Stepping Outside Classroom Walls

Designing Experiences for Teachers in a Massive Open Online Course [MOOC] on Teaching Statistics

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http://tinyurl.com/iase15-hslee
TO USE INVESTIGATION CYCLES TO TEACH STATISTICS...
Background

- Part of series of 6 MOOC-Eds at NC State's *Friday Institute for Educational Innovation*
  - funded by Hewlett Foundation
  - use custom-made platform—*not* Coursera, EdX, etc...
- Support and development staff
- Free software donation from Pearson for StatCrunch
- Tech support from TUVA
- Many free resources from ASA
- Advertising help from ASA, IASE, NCTM
Designing for Online Learning

The World of Designing for MANY Teachers' Learning Online

- Free and open access
- Personalized
- Does not assume strong statistical knowledge
- Creates a community of professional learners
- Includes strong contributions by, and presence of, the instructor

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Designing for Online Learning
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Free and open access
Personalized
accounts for classroom variation
is not tied to US state or country curriculum
does not assume strong statistical knowledge
creates a community of professional learners
includes strong contributions by, and presence of, the instructor
Why do a MOOC on Teaching Statistics?

Introduce teachers to:
- framework to guide instruction and assessment
- technology tools
- websites for great data (e.g., Census at Schools)
- quality tasks and lesson plans
- classroom ready videos
- easy to read articles
- colleagues around the world teaching statistics to children, adolescents, or adults

So teachers can help students
- ask questions about real data
- engage in investigative cycles
- develop statistical habits of mind
- utilize power of technology
- develop sophistication with statistics over time
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Design Principles

- foster self-directed learning
- foster peer-supported learning
- use authentic learning experiences grounded in practice
- integrate multiple voices
- support crowdsourcing and use of open education resources
Design Challenge 1: Create Framework for Teachers

Adapted from the GAISE framework endorsed by American Statistical Association 2005

Extended to include recent research and integrate habits of mind
Adapted from the GAISE framework endorsed by American Statistical Association 2005
Extended to include recent research and integrate habits of mind
LEVEL C
Creating statistics questions

LEVEL B
Increasing awareness of statistics questions

LEVEL A
Beginning awareness of statistics questions

Designing for group differences incorporating effect of sample size
Designing for group differences and aware of sample size
Designing for sample size and aware of group data

LEVEL A
Using particular properties of distribution to describe group and associations

LEVEL B
Using properties of distributions to compare groups and examine relationships

LEVEL C
Using distributions and modeling relationships in flexible ways

context variability

skeptic uncertainty

variability trends visuals

sampling measurement
# Statistical Habits of Mind

## Pose Questions
- **Context**: Ask contextually-based questions that call for the use of data to answer.
- **Variability**: Seek to explain and control variability.

## Collect Data
- **Measurement**: Consider how to best measure attributes in a context for answering a question.
- **Measurement**: Use appropriate tools (physical and online) to collect and manage data.
- **Sampling**: Consider sample size – it matters.
- **Sampling**: Use random sampling to help control bias.
- **Sampling**: Identify and account for sources of potential variability in data collection methods.
Schoolopoly Task
For Students

Schoolopoly: Is the die fair or biased?

Background
Suppose your school is planning to create a board game modeled on the classic game of Monopoly. The game is to be called Schoolopoly and, like Monopoly, will be played with dice. Because many copies of the game expect to be sold, companies are competing for the contract to supply dice for Schoolopoly. Some companies have been accused of making poor-quality dice, and these are to be avoided, since players must believe the dice they are using are actually “fair.” Each company has provided dice for analysis, and you will be assigned one company to investigate:

<table>
<thead>
<tr>
<th>Luckytown Dice Company</th>
<th>Dice, Dice, Baby!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dice 'R' Us</td>
<td>Pips and Dots</td>
</tr>
<tr>
<td>High Rollers, Inc.</td>
<td>Slice 'n' Dice</td>
</tr>
</tbody>
</table>

Your Assignment
Working with a partner, investigate whether the dice sent to you by the company is fair or biased. That is, collect data to infer whether all six outcomes are equally likely and answer the following questions:

1. Do you believe the dice you tested are fair or biased? Would you recommend that dice be purchased from the company you investigated?
2. What compelling evidence do you have that the dice you tested are fair or unfair?
3. Use your data to estimate the probability of each outcome, 1-6, of the dice you tested.
Dice R' Us

What we think is that we shouldn't buy dice from this company because our evidence shows that it is not close to, but even.

