Developing Statistical Skills for School Level Teachers and Students

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Data are Everywhere!
Quantified Self Movement

Social Media

Always Generating Data
Crossroads

fMRI data

How to Become Data Savvy
What story might these # tell?

• 1
• 2
• 22
• 43
• 626

These # represent?

• 1 Statistician Best Business Job Rank
• 2 Statistician Best Overall Job Rank; Best STEM Job

From 2019 US News and World Report

• 22 % increase in statistics bachelor degrees 2016-17
• 43 % females earning statistics bachelor degrees 2016-17
• 626% increase in statistics bachelor degrees 1987-2017

From National Center for Education Statistics

Future Jobs – In Statistics

Jobs in statistics are expected to grow faster than average for all occupations


1997 AP Statistics becomes Reality

Number of Advanced Placement Statistics Exams 1997 to 2017
ASA, 2007, Franklin et al.

The practice of statistics
GAISE (2007) – “statistical problem solving”
- Formulate Questions - Anticipating Variability;
- Collect Data - Acknowledging Variability;
- Analyze Data - Accounting of Variability;
- Interpret Results - Allowing for Variability.

Mathematics and statistics: What do you think are similarities and differences?

Mathematics and statistics

Differences
- Where’s the proof? Vs Where’s the data?
- Inductive vs deductive reasoning
- Anticipate, acknowledge, account for, and allow for variability in data as relates to a context
- Deterministic vs probabilistic interpretation

Similarities
- Involves problem solving
- Precision
- Modeling and look for structure
- Use appropriate tools strategically
- Critiquing arguments and reasoning of others
- Look for patterns

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
NGSS

Huge Opportunities
- Statistical literacy for all!

Huge Challenges
- Preparing teachers to deliver the statistical content in the CCSS
- Implementing statistics and data science in all K-12 classrooms including science and other fields.

Teacher Preparation a Must Priority

ASA, 2015, Franklin et al.

Six Recommendations
- Prospective teachers need
  - a deep conceptual understanding of the statistics they will teach and develop habits of mind for practicing statistics
  - a statistics education community that includes statisticians as one of many constituencies committed to working together to improve statistics instruction at all levels and to raise professional standards in teaching
  - An introductory statistics course that MODELS the pedagogy the teachers will use at the school level
**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

**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

**The Statistical Education of Teachers**
- The report emphasizes that teachers of all grade levels need to understand the “statistical investigative process:”
  - Formulate questions – Anticipate variability
  - Collect data – Acknowledge variability
  - Analyze data – Accounting for variability
  - Interpret results - Allowing for variability

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

**Mathematical Practices (under a Statistical Lens)**
- MP’s describe ways students of math and stats should engage with the subject content – MP’s are processes and practices that complement content knowledge
  - Emphasize problem solving, reasoning, communications, connections, representations
- Statistical habits of mind: context, measurement, variability, uncertainty, sampling, visuals and trends, skeptic (Lee and Tran, 2015)
MP6: Attending to Precision

Mathematical Precision
- Communicate precisely to each other
- Use clear definitions and state the meaning of symbols
- Specify units of measurements and label axes
- Calculate accurately and efficiently and express numerical answers with a degree of precision appropriate for context
- By high school learn to examine claims and make explicit use of definitions

Statistical 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.

Example: Traditional Statistics Assessment Item

Example: Conceptual Statistics Item
A school is planning a field trip to the aquarium or to the zoo for students in grades 6 through 9. There are 100 students in 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.

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
Coming Soon in 2020

- Modeling Book for Secondary School
- Book for Teacher Educators
- Pre-K-12 GAISE Framework 2

Collaborations Nationally

- New Zealand Statistics Education Committee
- International Data Science in Schools Project (IDSSP)

Collaborations Internationally

- New Zealand Statistics Education Committee
- International Data Science in Schools Project (IDSSP)

Conclusion – The Art and Science of Learning from Data

- Statistical Literacy for All! Must begin at school level
- Questioning Essential throughout Statistical Problem Solving Process – healthy skeptics
- Statisticians are not data crunchers instead problem solvers
“Food for thought” at K-16
Collaboration needed for teacher preparation
Need more research in statistics education especially at the school level
Catching up with data and statistical literacy expectations at post secondary level

Thank You!

Questions?
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