An American Statistical Association Policy Document

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- I am

1. a high school teacher
2. a middle School teacher
3. an elementary School teacher
4. an administrator
5. a PD developer/administrator

What is your confidence level with the statistics standards in the Common Core for the grade band you teach?

1. very confident
2. confident
3. neutral
4. not comfortable
5. terrified!

Do you teach statistics units/courses?

1. I am supposed to teach statistics but I leave it to the end of the year and often do not get to it

2. I teach 1 or 2 units/chapters on statistics and probability

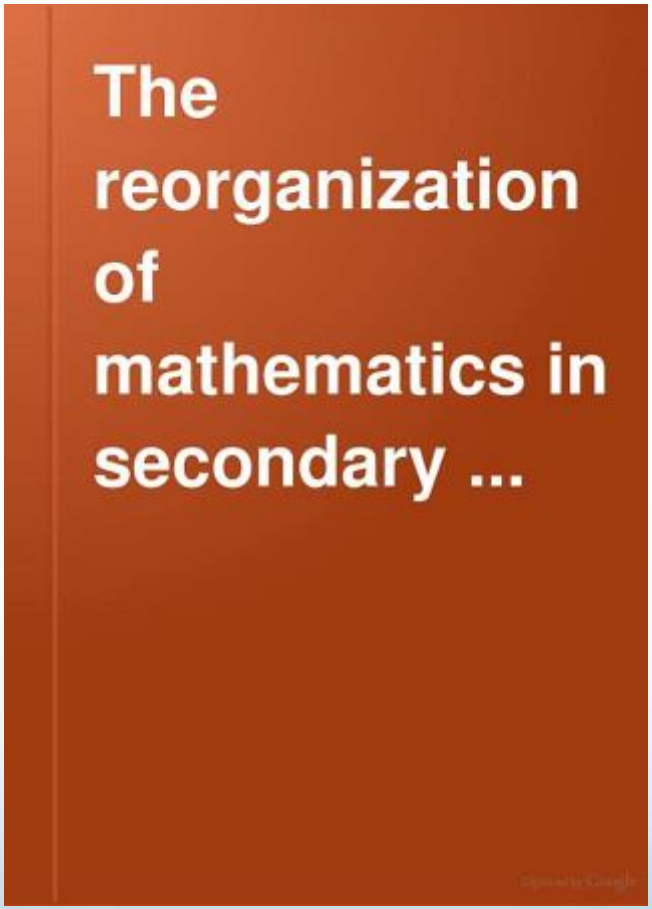
3. I teach a lot of statistics and probability but not a full course

4. I teach a full course dedicated to statistics and probability

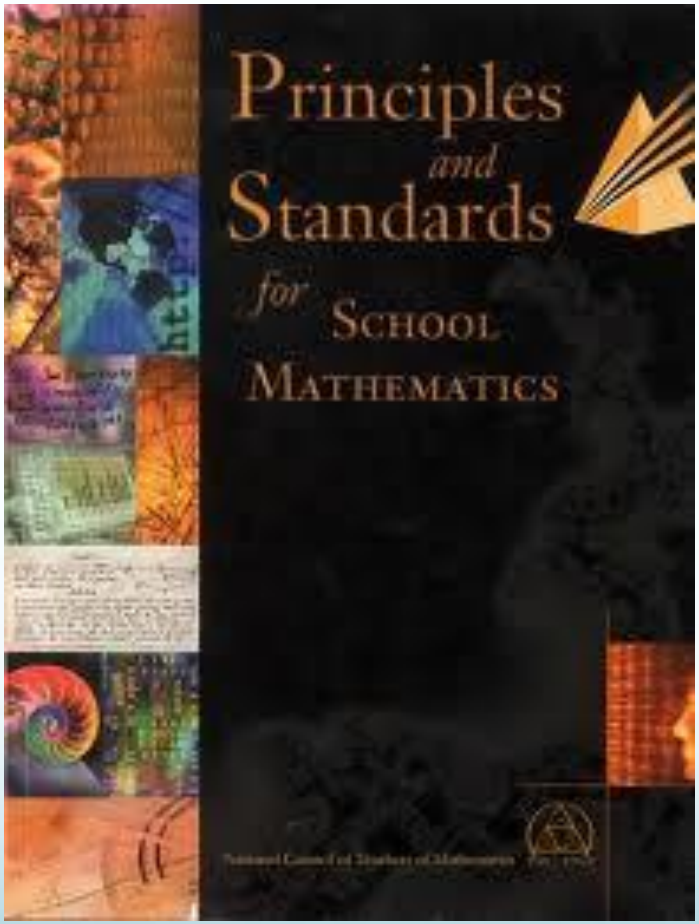
Data Scientist: Sexiest Job of the 21st Century

