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Statistical Significance: What is it? NCTM San Francisco, April 2016

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### **Session Goals**

By the end of this session, you will...

- engage in the statistical problem solving process.
- develop an understanding of a progression of CCSS-M Statistics from grades 6 through 12.



### The Framework

#### **Statistical Problem Solving Process**

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- I. Formulate Questions
- II. Collect Data
- III. Analyze Data
- **IV. Interpret Results**



http://www.amstat.org/education/gaise/GaiseCollege\_full.pdf



### Attend to precision.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

# Memorizing Words



## Memorizing Words – I. Formulating Questions

The statistical question we will be investigating is, "Is it easier for participants to memorize words that have meaning over words that do not have meaning?"



## Memorizing Words – II. Collect Data

Data collection instructions:

 You will have 1 minute to study your list of words.
You will then turn over your list and write down as many words as you can remember on a blank sheet of paper in 1 minute.

3. You will trade papers with someone of a **non**matching color and check how many he/she has correct.

4. Write your number correct on a matching sticky note color (blue/orange for your word list) and post on the appropriate number line. End







# **Box plot**

The box plot is created from dividing an ordered data set into four groups with approximately the same number of data values in each set (about one fourth).

#### **Five-Number Summary**

- Minimum
- First Quartile (Q<sub>1</sub>)
- Median
- Third Quartile (Q<sub>3</sub>)
- Maximum
- Interquartile Range (IQR)





Number of Correctly Recalled Words

#### Describe the distribution.



#### Marking the outlier

Meaningful Words



Number of Correctly Recalled Words



When comparing two distributions, it is important to note similarities (overlap) and differences (areas of separation).

- What can you say about the similarities or overlap?
- What can you say about the differences or areas of separation?
- What conclusions might you draw?



Number of Correctly Recalled Words

The Brookhill Institute of Mathematics exists to raise the mathematical literacy of every learner.



Turn and Talk





## Compare 9<sup>th</sup> Grade Data IV. Interpret Results

Is a difference of 5 words large enough to matter? Is this a meaningful difference or is it just not that meaningful?



#### How many IQRs separate the medians?

Meaningful Words



Number of Correctly Recalled Words



#### How many IQRs separate the medians?

Median of meaningful words – median of nonsense words

IQR

$$\frac{12-7}{4} = 1.25$$



## Compare 9<sup>th</sup> Grade Data IV. Interpret Results

Is the difference between the medians of 5 words large enough to matter?

Is this a significant difference?



### Simulation

Assume there is no difference between the median number of meaningful words and the median number of nonsense words. If the list a person receives does not influence how many words he/she recalls, how likely would a difference in the medians as large or larger than 5 occur purely by chance if the true difference between the medians is 0?



### **Simulation Directions**



With a partner, shuffle the 26 cards together and then "deal" the cards into two piles of 13 cards.

Designate one pile A (meaningful) and the other B (nonsense). Find the median of each pile.

Find the difference in the medians (median of meaningful *A* – median of nonsense *B*)



### Analyze the Results Describe the dot plot Shape, center, spread What do the values represent? Where do the values center? Does this value make sense?

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#### Analyze the Results

Where does the value of 5 words (actual difference between the medians) fall in this distribution?

Is this difference likely to have happened by <u>chance</u> if the true difference is 0?



### Simulation using Technology

#### http://www.nctm.org/coremathtools/

Core Math Tools is a downloadable suite of interactive software tools for algebra and functions, geometry and trigonometry, and statistics and probability. The tools are appropriate for use with any high school mathematics curriculum and compatible with the Common Core State Standards for Mathematics in terms of content and mathematical practices. Java required.



General Purpose Tools CAS, Spreadsheet, Geometry, Data Analysis, and Simulation	Custom Apps Focused explorations of specific topics	Advanced Apps Focused explorations of advanced topics
Sample Lessons	Data Sets	How-To Pages
Problem-based lessons that	Wealth of data sets	Help, hints and steps to
employ Core Math Tools	organized by data type	do basic tasks





## Reflection



### The Framework

#### **Statistical Problem Solving Process**

- I. Formulate Questions
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- III. Analyze Data
- **IV. Interpret Results**





How did you see the progression from middle school to high school?



### Cluster: Draw informal comparative inferences about two populations.

7.SP.3 Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.

7.SP.4 Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.



Conceptual Category: Probability and Statistics Domain: Interpreting Categorical and Quantitative Data

Cluster: Summarize, represent, and interpret data on a single count or measurement variable

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.



Conceptual Category: Probability and Statistics Domain: Making Inferences and Justifying Conclusions

Cluster: Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

S-IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.



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"Statistical problem solving is an investigative process that involves four components." GAISE



### Thank you!





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