What If?

Developing Statistical
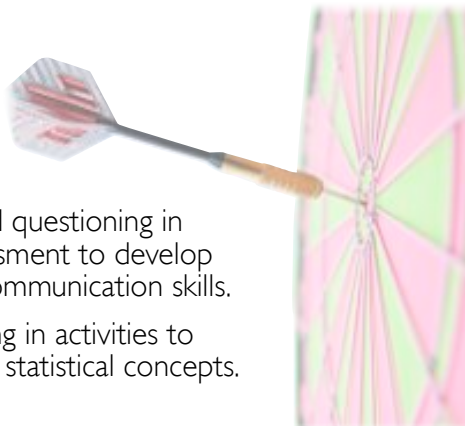Reasoning Through
Structured Questioning

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York, PA

Learning Targets

Session Goal: Explore structured questioning to develop conceptual understanding for AP and Common Core State Standards in Statistics.
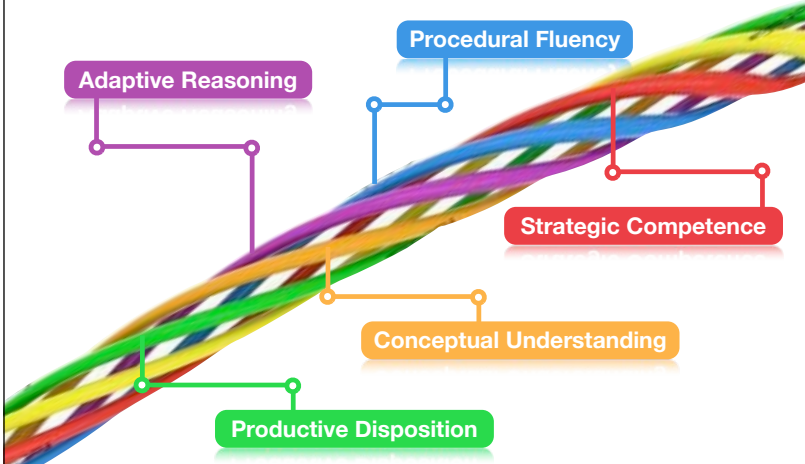
- I can apply structured questioning in discussions and assessment to develop understanding and communication skills.
- I can apply questioning in activities to explore and illustrate statistical concepts.

Part 1

The Researchy
Background
Stuff

Statistical Proficiency

- Adaptive Reasoning
- Procedural Fluency
- Strategic Competence
- Conceptual Understanding
- Productive Disposition

National Research Council. (2001). Adding it up: Helping children learn mathematics. J Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee. Washington, DC: National Academy Press.

Reasoning and Sense Making

"Assessment/Activities that focus primarily on students' abilities to...perform basic computations will lead students to believe that reasoning and sense making are not important...

We must ask students to explain their thinking."

NCTM Focus in High School Mathematics: Reasoning and Sense Making

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Free-Response Questions

"Statistics is a discipline in which clear and complete communication is an essential skill.

...free-response questions require students to use their analytical, organizational, and communication skills to formulate cogent answers."

Students must...

Relate two or more different content areas as they formulate a complete response or solution to a statistics problem.

Conceptual Understanding

Demonstrate their mastery of statistics in a format that requires them to determine how they will organize and present each response.

Clear Communication

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CCSS - Statistics Standards

- Interpret Categorical and Quantitative Data

- Conditional Probability and the Rules of Probability

- Use Probability to Make Decisions

- Make Inferences and Justify Conclusions

CCSS - Statistics Standards

- **Make Inferences and Justify Conclusions**

  - Understand and evaluate random processes underlying statistical experiments

  - Make inferences and justify conclusions from sample surveys, experiments, and observational studies

