SET

Statistical Education of Teachers

Essential Knowledge for Effective Teaching and Learning of Statistics

Christine Franklin, University of Georgia
Denise Spangler, University of Georgia
Anna Bargagliotti, Loyola Marymount University

Data are Everywhere!

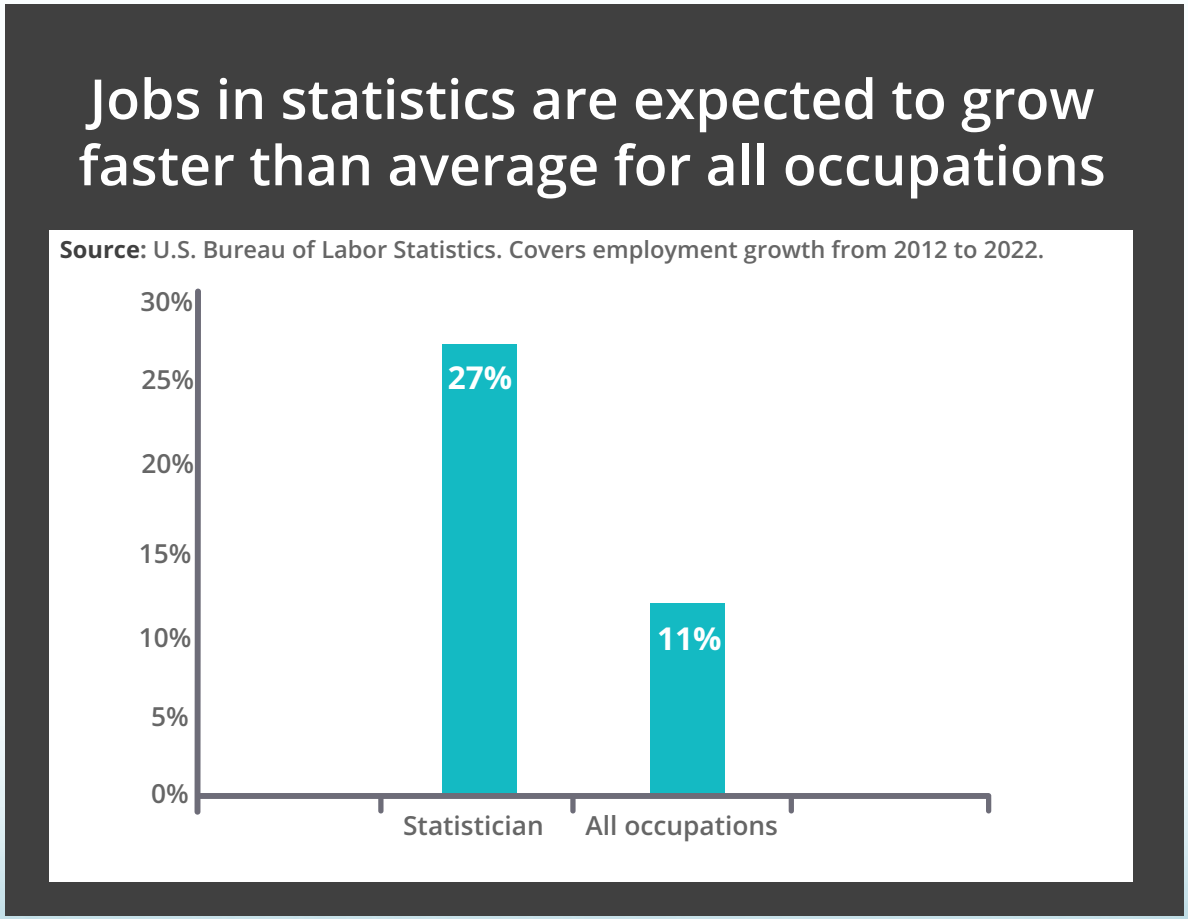
Quantified Self Movement

How to Become Data Savvy

Data Scientist: Sexiest Job of the 21st Century

- Harvard Business Review

The Future Jobs – In Statistics



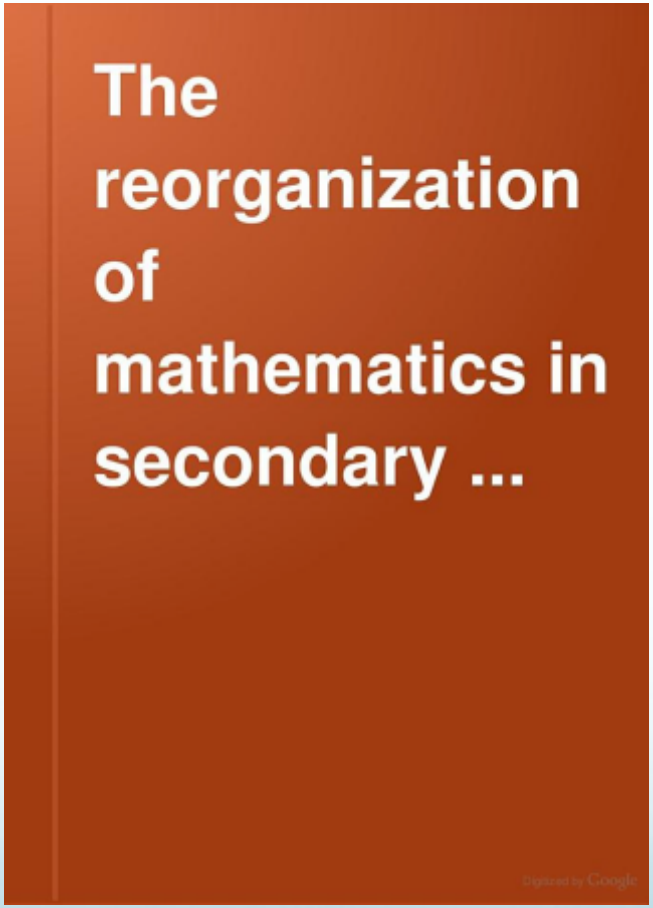
Data Science Class Offers L.A. Unified Students New Handle on Math

