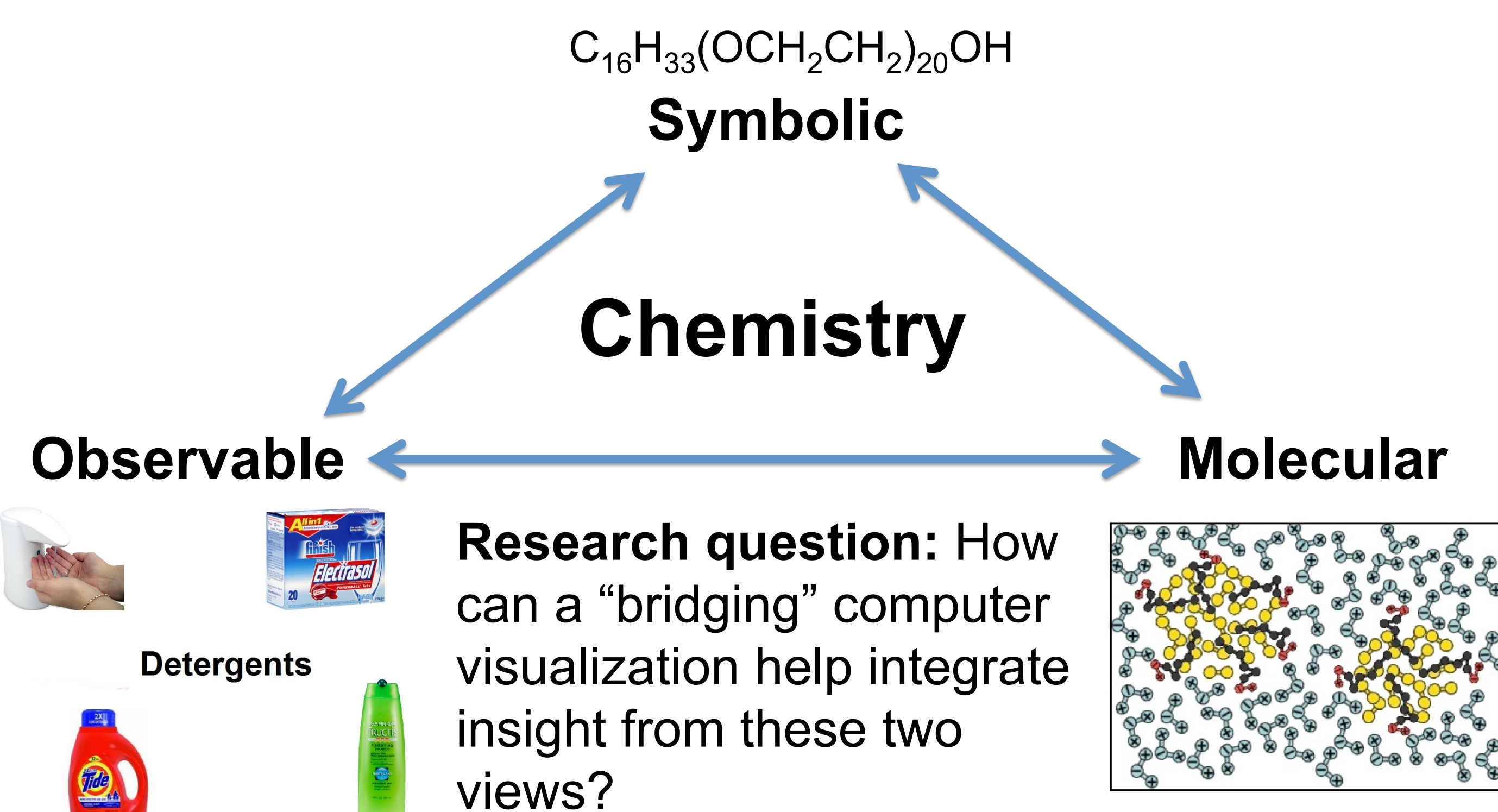


Connecting observable and molecular views

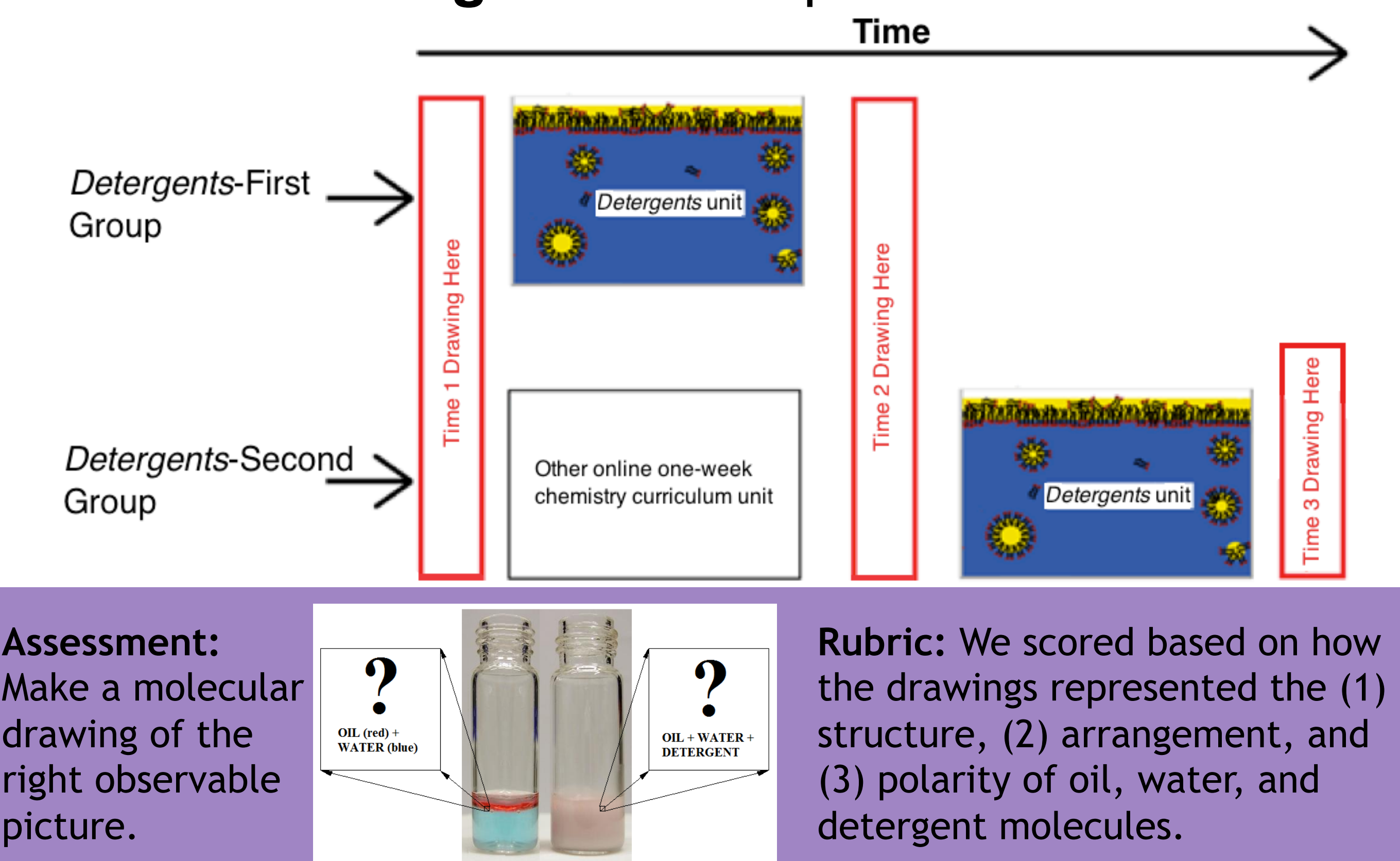


- Rationale**
- Computer visualizations can help students understand dynamic molecular phenomena (Kelly & Jones, 2008)
 - However, students struggle to connect molecular and observable views (Johnstone, 1993; Kozma & Russell, 1997)
 - Similar to bridging analogies (Clement, 1993), we proposed that a “bridging” visualization can support such connections

