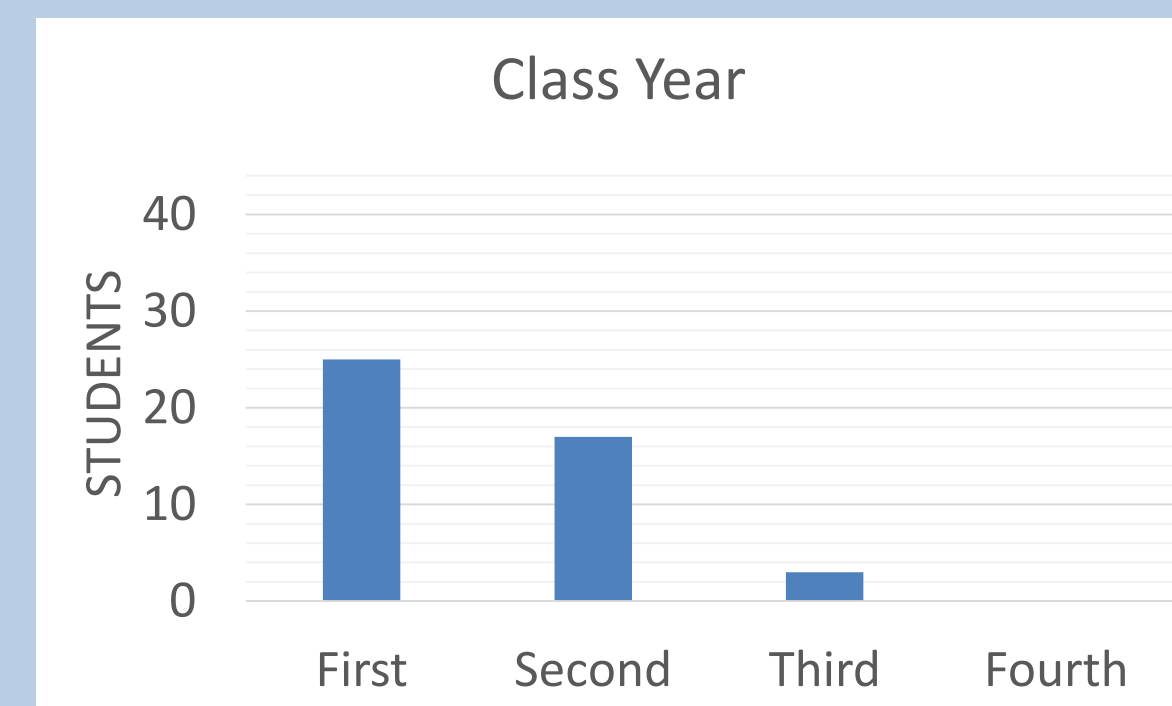
## Relevant Physics 008 Learning Outcomes

- You should be able to demonstrate your expertise in this subject by utilizing the definitions, language, and mathematical tools to discuss classical mechanics problems verbally, in writing, and mathematically.
- You should be able to analyze a written problem or observed phenomena, simplify it, identify the key known and unknown features, make predictions, and evaluate those predictions based on the principles of physics

## References

- <sup>1</sup> L. W. Anderson and D. R. Krathwohl. *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Pearson, 2001.
- <sup>2</sup> S. V. Franklin, E. C. Sayre, and J. W. Clark. Traditionally taught students learn; actively engaged students remember. *Am. J. Phys.*, 82(2): 798-801, 2014
- <sup>3</sup> L. Kober. *Reaching Students: What Research Says About Effective Instruction in Undergraduate Science and Engineering*. The National Academies Press, 2014.

## General Status of Incoming Student Body: Entrance Survey Results



### CHARACTERIZATION (45 STUDENTS)

- Have post-graduation plans
- Prefer to study in groups, are visual learners

### MATH AND PHYSICS BACKGROUND

- Showed having strong math background – most completed first semester of Calculus, and have enjoyed math
- Base physical intuition on “gut feeling” rather than logic – may be associated with having to apply knowledge across disciplines

### CHALLENGES IN PHYSICS STUDENT EXPECTATIONS

- Treat math in physics as numbers with no significance, yet agree equations are not just random math and symbols
- Do not fully realize that equations are derivable
- Believe only one correct method exists per problem

## The Project: Development of Robust Solutions

- Problem: students will often leave out key elements or not analyze their final answer to homework and exam questions, which could be a result of their lack of practice
- Homework notebooks are already implemented, which grades a solution based on its robustness
- Students are not always doing their homework directly in these notebooks, but will solve problems elsewhere to see if their answer is correct before writing it in the notebooks
- Mandatory discussion sessions are 110 minutes long, and are typically used to provide students with problems to practice concepts
- **How does the problem-solving process for an individual student improve through the implementation of robust solution presentations in small groups?**
- Have students present problems in groups of three, each with a role (scribe, orator, moderator)
- Audience members grade presenters based off their roles and modified homework notebook rubric
- Monitor robustness improvement through homework notebook and exam scores

