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# FRAPPYs

Utilizing **F**ree **R**esponse  
**AP P**roblems (**Y**ay!)  
as Formative Assessments

**Atlanta Area AP Statistics  
Teachers Association**

Atlanta, GA

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**Jason M. Molesky**

*Assessment & Accountability Coordinator*

*Lakeville Area Public Schools: Lakeville, MN*

**statsmonkey@mac.com**



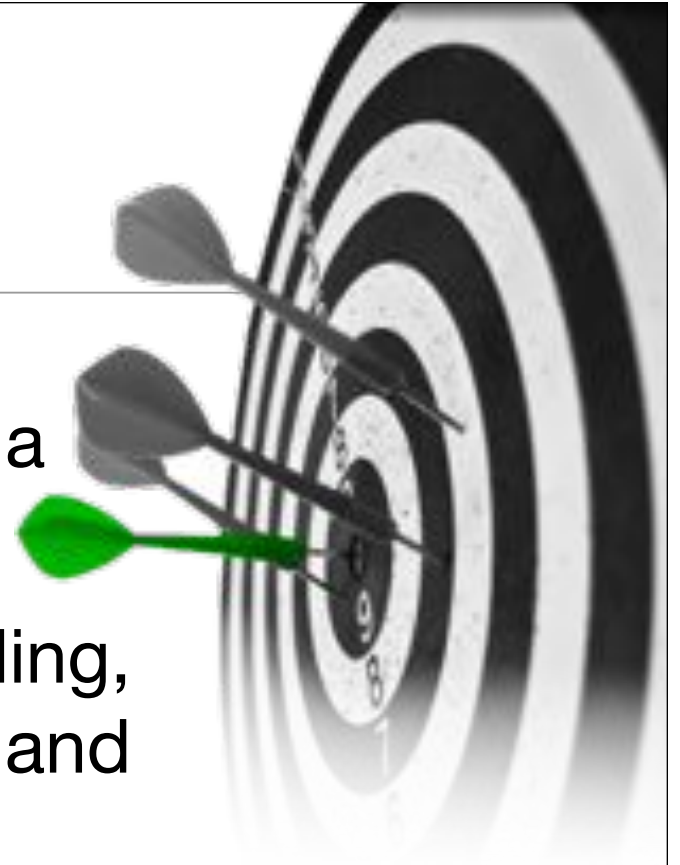
# LEARNING TARGETS

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## Session Goal:

Introduce the FRAPPY process as a formative assessment tool to:

- ✓ Strengthen student understanding,
  - ✓ Develop communication skills, and
  - ✓ Provide AP Exam preparation.
- 
- ✓ I can describe a quality statistical response.
  - ✓ I can utilize AP Free Response Problems as formative assessments to develop statistical understanding and effective communication skills.



# PARADOXICAL INTENT

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**What are the least effective ways to use AP Free Response Questions in your classroom?**

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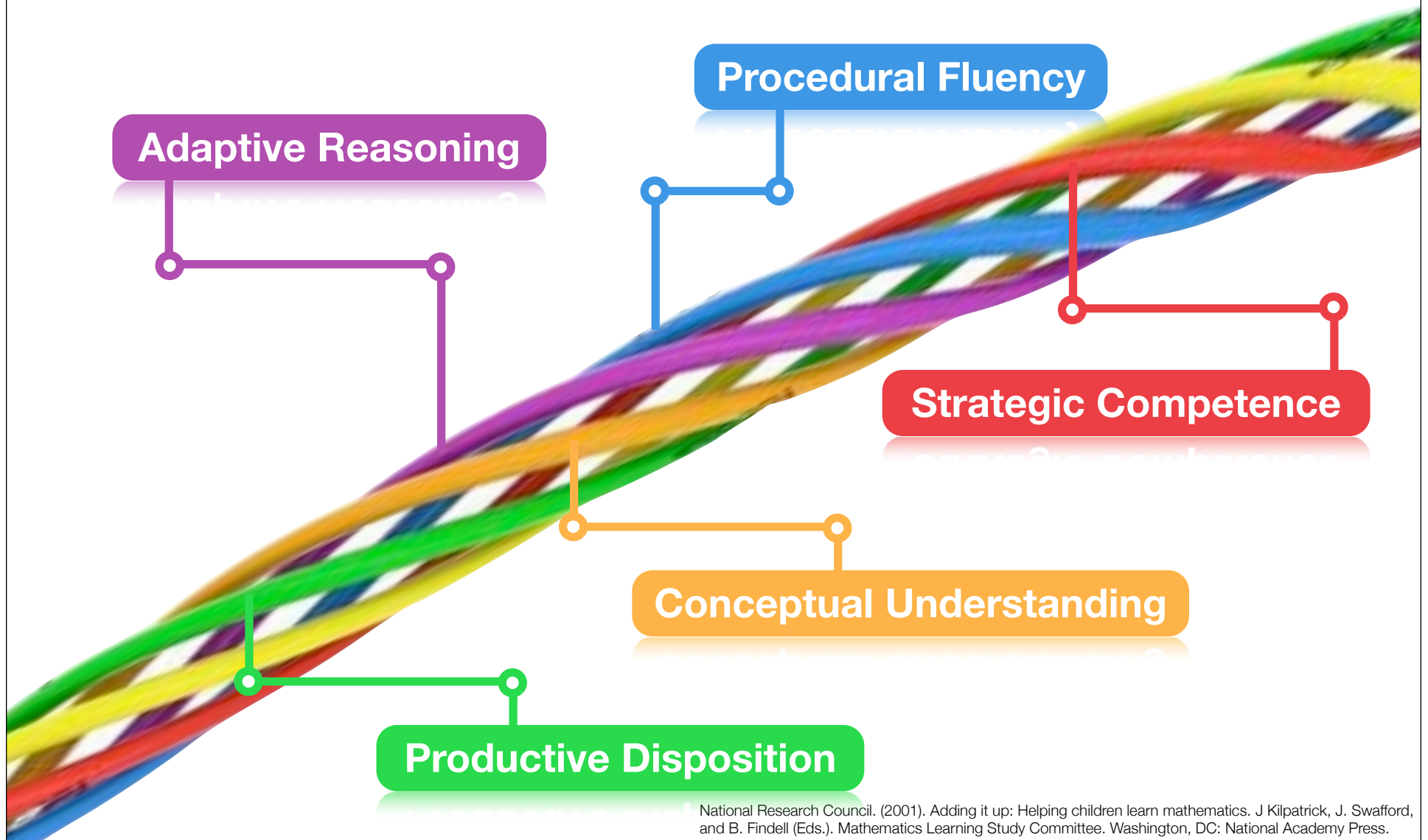
# Part 1:

