rative, and Problem-Based Learning- Why, What, and How

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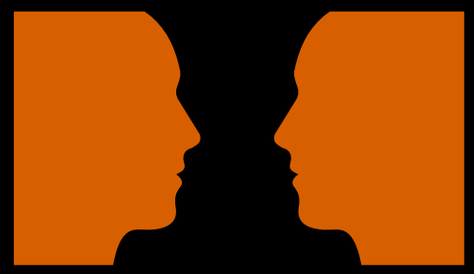
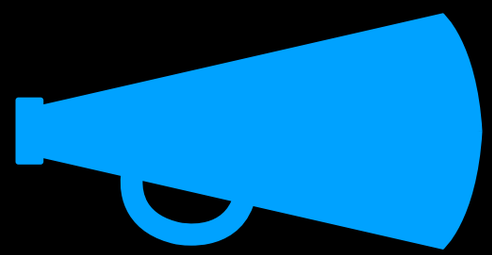
1.

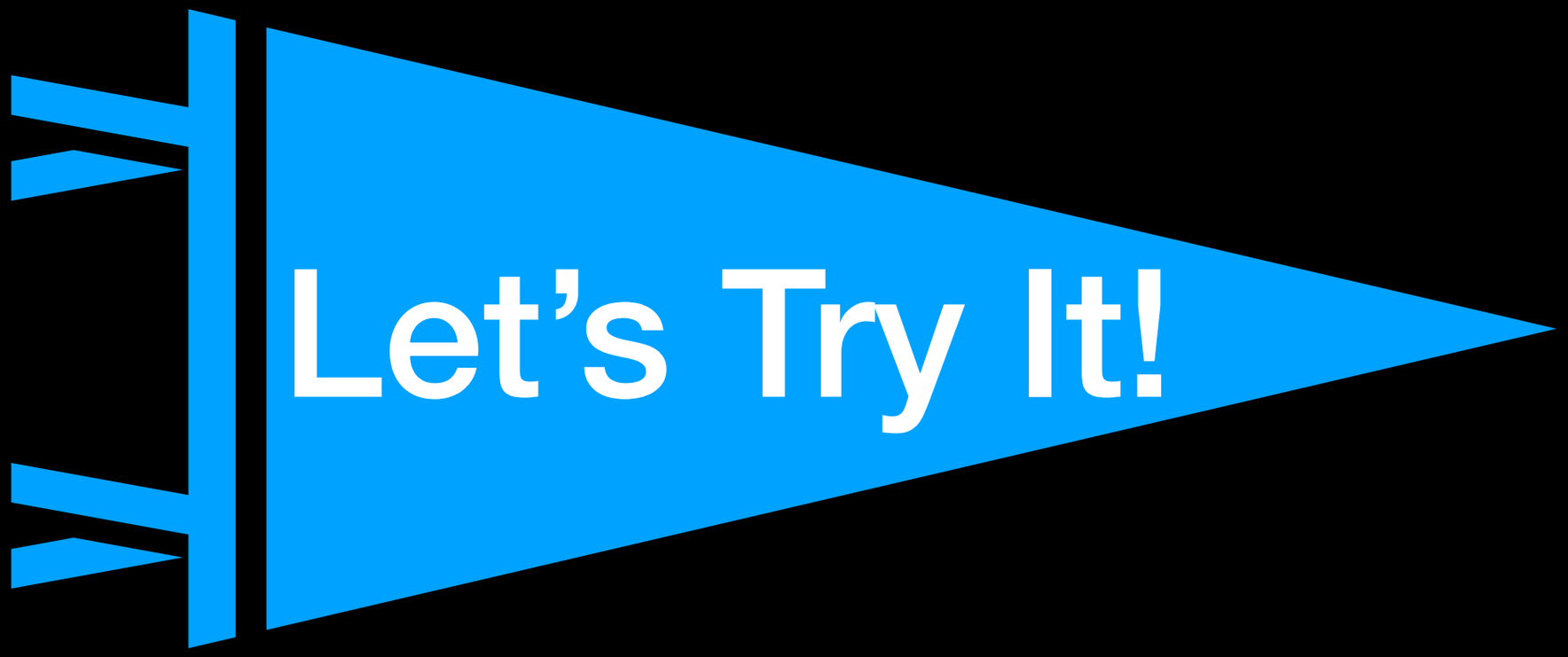




Think-Pair-Share

Discuss with a neighbor.

Let’s share!



1 minute to think and write:
What are some things your students have said or done that make you want to scream?

2 minutes to share with one neighbor
(share the time)

Then, I will call on a few people to share!

Active learning:
Any approach where students are not *passive recipients* of instruction, but instead purposefully engage in learning-related activities

We have lots of choices!

Continuum of Active Learning

Lecture+ **Active Classroom** **Learner-Led Classroom**

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LECTURE ONLY

- Think-Pair-Share
- Minute Paper
- Reflections / Summaries

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Minute Paper

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Active Classroom

Active Examples

Physical Analogies

Peer Instruction
& Inquiry-Based Activities

Collaborative Learning

Learner-Led Classroom

Continuum of Active Learning

Instructor Centered → Learner Centered

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- Physical Analogies
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Learner-Led Classroom

- Problem Based Learning
- Project Based Learning
- Product Based Learning

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- Product Based Learning
- Game Based Learning
- PBL in the Makerspace
- Student authoring

Impact on Learning Technical Content

What works?

Hake, 1998 “Interactive engagement vs. traditional methods: A six-thousand student survey of mechanics test data for introductory physics courses. American Journal of Physics 66(1) p 64.

