Fun and Engaging Labs

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COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

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BYU
BRIGHAM YOUNG UNIVERSITY

Workshop Outline

8:00 Introduction to the Fun Lab philosophy

8:20 Introductions

8:30 Participants form groups of 3-4 and conduct one lab

9:30 More Fun lab philosophy

9:45 Groups conduct more labs

11:40 Data supporting effectiveness

11:55 Evaluations

Today's Lab Menu

- Newspaper and a Snicker's bar
- Balloon boy
- Ball in can energy lab
- Resistance walking
- Investigating how music is made
- Fun with tape

Introductions

- Name
- Affiliation
- What classes and who you teach

Small groups

- Find a group of 3 - 4
- Identify two labs that your group will conduct
- Have fun
- Repeat

Motivation

- Faculty work hard to create labs that encourage students to investigate important concepts.
- Outcome
  - Students do not approach lab as a learning experience
  - Faculty treat it very differently as well

Motivation

- Students:
  - Rush through lab
  - Get correct answer once and are satisfied even if several other trials produced the same different answer!
  - Students divide and conquer
  - “Remember in lab when you …”
    - Blank look from entire class!
  - Common complaint: Lab doesn’t coincide with class

Adams' Labs

- Inspired by a talk by Duane Merrell

Perception

- Faculty:
  - Often feel it's important that it only includes material students "know" - "confirmation labs"
    - Throughout Middle and High School
  - If a student retakes the course, they can skip lab and use their grade from the previous semester.

New Perception

- Lab
  - Small groups 24 – 28
  - 1 instructor plus an undergraduate TA
  - 170 minutes per week
- Lecture
  - 130 students
  - 1 instructor
  - 200 minutes per week

46% of the contact hours

Lab is the ideal learning environment!

New Perception

- ~~Lab~~ – 3 hour block
  - Part of class
    - Class preps for lab
    - Lab necessary for class to progress
    - Lab material shows up on quizzes and exams
  - Don’t overwhelm them with calculations!

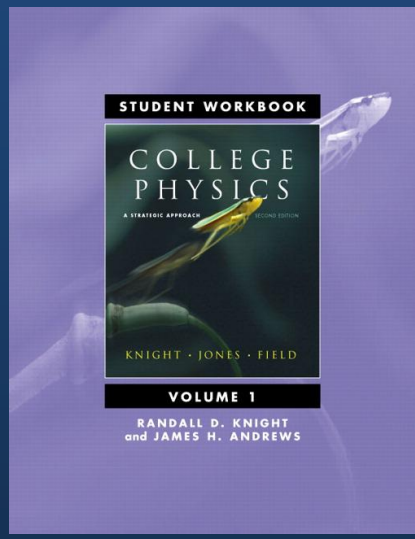
- Real difference is what you can do with resources
  - Student instructor ratio
  - Computer per 2 students
  - Hands on space
  - Longer chunk of time

Several years of experimenting – found recipe!

- Students want to stay to see how others do
- Break time into chunks
- “Real” hands-on materials were most popular over “physics” real equipment or sims.

Adams' current solution

½ recitation, ½ lab



- Recitation
  - Knight, Jones and Field workbooks
  - Individual work turned in (work in groups)
  - Goal: conceptual understanding (hard work)
- Fun, Engaging Problem Solving Lab
  - Designed for divide and conquer
  - Goals: Have fun, relate physics to life, focus on one aspect of their choosing of the concept .

What seems to work

- Balanced Challenges
  - Not too hard OR too long
  - Challenge or competition between lab groups
- Student choice
  - One of the hardest things for me to let go of!
- Real life materials
  - Force lab, rotational motion demo lab, elastic properties of plastic spoons, straw instruments, lenses, mirrors, tape lab, EKG, …

Adams' current solution

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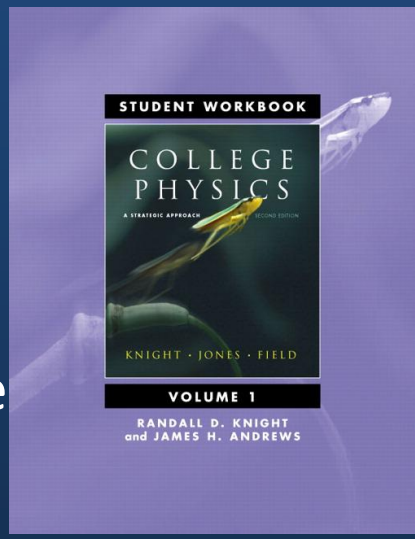
- Fun, Engaging Problem Solving Lab
  - .



Workbooks

4 Forces and Newton's Laws of Motion

4.1 What Causes Motion?

4.2 Force

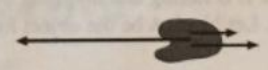
1. Using the particle model, represent the force a person exerts on a table when (a) pulling it to the right across a level floor with a force of magnitude F, (b) pulling it to the left across a level floor with force $2F$, and (c) *pushing* it to the right across a level floor with force F.

a. Table pulled right with force F

b. Table pulled left with force $2F$

c. Table pushed right with force F

2. Two or more forces are shown on the objects below. Draw and label the net force $\vec{F}_{net}$.



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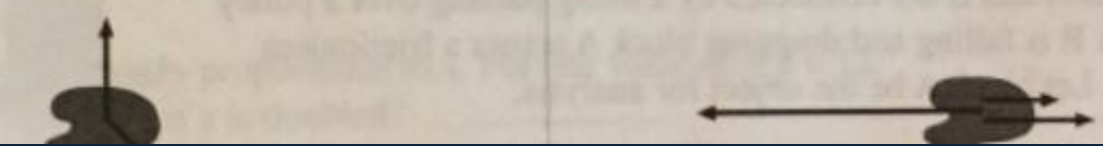


Workbooks

Exercises 17–22:

- Draw a picture and identify the forces, following Tactics Box 4.2, then
- Draw a free-body diagram for the object, following each of the steps given in Tactics Box 4.3. Be sure to think carefully about the direction of $\vec{F}_{net}$.

Note: Draw individual force vectors with a **black** or **blue** pencil or pen. Draw the *net* force vector $\vec{F}_{net}$ with a **red** pencil or pen.

17. A heavy crate is being lowered straight down at a constant speed by a steel cable.

18. A boy is pushing a box across the floor at a steadily increasing speed. Let the box be the object for analysis.

19. A bicycle is speeding up down a hill. Friction is negligible, but air resistance is not.

Phys 220 - Force Vectors

Materials and equipment: 5 sheets of newspaper, blue 2 inch painter's tape, ring stand and a 2 ounce Snicker's bar.

Your group's challenge is to use only the 5 sheets of newspaper and tape to get your Snicker's bar as far from your ring stand as possible. The group with the largest distance receives 5 bonus points.