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- ✓ Statistical Thinking
- ✓ AP Free Response Questions
- ✓ Lessons Learned from the Reading



# ATTRIBUTES OF STATISTICAL PROFICIENCY



# REASONING AND SENSE MAKING

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**"Assessment that focuses primarily on students' abilities to...perform basic statistical 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



# FREE RESPONSE QUESTIONS

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

The 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**

# WHAT HAVE WE LEARNED AS READERS?

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- 
- ✓ AP FRQ's are **QUALITY** assessment items.
  - ✓ **COLLABORATION** is critical for success.
  - ✓ There are 4 things that will maximize a student's score on a Free Response Question.

**1. PROPER APPLICATION OF STATISTICAL CONCEPT**

**2. CLEAR COMMUNICATION**

**3. CLEAR COMMUNICATION**

**4. CLEAR COMMUNICATION**



## Part 2:

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- ✓ **What is Formative Assessment?**
- ✓ **Strategies of Assessment for Learning**
- ✓ **The Purpose of the FRAPPY**



# WHAT IS FORMATIVE ASSESSMENT?

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How do we increase Conceptual Understanding and Communication Skills {ie. Statistical Proficiency}?

## **Formative Assessment**

Formal and informal processes teachers AND students use to gather evidence for the purpose of improving learning.



# STRATEGIES OF ASSESSMENT FOR LEARNING

## ■ Where Am I Going?

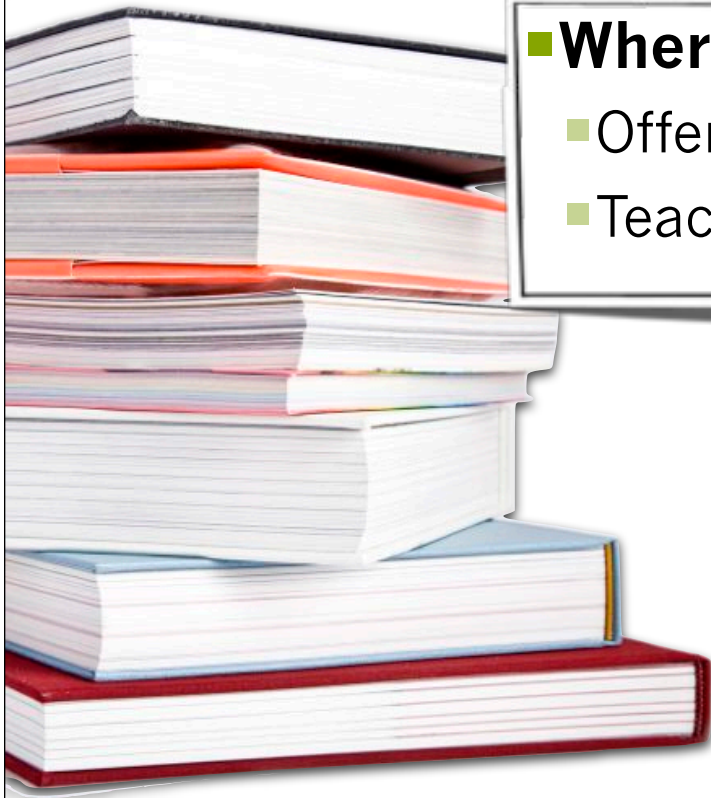
- Provide Clear, Understandable Learning Targets
- Use Examples and Models of Strong and Weak Work