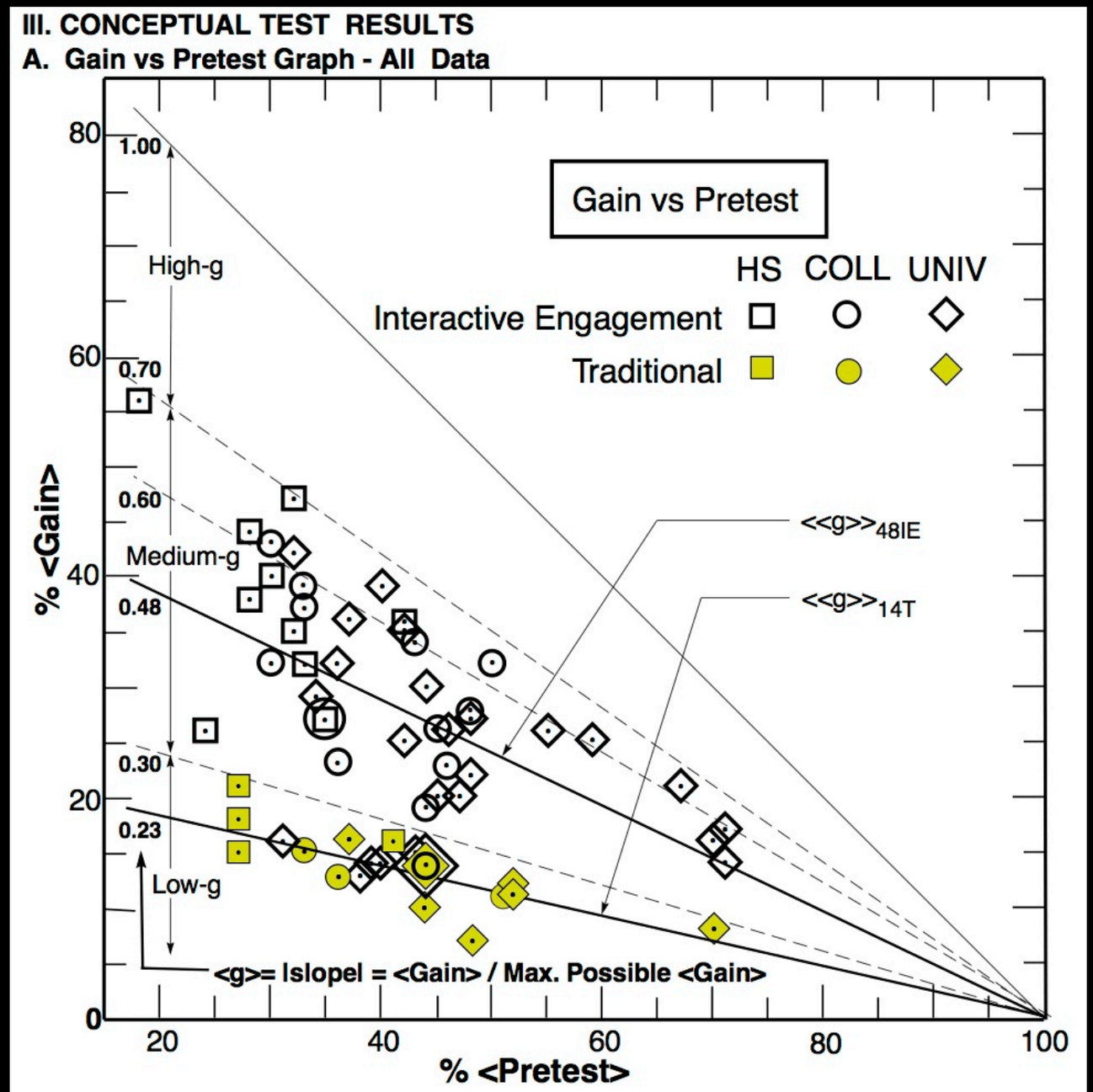

Fig. 1. %<Gain> vs %<Pretest> score on the conceptual Mechanics Diagnostic (MD) or Force Concept Inventory (FCI) tests for 62 courses enrolling a total N = 6542 students: 14 traditional (T) courses (N = 2084) which made little or no use of interactive engagement (IE) methods, and 48 IE courses (N = 4458) which made considerable use of IE methods. Slope lines for the average of the 14 T courses $\langle\langle g \rangle\rangle_{14T}$ and 48 IE courses $\langle\langle g \rangle\rangle_{48IE}$ are shown, as explained in the text.

Additional Professional Impacts

- Enhanced engagement (Ahlfeldt et al, 2005)
- Improved critical thinking;
- Better orientation to life-long learning;
- Improved intercultural-effectiveness (Kilgo et al, 2014)
- Better recall and transfer of knowledge (Halpern & Havel, 2003)

Today's Menu

- Think-Pair-Share
- Minute Paper / Muddiest Point
- Photo Safari
- Concept Questions (also called Clicker Questions) & Peer Instruction
- Inquiry-Based Activities
- Potential bonus: Device-Enhanced-Active-Learning and/or Problem Based Learning (if time and interest permit)

A little Reflection on Think-Pair-Share

- Time the time for “think”
- Share is less scary because it’s speaking for two (or more)
- Share on the board
- Share electronically
- Share verbally

2. Minute Paper / Muddiest Point

- START class with 2-min writing: What did we learn last time?

Or

- END class with 2-min writing: What was the main point today? What was the muddiest point today?

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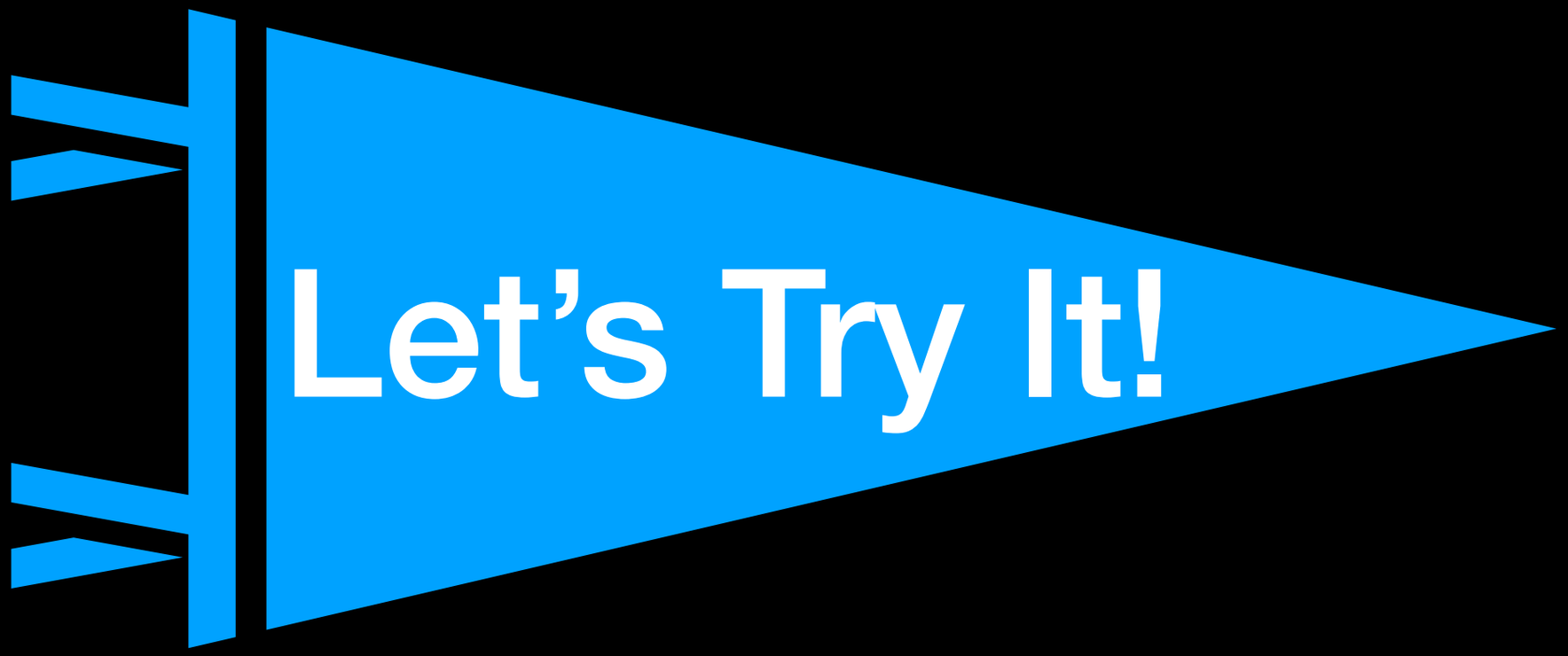


2 minutes:
If you were at this conference two years ago, what did you learn and use in the classroom?