Inquiry unit on *Detergents*

Activity	Screenshot
1: Can detergents help save wildlife in oil spills?	
2: Why do oil and water separate?	
3: What is polarity?	
4: How do other liquids mix?	
5: How do detergents work?	
6: Organize and report	

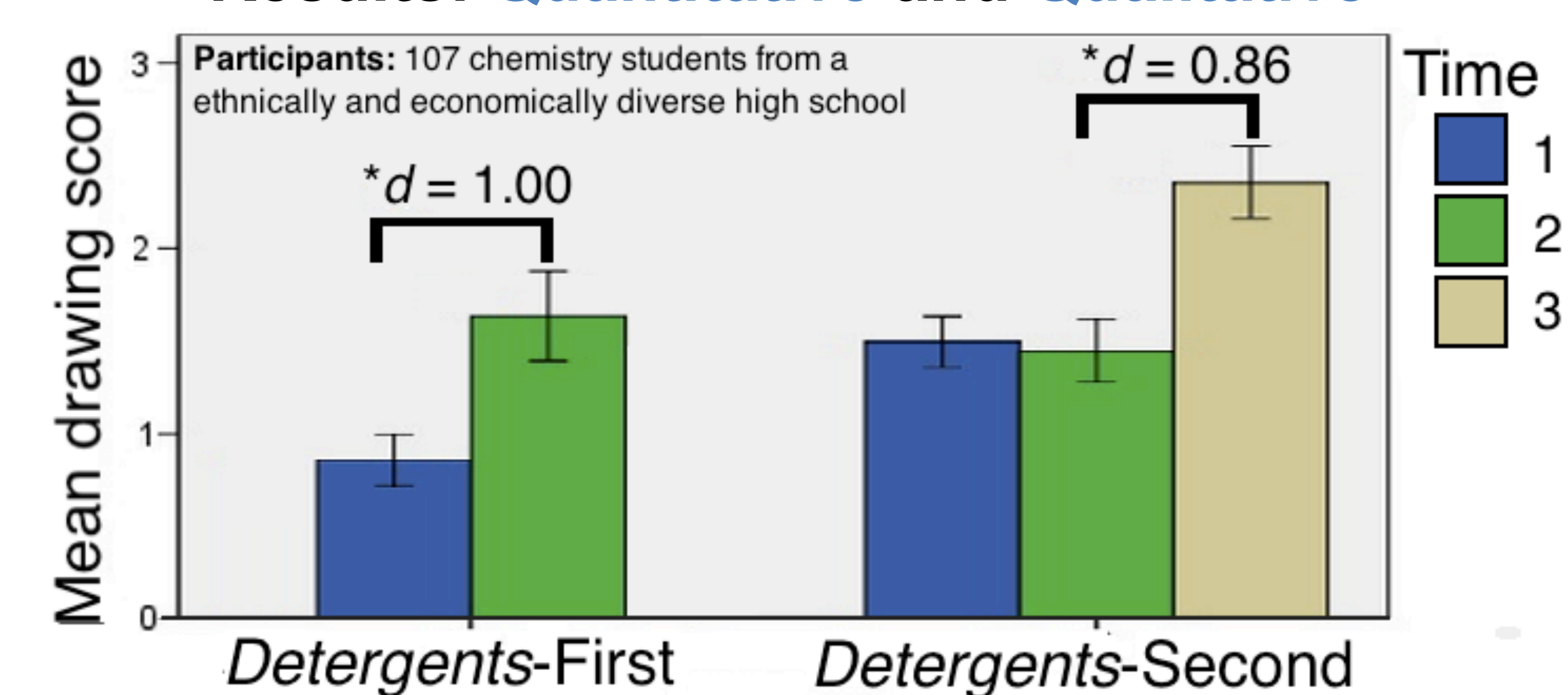
Research Design: Quasi-experimental cross-over