mobilize

Our data. Our lives.

www.mobilizingcs.org

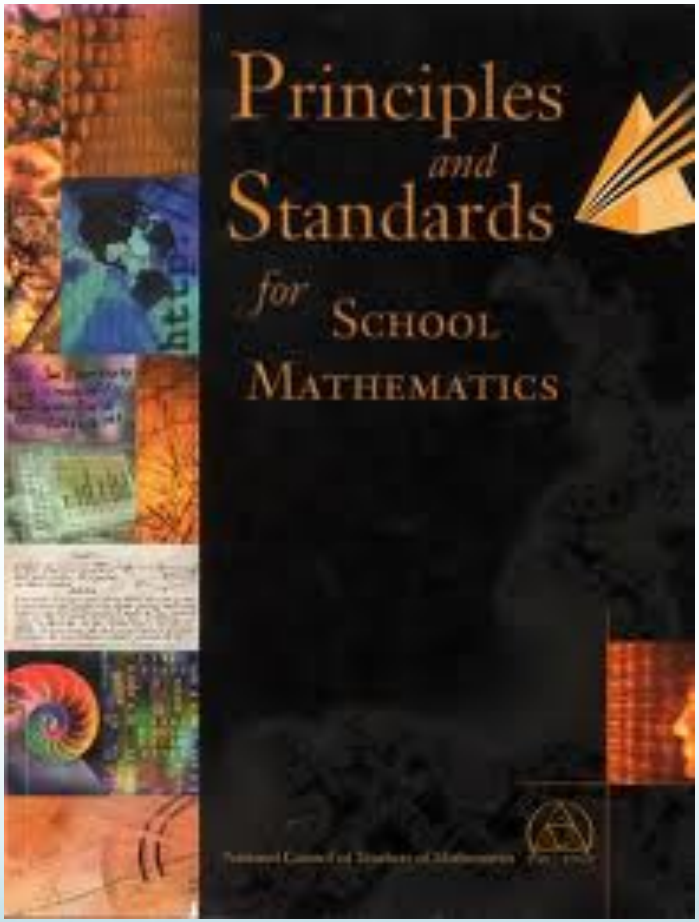
MAA – 1923: Junior high should include statistics and a stat course in high school