## ■ Where Am I Now?

- Offer Regular Descriptive Feedback
- Teach Students to Self Assess and Set Goals

## ■ How Can I Close the Gap?

- Teach Students Focused Revision
- Engage Students in Self-Reflection



# ...NOT ROCKET SCIENCE

**To improve, students must:**

- Know what good work looks like
- Compare their work to that standard
- Understand how to close gaps

**The POWER is in the INTENTIONAL,  
STUDENT-INVOLVED use of FRAPPYs as  
LEARNING TOOLS!**

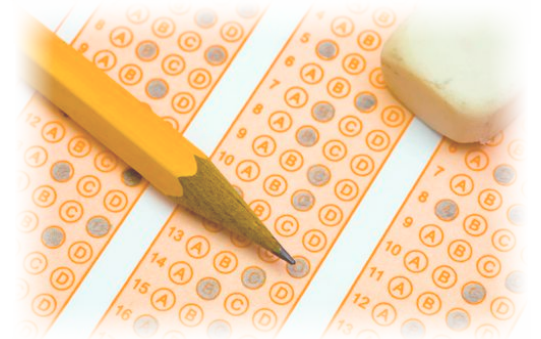
*Sadler, R.- Presented by Rick Stiggins  
Assessment Training Institute*



# THE PURPOSE OF THE FRAPPY

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- Important Note #1: We over-TEST our kids.
  - We under-ASSESS them.



- Important Note #2: AP Statistics is NOT a test-preparation course.
  - Our goal is to teach students statistical concepts, how to apply them, and how to communicate statistically.

*The primary intent of the FRAPPY process is NOT to prepare for the AP exam or assign grades...*

*...its purpose is to help develop students' conceptual understanding and communication skills.*

# Part 3:

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## The FRAPPY Process

- ✓ Step 1
- ✓ Step 2
- ✓ Step 3
- ✓ Step 4
- ✓ When Should I FRAPPY?



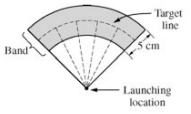
# THE FRAPPY PROCESS

**2006 Problem 1**

**Chapter 1 “FRAPPY”**  
 {Free Response AP Problem...Yay!}

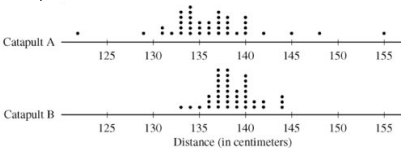
The following problem is taken from an actual Advanced Placement Statistics Examination. Your task is to generate a complete, concise statistical response in 15 minutes. You will be graded based on the AP rubric and will earn a score of 0-4. After grading, keep this problem in your binder for your AP Exam preparation.

Two parents have each built a toy catapult for use in a game at an elementary school fair. To play the game, students will attempt to launch Ping-Pong balls from the catapults so that the balls land within a 5-centimeter band. A target line will be drawn through the middle of the band, as shown in the figure below. All points on the target line are equidistant from the launching location.



If a ball lands within the shaded band, the student will win a prize.

The parents have constructed the two catapults according to slightly different plans. They want to test these catapults before building additional ones. Under identical conditions, the parents launch 40 Ping-Pong balls from each catapult and measure the distance that the ball travels before landing. Distances to the nearest centimeter are graphed in the dotplots below.



**Scoring:**

E P I (a) Comment on any similarities and any differences in the two distributions of distances traveled by the balls launched from catapult A and catapult B.

E P I (b) If the parents want to maximize the probability of having the Ping-Pong balls land within the band, which of the two catapults, A or B, would be better to use than the other? Justify your choice.

E P I (c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

Total: \_\_\_/4

- 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?

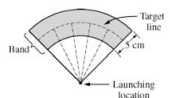
# STEP 1

**2006 Problem 1**

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

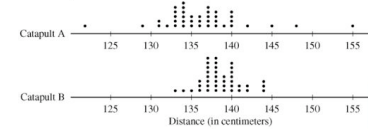
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**Scoring:**

E P I (a) Comment on any similarities and any differences in the two distributions of distances traveled by the balls launched from catapult A and catapult B.

E P I (b) If the parents want to maximize the probability of having the Ping-Pong balls land within the band, which of the two catapults, A or B, would be better to use than the other? Justify your choice.

E P I (c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

Total: \_\_\_/4

- 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

(a) Comment on any similarities and any differences in the two distributions of distances traveled by balls launched from catapult A and catapult B.