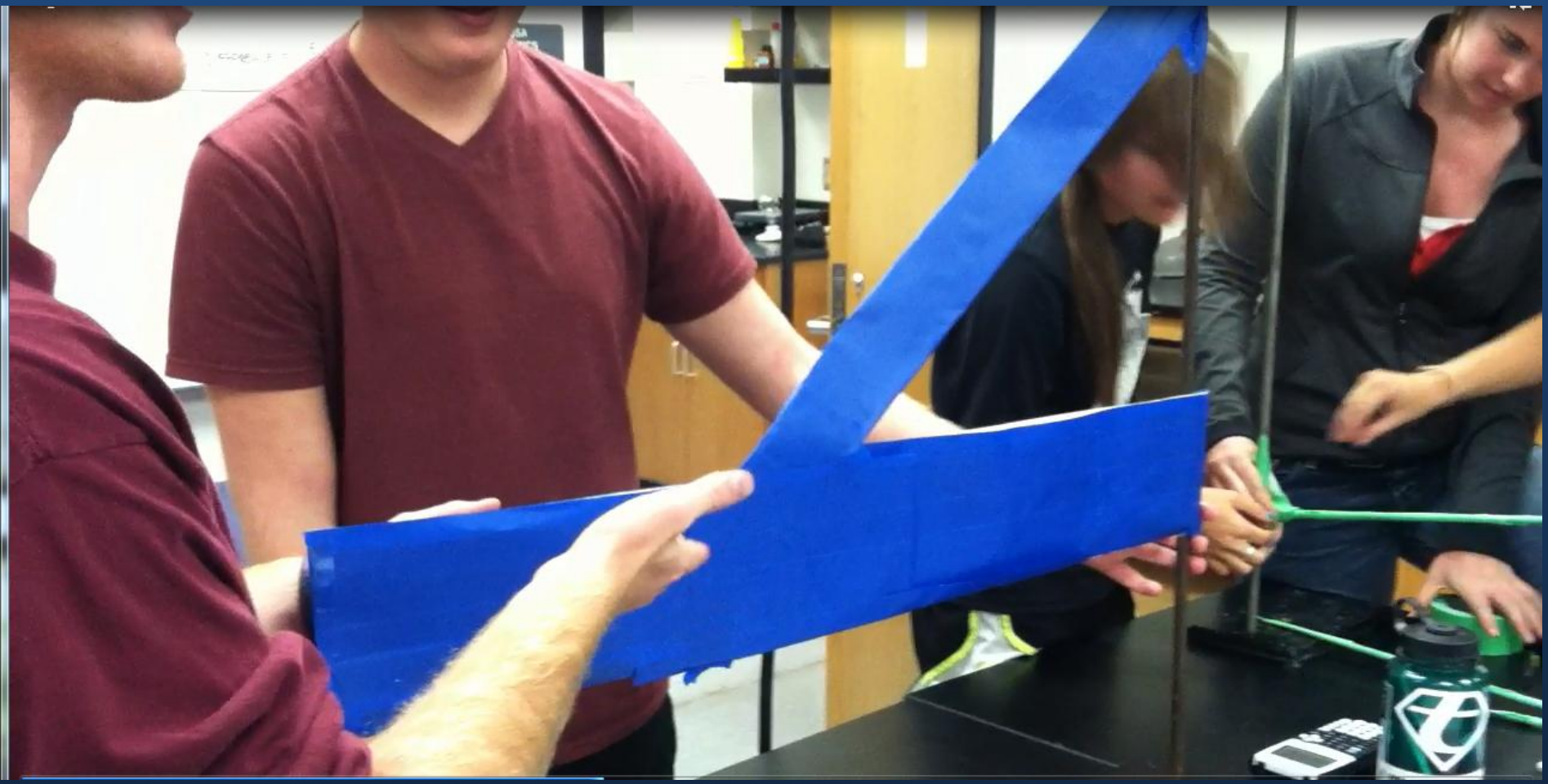
Rules:

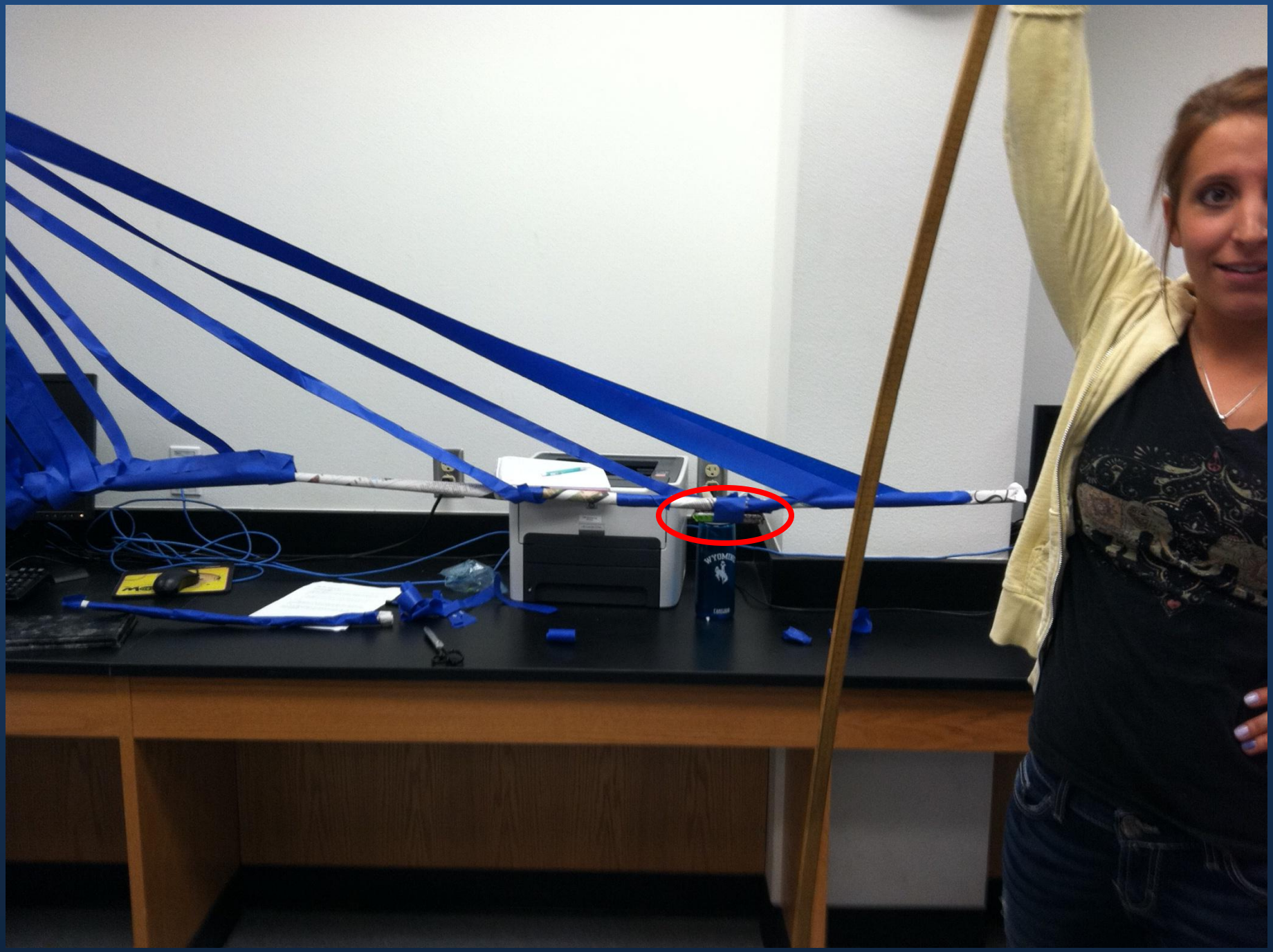
1. The ring stand must stand upright, as designed, flat on the table or floor.
2. You can only attach your materials to the post part of the ring stand, not the base of the stand, the table, ceiling or any other item.
3. The Snicker's bar must be suspended only by the materials described above.
4. No distance below the base of the ring stand will count.
5. The suspended Snicker's must be in equilibrium. No motion for a full minute.
6. The minimum distance between the closest portion of the post to the Snicker's bar will be measured.