1990's AP Statistics becomes Reality

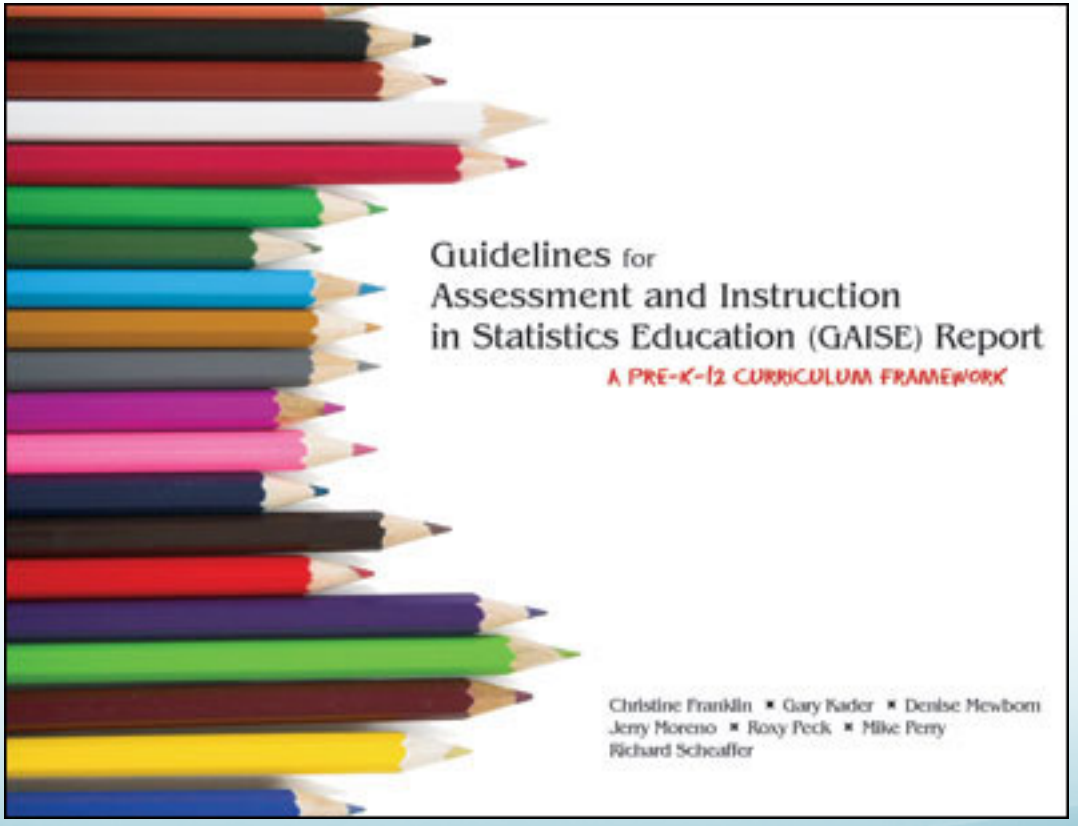
CollegeBoard
Advanced Placement Program

2000 NCTM Standards: Includes the Probability and Data Analysis Strand



2005/2007 Pre-K-12 GAISE sponsored by ASA

- http://www.amstat.org/education/gaise/gaiseprek-12_full.pdf



2012 Common Core and Statistics

COMMON CORE
STATE STANDARDS INITIATIVE
PREPARING AMERICA'S STUDENTS FOR COLLEGE & CAREER

Math Standards
Common Core State Standards

Statistics in the Common Core

- The presence of statistics in elementary school is important but is limited

- 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

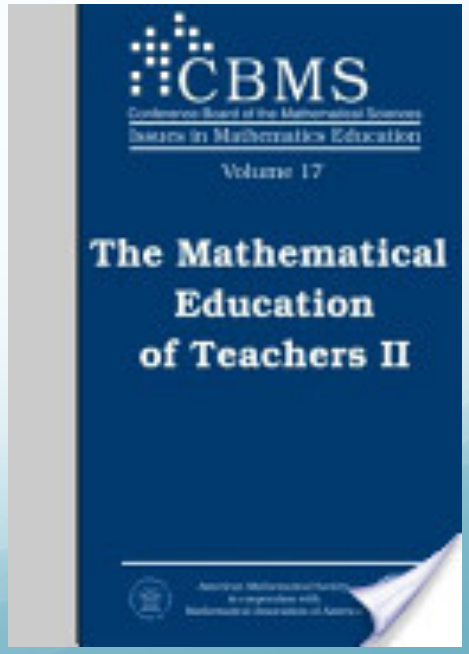
- Statistical Literacy for All!

Huge Challenges

- Preparing teachers to deliver the statistical content in the CCSS
- Implementing statistics and data science in K-12 classrooms

MET 2

- Recommends a statistic course beyond intro statistics for middle school
- Recommends for high school a modern day one or two intro course sequence
- Emphasizing concepts
- Utilizing activities and technology
- http://www.cbmsweb.org/MET_Document/



SET

Statistical Education of Teachers

- Writers:
  - Christine Franklin, University of Georgia
  - Anna Bargagliotti, Loyola Marymount University
  - Catherine Case, University of Florida
  - Gary Kader, Appalachian State
  - Richard Schaeffer, University of Florida
  - Denise Spangler, University of Georgia

http://www.amstat.org/education/SET/SET.pdf

Format of SET Report

- Chapter 1: School Statistics and Teachers' Statistics
- Chapter 2: General Recommendations and Program recommendations
- Chapter 3: Mathematical Practices through a Statistical Lens
- Chapters 4 -6: Grade level content chapters
- Chapter 7: Assessment
- Chapter 8: Research
- Chapter 9: History
- Appendix of Examples

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.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
6. Attend to precision.

2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.

Reasoning and Explaining

4. Model with mathematics.
5. Use appropriate tools strategically.

Modeling and Using Tools

7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Seeing Structure and Generalizing

MP6: Attending to Precision

- In statistics, one must be precise about ambiguity and variability.
- Students understand the statistical problem-solving process begins with the precise formulation of a statistical question that anticipates variability in the data collected that will be used to answer the question.
- Precision is also necessary in designing a data-collection plan that acknowledges variability.
- Students are precise about choosing the appropriate analyses and representations that account for the variability in the data.
- Students can transition from exploratory statistics to inferential statistics by using margin of error to quantify sampling variability around a point estimate. Students recognize the precision of this estimate depends partially upon the sample size.

The Statistical Education of Teachers (SET)

- The report emphasizes that teachers of all grade levels need to understand the “statistical process”
  - Formulate questions
  - Collect data
  - Analyze data
  - Interpret results

- The statistical process components are the common headings in the three chapters (elementary, middle, and high) of SET

NCTM NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

ASA AMERICAN STATISTICAL ASSOCIATION American Statistical Association

The Statistics Teacher Network

www.amstat.org/education/stn/index.html

Number 68 ASA/NCTM Joint Committee on the Curriculum in Statistics and Probability Winter 2006

A Sequence of Activities for Developing Statistical Concepts

Christine Franklin & Gary Kader

Introduction

The Board of Directors of the American Statistical Association (ASA) at its May 2005 meeting endorsed the report, "A Curriculum Framework for Pre K-12 Statistics Education." The development of this *Framework* was supported by the ASA though funding of a Strategic Initiative Grant proposed by the ASA Advisory Committee on Teacher Enhancement. The *Framework* is designed to give educators guidance towards developing statistically literate citizens. The writers of the *Framework* were Christine Franklin, Gary Kader, Denise Mewborn, Jerry Moreno, Mike Perry, Roxy Peck, and Richard Scheaffer.