Conceptual Categories

Producing Data
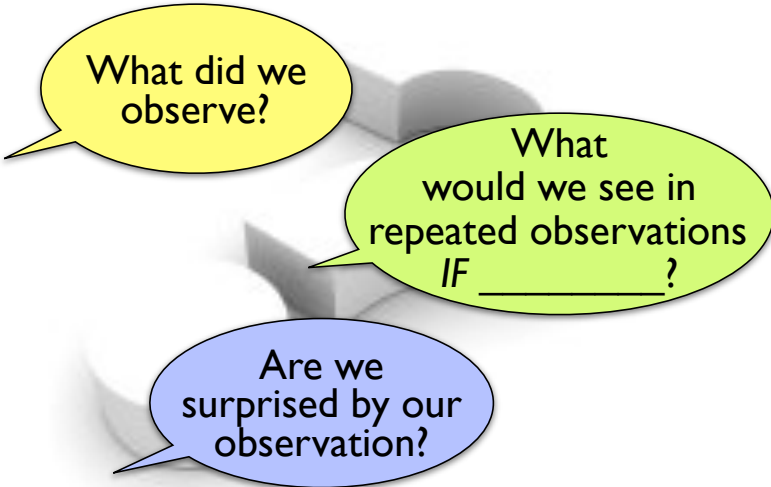
Descriptive Statistics

Variability

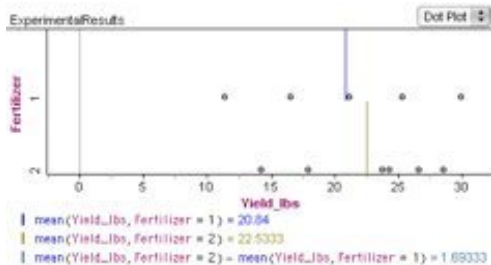Understanding Chance Behavior

Inferential Thinking

Part 2

Key Questions
in Statistics

Key Questions

What did we observe?

What would we see in repeated observations *IF* _____?

Are we surprised by our observation?

Key Questions

What did we observe?

ExperimentalResults — Dot Plot

mean(Yield_lbs, fertilizer = 1) = 20.84
mean(Yield_lbs, fertilizer = 2) = 22.5333
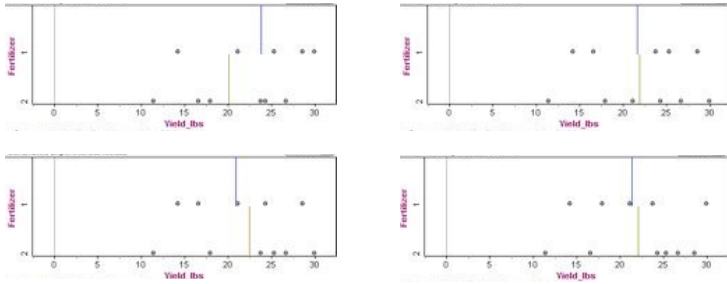mean(Yield_lbs, fertilizer = 2) − mean(Yield_lbs, fertilizer = 1) = 1.69333
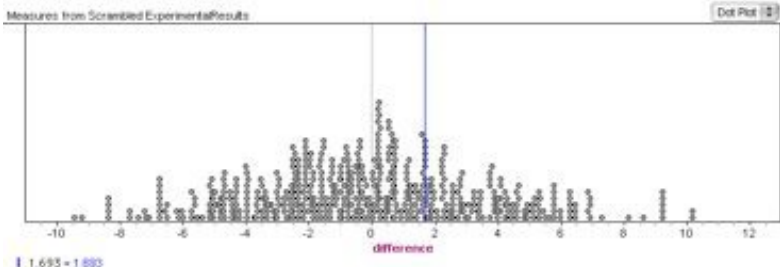
Key Questions

What would we see in repeated observations *IF* _____?

Key Questions

Are we surprised by our observation?

Key Questions

When Can We Ask These Questions?

Part 3

Activity Time!

Example Activity

A new fertilizer (BetterPlant) has been developed that claims to increase the average tomato crop yield over that of an existing fertilizer (RapidGro).

To test this claim, a randomized experiment is designed in which tomatoes are planted in 11 plots.

The new fertilizer (B) is applied to 6 randomly chosen plots and old fertilizer (R) is applied to 5 randomly chosen plots.