Write up:

Please describe your approach. Include in your description any ideas that your group had but decided not to try and why you decided against them. Also please describe any other approaches that you tried today and why they did not work as well as your final set up.

Draw a diagram showing your final setup with all distances noted. Draw the force vectors of your final setup. Explain why, using these force vectors, your setup successfully suspended the Snicker's bar in the air. Don't forget to consider the x and the y directions separately.



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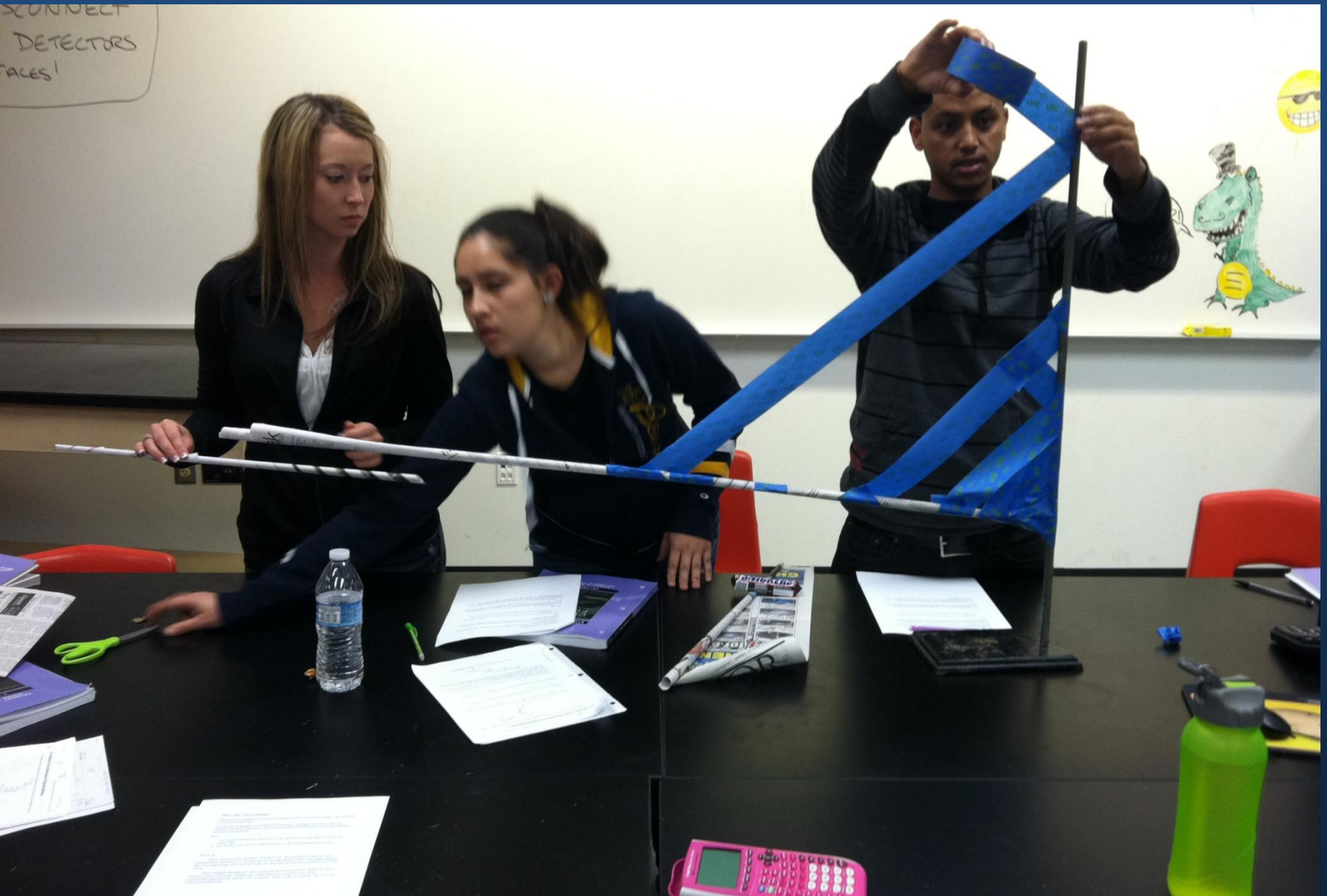
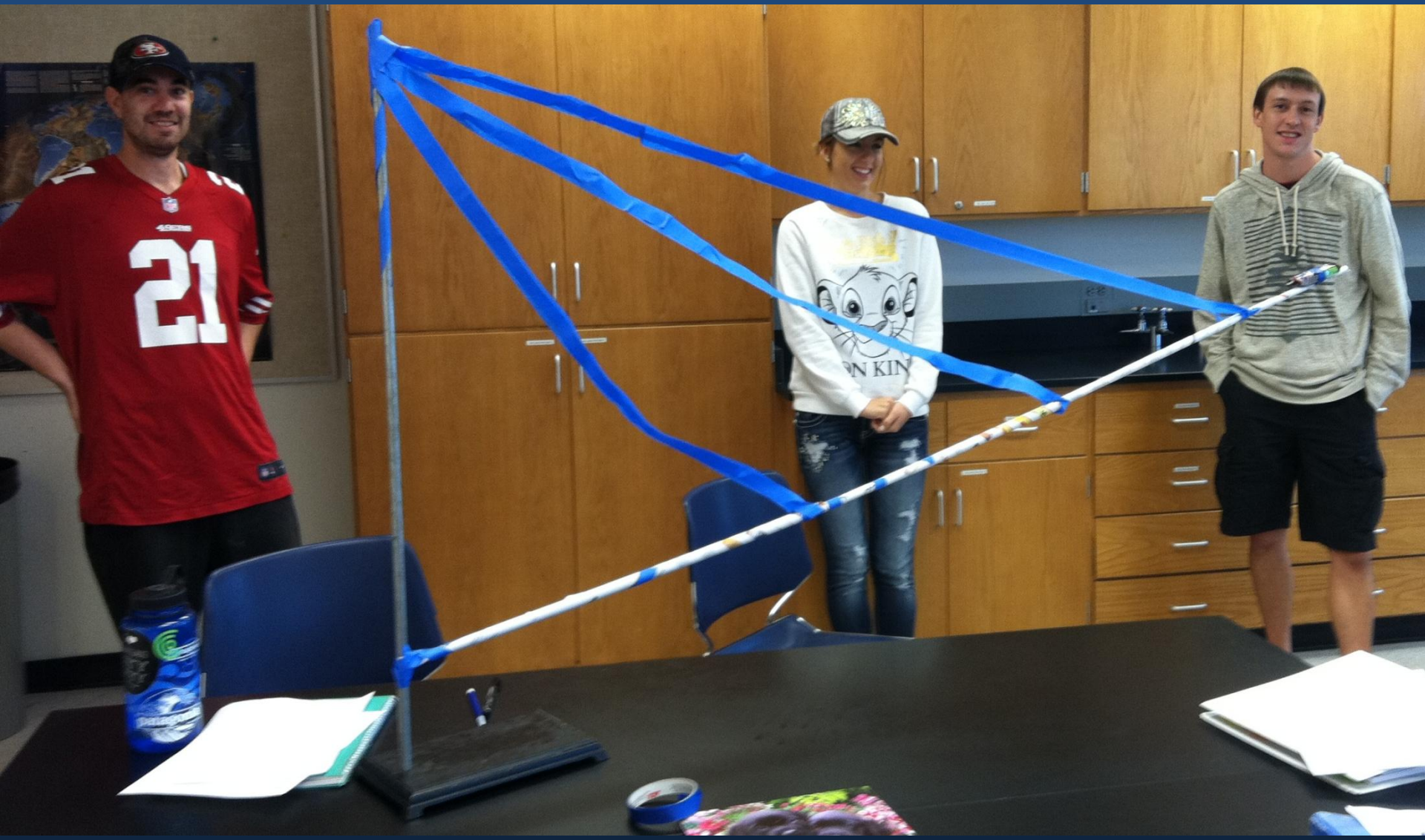
Winners!



