Engaging Students through Interactive Lecture Demonstrations

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Washington College Chemistry Teachers Association Meeting

October 12, 2018

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Predict-Observe-Explain (POE) Demonstrations

Project Information – funded by NSF and HHMI

SUMMARY: The demonstration project's goal is to develop and test in-class demonstrations that increase students' learning of key concepts in introductory chemistry. Consistent with this goal, we are building on previous research in science education by testing the efficacy of the Predict-Observe-Explain (POE) framework[1] with demonstrations that illustrate key concepts in general chemistry. Our intent is to document student learning with the POE approach, and publish a series of POE frameworks, some including video demonstrations, that can be used with existing demonstrations in existing courses across institutions.

1. Crouch, C., Fagen, A.P., Callan, J.P., and Mazur, E. (2004), Classroom demonstrations: Learning tools or entertainment? *Am. J. Phys.*, 72, 835-838.

RESOURCES FOR DEMONSTRATIONS: resources we have found useful on specific demonstrations
UW-Seattle: http://depts.washington.edu/chem/facilserv/lecturedemo/index.html (will be revised for project)

University of Oregon: https://chemdemos.uoregon.edu/

University of Massachusetts: https://lecturedemos.chem.umass.edu/

LET US KNOW IF YOU'D LIKE MORE INFORMATION ON THE PROJECT OR POE DEMONSTRATIONS.

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WELCOME

As you enter,
please add to the list of
DIFFICULT CONCEPTS
on the tables.

Reflection Activity: Difficult Concepts

Column A

Thinking about the courses you teach, what concepts have been particularly difficult for students to understand and master?

Write one concept per post-it note (small) and place it in the left column.

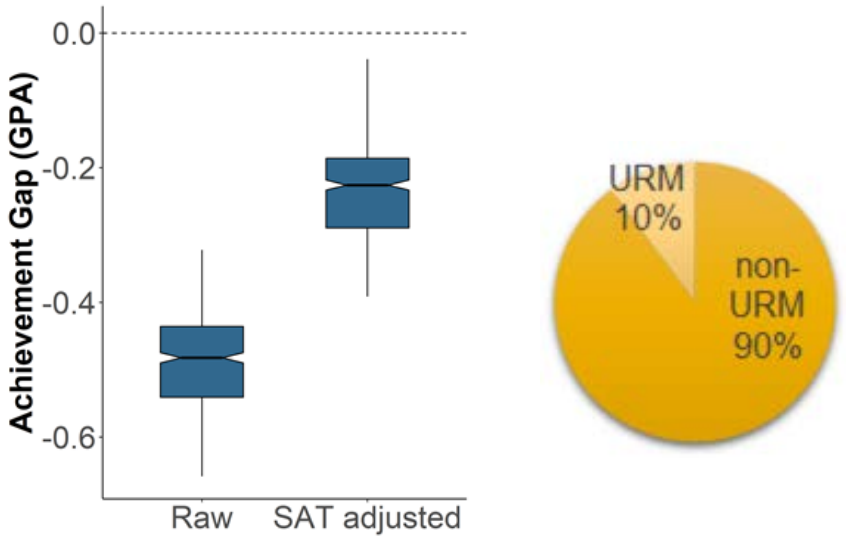
Column B

Is there a reason students struggle with this particular concept?

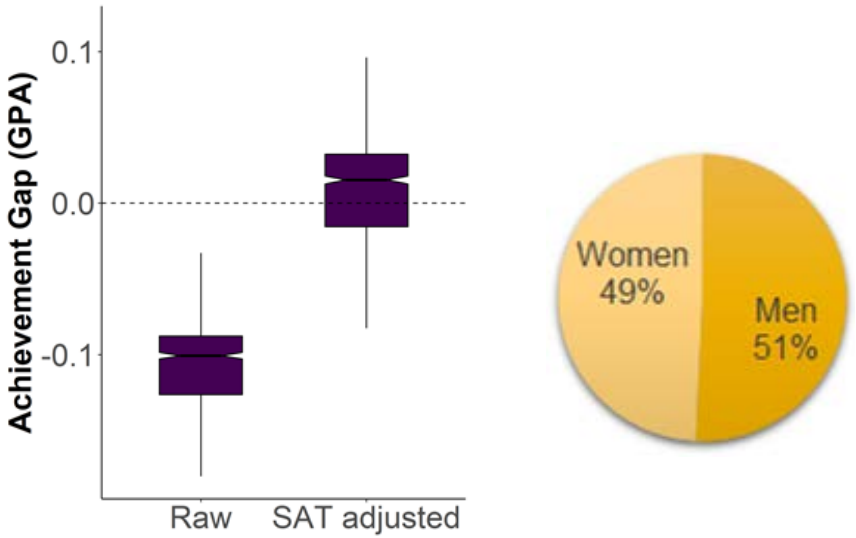
Write one reason per post-it note (small) and place it in the right column.