The Framework Model

Statistical Problem Solving and the Evolution of Statistical Concepts

The *Framework* presents statistical problem solving as an investigative process that involves four components:

(1) Question formulation,

(2) Data collection,

(3) Data analysis,

(4) Interpretation.

The *Framework* stresses the importance of understanding variability in the practice of this process. The formulation of a statistics question requires an understanding of the difference

between a question that anticipates a deterministic answer and a question that anticipates an answer based on data that vary. The anticipation of variability is the basis for understanding this distinction. Data collection designs must acknowledge variability in data and frequently are intended to reduce variability. An understanding of data collection designs that acknowledge variability is required for effective collection of data. The main purpose of statistical analysis is to give an accounting of the variability in the data. Accounting for variability with the use of distributions is the key idea in the analysis of data. Statistical interpretations are made in the presence of variability and must allow for it. Looking beyond the data to make generalizations must allow for variability in the data.

Understanding the role of variability in the statistical problem solving process requires maturation in statistical thinking. The beginning student cannot be expected to make all of these linkages. Statistical education should be viewed as a developmental process, and this report provides a framework for statistical education over three developmental levels, A, B, and C. Although these three levels may parallel grade levels, they are based on development in statistical thinking, not age. Thus, a middle school student who has had no prior experience with statistics will need to begin with Level A concepts and activities before moving to Level B. This holds true for a secondary student as well. If a student hasn't had Level A and B experi-

Also In This Issue...

http://www.amstat.org/education/stn/

Distinction of Levels: Questions and Type of Survey

All four steps of the statistical process are used at all three levels A, B, C. The depth of understanding and sophistication of methods used increases across the levels.

Statistical questions at each level and data collection:

Level A: What type of music is most popular among students in our class (rock, country, rap)? [A census]

Level B: What type of music is most popular among students at our school? How does music preference differ among classes? [Use sampling and consider random sample]

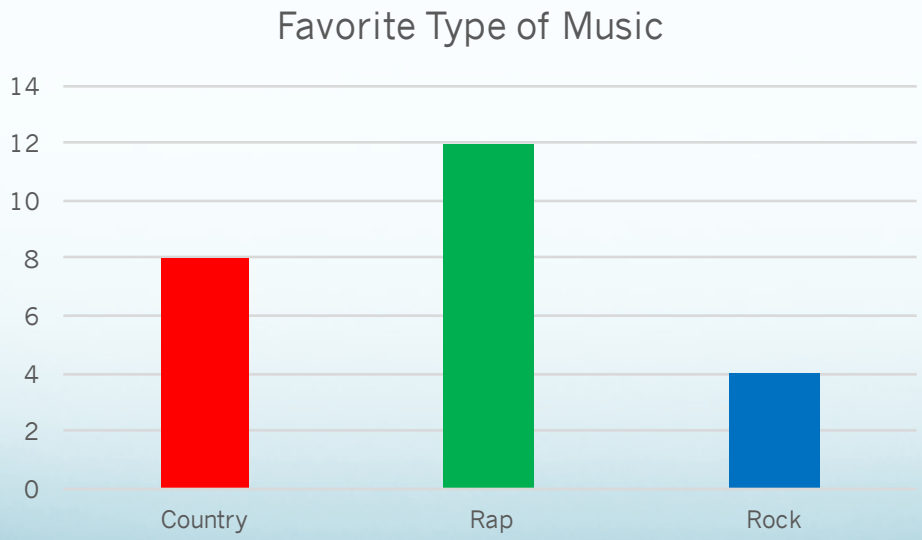
Level C: Is there an association between liking rock and liking rap music at all high schools in the school district? [Use simple random sample]

Distinction of Levels: Distributions

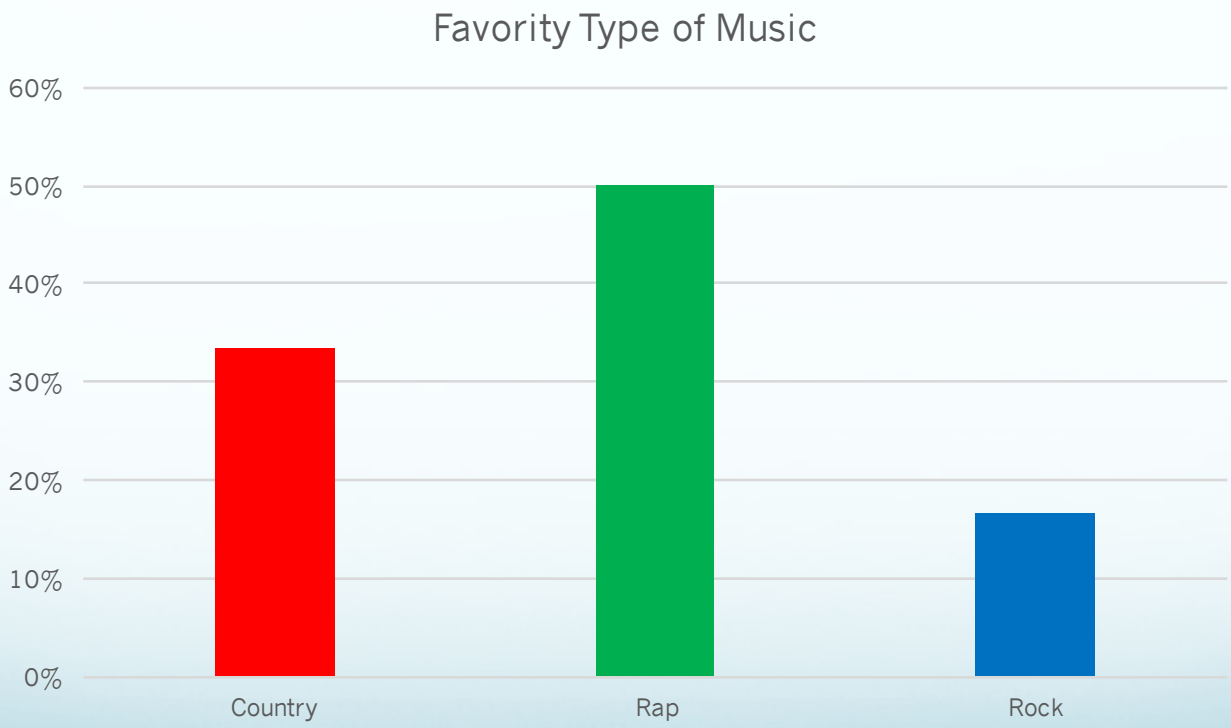
What type of music is most popular among students in our class? (rock, country, rap)