- *Harvard Business Review*

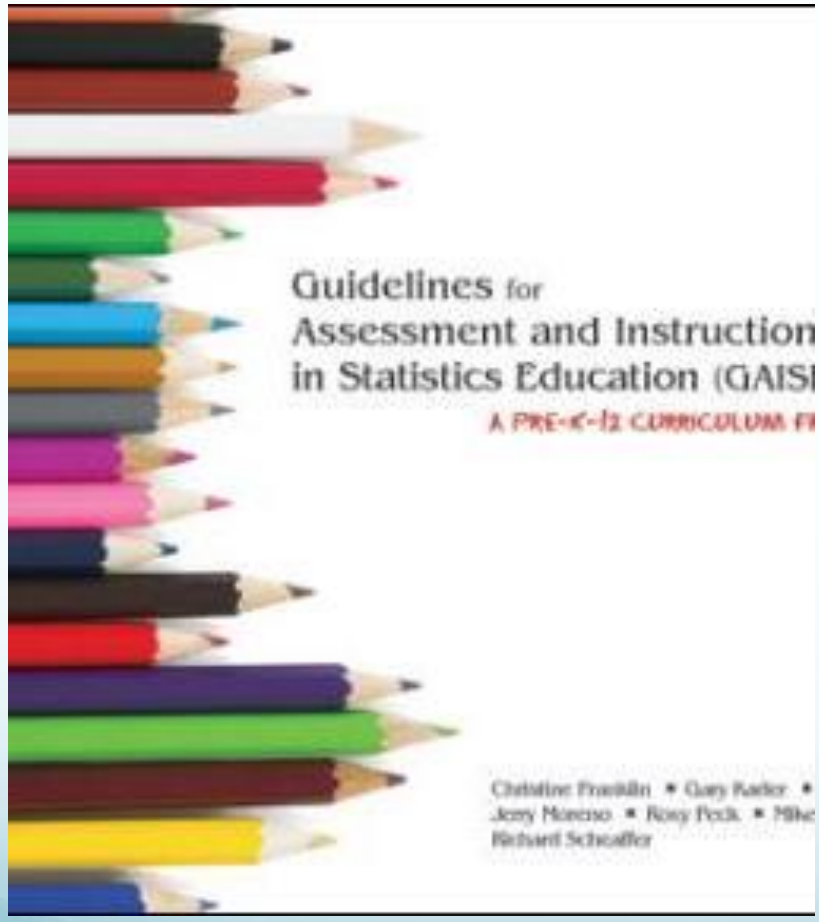
MAA – 1923: Junior high should include statistics and a stat course in high school



2000 NCTM Standards: Includes the Probability and Data Analysis Strand



2005/2007 GAISE sponsored by ASA



2012 Common Core and Statistics

Statistics in the Common Core

- Statistics in elementary school is important but limited to
  - Representing and interpreting categorical data using picture and bar graphs
  - Generating, representing and interpreting measurement data using line plots
- Main topics in middle school include
  - Statistical investigative process introduced
  - Statistical variability
  - Distributions
  - Drawing inference about populations using samples
  - Simulations
  - Bivariate data analysis
- Main topics in high school include
  - Categorical and quantitative data analysis
  - Inference using randomization tests and simulation
  - Conditional probability and probability rules
  - Probability for decision making