Winners!

186 cm



Today's Lab Menu

- Balloon boy
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Good motivation and questions

People stayed to see who won!!

Why did theirs work?

What is wrong with ours?

Is it too heavy?

Lots of tape was not a good plan was it?

How do I know?

- Measure engagement by:
  - If they stick around after they finish their lab
  - Time spent on Phone

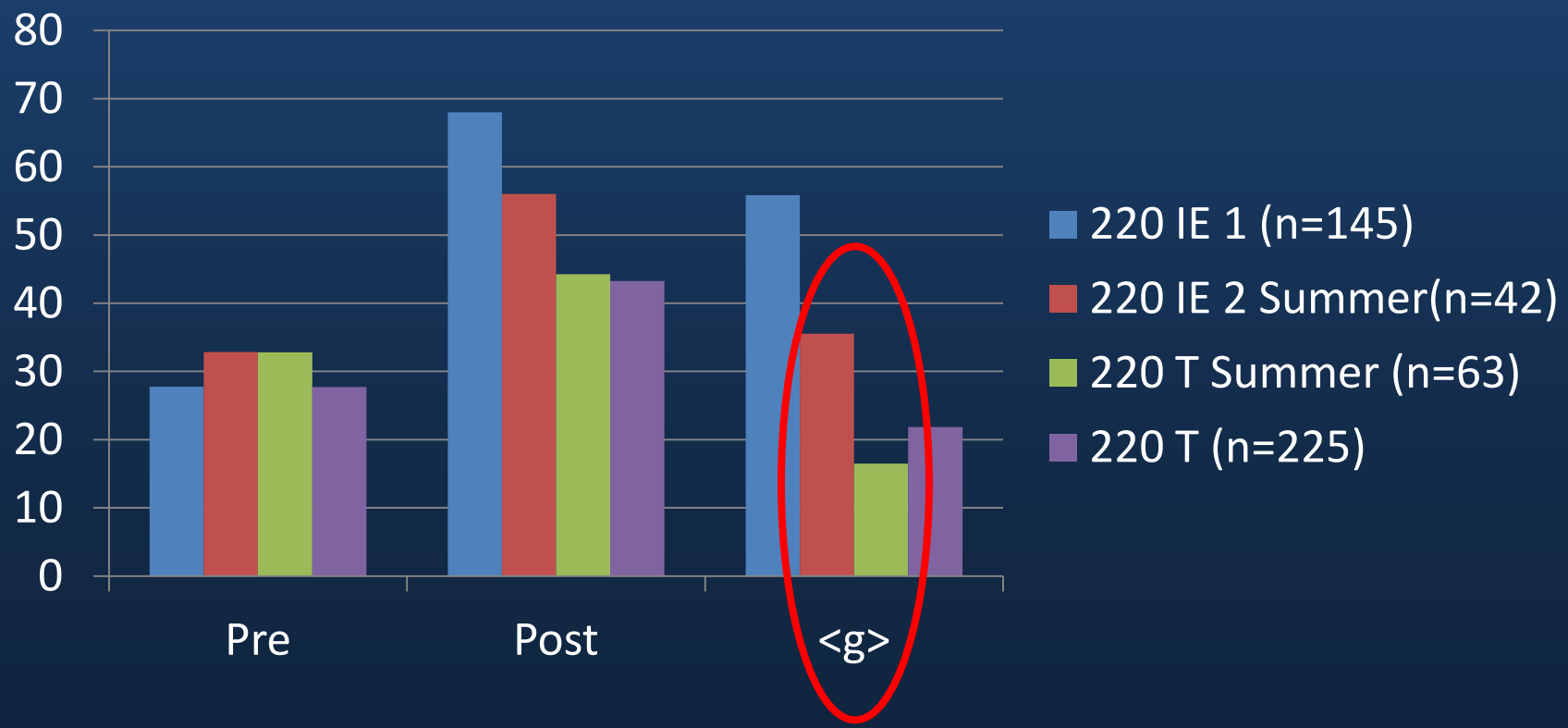
How do I know?