Design Implications

- Advantages**
- **Finding:** *Detergents* yielded large, robust learning gains among a diverse, economically underserved student population.
 - **Communicative:** The bridging visualization highlights information (micelle arrangement) difficult to convey in the molecular visualization
 - **Connective:** Similar to bridging analogies (Clement, 1993), a bridging visualization could help connect two views (e.g., molecular/observable) for a range of emergent phenomena

Results: Quantitative and Qualitative



Student #1: Relies more on bridging visualization

Before Detergents: After Detergents:

- Arrangement - Detergents are placed between oil and water.
- Arrangement - Detergents form oil-in-water micelles: In addition to placing detergents between oil and water, the student also arranges the molecules into oil-in-water micelles.

Student #2: Relies more on molecular visualization

Before Detergents: After Detergents:

- Arrangement - Detergents are placed between oil and water.
- Structure - Detergents have two qualitatively different ends.
- Polarity - Detergents are both polar and nonpolar (as shown by the “+” and “-” symbols).

- After instruction, only 13% of students drew micelles
- 33% placed detergents between oil and water
- 54% represented detergents as single circles
- 21% drew detergents having two different ends

Challenges

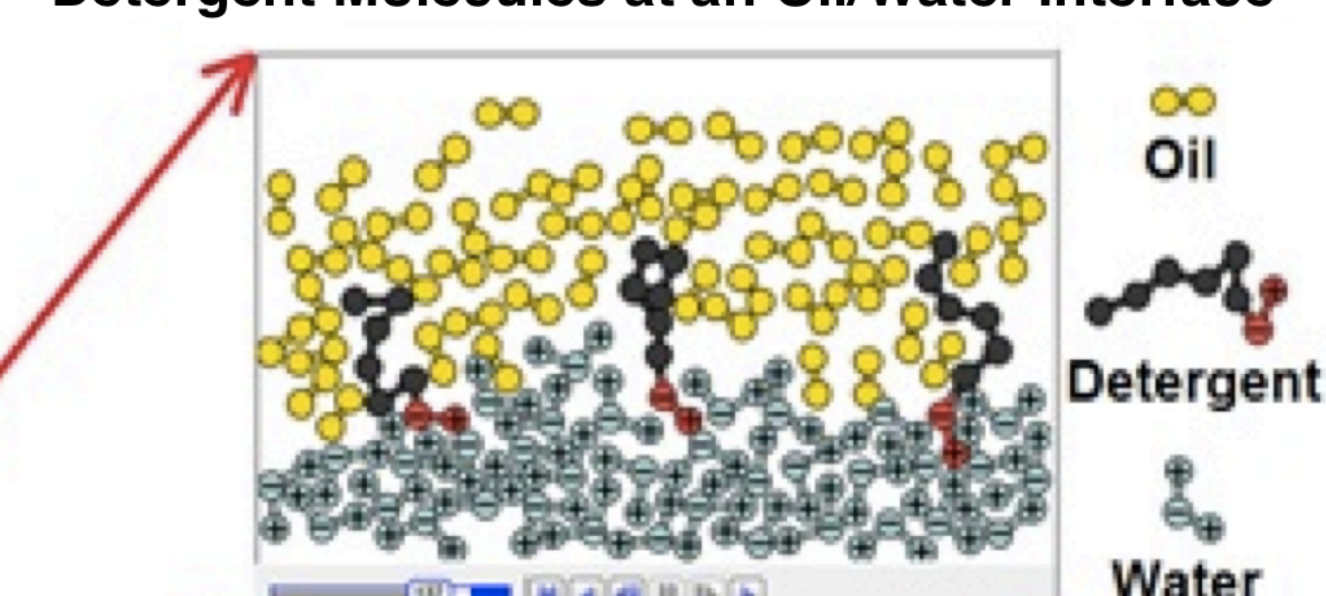
- **Finding:** Drawings suggested students relied on the bridging and molecular visualizations to varying degrees, struggling to integrate insight from both.
- **Complexity:** This bridging approach added a second visualization to interpret
- **Scaffolds:** We’re refining scaffolds (e.g., drawing steps) to strengthen the connections between the two visualizations