Catapult A has a median of about 136, is relatively normal, and has a range of about 35.

Catapult B has a median of about 138, is also relatively normal, and has a much smaller range of about 11.

(b) If the parents want to maximize the probability of having the Ping-Pong balls land within the band, which one of the two catapults, A or B, would be better to use than the other? Justify your choice.

Catapult B would be the better choice because a smaller range indicates less variation among distances. This will result in a more accurate catapult that is more likely to hit the target.

(c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

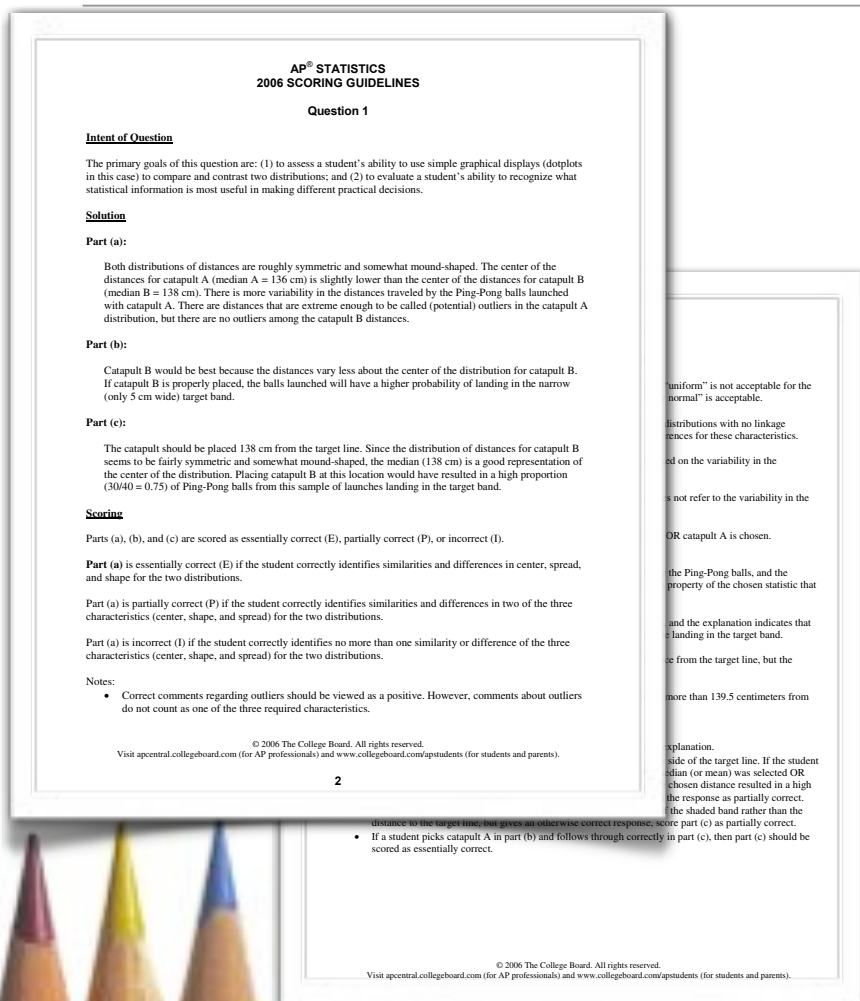
Catapult B should be placed about 138 cm away from the target because that is the median distance reached during the trials.

- **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



# WHERE AM I NOW?

# STEP 3



AP<sup>®</sup> STATISTICS  
2006 SCORING GUIDELINES  
Question 1

**Intent of Question**

The primary goals of this question are: (1) to assess a student's ability to use simple graphical displays (dotplots in this case) to compare and contrast two distributions; and (2) to evaluate a student's ability to recognize what statistical information is most useful in making different practical decisions.

**Solution**

**Part (a):**

Both distributions of distances are roughly symmetric and somewhat mound-shaped. The center of the distances for catapult A (median  $A = 136$  cm) is slightly lower than the center of the distances for catapult B (median  $B = 138$  cm). There is more variability in the distances traveled by the Ping-Pong balls launched with catapult A. There are distances that are extreme enough to be called (potential) outliers in the catapult A distribution, but there are no outliers among the catapult B distances.

**Part (b):**

Catapult B would be best because the distances vary less about the center of the distribution for catapult B. If catapult B is properly placed, the balls launched will have a higher probability of landing in the narrow (only 5 cm wide) target band.

**Part (c):**

The catapult should be placed 138 cm from the target line. Since the distribution of distances for catapult B seems to be fairly symmetric and somewhat mound-shaped, the median (138 cm) is a good representation of the center of the distribution. Placing catapult B at this location would have resulted in a high proportion ( $30/40 = 0.75$ ) of Ping-Pong balls from this sample of launches landing in the target band.