Level A

Summarize frequencies in table or bar graph

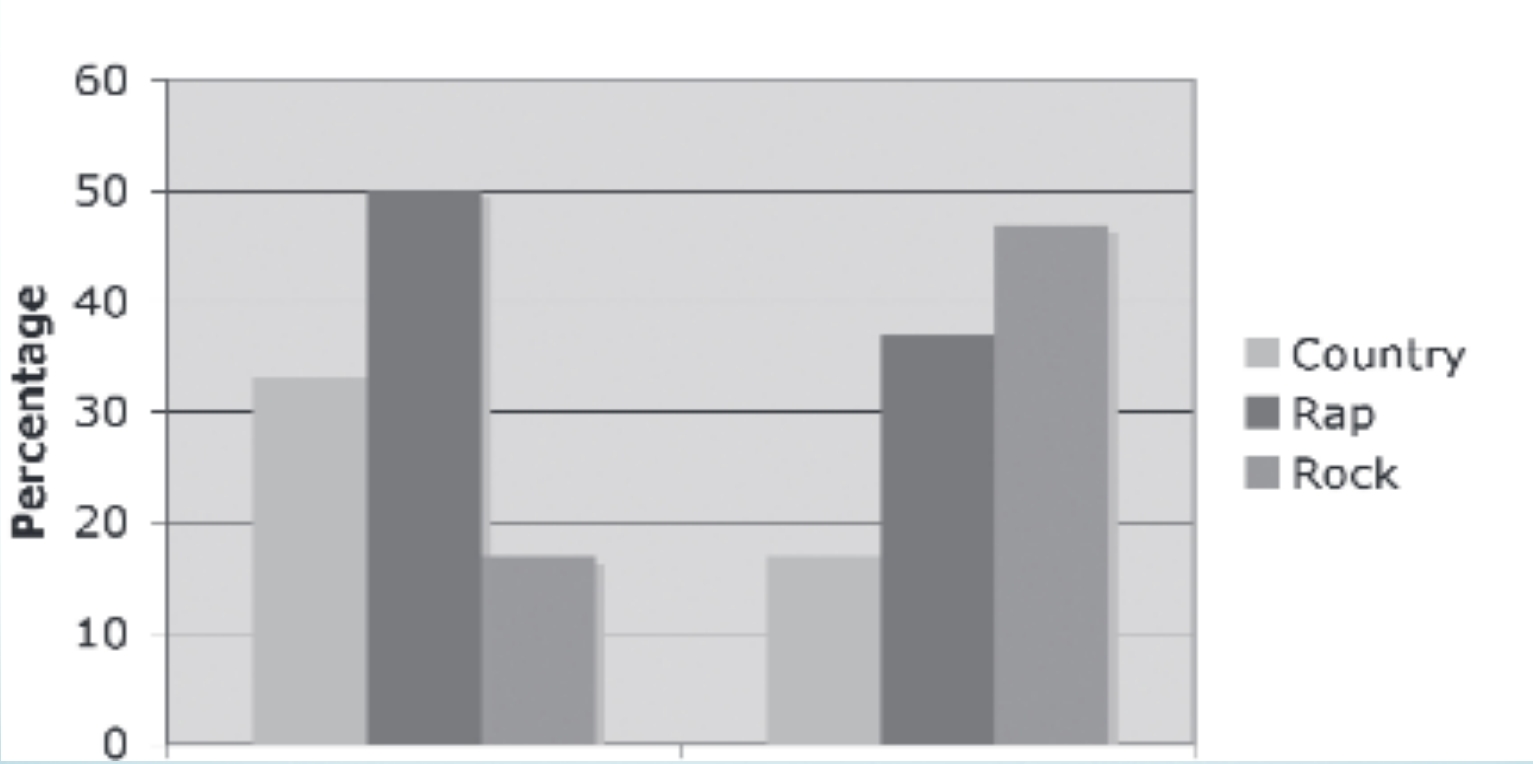


Level B
Relative Frequencies



Level B Comparison

- How does music preference differ among classes?