UW General Chemistry

- Three-quarter sequence in general chemistry (142/152/162)
- Classes are large: 300-600 students
- Class structure: lecture, discussion, labs
- Student population:



URM to White/Asian/Int'l



Women to men


Improve Logical Reasoning Skills
Enhance Argumentation Skills
Improve Test Performance
Reduce Achievement Gaps
Improve Mathematical Reasoning
Increase Student Engagement
Foster Metacognitive Skills

ChEdR

At the end of this session we hope that you will….

- Recognize the value of drawing on the macroscopic domain to improve student understanding of chemical concepts.
- Learn new strategies for incorporating demonstrations designed to foster student reasoning and argumentation skills.
- Incorporate (more) interactive lecture demonstrations in your course to increase student learning and engagement.

Group Activity
Difficult Concepts

In your groups -

1. Share your list of difficult concepts.
2. Is there a common theme across these concepts and reasons for why students struggle?

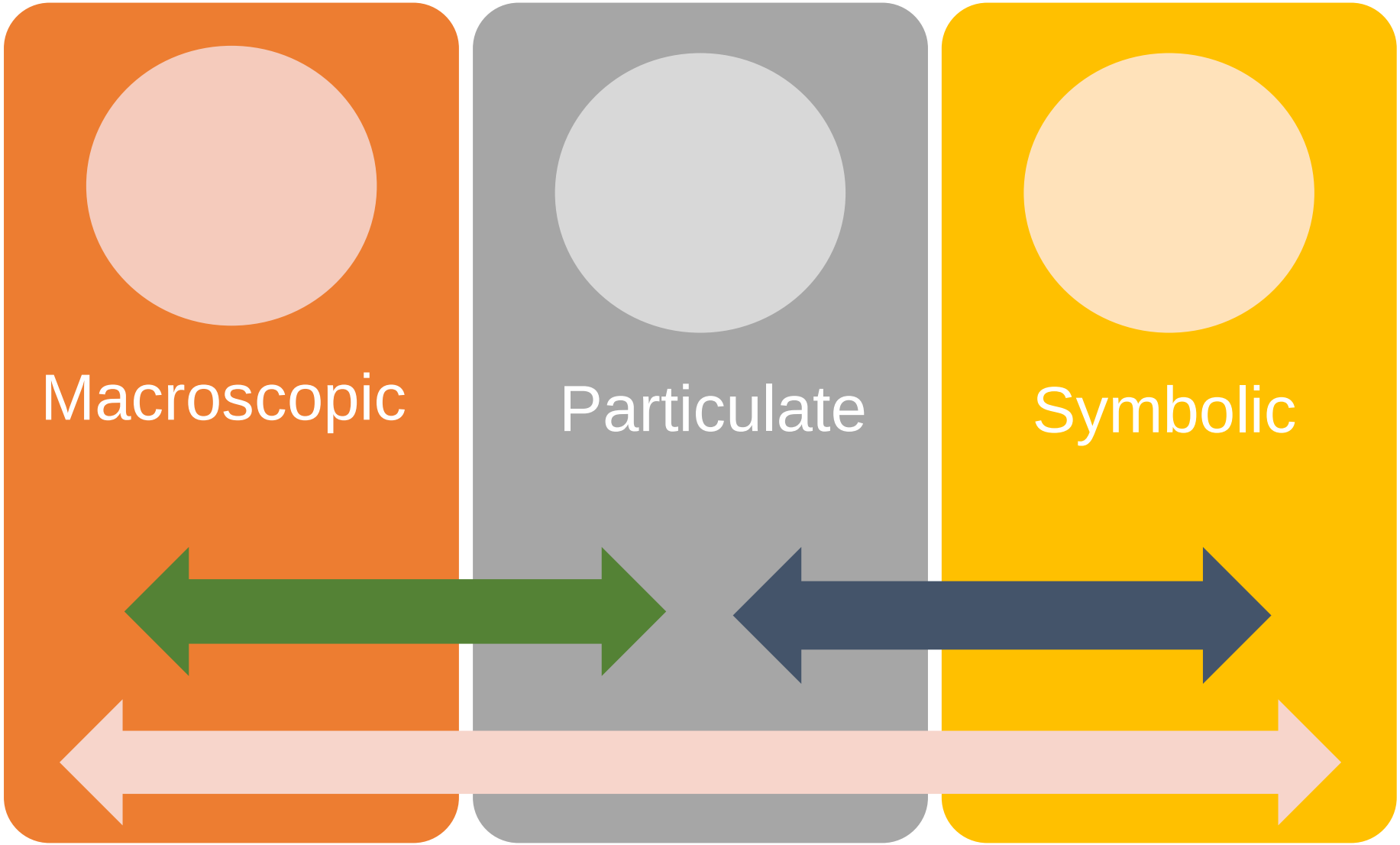
Time: 3 mins

Group Debrief

Briefly share your group's

i. Common themes across these concepts
ii. Possible reasons for why students struggle

What makes chemistry challenging



The Three Domains - Johnstone, H. A., *J Comput Assist Learning., 7*(2), 75.

Why demos for active learning?

- ✓ provide an inquiry learning experience for students
  - build, deepen, and apply their knowledge of core ideas (NGSS)