**Scoring**

Parts (a), (b), and (c) are scored as essentially correct (E), partially correct (P), or incorrect (I).

**Part (a)** is essentially correct (E) if the student correctly identifies similarities and differences in center, spread, and shape for the two distributions.

**Part (a)** is partially correct (P) if the student correctly identifies similarities and differences in two of the three characteristics (center, shape, and spread) for the two distributions.

**Part (a)** is incorrect (I) if the student correctly identifies no more than one similarity or difference of the three characteristics (center, shape, and spread) for the two distributions.

**Notes:**

- Correct comments regarding outliers should be viewed as a positive. However, comments about outliers do not count as one of the three required characteristics.

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distance to the target line, but gives an otherwise correct response, score part (c) as partially correct.

- If a student picks catapult A in part (b) and follows through correctly in part (c), then part (c) should be scored as essentially correct.

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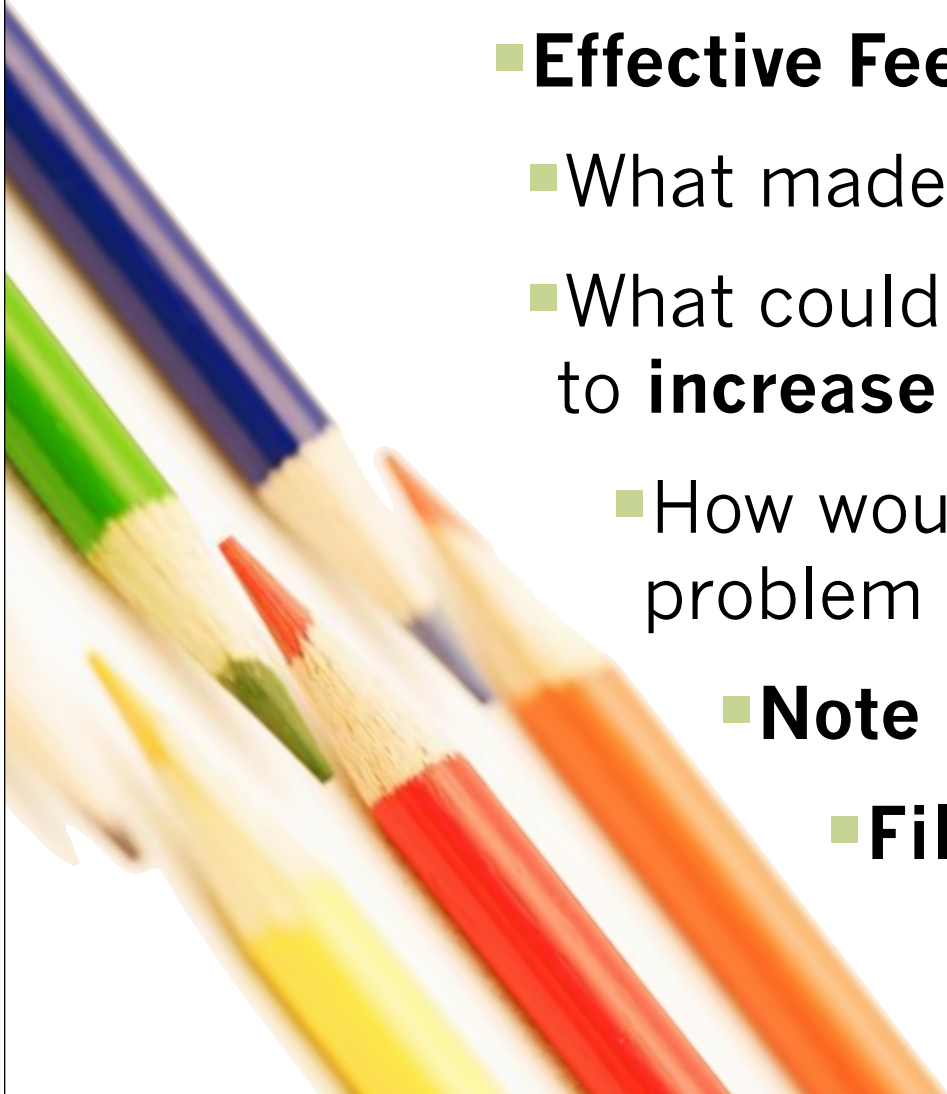
- **Share** Rubric/Scoring Guideline
- **Review** Intent of Question
- **Identify** “model solution” for each part
- **Score** your papers with a partner
  - Each part receives
  - **Essentially Correct,**
  - **Partially Correct,** or
  - **Incorrect**
- **Assign** 1-4 score using a holistic approach