### Original Discussion Style

TA goes over concepts from class needed for discussion

Students work on worksheet (provided by instructor) in small groups at whiteboards

TA recaps, addresses misconceptions

### Modified Discussion Style (10/15)

TA goes over concepts from class needed for discussion

Students work on worksheet (provided by instructor) in small groups at whiteboards

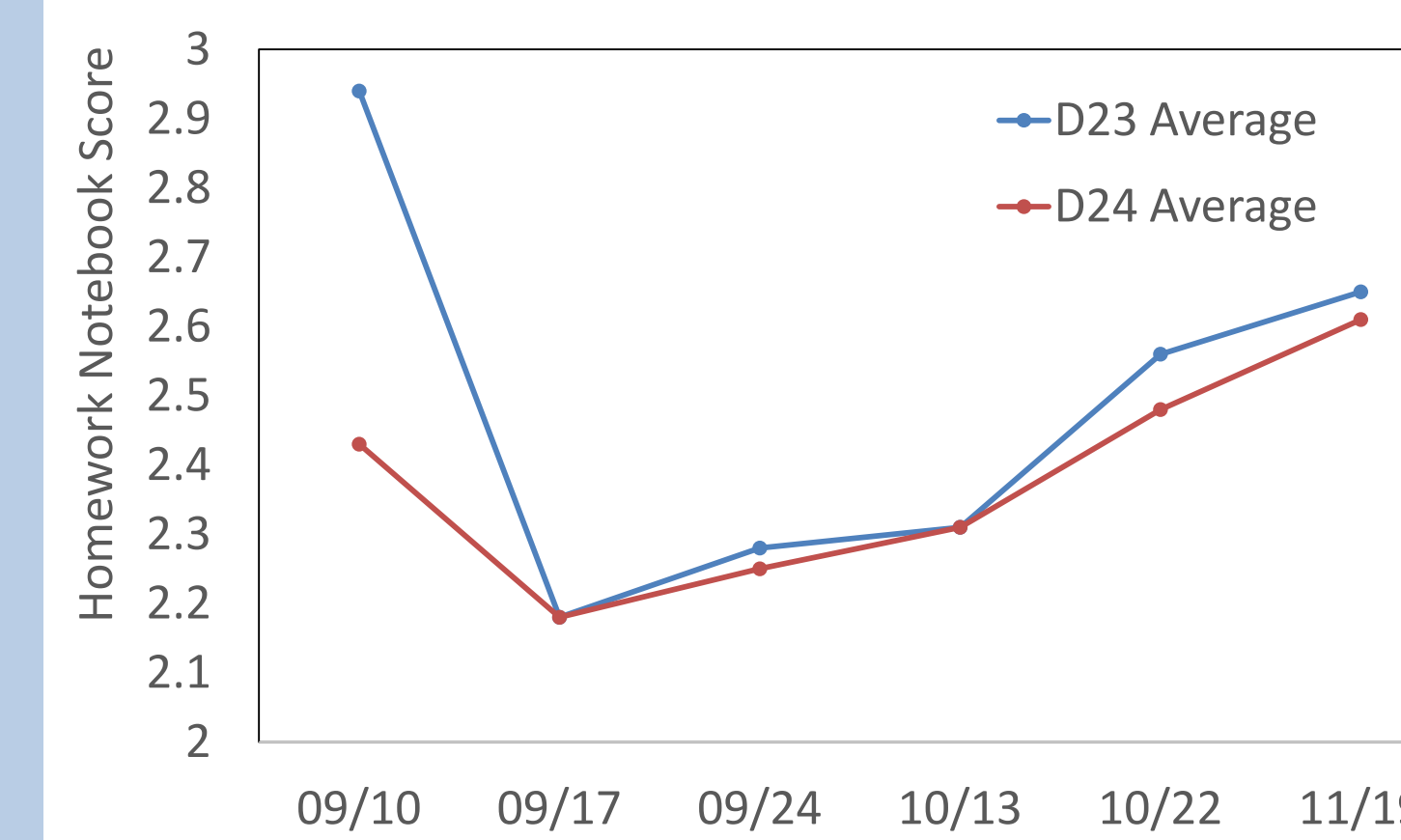
Presentation by first group, followed by mandatory questions from audience