- ✓ assist students with an understanding of the fundamental habits of scientific thinking
  - curiosity, informed skepticism, openness to new ideas (Project 2061)
- ✓ easier faculty adoption of active learning techniques
  - start with something we already use and improve upon it

But, do students actually learn from demonstrations?

Traditional Show and Tell

✓ format may produce no actual learning gains
(Halloun & Hestenes, 1985; Kraus, 1997; Roth, 1997)

✓ may reduce student learning through erroneous interpretations of what they have observed
(Milner-Bolotin et al., 2007)

POE Approach

- Instructor describes demo
- Students **predict** demo outcome

- Instructor performs demo
- Students **observe** & describe observations

- Students **explain** what they observed
- Students & instructor relate demo to concepts

Deeper Dive

Balloon Race Demo

$NaHCO_3(s) + HC_2H_3O_2(aq) \rightarrow NaC_2H_3O_2(aq) + H_2O(l) + CO_2(g)$

Learning Outcome: Students will relate the **extent of a reaction** to the **amount of limiting reagent** present using **evidence** from observing the reaction.

Walker, J.P., Sampson, V, Zimmerman, C.O., Grooms, J.A., *J. Che. Ed. 2011, 88, 1243-1246*

Step 1: Predict

Which balloon do you think will be the smallest?

Which balloon do you think will be the largest?

Step 2: Observe

Examine the flask with the green balloon.

Which of the following is the limiting reactant?