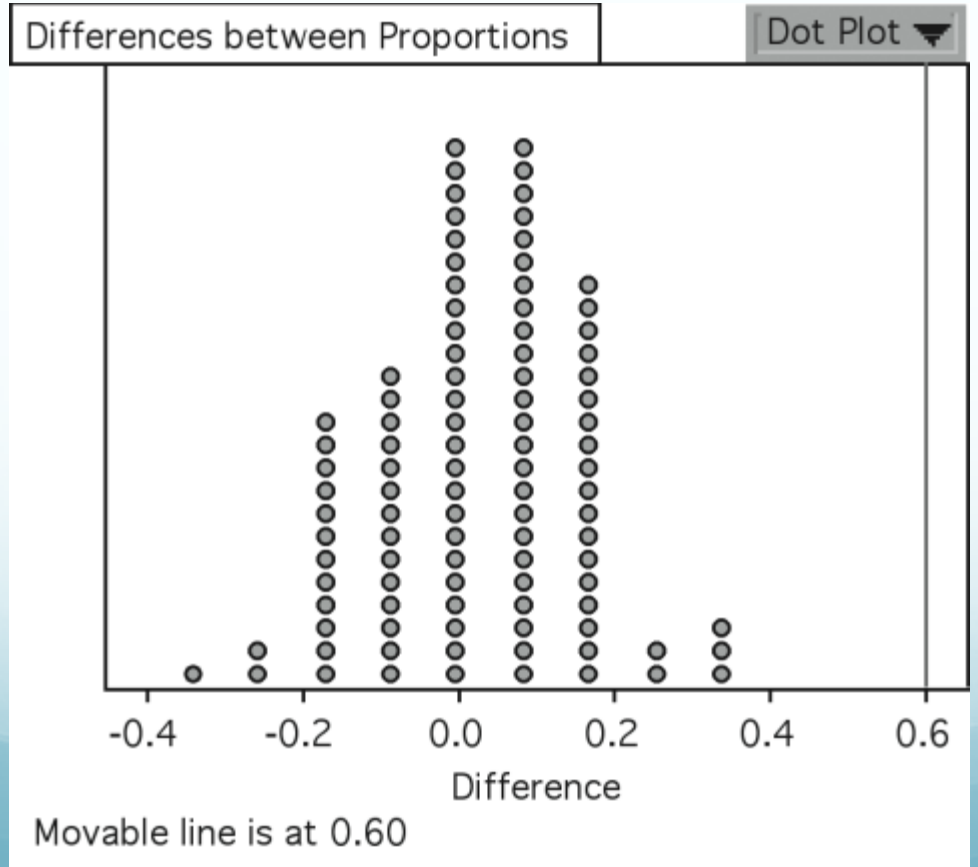
Level B
Association between 2 variables

- Is there an association between liking rock and liking rap music at all high schools in the school district?
- Is the proportion of rap lovers who like rock different than the proportion of rap lovers that do not like rock?

$25/31 = 0.81$ $4/19 = 0.21$ $0.81 - 0.21 = 0.60$		**Like Rock Music?**		
		Yes	**No**	**Row Totals**
Like Rap Music?	**Yes**	25	4	29
	No	6	15	21
Column Totals		31	19	50

Level C
Association between 2 variables

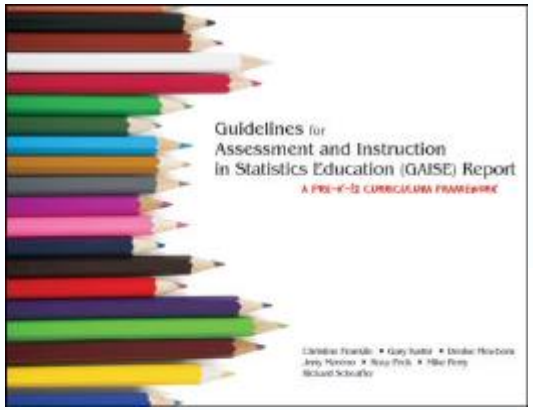
- Dotplot showing simulated sampling distribution of the difference in proportions using a randomization test to observe what happens due to chance variation – find a simulated P-value

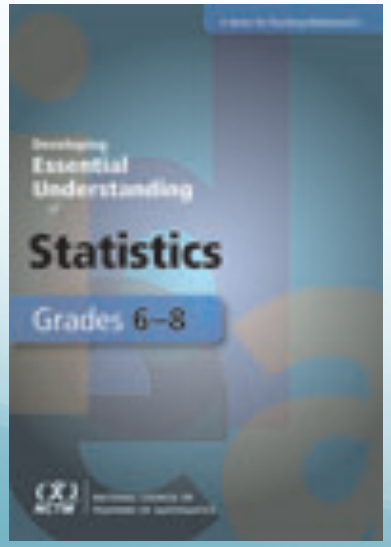


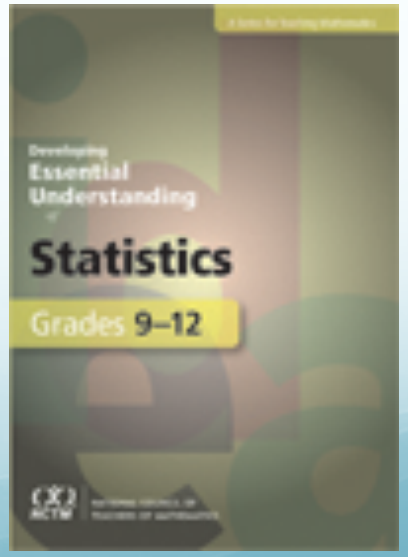
Appendix

- 12 scenarios focused around the themes:
- Question/Design Alignment
- Connections between Data type, Numerical Summaries, and Graphical Displays
- Proportional Reasoning in Statistics
- The Role of Randomness in Statistics
- Common misconceptions are discussed