Huge Opportunities

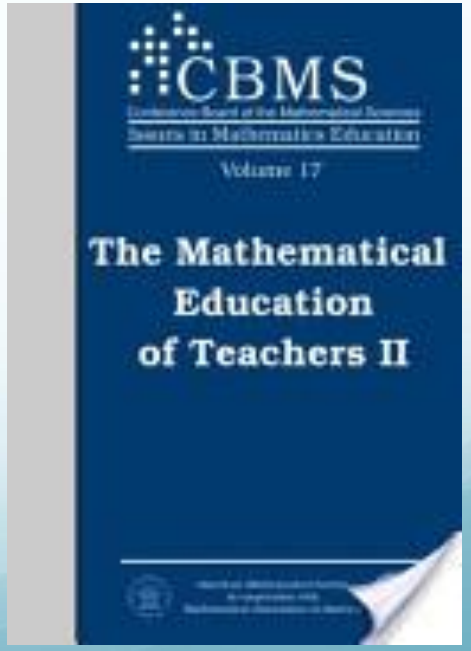
- Statistical Literacy for All!

Huge Challenges

- **Preparing K-12 teachers to deliver the statistical content in the CCSS – both pre-service and in-service teachers**

MET 2

- Recommends a statistic course beyond intro statistics for middle school
- Recommends a modern day one or two course intro sequence for high school
- Emphasizing concepts
- Utilizing activities and technology



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Format of SET Report

- Chapter 1: Background and Motivation for SET
- Chapter 2: Recommendations
- Chapter 3: Mathematical Practices through a Statistical Lens
- Chapters 4-6: Grade level content
- Chapter 7: Assessment
- Chapter 8: Overview of Research
- Chapter 9: A Brief History of Statistics in the School
- Appendix of Examples

Recommendations for Elementary Teacher Preparation

- SET recommends that elementary teachers take
  - A special section of an introductory course

  OR
  - An entire course in statistics content for teachers

  OR
  - A reconfiguration of an existing content course for teachers to include at least 6 weeks of study of statistics and related ideas in probability

Recommendations for Middle Teacher Preparation

- SET recommends that middle school teachers take
  - A special section of an introductory course

  AND
  - A course focused on the statistical content they will be teaching using the GAISE framework as a model
    - Emphasis on connections across grade bands and areas of study

Recommendations for High School Teacher Preparation

- SET recommends that high school teachers take:
  - An introductory course that emphasizes modern data analysis, simulation approaches to inference using the appropriate technologies
  - A second course in statistical methods that builds on first course including randomization and classical procedures for inference [for example comparing two parameters, ANOVA, and tests for categorical data]
  - A statistical modeling course based on multiple regression, including the use of both categorical and numerical explanatory variables and the fitting of exponential and power models

Summary of “Courses”

- Elementary
  - 6 weeks to 1 course
- Middle
  - 2 courses
- High
  - 3 courses
- These recommendations are consistent with MET II.
- Courses should incorporate a pedagogical component demonstrating how best to foster statistical reasoning.

The Introductory Course

- The standard college level introductory statistics course is *not* adequate for teacher preparation.
- SET recommends a modern day introductory course that emphasizes
  - data analysis
  - simulation approaches to understanding inference
  - modeling
  - probability as a tool for statistics
- The typical introductory course tends to be formula-based, covering a list of hypothesis tests and probability topics somewhat removed from the statistical concepts.

Switch Gears….

- Let’s talk about statistics!

The Statistical Process

- Formulate questions
- Collect data
- Analyze data
- Interpret results

Connections

- We want statistics to be connected throughout the grade bands
  - Elementary → Middle → High
- We want content at each grade band that will progress students through the statistical investigative process

- Let’s explore an example from SET taken across all three levels to show what statistics should look like across the grade bands.

Bottle and Tap Water

- Students have just learned that bottled water consumption is on the rise.

Grade Band Progression of Questions

- **Elementary**: Students wonder whether students at their school prefer to drink bottled water or tap water
  - In our class, what type of water (bottle or tap) do students prefer to drink?
- **Middle**: Students wonder whether people actually prefer bottle to tap or if they could tell the difference between the two
  - Are people more likely than not to correctly identify bottled water in a taste test?
- **High**: Students wonder whether people actually prefer bottle to tap or if they could tell the difference between the two
  - Is there evidence that people can tell the difference between bottled water and tap water by taste alone?

Audience Question

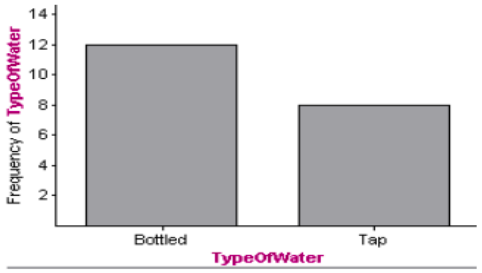
- What differences do you notice in question formulation among the grade levels?