Upon harvesting, the yield of each plot is measured (in lbs.) and the average yield for the plots treated with the new fertilizer is compared to the average yield of those treated with the old fertilizer.

| 1 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 |

Example Activity

What did we observe?
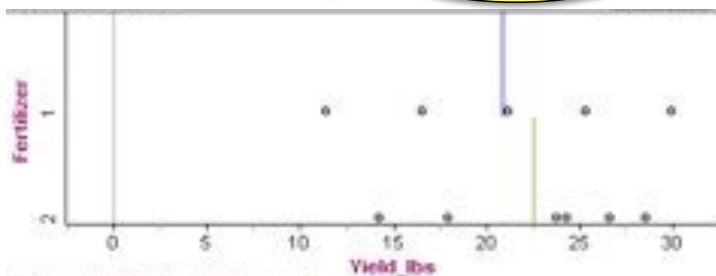
⬛ Mean Yield 2 (BetterPlant): 22.53 lbs

🟥 Mean Yield 1 (RapidGro): 20.84 lbs

Difference: (BetterPlant-RapidGro): 1.69 lbs

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Example Activity

What would we see in repeated observations *IF* _____?

29.9	11.4	26.6	23.7	25.3	28.5
14.2	17.9	16.5	21.1	24.3	

Example Activity

- Shuffle 11 cards (6 Black, 5 Red).
- Deal to assign fertilizer to plots.
- Calculate and record mean yield (to nearest 0.1) for each repetition.
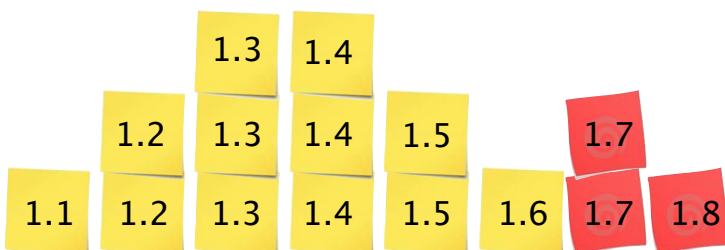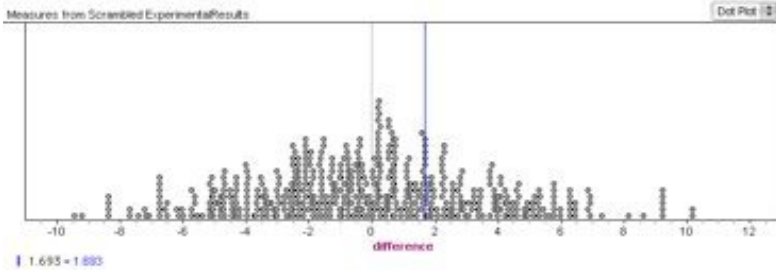
- BetterPlant

  ♠ ♣

- RapidGro

  ♥ ♦

Example Activity

- Record mean yields < 1.7 on yellow post-it.
- Record mean yields ≥ 1.7 on red post-it.
- Construct a post-it "dotplot" of all results.

```
              1.3  1.4
         1.2  1.3  1.4  1.5            1.7
1.1  1.2  1.3  1.4  1.5  1.6  1.7  1.8
```

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Key Questions

Are we surprised by our observation?

Measures from Scrambled ExperimentalResults   Dot Plot

difference

1.695 = 1.693

Part 4

Structured FRAPPY Process

Key FRAPPY Questions

- What is the intent of the question?

  - What did the student(s) do well?

  - What could they have done better?

  - How would I score their response?

- What did I do well? What could I do better?

- What do I need to remember when I see a problem like this in the future?

THE FRAPPY PROCESS

Chapter 1 "FRAPPY"
{Free Response AP Problem...Yay!}

- **The FRAPPY Process**
  - **"Free Response AP Problem, Yay!"**
  - **1 Problem - 1 Class Period**

  - ☑ **Intent of Question**
  - ☑ **Sample Responses**
  - ☑ **Rubric Discussion**
 - ☑ **Score and Reflect**
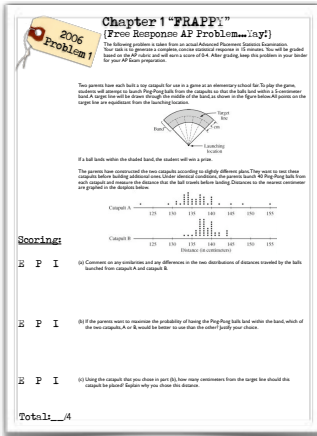
WHERE AM I GOING?   STEP 1