Joint ASA – NCTM Committee







ASA K-12Resources

STatistics Education Web
STEW
online journal of K-12 statistics lesson plans

https://www.amstat.org/education/stew/

MWM
Meeting Within a Meeting
a statistics workshop for K-12 teachers

https://www.amstat.org/education/mwm

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American Statistical Association
The Statistics Teacher Network

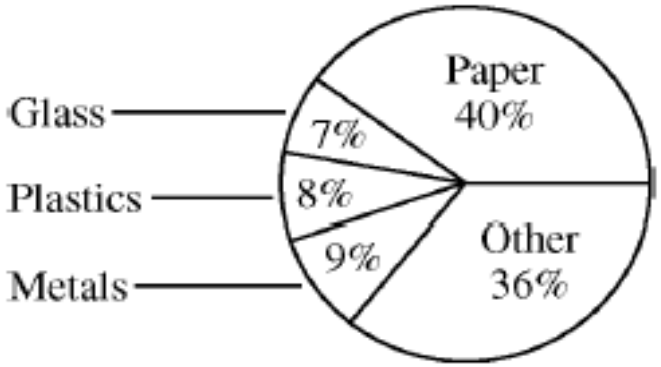
http://www.amstat.org/education/stn/

CENSUS at SCHOOL

https://www.amstat.org/censusatschool/

ASSESSMENT TIME

Traditional Statistics Assessment Item



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

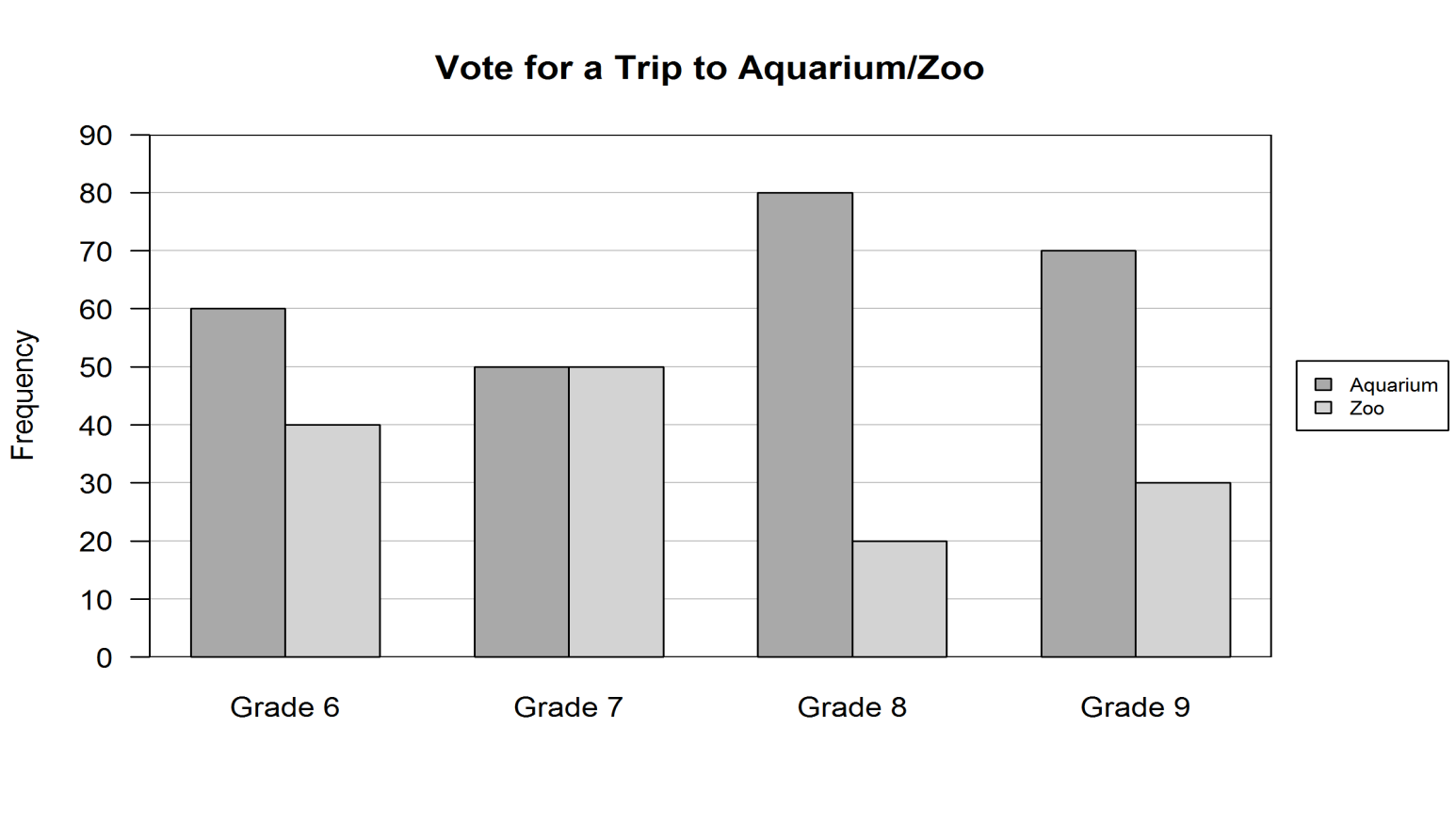
LOCUS NSF Project

LOCUS
Levels of Conceptual Understanding in Statistics