Elementary

- Class participate in a study
  - Survey the class
  - “What type of water, bottled or tap, do you prefer to drink?”
- Each classmate answers either bottled (B) or tap (T)
- The data are categorical

Elementary Cont.

Type of Water Preferred	Frequency (Count)
Bottled	12
Tap	8
Total	20



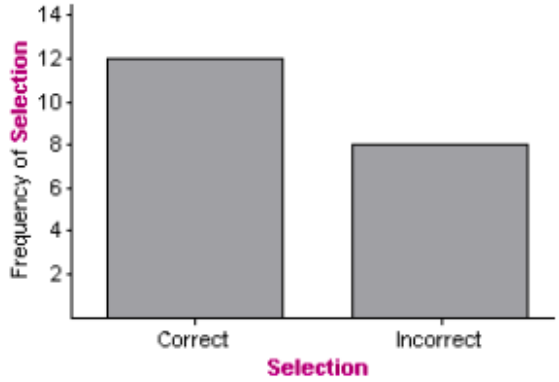
- The teachers can conclude that a majority of students in the class preferred to drink bottled water.
- Can they infer this result to all students at the school? Would other classes have the same preference?

Middle

- Teacher investigates
  - “Are people more likely than not to correctly identify bottled water in a taste test?”
- This requires data on the categorical variable “which cup a participant identifies as bottled water”
- Recorded values consist of correctly selected bottled water (C) or incorrectly selected (I)
- 20 students are given 2 cups of water (one with bottled and one with tap)
- Students asked to identify the bottled

Middle Cont.

Selection	Frequency (Count)
Correct	12
Incorrect	8
Total	20



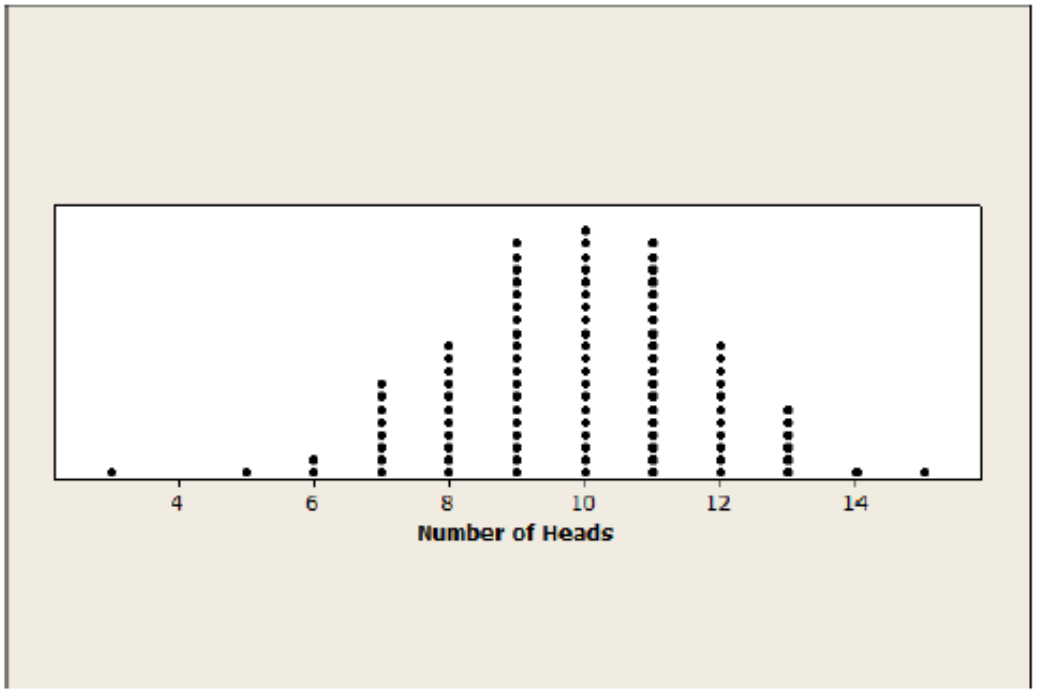
- Frequency table and bar graph summary of the data
- 12 (or 60%) or participants were correct, because this was more than half the participants it provides some evidence that people are more likely than not to identify bottled water
- 12 (or 60%) are sample statistics since computed using sample data

Middle Cont.