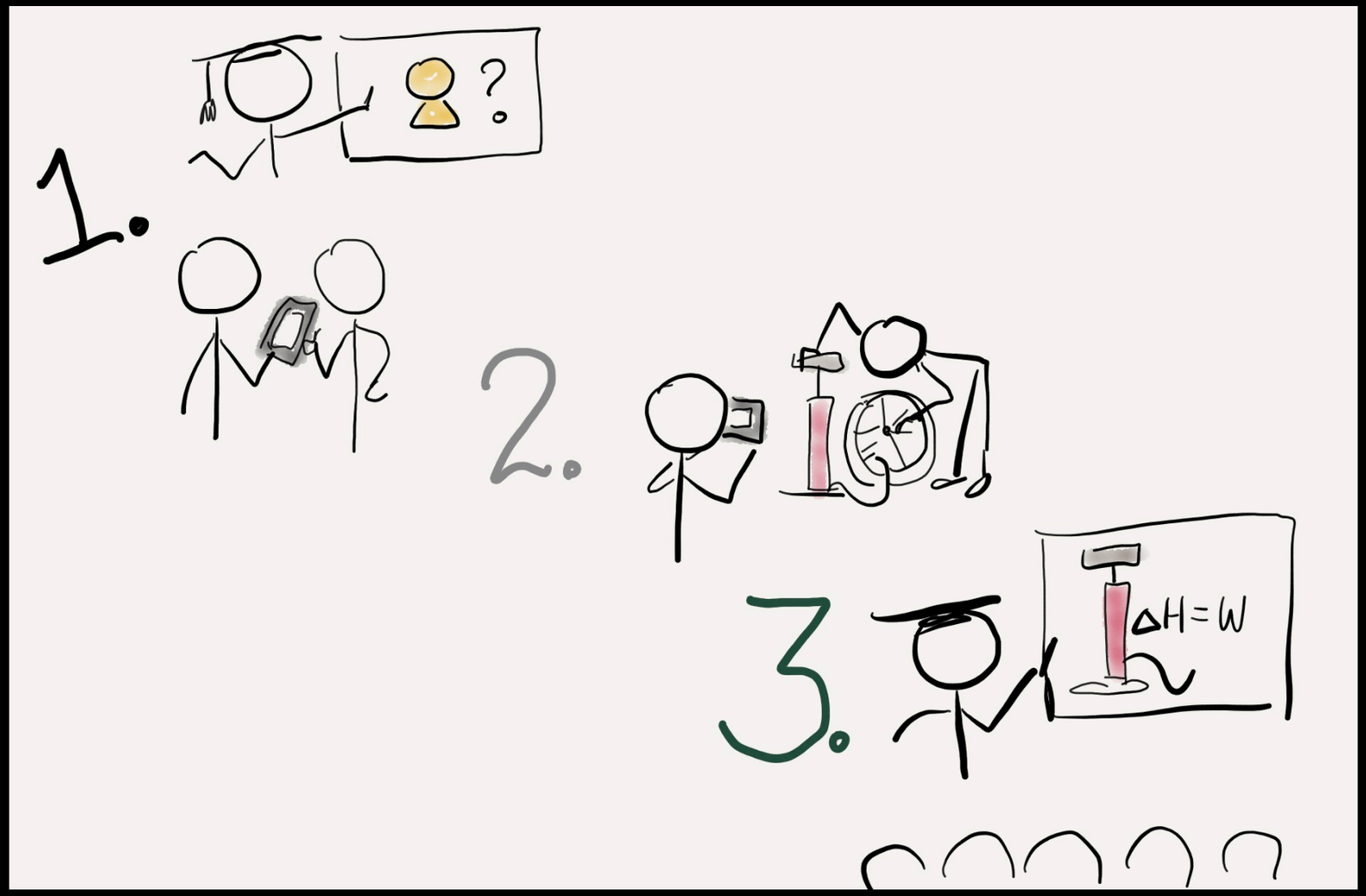
If not, what are you hoping to learn at the conference this time?

A little Reflection on Minute Papers

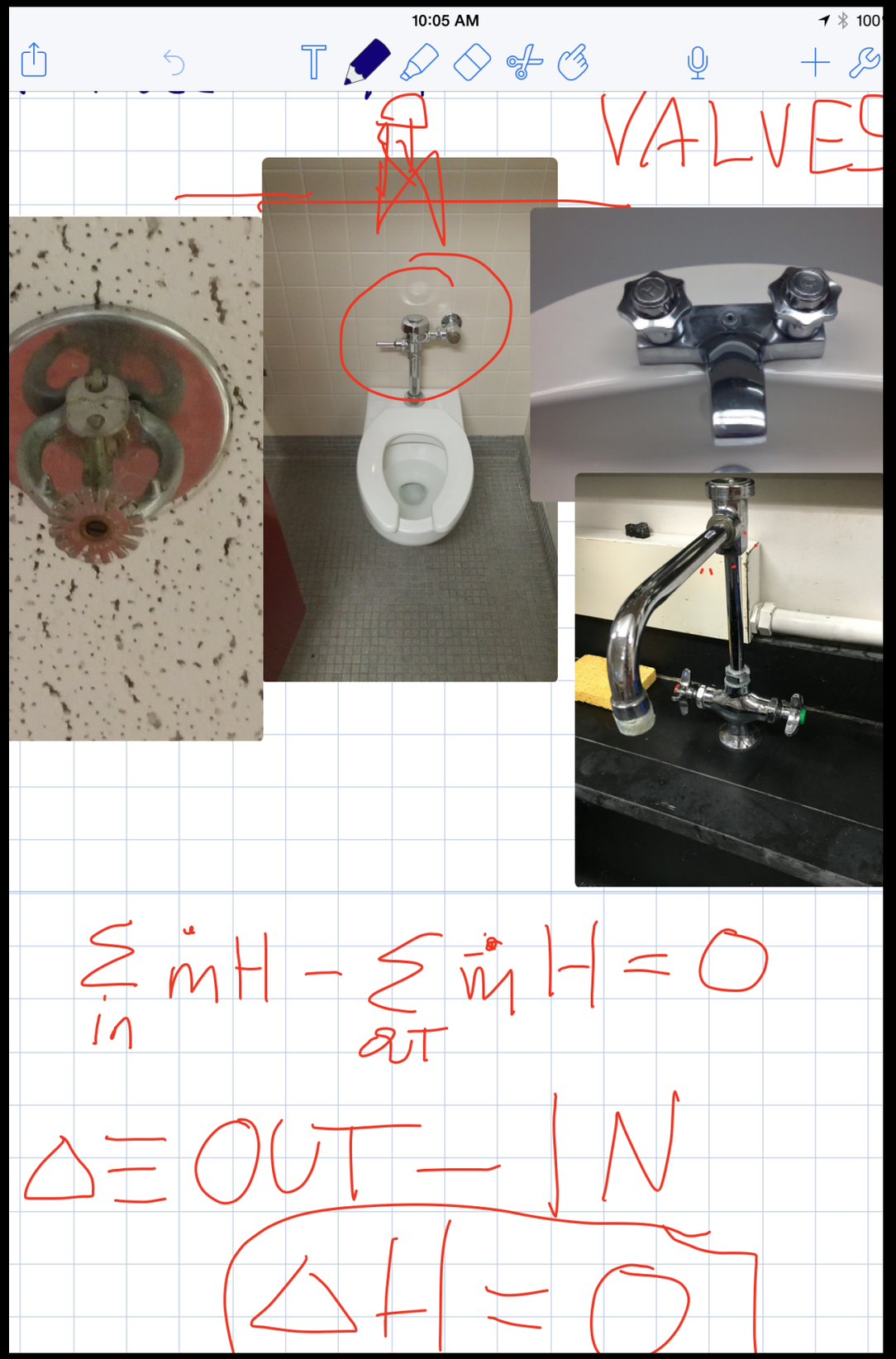
- A good way for you to quickly measure understanding.
- A good way to encourage students to practice retrieval of information.
  - Ask:
    - What were the main points from today's class?
    - What were the main points from last class?
    - What are you most confused about from this class?
- A good attendance measure.
- Electronic results are harder to lose.