Supported by: NSF
DRL-1118168

https://locus.statisticseducation.org

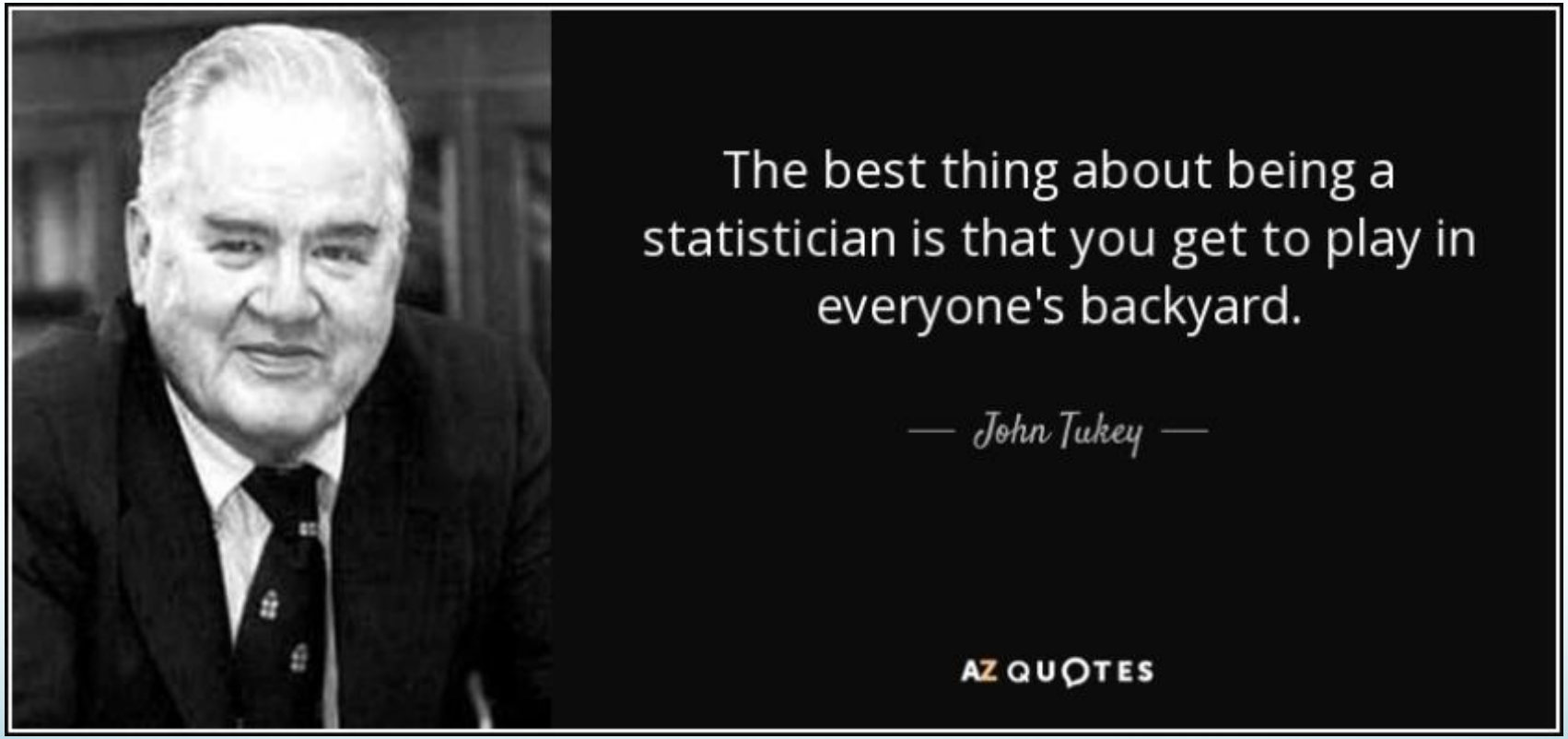
In which grade level did the responses vary the most?



In which grade level did the responses vary the most?

- Grade 6 1%
- Grade 7 13%
- Grade 8 85%
- Grade 9 2%

Exciting time to be a Statistician



Take-aways

- Professional development for teachers aligned with the SET recommendations is key to achieving a data literate society
- Leverage AP Stat teachers' expertise
- Make use of the many free resources available
- Build teacher learning communities focused on statistics teaching and learning and use local/relevant data

Feel free to Email Us

- Christine Franklin: codycory@uga.edu
- Denise Spangler: dspangle@uga.edu
- Anna Bargagliotti: abargagl@lmu.edu