Presentation by second group, followed by mandatory questions from audience

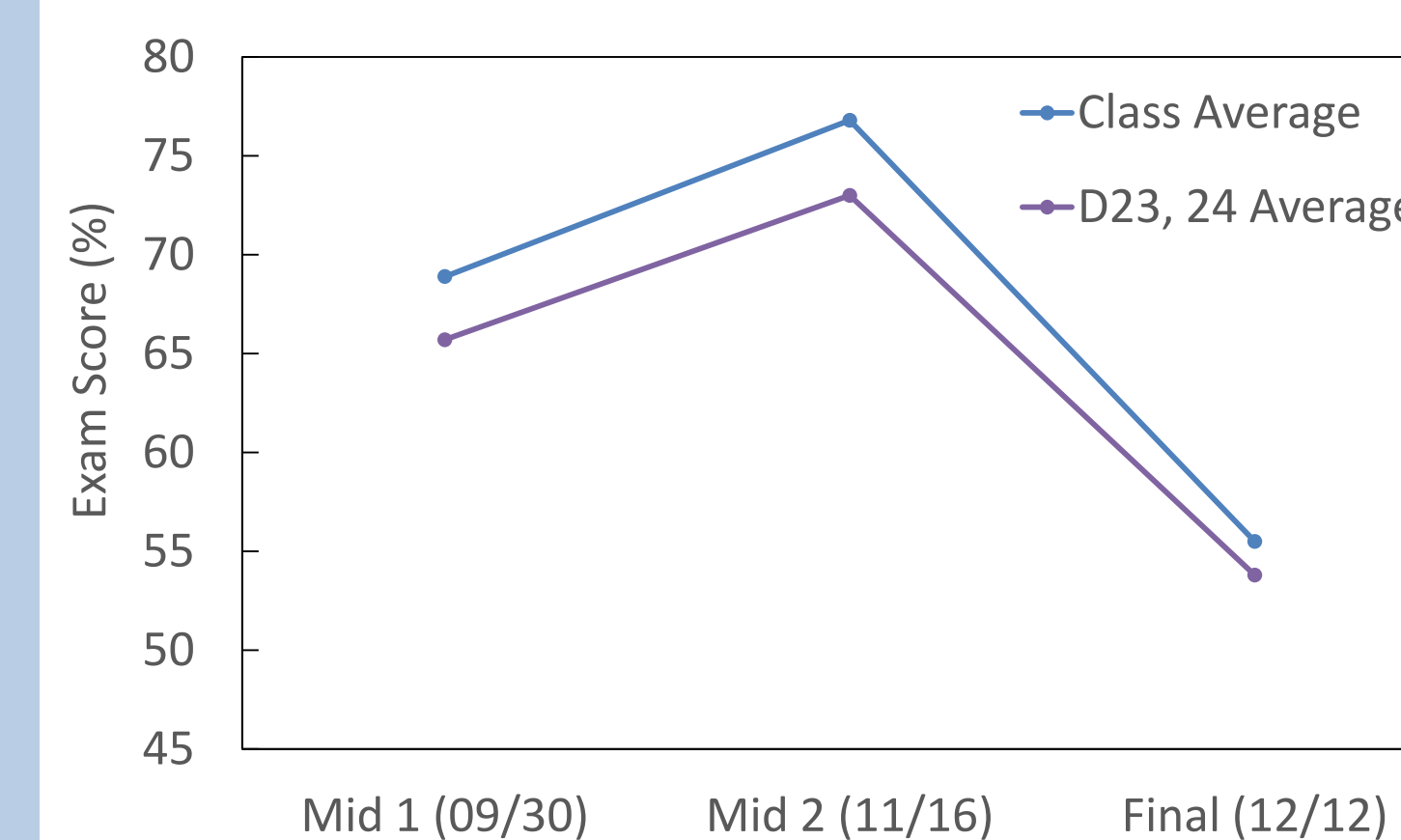
TA recaps, addresses misconceptions

## Results

### Homework Performance Over Time



### Exam Performance Over Time



### Homework Notebook

- Two discussion sections, averages of submitted work only
- D23: 23 students
- D24: 24 students
- Scores increased before presentations, most likely from students familiarizing themselves with method and feedback
- Largest increase between 10/13 and 10/22, continued to increase; result of students understanding expectations for a robust solution

### Exam Scores

- Average scores of class and modified discussion style sections, includes dropped students
- Class: 161 students
- D23, 24: 47 students
- Scores for both the entire class and discussion sections increased by about the same amount for midterm 2
- A decrease is visible for both for final, but the class average had a larger decrease; final average of one modified discussion style section was 2% higher than class average

## Conclusions

- By having students present and assess one another through the use of rubrics, their average scores on a low stakes assignment (homework notebooks) increased
- The high stakes assignment (exams) did show a possible advantage with this method, but the overall scores still decreased
- Time taken for robust solutions was not monitored, which may affect exam scores
- Weekly quizzes may help students with both robust solutions and timing issues
- Full potential of modified method may not be visible due to possible resistance to style change during semester
- To more accurately demonstrate the effectiveness of group presentations for robust solutions from an individual student, a comparison between the standard approach and this method must be conducted from the first discussion session.

## Acknowledgements

Professor Angela Winek, Dr. Anne Zanzucchi, Dr. Laura Martin, Dr. Antoinette Stone, Dr. Carrie Menke, Dr. Jay Sharping, Dr. Leily Kiani, Fall 2015 Physics 008 Discussion 23 and 24 Students