Probability of rolling each number:

- $\text{1} = 13\%$
- $\text{2} = 18.4\%$
- $\text{3} = 17.8\%$
- $\text{4} = 20.8\%$
- $\text{5} = 18\%$
- $\text{6} = 12\%$
Design Challenge 1: Create Framework for Teachers

Adapted from the GAISE framework endorsed by American Statistical Association 2005

Extended to include recent research and integrate habits of mind
Design Challenge 2: Integrate Multiple Voices

Expert Panel speaking from different perspectives:
Susan Friel (UNC-CH),
Webster West (NC State),
Chris Franklin (UCI)

"Working interviews" with the Experts

Essential resources included brief excerpts from papers or video clips from others
Expert Panel speaking from different perspectives:
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Teaching Statistics Through Data Investigations
"Working interviews" with the Experts
Essential resources included brief excerpts from papers or video clips from others.
Types of Data:
Nominal
Ordinal
Interval/Ratio

http://course.statslc.com/
What Makes a Good Question?

The following is a direct excerpt from pages 8-11 in the article:


In dialogues with data we create meaning from images by making sense of and verbalizing in words what we see and understand (Bakker, 2004; Makar & Confrey, 2005). Therefore two key components for promoting statistical reasoning are *image* and *language*. To determine what makes a good question we need to address: Does the language used invoke an image which *shows* what the question is asking and does this image highlight *exactly* what we need to find out about to be able to answer the question? Does the investigative question ask what we really mean (Arnold, 2008)? To answer these questions the use of precise language is critical and vocabulary and sentence structure are important.

Our investigative question in the guide, “Do right foot lengths for 13 year-old NZ boys tend to be bigger than right foot lengths for 13 year-old NZ girls?”, ensures there is a strong link between the precise language used and a mental picture. The question is structured with the key
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Design Challenge 3: Authentic Learning from Practice

- Consider conceptual assessment items by taking the LOCUS test
  
  http://locus.statisticseducation.org

- Animations and videos that illustrate students' work on tasks

- Opportunity to develop a project to implement in their classroom
Consider conceptual assessment items by taking the LOCUS test

Example 1: A 13-year study of 1328 adults randomly selected from a population carefully monitored the personal habits and health conditions of participants. Personal habits included tobacco use and coffee consumption. Health conditions included incidence of stroke. Which of the following questions about this population CANNOT be answered using data from this study?

(A) Are coffee drinkers more likely to smoke than adults who do not drink coffee?
(B) Does coffee consumption cause a reduction in the incidence of stroke?
(C) Do coffee drinkers have fewer strokes than adults who do not drink coffee?
(D) What percentage of the population are coffee drinkers?

http://locus.statisticseducation.org
Animations and videos that illustrate students' work on tasks
Teaching Statistics Through Data Investigations
The following questions can be used to consider the components of a statistical task as a teacher develops, adapts, and analyzes tasks that can engage students in doing statistics.

<table>
<thead>
<tr>
<th>Component of a Statistics Task</th>
<th>Questions to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning Goal</strong></td>
<td>What learning goals does the task aim for students to accomplish? Does the task focus on answering questions that are statistical or mathematical? e.g., Does the task ask students to use computations or graphs? Are these in support of analyzing data to make a decision? or is the use of an algorithm or creation of a graph the focus?</td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td>Does the task call for the use of data (either to collect or use already collected data to answer)? Does the data appear to come from a real source?</td>
</tr>
<tr>
<td><strong>Context</strong></td>
<td>Is context a salient part when solving the problem? Is the context likely to be of interest to the students engaging in the task?</td>
</tr>
<tr>
<td><strong>Investigation Cycle</strong></td>
<td>Does the task address only one phase of a statistical investigation, some phases, or all phases of the cycle?</td>
</tr>
<tr>
<td><strong>Pose</strong></td>
<td>Is the question already posed (by teachers, or curriculum developers) or do students have opportunities to pose statistical questions based on their interest?</td>
</tr>
<tr>
<td><strong>Collect</strong></td>
<td>Does the task offer opportunities for students to plan to collect data: sampling, sample size, attribute, and measurement? Do students conduct the data collection?</td>
</tr>
</tbody>
</table>
Task 1. Car Weight and Mileage

Recall the equation of the least squares regression line is

$$\hat{y} = a + bx$$

Where the slope coefficient $b$ and intercept coefficient $a$ are determined from the sample data, specifically the means and standard deviations for each variable and the correlation coefficient between them:

$$b = r \frac{s_y}{s_x} \quad a = \bar{y} - b\bar{x}$$

The means and standard deviations of sports cars’ weight and fuel efficiency and the correlation between them are reported in the table below:

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Standard Deviation</th>
<th>Correlation</th>
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<tbody>
<tr>
<td>Weight</td>
<td>2997</td>
<td>357.6</td>
<td>-0.816</td>
</tr>
<tr>
<td>MPG</td>
<td>20.867</td>
<td>3.044</td>
<td></td>
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a. Use this information to determine (by hand) the coefficients of the least squares line for predicting a car’s miles per gallon rating from its weight. Report the equation of this line.
b. Use the regression line to predict the city MPG rating for the Audi TT, whose weight is 2655 pounds.
Featured STEW Lesson Plan
For this and other free, peer-reviewed lessons, please visit www.amstat.org/education/stew.

Additional resources accompanying this lesson also are posted.

Sampling in Archaeology

Mary Richardson, Grand Valley State University

This activity allows students to practice taking simple random samples, stratified random samples, systematic random samples, and cluster random samples in an archaeological setting. Additionally, students can compare the performance of simple random sampling and stratified random sampling within the context of a specific archaeological problem.

GAISE Components
This investigation follows the four components of statistical problem solving set forth in the Guidelines for Assessment in Statistics Education.

S-IC. 3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S-IC. 4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.
Using Census at Schools

http://www.amstat.org/censusatschool
Opportunity to develop a project to implement in their classroom
Design Challenge 3: Authentic Learning from Practice

Consider conceptual assessment items by talking the LOCUS text

Animations and videos that illustrate students' work on tasks

Opportunity to develop a project to implement in their classroom

http://locus.statisticseducation.org
Preliminary Results

788 enrolled
43 countries

64% classroom teachers
11% teacher educators
70% had never before participated in statistics-focused professional development

589 engaged in some way at beginning of course
- 197 (33%) active in discussion forum
  (at least 2 posts)
- 142 engaged in final unit (24%)
- strong sense of community developed among participants

Course serves as a trigger for future professional development in statistics
Two examples:
- "I am a teacher educator. I have been posting on what I have learned in lectures and presentations to teachers.
- Instructor in Honduras creating faculty development workshops using TDA MOOC materials and translating all to Spanish"

Classroom Impacts and Their Triggers

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"As I am a teacher educator, I have been passing on what I have learned in activities and presentations to teachers."

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Classroom Impacts and Their Triggers

"I have changed my planning process for statistics. I will use more technology in my teaching and spend more time on the first 2 phases of the investigative cycle. I will encourage statistical habits of mind and movement through the levels of the SASI framework."

"I used to worry about giving students data that was messy and realistic. Now, I look forward to these opportunities because they prompt interesting conversations and engage my students."

"I rely even more on visualization of data. And I use more real-life data in class."

"I will go beyond the textbook, introducing other resources and making sure that the emphasis is on the interpretation of the data and the research question, not just on the computation."

"I will adopt and use the habits of mind. 2. Use the SASI framework. 3. Use data visualization tools. 4. Tell all the teachers I can about what I learned in the MOOC."

"I will utilize the cycle more in my classroom. I will definitely apply some of the resources like the Census in Schools website."
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Acknowledgments

Shout-Out to:
• my co-designers: Dr. Dung Tran, Theresa Gibson, Jennifer Lovett, Tasha Elliott
• the magic makers: Mark Samberg, Alex Dreier, Benjamin Robinson
• Glenn Kleiman and the Hewlett Foundation for making this possible!

Thank you to organizations such as ASA and IASE for helping to spread the word!

Todd Lee, my family, colleagues, and friends for all their support and putting up with my insane schedule and listening to my ideas!

Help spread the word and join us in the fall.

We launch September 28th!

http://www.mooc-ed.org/tsdi
Important links and references

YOUTUBE Playlists of course videos
TSDI-Unit Introduction Videos
https://www.youtube.com/playlist?list=PLG6iFkLydgaoycUA2REsJ9Qfhq-jK4JFE

TSDI-Expert Panel in Statistics Education
https://www.youtube.com/playlist?list=PLG6iFkLydgarS6rnuPUOr3mIdZPYQLhly

TSDI-Animated Illustrations of Students' Statistical Reasoning
https://www.youtube.com/playlist?list=PLG6iFkLydgapK5YqVVqzWMSXja4ZvOPKx

TSDI-Instructional Support Videos in Statistics Education
https://www.youtube.com/playlist?list=PLG6iFkLydgqqtZf9psTZsuWYyAyDA7-h

In September 2015, read a column written by myself and Dalene Stangl about both of our MOOCs in ASA's CHANCE magazine! http://chance.amstat.org/
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