- 15 Minutes to work on Problem
- READ the ENTIRE problem.
- Determine "**Intent of Question**"
  - *What are they looking for?*
- Formulate Response
  - **Proper application of concept(s)**
  - **Clear Communication**
  - **Context, Context, Context!**
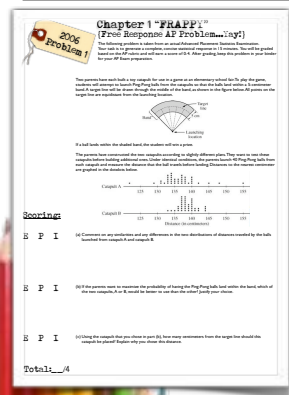
WHAT DOES GOOD LOOK LIKE?   STEP 2

- **Discuss** Intent of Question
- **View** sample student responses
  - *Available at AP Central*
  - *NCTM Assessment Sampler*
  - How would **YOU** score these?
- Determine what constitutes...
  - **Minimal**
  - **Developing**
  - **Substantial**
  - **Complete**

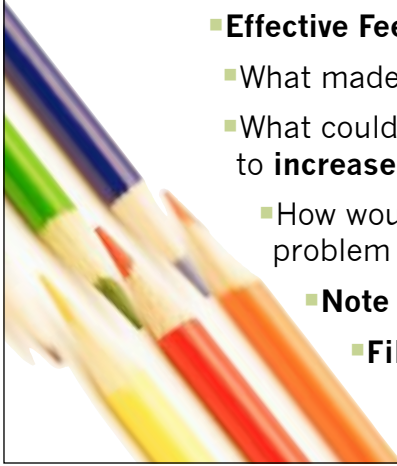Friday, April 11, 14
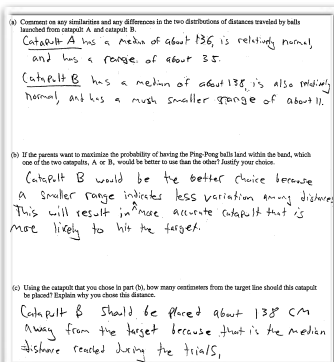
WHERE AM I NOW?   STEP 3

- **Share** Rubric/Scoring Guideline
- **Review** Intent of Question
- **Identify** "model solution" for each part
- **Score** your papers with a partner
  - Each part receives
    - **Essentially Correct**,
    - **Partially Correct**, or
    - **Incorrect**
- **Assign** 1-4 score using a holistic approach

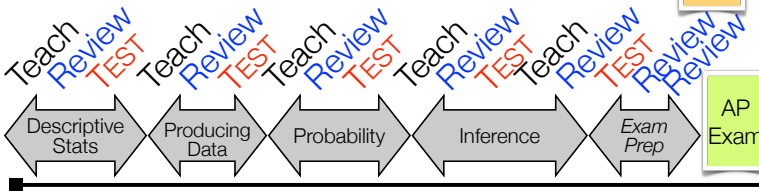## HOW CAN I CLOSE THE GAP?   STEP 4

- **Effective Feedback** is critical
  - What made each part an **E**, **P**, or **I**?
  - What could you have done differently to **increase** your score?
    - How would you approach a similar problem in the future?
      - **Note** key items on your FRAPPY.
        - **File** for Review and Prep.

WHEN SHOULD YOU FRAPPY?

FRQs as *Formative Assessment*

FRQs as **"Test Preparation"**

FRQ

| Teach Review TEST | Teach Review TEST | Teach Review TEST | Teach Review TEST | Teach Review TEST | Review Review |

| Descriptive Stats | Producing Data | Probability | Inference | *Exam Prep* | AP Exam |

Sep Oct   Nov Dec   Jan Feb Mar   Apr May

FRAPPY early. FRAPPY often.

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Questions - Discussion

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