My Three Favorite Activities for Statistics Class

PSMATYC Conference – April 11, 2015
(http://homepage.villanova.edu/Michael.Posner)

Michael A. Posner, Ph.D., PStat®
Associate Professor of Statistics
Department of Mathematics and Statistics
Director, Center for Statistics Education
Villanova University
Outline

• TANGO Stat Ed Mentorship Program
• Magic of Statistics - Hypothesis Testing
• Random Rectangles – Random Sampling
• Stars in the Sky – Sampling Methods
• My favorite videos
Training a New Generation of Statistics Educators (TANGO Stat Ed)

- An NSF-funded grant to create mentorship communities for community college instructors in four regional hubs around the US (Philly, LA, two more TBD)
- An ASA-funded initiative to create mentorship communities for community college instructors nationwide (no additional expenses)
Two-year Colleges

- 137,000 students enrolled in Intro to Stats at two-year community colleges in 2010 in the US (2010 CBMS report)
- Statistics is a more relevant course than college algebra or calculus for non-quantitative majors (Benjamin, 2009); and
- Statistics is a better endpoint for students in two-year colleges (Bryk and Treisman, 2010).
Reality at Two-Year Colleges

- Only 2% of full-time and 2% of part-time instructors have a degree in statistics at the two year community colleges.
- The majority have no formal training in statistics content knowledge (let alone pedagogical content knowledge)
- 60% of the statistics courses are taught by part-time instructors

2010 CBMS report
TANGO Stat Ed has 3 main components

1. Pair faculty who teach statistics at the community colleges with mentors.

- The mentors selected to participate are experienced statistics educators and active researchers and participants in the field of Statistics Education.
TANGO Stat Ed has 3 main components

2. Faculty will attend an initial training session held at USCOTS (the US Conference on Teaching Statistics), May 26-30, 2015 @ Penn State.

- The participants will get all the cost of attending USCOTS covered
- This will enable/deepen the connections with the broader statistics education community
TANGO Stat Ed has 3 main components

3. Monthly professional learning community (PLC) meetings in each hub that will persist beyond the timeframe of the grant

- PLCs will provide ongoing opportunities for community college instructors to interact with the vibrant and inspiring statistics education community that is dedicated to quality statistics education
GOALS OF TANGO STAT ED

- Provide professional development opportunities beyond the abilities of most community colleges.
- Help community college students, who will be the largest benefactor of this program (over 10,000 students served).
- Benefit society as a whole.
- "There are three kinds of lies: lies, damned lies and statistics."
Who would like to Tango?

- Instructors from two-year colleges who will be teaching statistics
- 36 (from the Philadelphia area) will be able to participate during the three year grant project. 18 in the first year and 18 the following year
- Also in Los Angeles (36) and two more regional hubs (18 each)
Three Statistics Activities

• Back to the regularly scheduled talk…
The Magic of Statistics…Revealed

• Overview
  – Hypothesis testing is a difficult concept. This magic trick makes it memorable.

• Prerequisite Knowledge
  – Independence, probability (mult rule)
  – (Binomial, normal approx to binomial)

• Alternatives
  – Two-headed coin
  – Single color deck of cards
“Out of this World”

• One of the top ten tricks
  – Rated by magicians from around the world
• Created in 1942
• Uses a regular deck of cards
• Single prediction modification created by Larry Smith
• Used by America’s Got Talent 2015 Winner!
Probability

• Define “success” as guessing right
• What is the probability of “success”? – Bayesian vs. Frequentist
Independence

- What is the probability of getting all n right?
- Does the guess of one student affect the next student?
  - Does the probability of “success” change?
  - Series of reds often forces the next guess to be black
Binomial Distribution

• Recall requirements
  – Dichotomous event
  – Independence
  – N trials
  – Constant probability of success (50%)

• What is the probability of getting all n right?
  \[ P(X = n) = p^n \]

• What is the probability of getting n-1 out of n right (modification)?
  \[ P(X = n - 1) = \binom{n}{n-1} p^{n-1}(1 - p) \]
Hypothesis Testing

• If the true probability of “success” is 50%, what is the chance you get all n right?
  – This is the p-value!
  – Binomial calculation
  – Normal approximation to the binomial
    • Only need n=10 until np and n(1-p) = 5

• In the end, students don’t need to understand how the trick works, just that their guesses were likely not random
  – This is how hypothesis testing often works in the real world – you don’t know data generation mechanism
## Calculated Probabilities