- Measure engagement by:
  - If they stick around after they finish their lab
  - Time spent on Phone
- Measure understanding by:
  - Quality of questions during lab
    - “Why did theirs work?”
    - “No… that won’t help. If you add mass it’ll increase the wave speed and that increases the size of the loop!”
  - Comments during class or in office hours:
    - Not only do they remember lab, they bring it up. “It’s like in lab when we did this…”

IE 1 = JITT, Peer Instruction, worksheets, group problem solving, workbooks and fun labs

IE 2 = workbook and fun labs, traditional lecture

T = Standard labs and traditional lecture

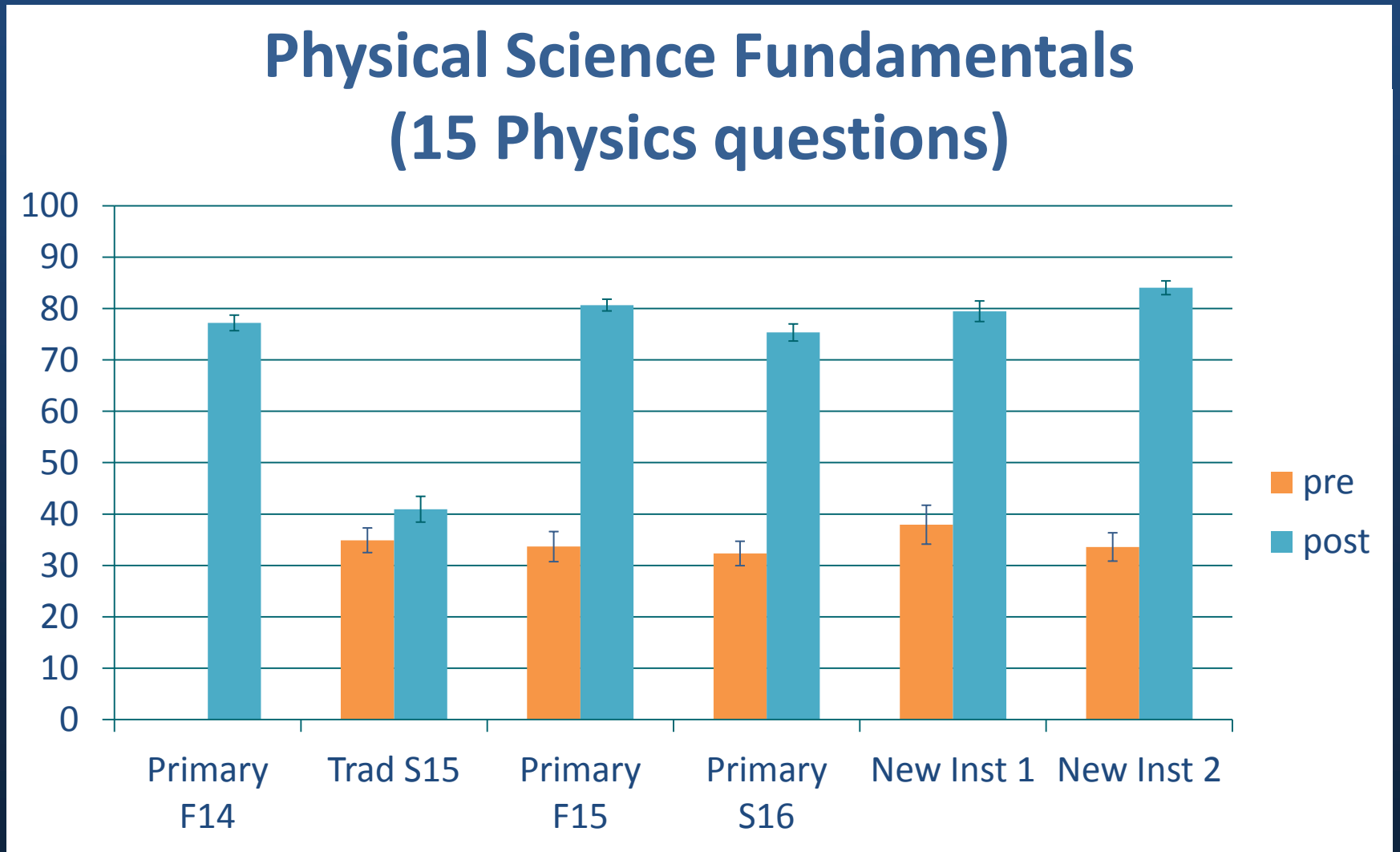


CLASS - Personal Interest

Physics (Algebra based) with JiTT/PI/fun Labs

Category	Pre	Post
Overall	64(3)%	70(3)%
Real World Connections	75(6)%	88(4)%
Personal Interest	55(6)%	75(6)%

Physical Science for Elementary Teachers



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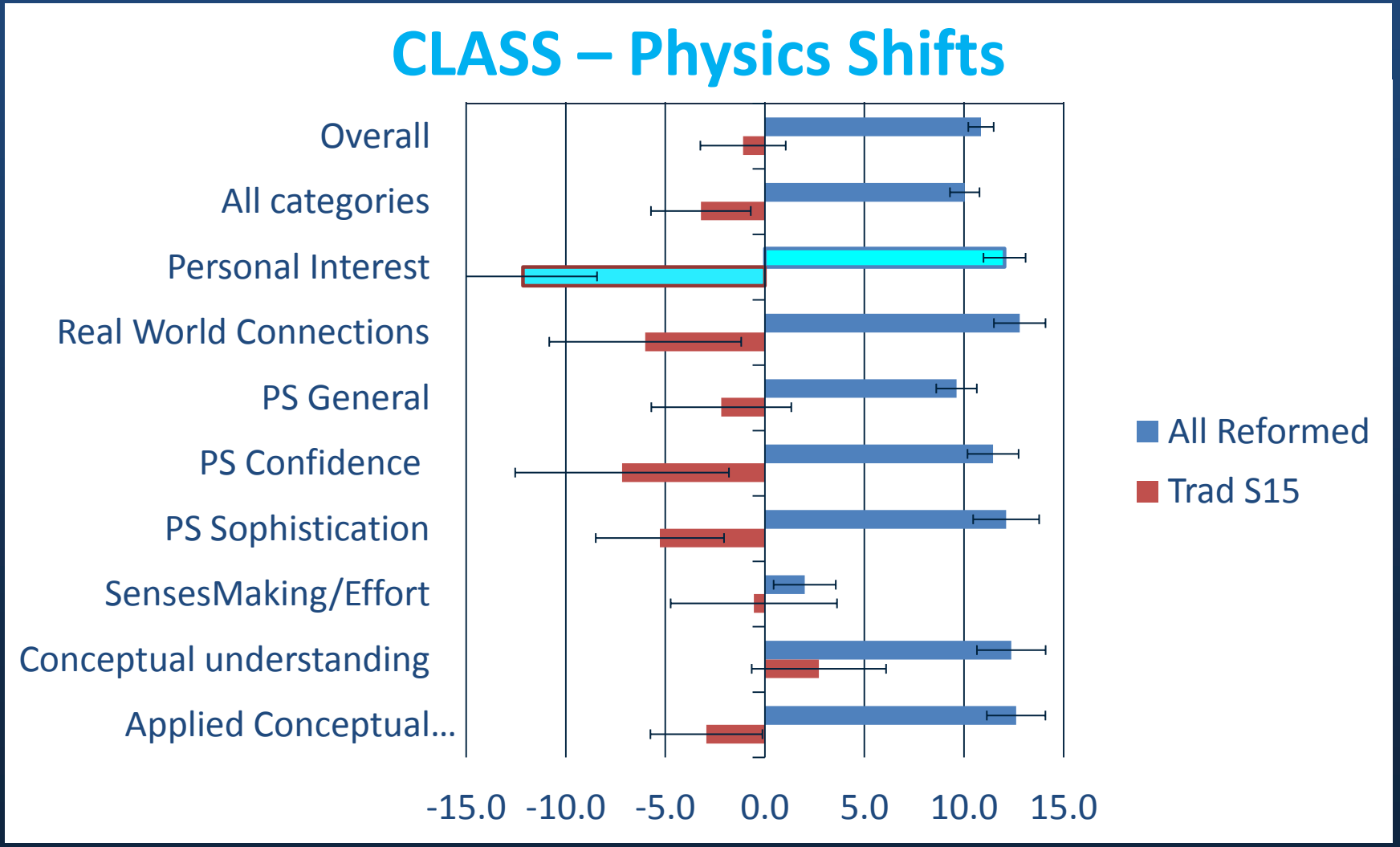