# HOW CAN I CLOSE THE GAP?

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## STEP 4

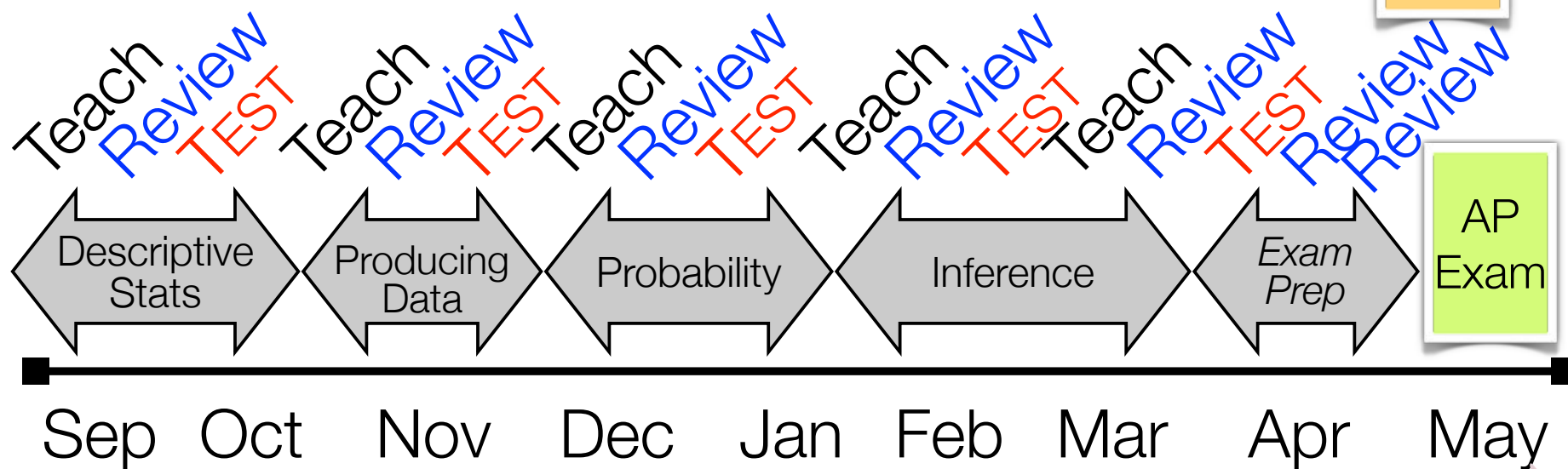
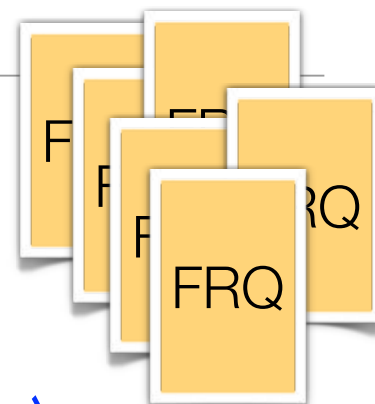
- **Effective Feedback** is critical
  - What made each part an **E**, **P**, or **I**?
  - What could you have done differently to **increase** your score?
    - How would you approach a similar problem in the future?
  - **Note** key items on your FRAPPY.
    - **File** for Review and Prep.



# WHEN SHOULD YOU FRAPPY?

FRQs as *Formative Assessment*

FRQs as “Test Preparation”



**FRAPPY early. FRAPPY often.**



# Part 4:

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**Let's FRAPPY!**

✓Time to role play

✓YOU are the student!



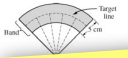
# IT'S FRAPPY TIME!

**2006 Problem 1**

### Chapter 1 "FRAPPY" (Free Response AP Problem...Yay!)

The following problem is taken from an actual Advanced Placement Statistics Examination. Your task is to generate a complete, concise statistical response in 15 minutes. You will be graded based on the AP rubric and will earn a score of 0-4. After grading keep this problem in your binder for your AP Exam preparation.

Two parents have each built a toy catapult for use in a game at an elementary school fair. To play the game, students will attempt to launch Ping-Pong balls from the catapults so that the balls land within a 5-centimeter band. A target line will be drawn through the middle of the band, as shown in the figure below. All points on the target line are equidistant from the launching location.



Part (a) asks for similarities and differences between the two catapults based on their dotplots. Part (b) asks for the optimal catapult choice to maximize the chance of landing a ball in the band. Part (c) asks for the optimal placement of a catapult relative to the target line.

**Scoring:**

E P I (a) Comment on any similarities and differences between the distributions of distances launched from catapult A and catapult B.

E P I (b) If the parents want to maximize the probability of landing a ball in the band, which catapult, A or B, would be the best choice?