3. Photo Safari

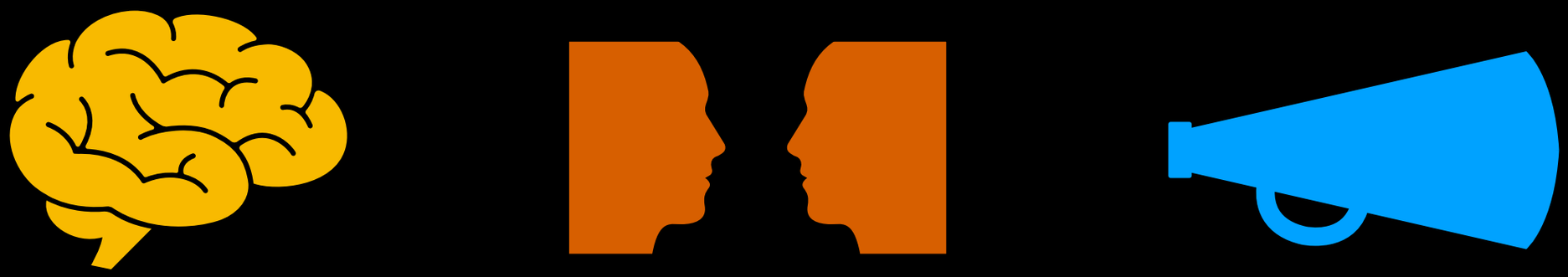
1. Establish teams that can take/send a picture
2. Send them out in search of “X” (time limit is key, here)
3. Use in class!



Use immediately!



Back!



Think-Pair-Share:

How might you use this?

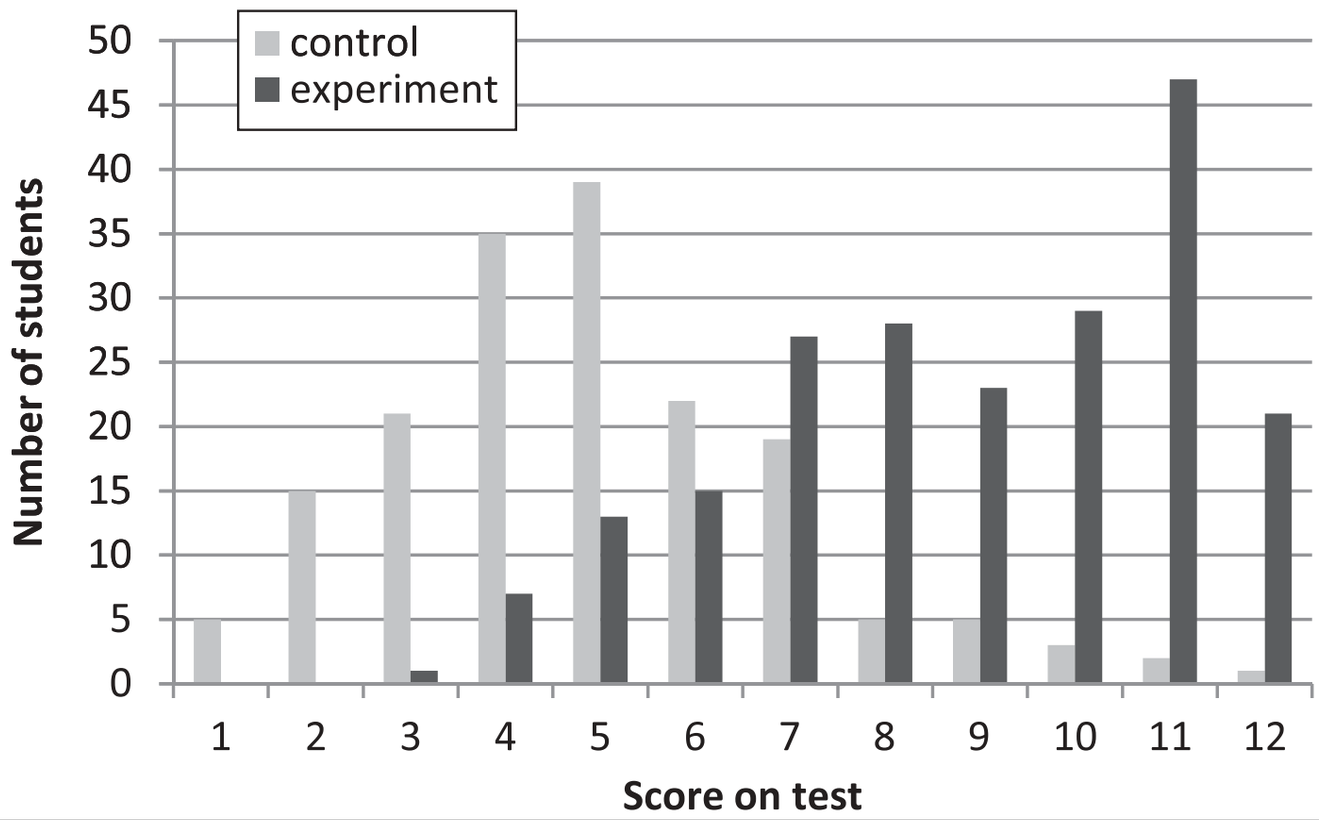
A little Reflection on Photo Safari

- Helps students connect their learning to the “real world”
- Can be an in-class activity OR homework
- Student pride in *their* picture being used

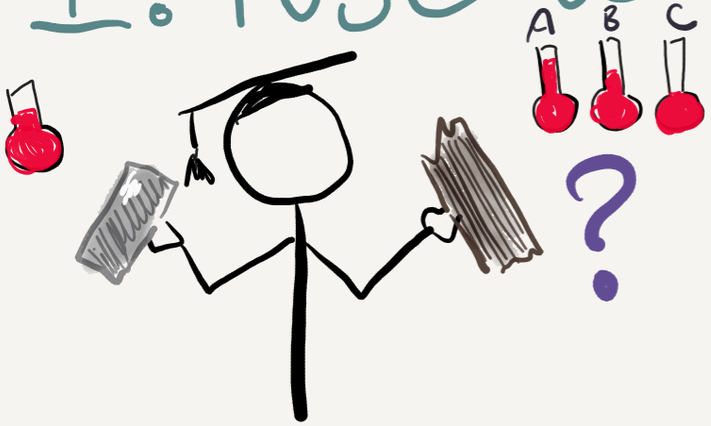
4. Concept Questions (“Clicker” Questions) & Peer Instruction

- Deslauriers, Schelew & Wieman, 2011 Improved learning in a large-enrollment physics class. Science 332 p862.

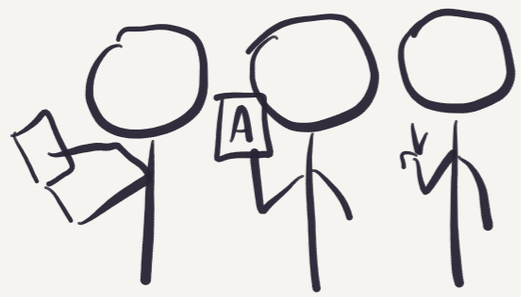
Fig. 1. Histogram of student scores for the two sections.