Dynamic Visualizations: Bridging and Molecular

- **Observable:** Based on a demonstration, students predict detergents’ structure. Then they engage with the computer visualizations and reflect as part of a predict-observe-explain inquiry sequence (Linn & Eylon, 2011)

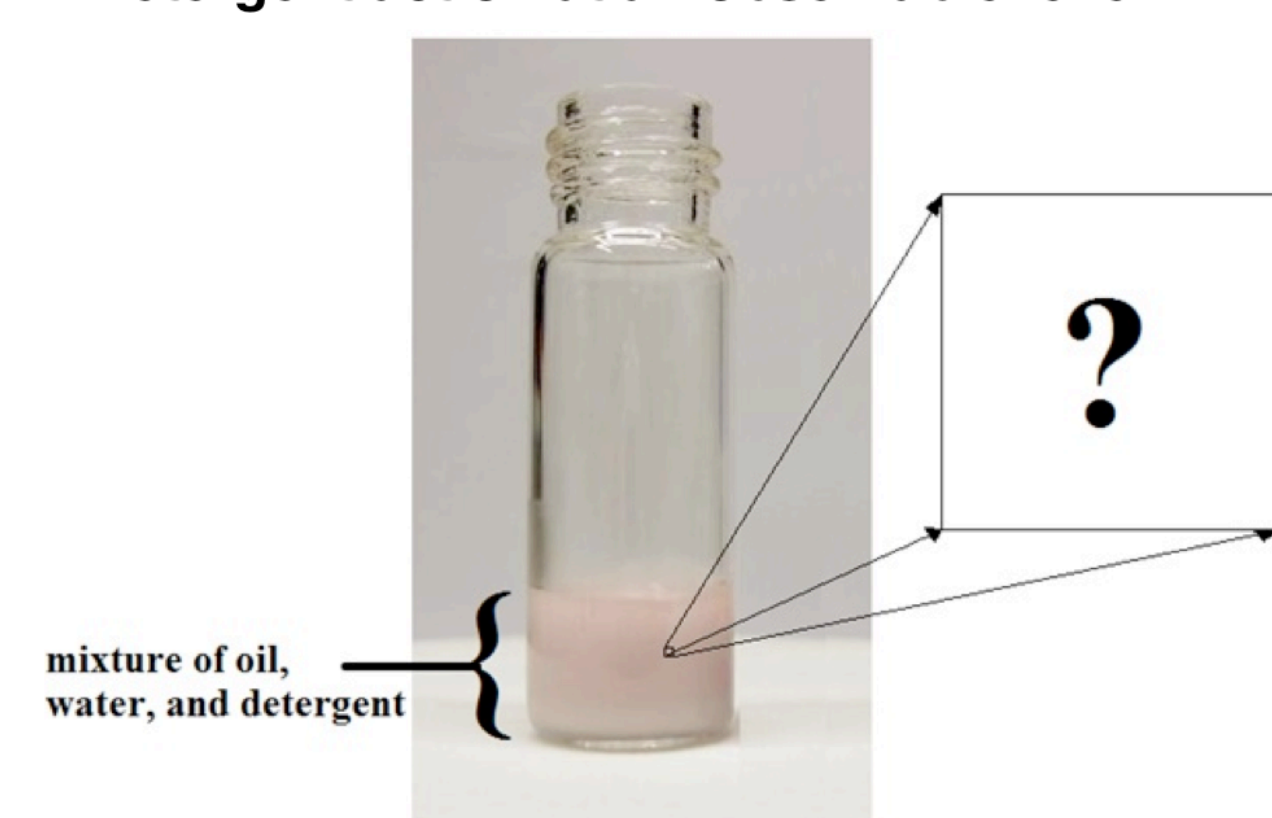
- **Bridging:** This visualization bridges the observable by focusing attention on how detergents arrange themselves in micelles, while showing oil and water schematically