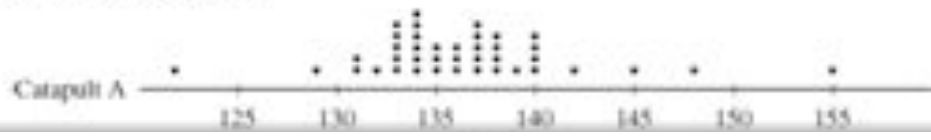
E P I (c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

Total: \_\_\_/4

Two parents have each built a toy catapult for use in a game at an elementary school fair. To play the game, students will attempt to launch Ping-Pong balls from the catapults so that the balls land within a 5-centimeter band. A target line will be drawn through the middle of the band, as shown in the figure below. All points on the target line are equidistant from the launching location.

**What is the "Intent of the Question"?  
Construct a complete, concise response.**

Under identical conditions, the parents launch 40 Ping-Pong balls from each catapult and measure the distance that the ball travels before landing. Distances to the nearest centimeter are graphed in the dotplots below.



## Intent of Question

The primary goals of this question are: (1) to assess a student's ability to use simple graphical displays (dotplots in this case) to compare and contrast two distributions; and (2) to evaluate a student's ability to recognize what statistical information is most useful in making different practical decisions.

(c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

# WHAT DID OTHER STUDENTS SAY?

(a) Comment on any similarities and any differences in the two distributions of distances traveled by balls launched from catapult A and catapult B.

The mean ~~data~~ and median distance of Catapult B is slightly higher than Catapult A. Catapult A has much more spread than catapult B; its range is almost

(b) If the parents want to maximize the probability of having the Ping-Pong balls land within the ball strip, one of the two catapults, A or B, would be better to use than the other? Justify your choice.

Catapult B would be a better choice in order to maximize the probability of having the ping-pong balls land within the ball strip. The center of distribution B is higher than the center of distribution A, so the ping-pong balls would travel a longer launch distance and land in the ball strip in order to maximize the probability of having the ping-pong balls land within the ball strip.

(c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

The catapult should be placed about 138 cm from the target line. Since the median of distribution B is 138 and the distribution is approximately bell-shaped and symmetrical, it is reasonable to assume that the expected distance of the ping pong ball is 138 cm, so the catapult should be placed that far from the target line to make sure that the balls land in the strip.

**How would YOU score this? Why? Any suggestions?**

**Substantial**

# WHAT DID OTHER STUDENTS SAY?

**How would YOU score this? Why? Any suggestions?**

(a) Comment on any similarities and any differences in the two distributions of distances traveled by balls launched from catapult A and catapult B.

Catapult A has a median of about 136, is relatively normal, and has a range of about 35.

Catapult B has a median of about 138, is also relatively normal, and has a range of about 35.

The parents want to maximize the probability of having the Ping-Pong balls land within the band, which of the two catapults, A or B, would be better to use than the other? Justify your choice.

Catapult B would be the better choice because

it has a smaller range, which indicates less variation among distances.

The smaller range indicates less variation among distances.

That is, the distances are more consistent, and that is

more likely to hit the target.

(c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

Catapult B should be placed about 138 cm away from the target because that is the median distance reached during the trials.

**Developing**

# WHAT DOES "GOOD" LOOK LIKE?

## Scoring

Parts (a), (b), and (c) are scored as essentially correct (E), partially correct (P), or incorrect (I).

**Part (a)** is essentially correct (E) if the student correctly identifies similarities and differences in center, spread, and shape for the two distributions.

**Part (b)** is essentially correct (E) if catapult B is chosen using a rationale based on the variability in the distances.

**Part (c)** is essentially correct (E) if:

the catapult is placed at the median (or mean) of the distances traveled by the Ping-Pong balls, and the explanation addresses why the median (or mean) was selected based on a property of the chosen statistic that relates to the context of the problem;

OR

the catapult is placed at a distance of 137.5-139.5 cm from the target line, and the explanation indicates that the chosen distance resulted in a high proportion of the balls in the sample landing in the target band.

Part (c) is partially correct (P) if the catapult is placed at an acceptable distance from the target line, but the explanation is incomplete or incorrect.

Part (c) is incorrect (I) if the catapult is placed less than 137.5 centimeters or more than 139.5 centimeters from the target line.

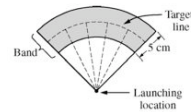
# HOW DID YOU DO?



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

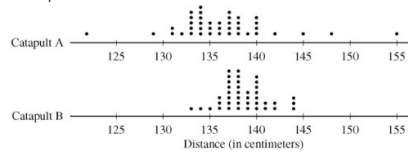
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### Scoring:

E P I

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E P I

(b) If the parents want to maximize the probability of having the Ping-Pong balls land within the band, which of the two catapults, A or B, would be better to use than the other? Justify your choice.

E P I

(c) Using the catapult that you chose in part (b), how many centimeters from the target line should this catapult be placed? Explain why you chose this distance.