1. Pose a multiple Choice Concept Question



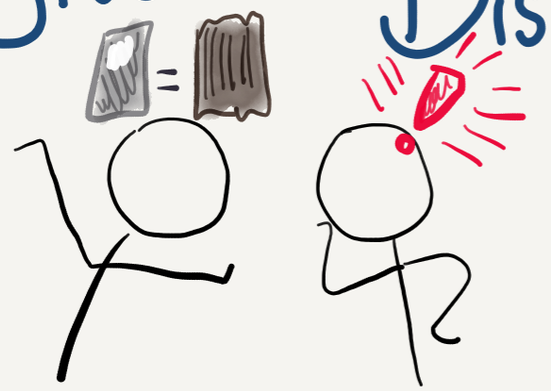
2. Students answer individually, Privately



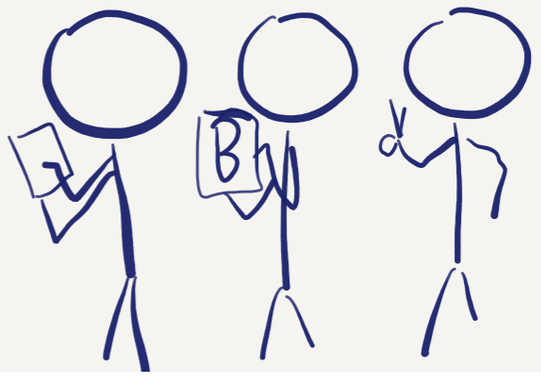
1/3 - 2/3 Correct

Return to 1

3. Students Discuss



4. Students Revote!



Mazur, Eric. Peer Instruction : a User's Manual. Upper Saddle River, N.J. :Prentice Hall, 1997.

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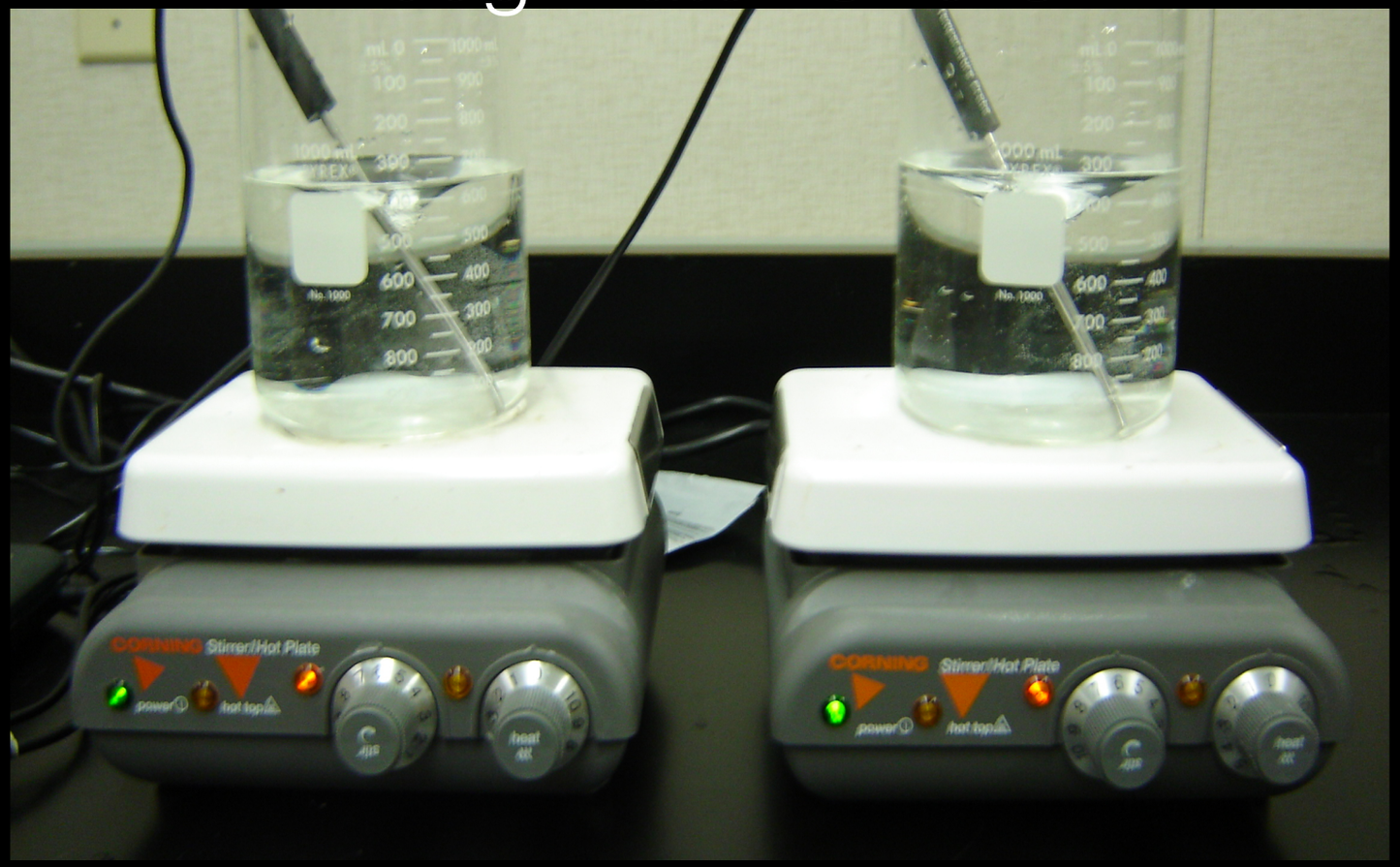
100g Water @25°C