Detergent Molecules at an Oil/Water Interface

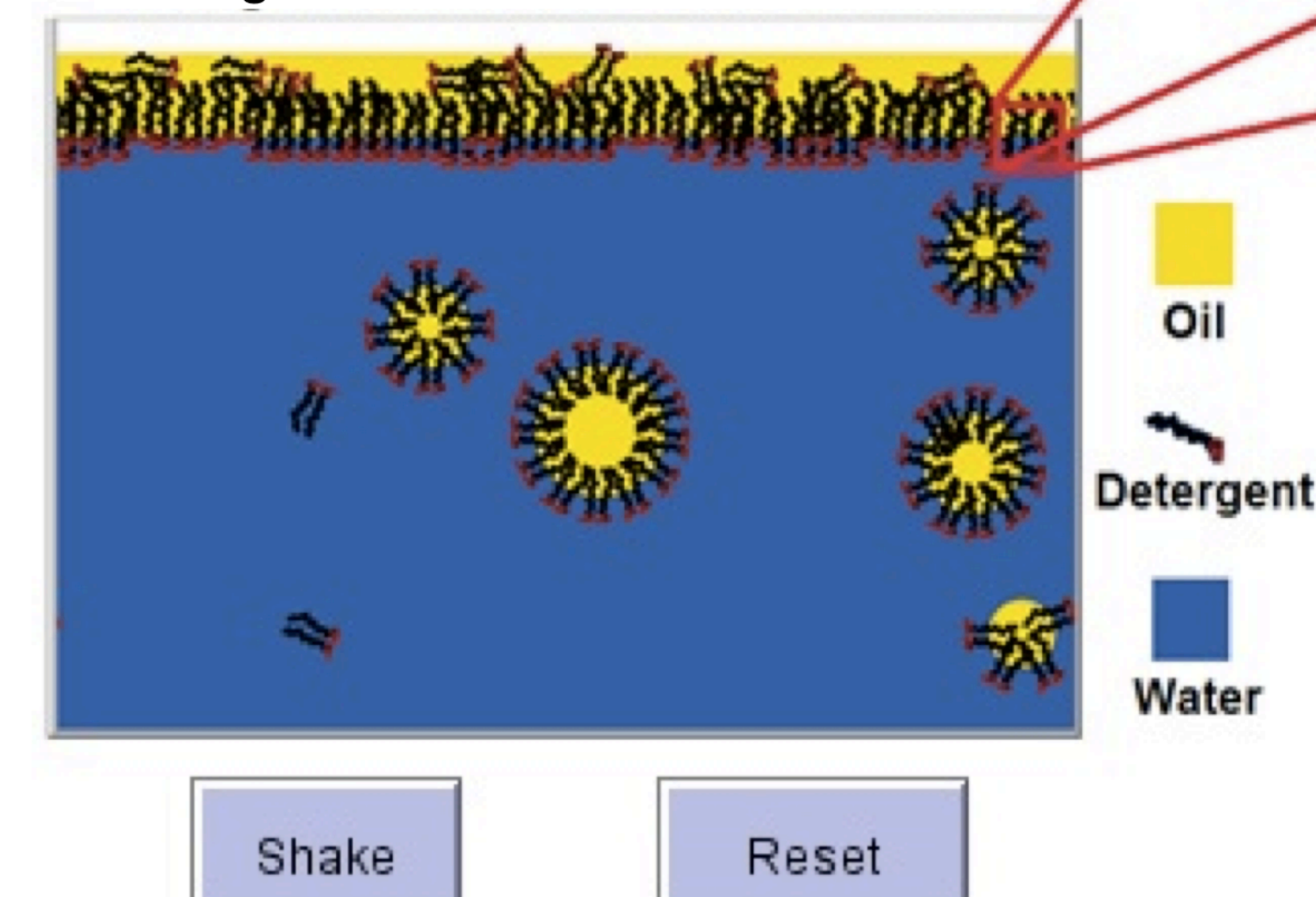


- **Molecular:** This visualization helps distinguish detergents’ polar and nonpolar ends. The nonpolar tail attracts oil and polar head attracts water.

Detergent action at an observable level



Detergents Create Oil-in-Water Micelles



← **OBSERVABLE**

MOLECULAR →

Acknowledgements

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