<table>
<thead>
<tr>
<th>N</th>
<th>Basic Trick</th>
<th>Single Error (p-value)</th>
<th>Single Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 in 2</td>
<td>1</td>
<td>1 in 48</td>
</tr>
<tr>
<td>2</td>
<td>1 in 4</td>
<td>3 in 4</td>
<td>1 in 64</td>
</tr>
<tr>
<td>15</td>
<td>1 in 32,768</td>
<td>1 in 2,048</td>
<td>1 in 98,304</td>
</tr>
<tr>
<td>20</td>
<td>1 in 1 million</td>
<td>1 in 49,932</td>
<td>1 in 2.4 million</td>
</tr>
<tr>
<td>25</td>
<td>1 in 34 million</td>
<td>1 in 1.3 million</td>
<td>1 in 62 million</td>
</tr>
<tr>
<td>30</td>
<td>1 in 1.1 billion</td>
<td>1 in 35 million</td>
<td>1 in 1.7 billion</td>
</tr>
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</table>
The REAL Magic!

• It makes students enjoy statistics class!
  – Many mention that “he does cool magic tricks” on course evaluations
    • (Although it’s the only one I know!)
  – Students love engagement with activities
Alternatives Hypo Test Activities

• Single color deck of cards
  – “Unopened”
• Two-headed coin
  – Adds motivation for $\alpha=0.05$
Random Rectangles

• Overview
  – Shows the process of random sampling and why it’s important by estimating the average area of 100 rectangles.

• Prerequisite Knowledge
  – How to determine area of a rectangle
  – How to calculate a mean

• Alternatives (for random sampling)
  – Jelly Blubbers Colony
  – Guessing numbers form 1-10

Your poll will show here

1. Install the app from pollev.com/app
2. Make sure you are in Slide Show mode

Still not working? Get help at pollev.com/app/help
or
Open poll in your web browser
Random Rectangles - Results

Dotplot of Guess, Represent, Random5, Random20
Random Rectangles – Summary Statistics & Inference

One-Sample T: Guess, Represent, Random5, Random20

Test of $H_0: \mu = 7.42$ vs $H_a: \mu \neq 7.42$

<table>
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<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>StDev</th>
<th>SE Mean</th>
<th>95% CI</th>
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<th>P</th>
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<td>21</td>
<td>8.286</td>
<td>3.349</td>
<td>0.731</td>
<td>(6.761, 9.810)</td>
<td>1.18</td>
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<tr>
<td>Represent</td>
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<td>3.246</td>
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<td>4.62</td>
<td>0.000</td>
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<tr>
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<td>7.252</td>
<td>2.137</td>
<td>0.466</td>
<td>(6.280, 8.225)</td>
<td>-0.36</td>
<td>0.723</td>
</tr>
<tr>
<td>Random20</td>
<td>5</td>
<td>7.124</td>
<td>1.362</td>
<td>0.609</td>
<td>(5.433, 8.815)</td>
<td>-0.49</td>
<td>0.652</td>
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Random Rectangles – Summary Statistics & Inference

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Random Rectangles - Lessons

• How to take a random sample
• Why random sampling is important
• Describing distributions from dotplots (or other univariate numerical graphical displays)
• Precision increases as sample size increases
• Estimation (Confidence Intervals) and Hypothesis Testing
Sampling Stars in the Sky

• Overview
  – Estimate the number of stars in the sky using Petocz’s activity using sampling techniques.

• Prerequisite Knowledge
  – Random sampling, sampling methods

• Extensions
  – Similar techniques can be used to estimate number of people in a crowd

from Petocz (1990), Sampling Space: Practical Experiments for Teaching Sampling
How many stars are in the sky?
My Favorite Videos

- Hans Rosling – 4 minutes Joy of Stats
- Art Benjamin – Stat vs. Calc
- Bonjour Paris L’Ecole - Confounders
- Esther Duflo – Social Justice
- Steve Wang – The Obvious Answer…
- Entertaining Videos – This is Statistics, Stats Can Be Cool, Realistic Statistics, When I Run A Test
Other Statistical Resources

• **Guidelines for Assessment and Instruction in Statistics Education (GAISE) Reports**
• Consortium for the Advancement of Undergraduate Statistics Education (CAUSE) - [causeweb.org](http://causeweb.org)
• **Stat2Labs** – Games
• **Qualifications for Teaching Intro Stats** (MAA/ASA Joint Committee on Statistics)
  – Including workshops, meetings, etc.
If you would attain to what you are not yet, you must always be displeased by what you are. For where you are pleased with yourself there you have remained. Keep adding, keep walking, keep advancing.

~Saint Augustine