25g chipped ice



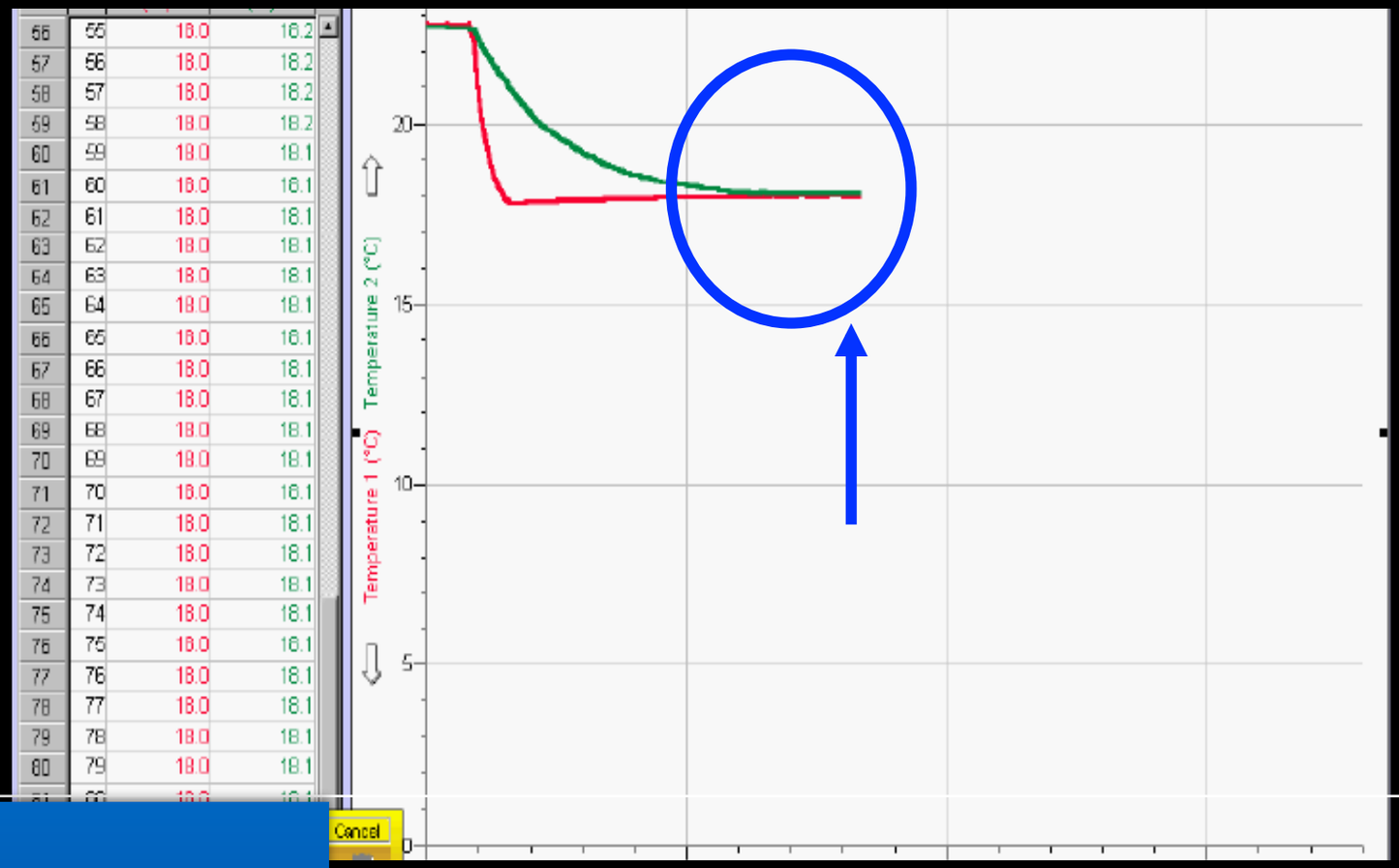
25 g ice cube

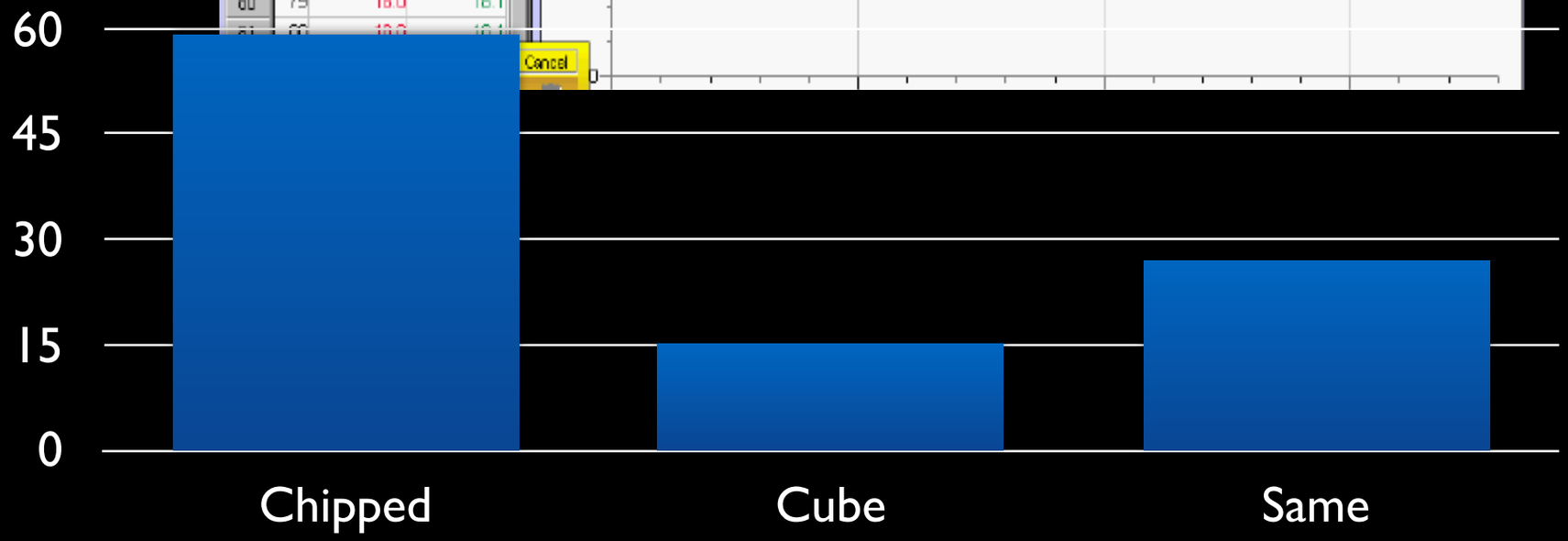
Which cools faster?
Which cools more?

Prince, M., M. Vigeant, and K. Nottis. “Using Inquiry-based Activities to Repair Student Misconceptions Related to Heat, Energy, and Temperature.” Paper presented at the Frontiers in Education, Seattle, WA, 2012.

Let’s Practice Peer-Instruction

- Turn to 1-2 neighbors, discuss your answers
- If your answers are different, discuss your reasoning
- Re-vote!


Temperature 2 (°C)
Temperature 1 (°C)
20
15
10
5
0
Cancel


60
45
30
15
0
Chipped
Cube
Same

In action….

- Can use phone / computer
- Can use “clicker”
- Can use hands or cards!

Where do clicker-questions come from?

- There are some question banks:
  - AIChE Concept Warehouse
  - LearnChemE.com
  - Your textbook (maybe)
- Or you write them
  - If you've taught a class before, you probably are aware of several already!

Let’s try it!

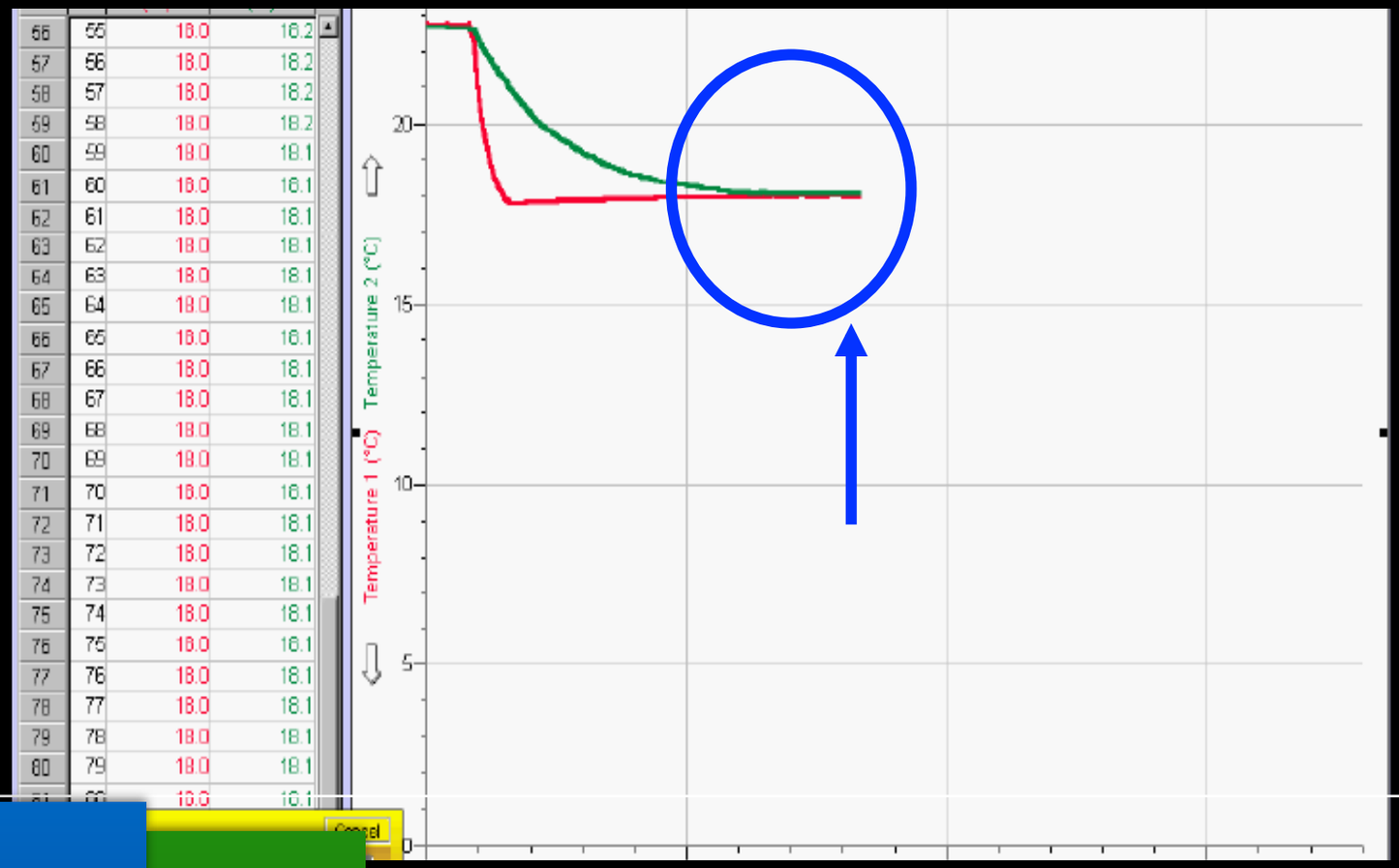
- Identify a challenging idea from your class
- Write a multiple choice question for it
- Wrong answers should be *attractive*
- Wrong answers should reveal misconceptions
- It shouldn’t be computation intensive
- At least 1/3 of the class should get it right, but not everyone