- It is still possible that each participant was simply guessing and in fact did not have a preference?
- Is 12 out of 20 a likely outcome when participants are just guessing?

Simulation

- Simulate 100 trials of flipping a coin 20 times
- Is it plausible that participants were simply guessing?



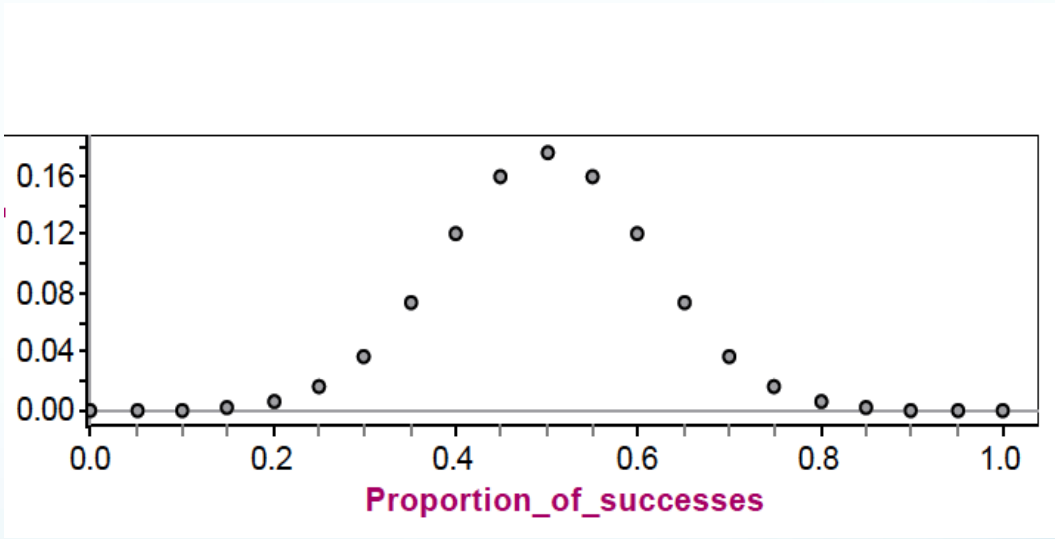
High

- Teacher investigate
  - “Is there evidence that people can tell the difference between bottled water and tap water by taste alone?”

- If people were just random guessing, the number of correct choices will have a binomial distribution with .5 probability of correct selection on each of the 20 trials

High School

Successes	Proportion of successes	Probability
0	0	0
1	0.05	0
2	0.10	0.0002
3	0.15	0.0011
4	0.20	0.0046
5	0.25	0.0148
6	0.30	0.0370
7	0.35	0.0739
8	0.40	0.1201
9	0.45	0.1602
10	0.50	0.1762
11	0.55	0.1602
12	0.60	0.1201
13	0.65	0.0739
14	0.70	0.0370
15	0.75	0.0148
16	0.80	0.0046
17	0.85	0.0011
18	0.90	0.0002
19	0.95	0
20	1	0



High Cont.

- The probability of seeing a success rate of 60% (12 out of 20) or more is about 25%
- This is called the p-value for this decision
- Because this probability is fairly large, getting 12 people out of 20 that correctly identified the bottled water is a reasonably likely outcome under the random guessing assumption
- There is very little evidence to support the argument that the participants were able to distinguish between bottled and tap

Audience Questions

- What do you notice as the difference in study design at the different grade levels?
- What do you notice about the difference in the way the data are analyzed at each level?
- What do you notice about the difference in the way the study results are interpreted at each grade level?

Now for more statistics fun!