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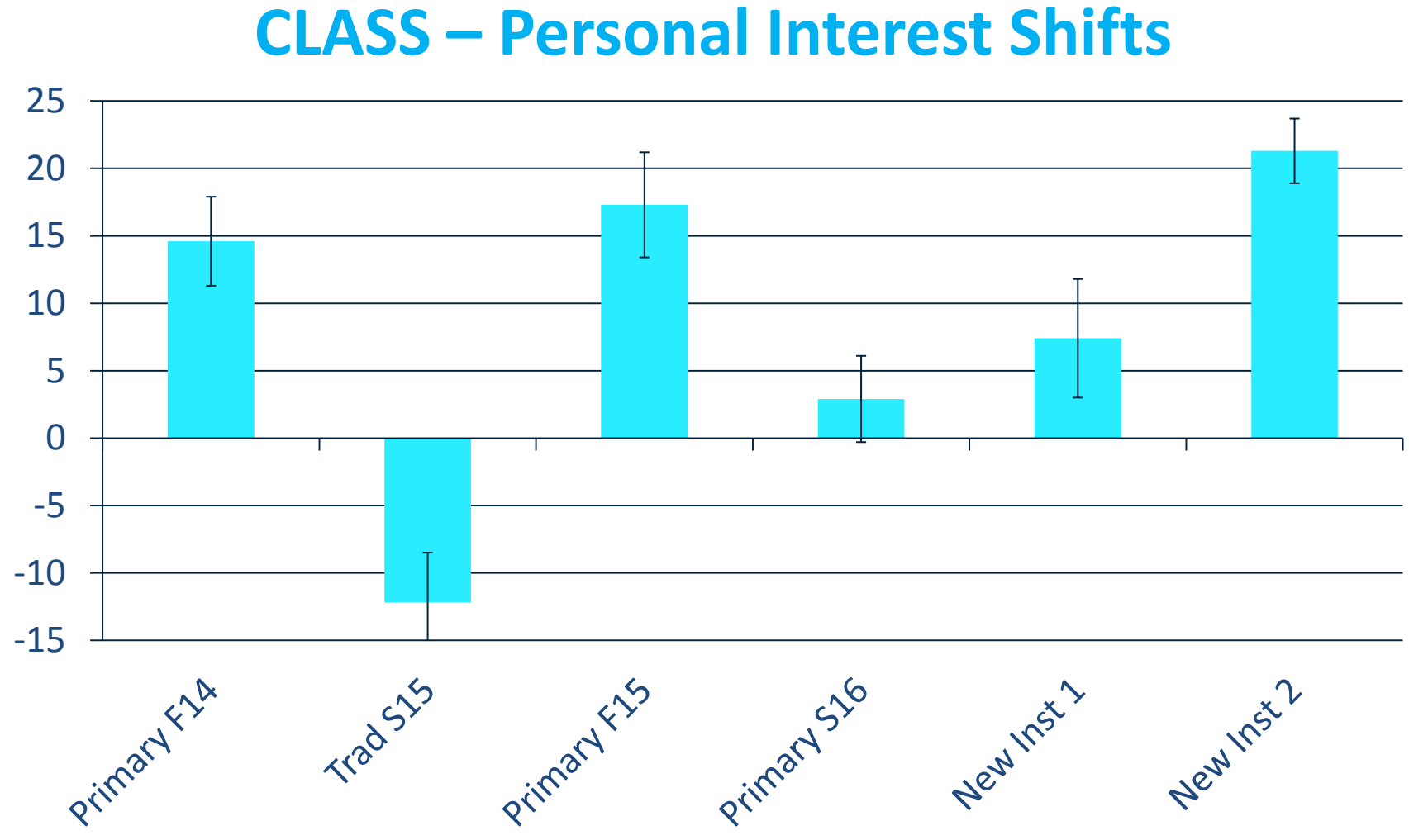