Reflection on Concept / Clicker Questions

- Writing a good question is challenging
- Use as a tool for learning, not testing
- You need 1/3-2/3% of students to have it correct for it to be worth discussing
- For use in-class, be prepared to be flexible with schedule

Other uses for “clicker” technology

- Muddiest Point / Minute Paper
  - Need text entry, like Socrative
- Reading check
- Anonymous poll (good for social issues, ethics)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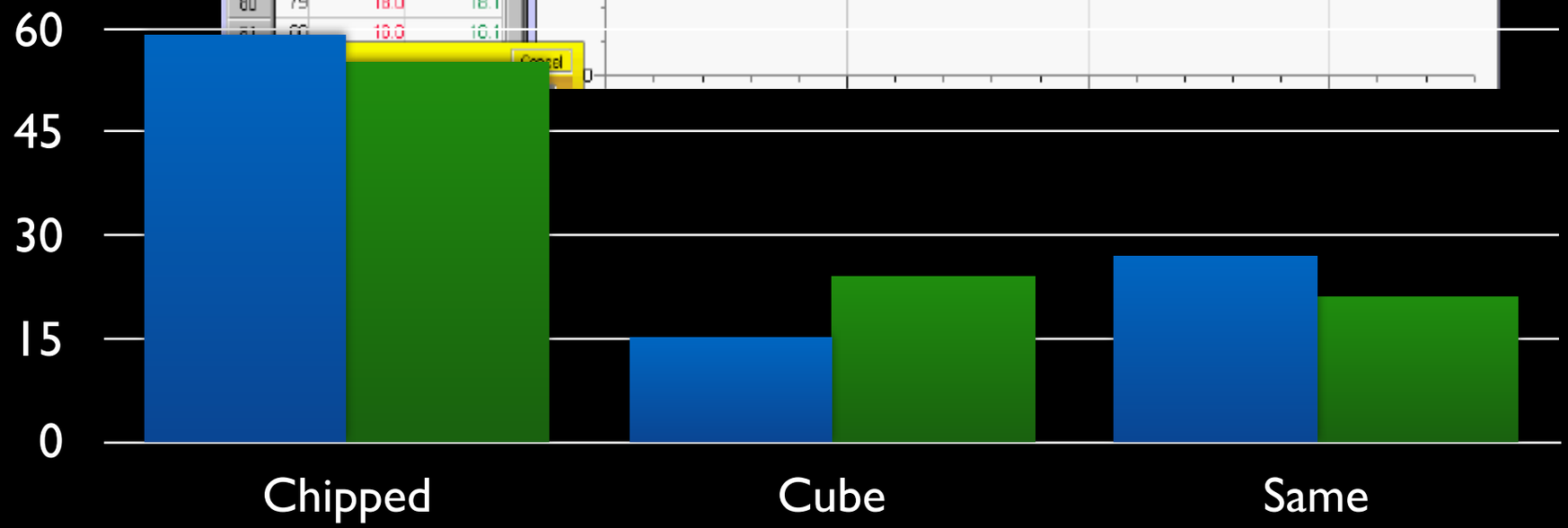
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0
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Same

5. Inquiry-Based Activities

- Follow-up to a concept question
- Hands-on or simulation
- Students are surprised, engaged, can see it’s not a trick
- See misconceptions fail to explain observations
- See correct conceptual understanding succeed

Process

Prediction
Activity
Reflection

b. What do you expect she will observe about the rate of the reaction?

1) The reaction proceeds very rapidly, perhaps even explosively
2) The reaction proceeds very very slowly
3) The reaction proceeds rapidly to start, then more slowly
4) It is impossible to say based on current information

Why?

The large, negative ΔG and large K show the reaction to be heavily pressured toward products, so the rate will be very fast

"This experiment shows that even if a reaction is favorable, it might not be a fast reaction unless it is under certain conditions."

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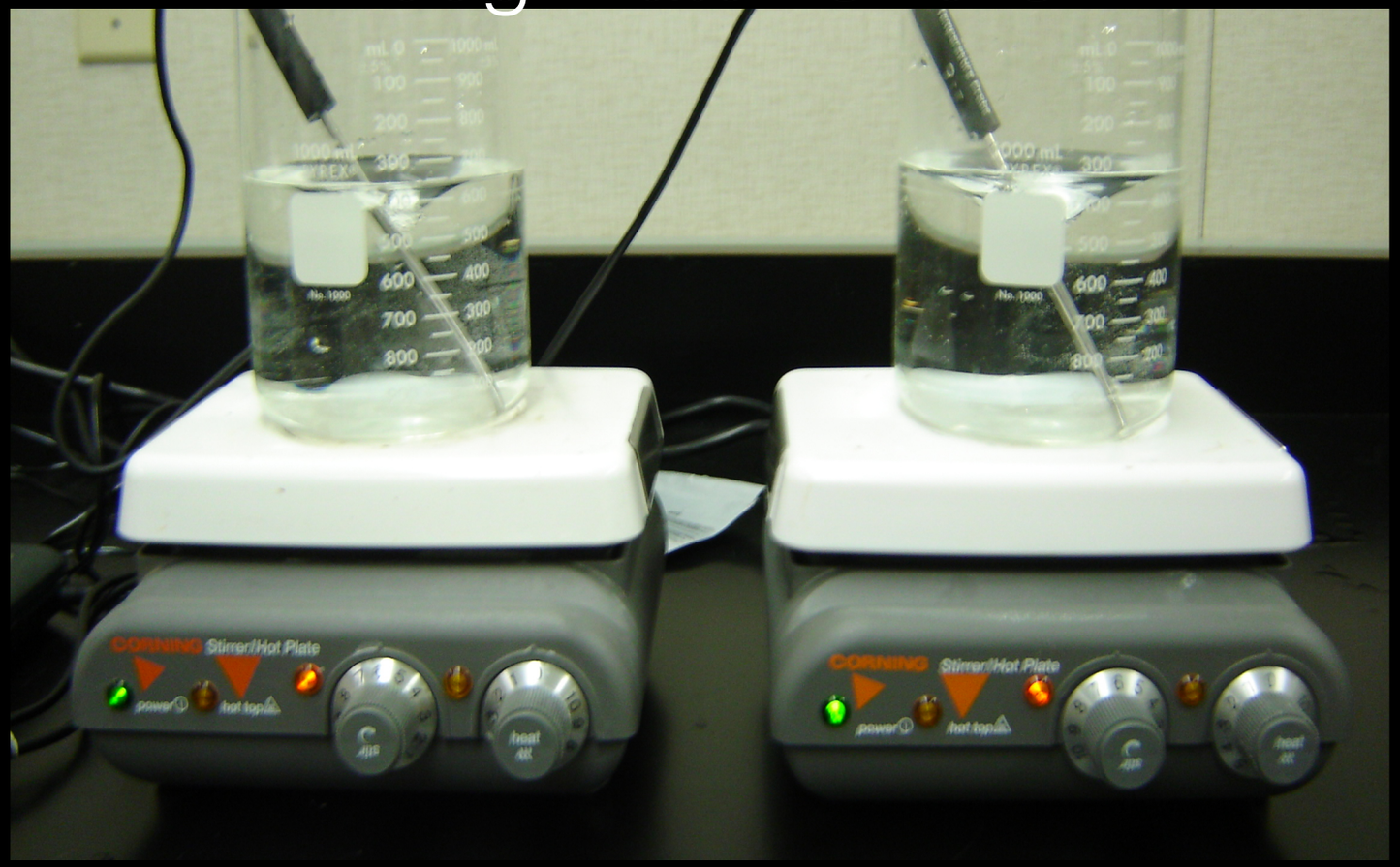
25g chipped ice