Scenario: Homework

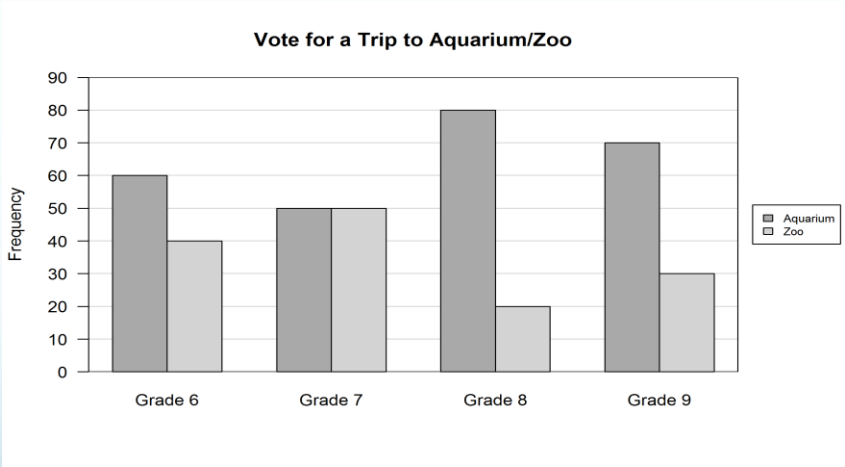
- A middle school student thinks that teachers at his school are giving too much homework, and he intends to make use of his statistics project to study his conjecture. This student needs to transition from this research topic to a statistical question to investigate. Which of the following questions would **not** be a good statistical question to investigate and why?

Some possible questions he could investigate are:

1. How many hours per week do students at this school spend on homework?
2. Do you think teachers at this school are giving too much homework?
3. How does the amount of time students spend on homework per week at our school compare with the amount of time students spend on homework per week at another school?
4. Is there an association between the number of minutes spent on homework each day and the amount of sleep students get on school nights?

Scenario: Aquarium and Zoo

- A school is planning a field trip to the aquarium or to the zoo for students in grades 6 through 9. To determine whether the school should go to the aquarium or the zoo, the school principal investigates the following statistical question:
- *Which field trip is most popular among students in each grade?*
- There are 100 students at each grade level and every student was asked which place he or she would prefer to visit. The bar graphs for the four grade levels are shown below.



- In which grade level were the responses least variable?

Procedural

- California Department of Education released item on the California Standards Test (7th grade item)

Jared scored the following numbers of points in his last 7 basketball games: 8, 21, 7, 15, 9, 15, and 2. What is the median number of points scored by Jared in these 7 games?

A 9

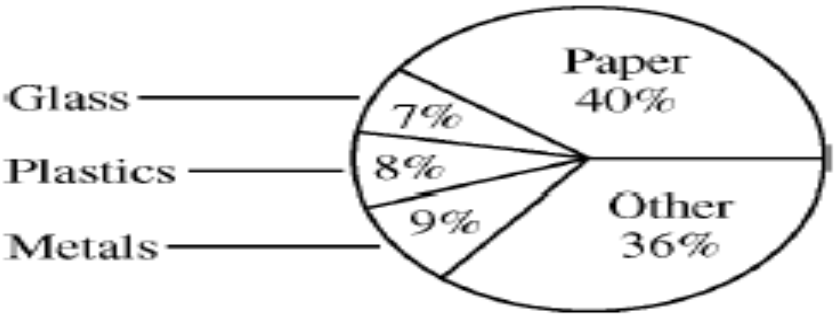
B 11

C 15

D 19

An other Procedural Example

- Item from the Praxis Series Middle School Mathematics Assessment, which is required for teacher licensure in more than 40 states and U.S. territories



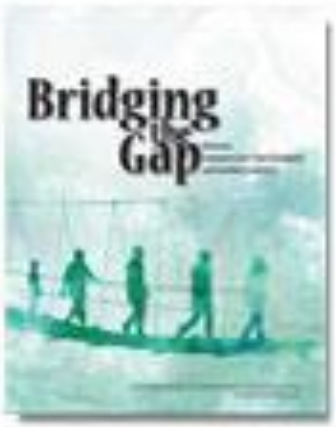
The graph above shows the distribution of the contents, by weight, of a county's trash. If approximately 60 tons of trash consists of paper, approximately how many tons of trash consist of plastics?

(A) 24
(B) 20
(C) 15
(D) 12

Take-Aways

- Teaching statistics should be focused on the statistical process
- The SET report provides recommendations to prepare teachers to successfully carry out the Common Core and other current state standards in their classrooms

ASA K-12 Resources



ASA K-12Resources