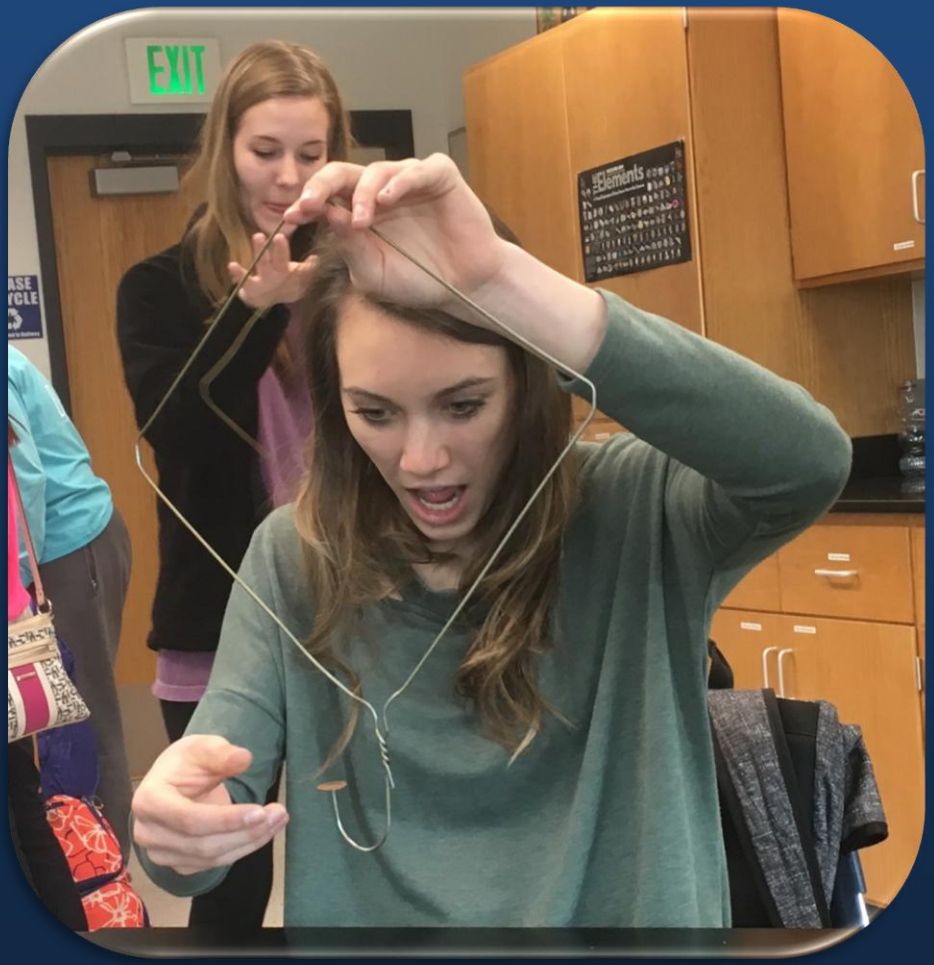
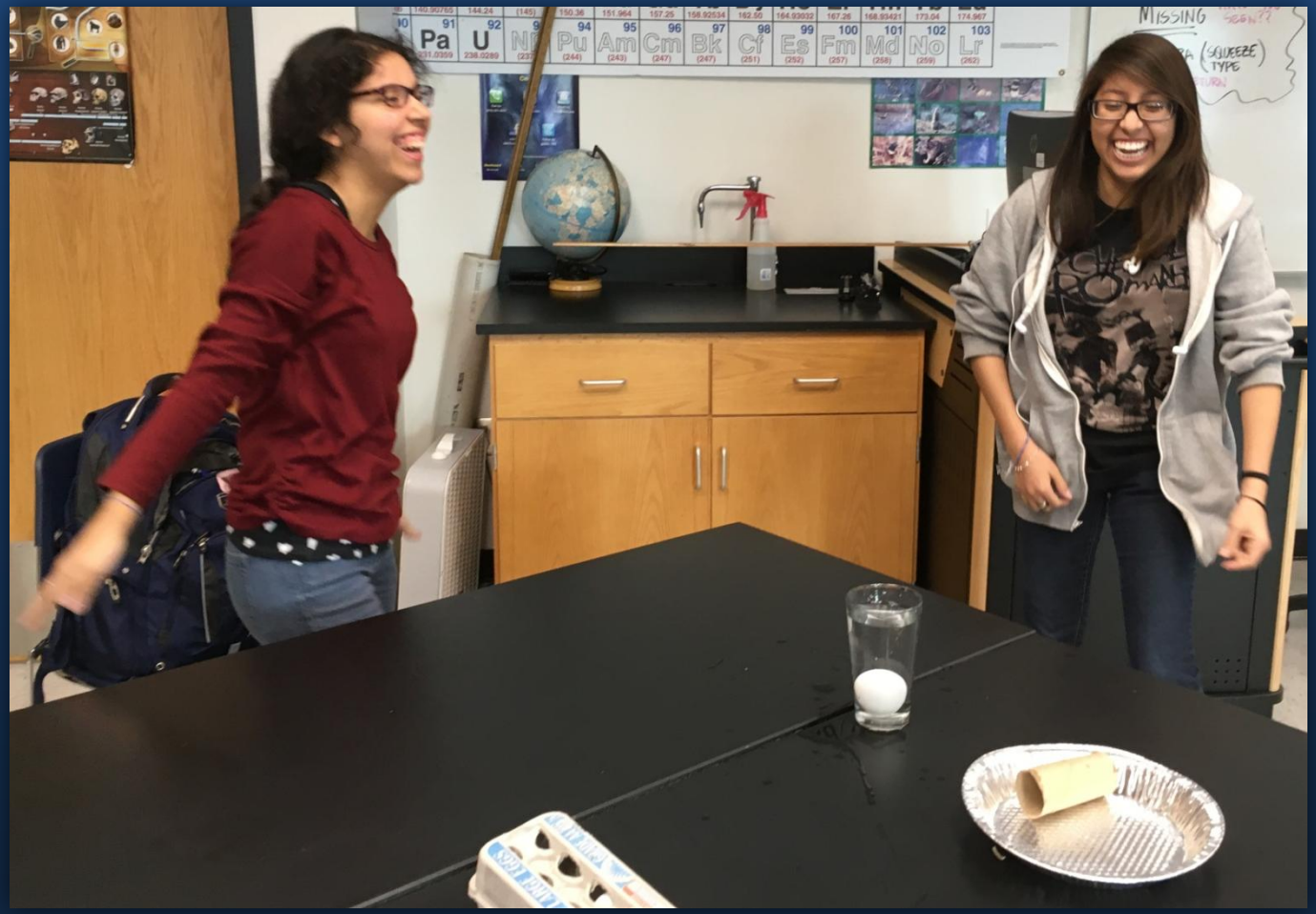