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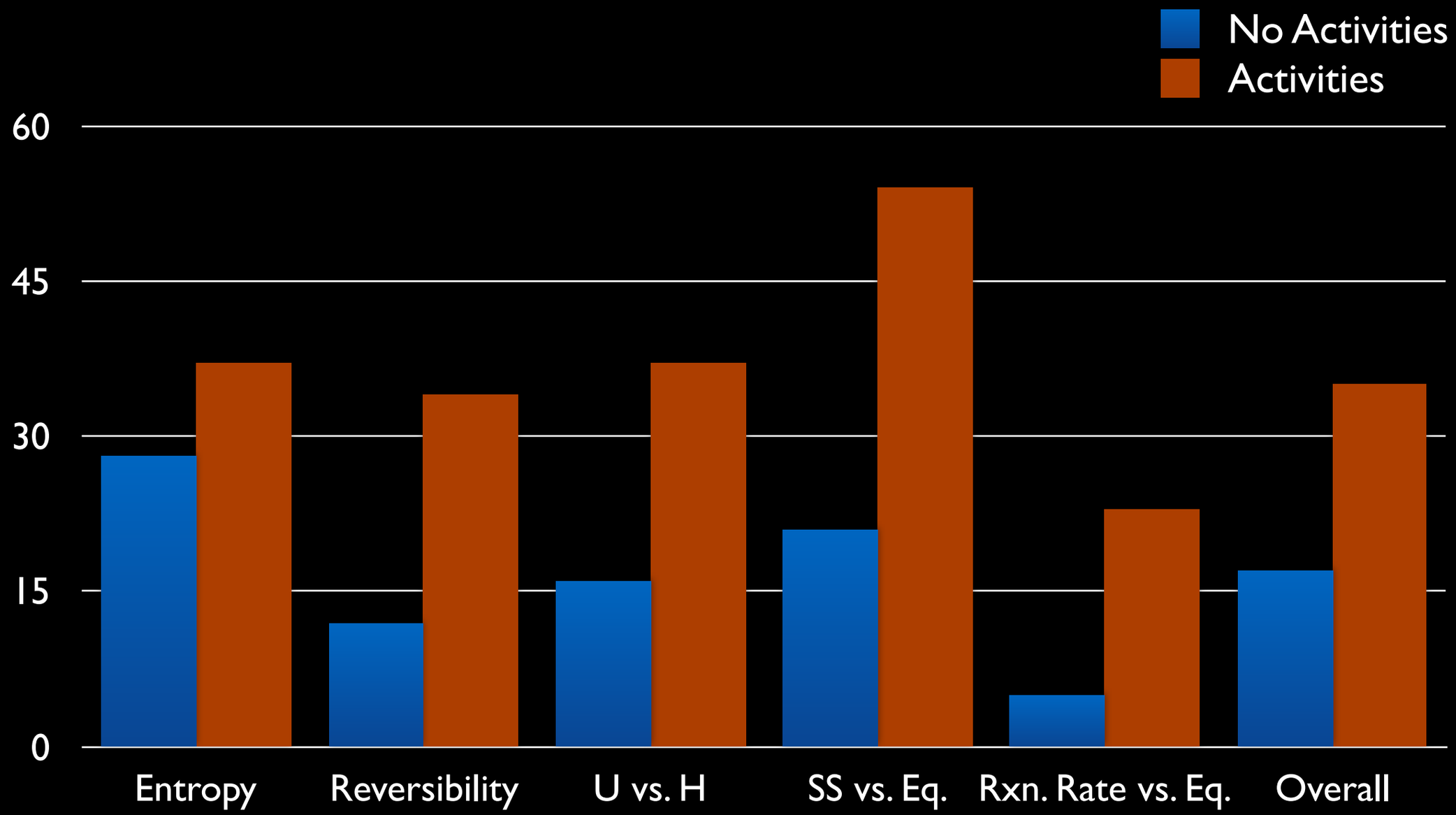
Conceptual Gain after Inquiry-Based Activity (end of semester, Thermodynamics)



Inquiry approach

- Work with peers
- Activity is open but guided
- Emphasize concepts over numbers
- Specific --> General
- Physical world as authority
- Evaluate

Let’s try it!

- For a concept students struggle with….
- Come up with a physical situation
  - ideally, inexpensive
  - ideally, that students can see there are no tricks
- Must answer concept question before, reflect afterwards for this to ‘stick’ as a demonstration or an experiment!

Reflection on Inquiry-Based Activities

- To be effective, requires written prediction AND reflection.
- 2x 15minute activities can double the effectiveness of a course for a given concept (Prince & Vigeant)

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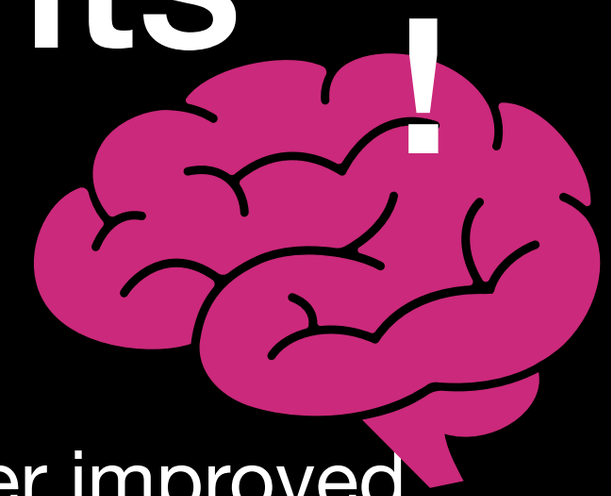
Closing Thoughts



- There are many active learning approaches
- Everything I shared has been shown to foster improved and/or expanded student learning
- Using these effectively in class takes time and practice
  - commit to one or more approaches on a regular basis
  - assess, modify, improve, keep going!

I would like to acknowledge my colleagues Mike Prince, Katharyn Nottis, and Milo Koretsky, our students, and funding support from the United States National Science Foundation

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