Total: \_\_\_/4

## ■ FRAPPY Step 3

■ Score your papers with a partner

- Each part receives
  - **Essentially Correct,**
  - **Partially Correct,** or
  - **Incorrect**

■ Assign 1-4 score using a holistic approach

■ **What did you do well? What could use some work? How could you improve your response?**

# Part 4:

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**Wrapping it up**

**✓ Resources**

**✓ Discussion**



# RESOURCES

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- **Past Free Response Question and Student Samples**

[http://apcentral.collegeboard.com/apc/members/exam/exam\\_information/8357.html](http://apcentral.collegeboard.com/apc/members/exam/exam_information/8357.html)



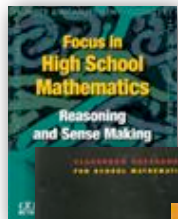
- **StatsMonkey Resource Clearinghouse, FRAPPYs**

<http://web.mac.com/statsmonkey/>



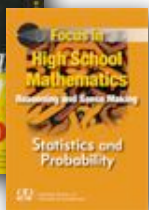
- **Pearson Assessment Training Institute**

<http://www.assessmentinst.com/>



- **NCTM Focus in High School Mathematics, Assessment Handbook**

<http://www.nctm.org/>

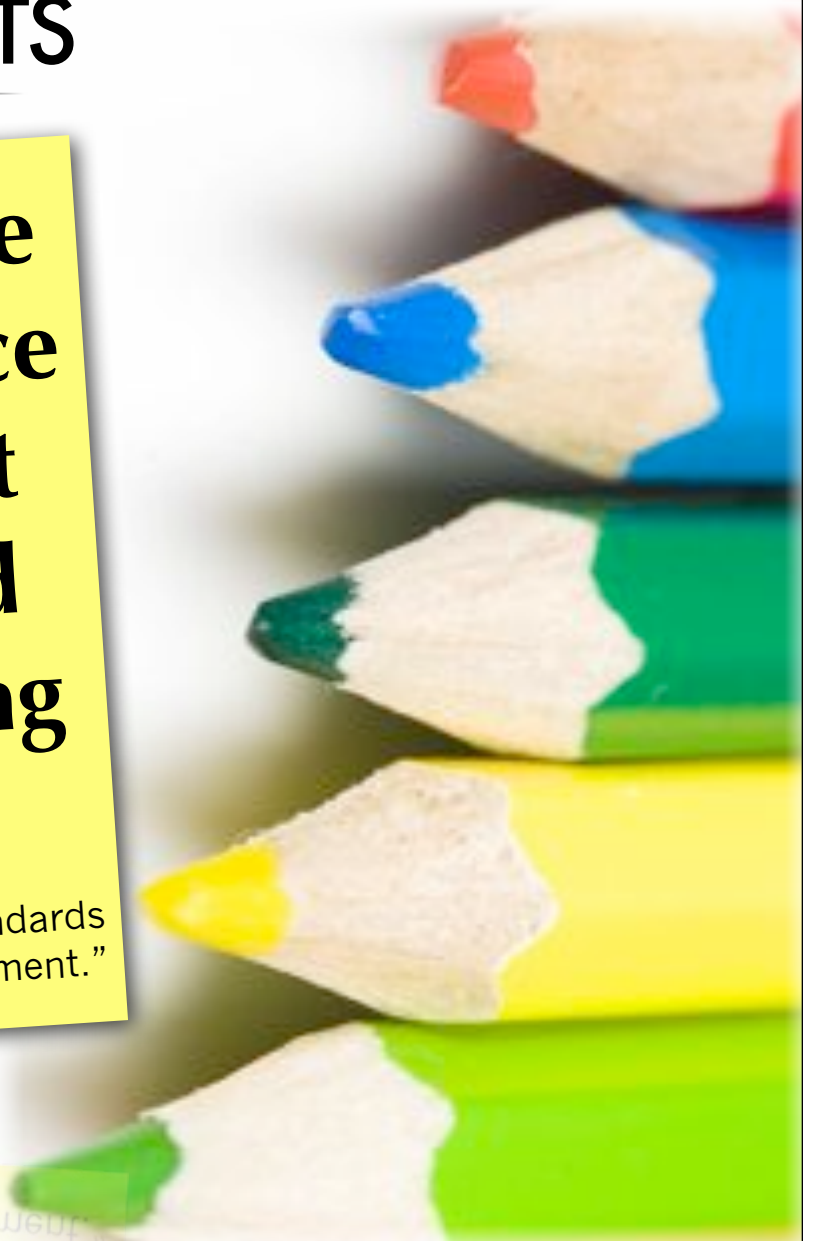


# CONCLUDING THOUGHTS

**“Innovations that include strengthening the practice of formative assessment produce significant and often substantial learning gains.”**

Black & William, “Inside the Black Box: Raising Standards Through Classroom Assessment.”

Black & William, “Inside the Black Box: Raising Standards Through Classroom Assessment.”



# QUESTIONS - DISCUSSION

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