EXIT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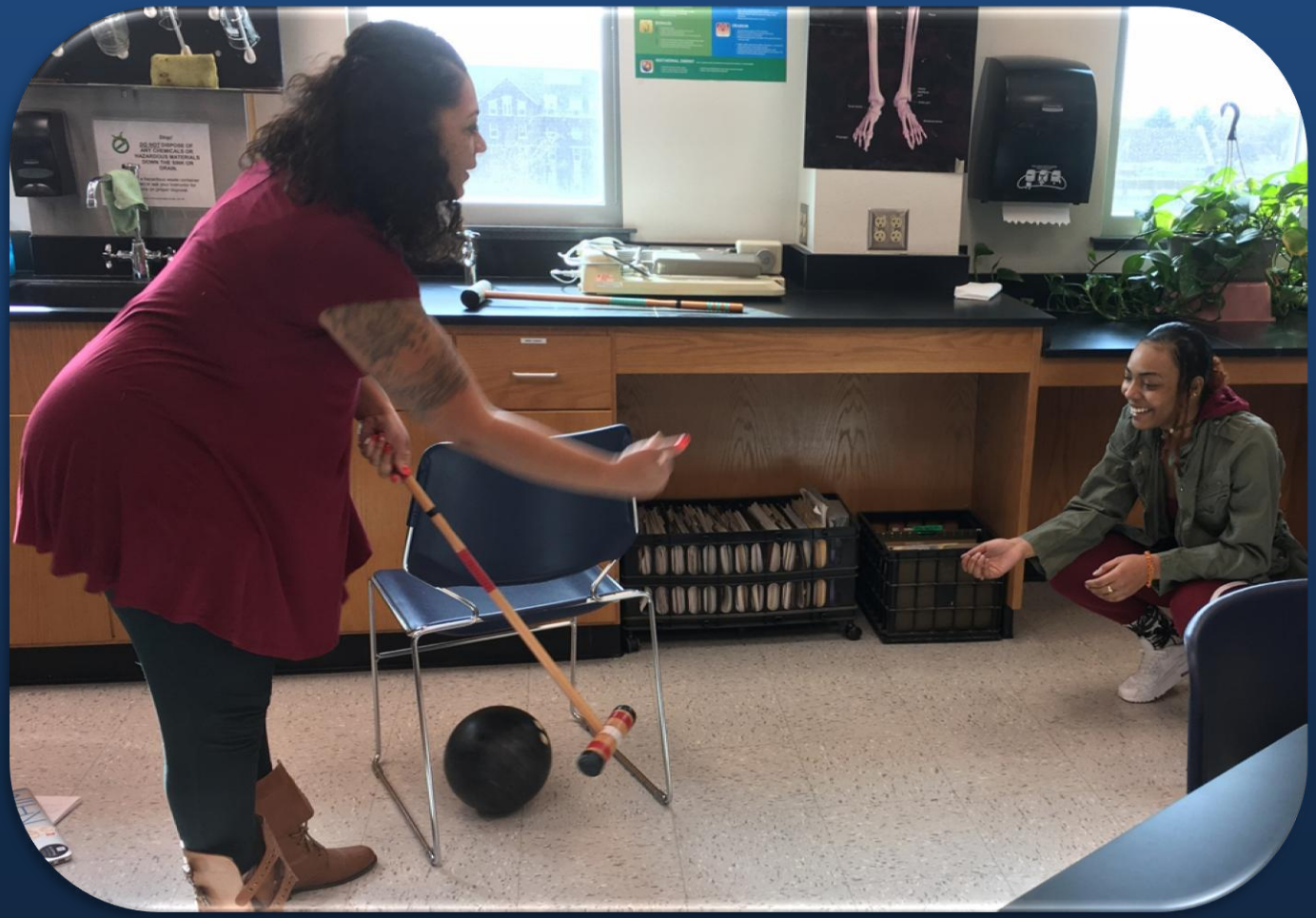
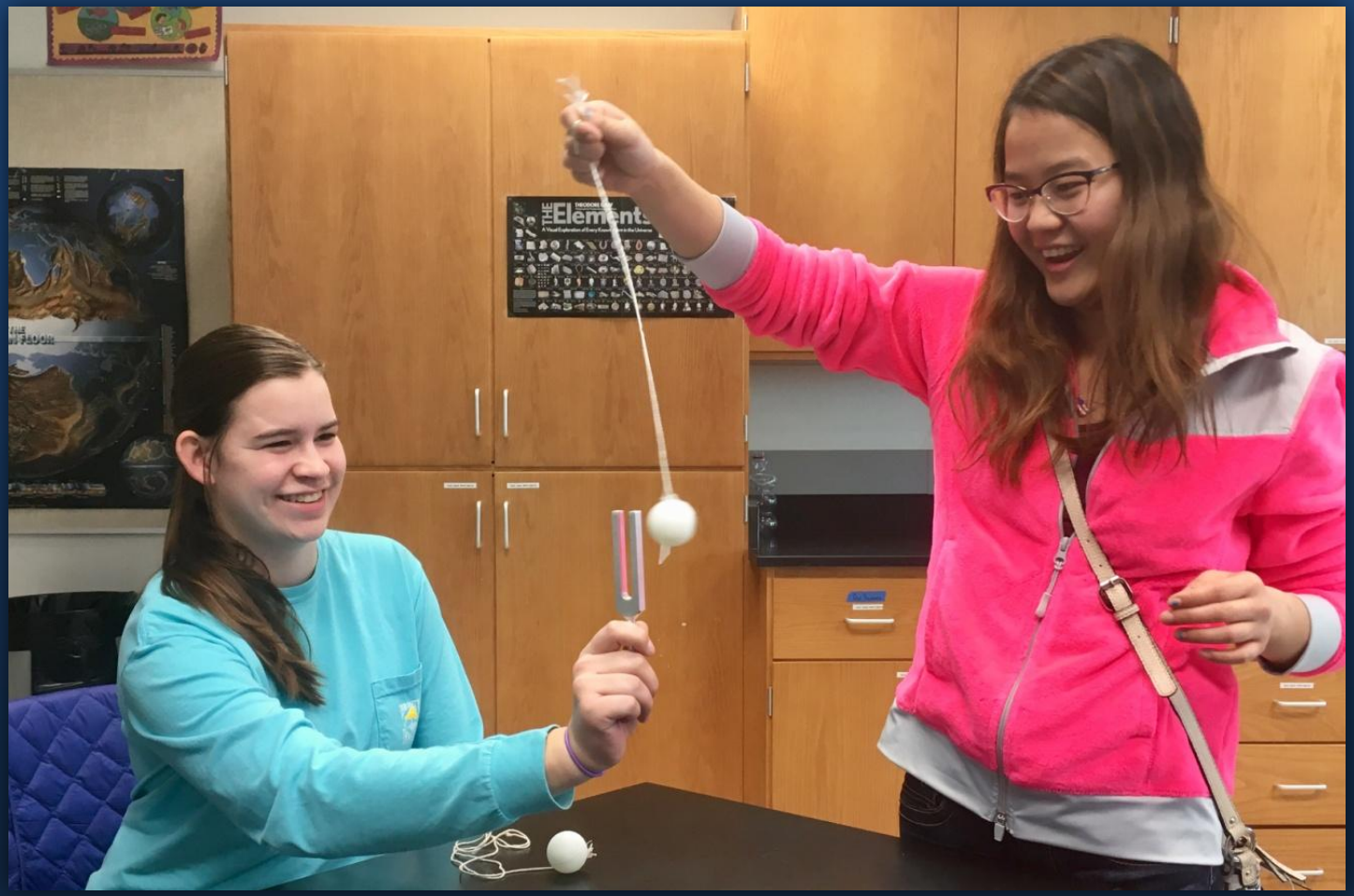

Stop!
DO NOT DISPOSE OF ANY CHEMICALS OR HAZARDOUS MATERIALS DOWN THE SINK OR DRAIN.


Elements

Conclusion

- **Treat labs similar to class time**
  - Shift for students
  - BIG shift for faculty
- **Intricate part of class**
  - Class time preps for lab
  - Lab is necessary for class to progress
- Split lab into two 1 ½ hour chunks (recitation and lab)
- Lab goals: fun, student choice, real life connections

Today's Labs are posted here