a) **Vinegar**
b) **Baking soda**
c) **neither**

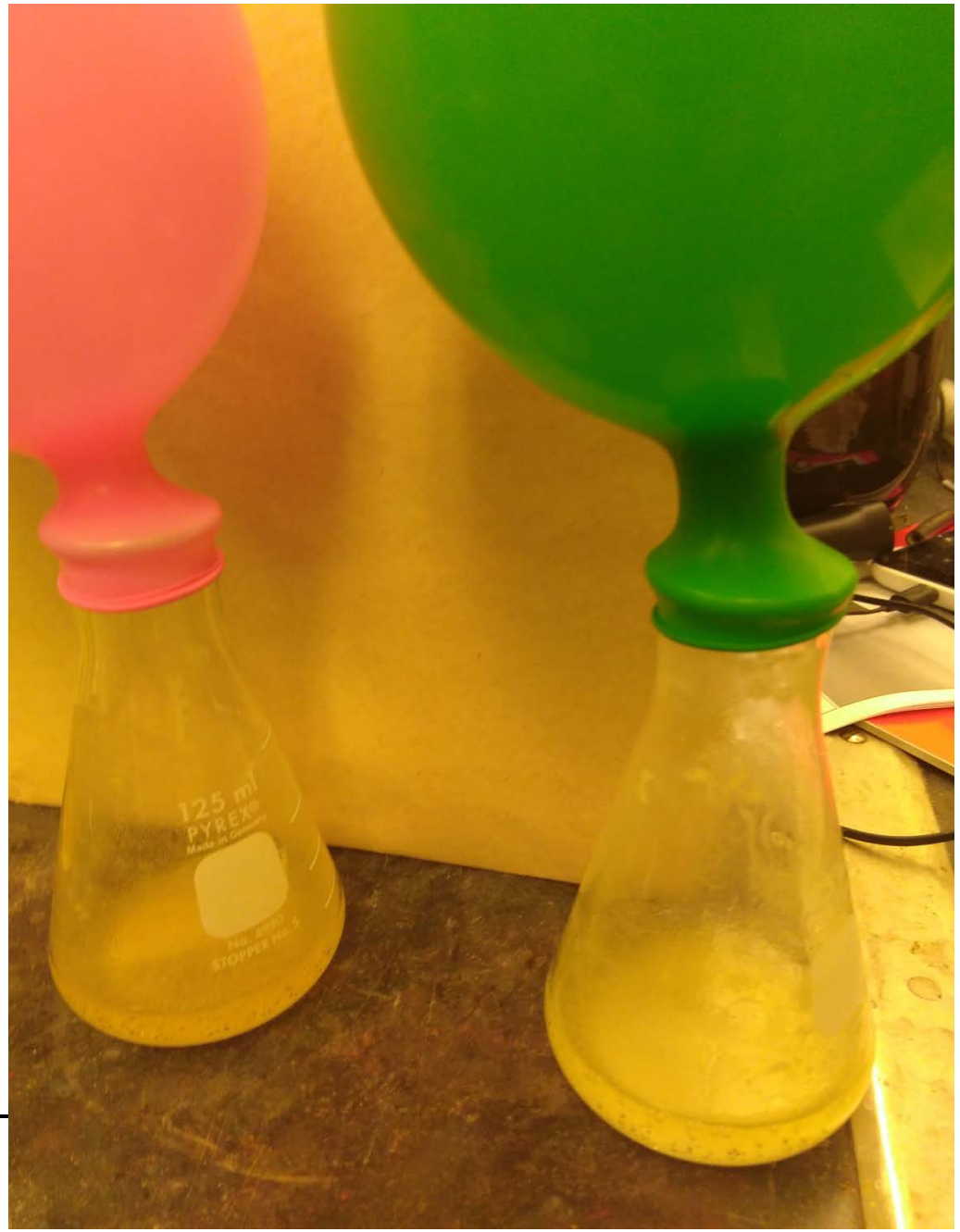
Step 3: Explain

How do you know?

Defend your explanation with appropriate evidence and reasoning.

The evidence is _____

The reasoning is _____



Balloon Race Results

Before

After

Debrief

- After doing this activity, what are some of the things you had never thought about before?

Chemistry Demonstrations

An Active-Learning Tool for Enhancing Students' Conceptual Understanding

Summer Undergraduate Researchers

- Can **student-oriented chemistry demonstrations** help reduce achievement gaps?
- Is there a generalized POE model that will encourage faculty adoption?

Feedback

What are some of challenges you foresee in implementing POE demos?

- ***How might we improve our design to address those challenges?***
- ***What resources would help you address those challenges?***

Acknowledgements

Chemistry Education Research (ChEdR) Group

- Colleen Craig
- Jasmine Bryant
- Tam’ra-Kay Francis
- Larry Goldman
- Sarah Keller
- Michael Mack
- Cynthia Stanich
- Debbie Wiegand

Undergraduate Researchers

- Samuel Byrne
- Shamey Kassim
- Lian Sun
- Stephanie Tantyo

Thanks to NSF and HHMI for Funding

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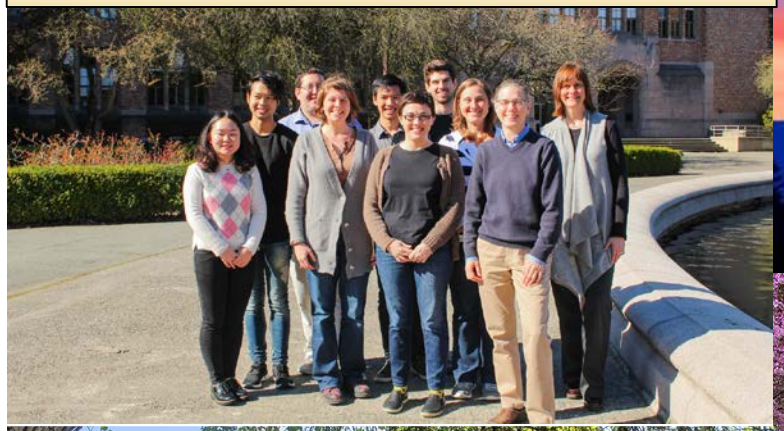

Questions?