

Flipping Online: Creating an Active Learning Classroom in an Online Biostatistics Course

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Outline

- How we use active learning in our in-person class
- How we have adapted active learning to work in an *online* class
- Feedback from online students

Setting

- Introductory course, Biostatistical Literacy, which aims to develop students' ability to read and interpret statistical results in the medical and public health literature.
- Online course using the Moodle learning management system.
- Graduate students in public health (e.g., MPH, DVM/MPH) and medical professionals (e.g., MD, DNP, DDS, PharmD).
- 50 – 80 students per term.

Topics

- Study designs and sampling methods
- Descriptive statistics
- Hypothesis testing and confidence intervals
 - T-tests, Chi-square tests, ANOVA
- Odds ratios and relative risks
- Screening tests
- Correlation and simple linear regression
- Multiple linear regression
- Logistic regression
- Survival analysis
 - Kaplan-Meier curves, log-rank tests, proportional hazards regression

November 6 - November 12

Unit 10 - Communicating Risk

Lesson

Learning objectives, readings
and recorded lectures


 [Unit 10 - Communicating Risk](#)

Assignments & Activities

 [Unit 10 Readiness Quiz \(due Wed 11/8\)](#)

 [Unit 10 Concept Activity & Collaborative Key \(due Sun 11/12\)](#)

 [Unit 10 Literature Activity & Collaborative Key \(due Sun 11/12\)](#)

 [Unit 10 End-of-Unit Quiz \(due Sun 11/12\)](#)

Supporting Materials

 [Unit 10 General Questions Forum](#)

Learning Objectives: Example

Unit 12: Multiple Linear Regression (MLR)

- Be able to describe when multiple linear regression can be used, and what it is used for.
- Be able to write down the equation for a multiple linear regression model (including interaction terms) and describe what each parameter means.
- Know what kind of a plot is used to assess how well a multiple linear regression model fits the data, and be able to interpret both the plot and the model R^2 value.
- Be able to interpret the fitted model regression coefficients, and make a conclusion from their confidence intervals and p-values.
- Be able to explain what 'variable selection' is, how to recognize it in an article, and why it is a potential issue.
- Be able to recognize or give examples of study designs which result in correlated data and cannot be analyzed using MLR.

Readiness Quizzes

- Formative assessment
 - Tests a basic level of understanding (e.g. terminology), so students are prepared for the learning activities
- About 20 multiple-choice questions, takes ~20 minutes
- Administered online
- Weekly, one per unit, so low stakes
- Can take it twice, best score counts
 - Encouraged to take it with a study partner or group

Readiness Quiz: Example Question

If you increased the sample size for a survey from 1000 people to 10,000 people, what would happen?

Select one or more:

- a. The estimated proportion would be more precise
- b. The estimated proportion would be less biased
- c. The margin of error would decrease
- d. The confidence interval for the proportion would get wider

End-of-Unit Quizzes

- Summative assessment
 - Directly tied to the week's learning objectives
- About 6 short-essay questions, takes ~1 hr.
- Administered online
- Weekly, one per unit, so low stakes
- Taken once, independently

End-of-Unit Quiz: Example Question

Use for Questions 7 – 9.

The following are excerpts from the abstract of a study concerning amyotrophic lateral sclerosis patients, which was published recently in PLOSOne.

“The Irish ALS register is a valuable resource for examining survival factors in Irish ALS patients. ... We employed Cox proportional hazards ... to examine factors affecting survival in Irish ALS patients.... Using this model we confirmed the association of known survival markers in ALS including age at diagnosis (Hazard Ratio (HR) 1.34 per 10 year increase; 95% CI 1.26–1.42), diagnostic delay (HR 0.96 per 12 weeks delay; 95% CI 0.94–0.97), definite ALS (HR 1.47 95% CI 1.17–1.84), bulbar onset disease (HR 1.58 95% CI 1.33–1.87), riluzole use (HR 0.72 95% CI 0.61–0.85) and attendance at an ALS clinic (HR 0.74 95% CI 0.64–0.86).”

Using the hazard ratio from the previous question, describe the effect of **riluzole use** on survival in Irish ALS patients in **this sample**.



A rich text editor toolbar containing various icons for text formatting and editing. The icons include: font face (Ff), font size (A_A), text color (T), background color (A), bulleted list, bold (B), italic (I), underline (U), numbered list, link, unlink, bulleted list, numbered list, bulleted list, bulleted list, bulleted list, bulleted list, image, clipboard, sun, subscript (X₂), superscript (X²), link (H), horizontal line, left indent, right indent, square root (√a), Omega (Ω), table, subscript (I_x), undo, redo, eye, ear, and code (<>). There is also a separate icon for full screen (four arrows pointing outwards).

In-Class Learning Activities

- Tuesdays: Concept Activity
 - Focus is on understanding a key concept for the unit, e.g. what is a sampling distribution
 - Some of these involve using software applets such as StatKey
- Thursdays: Literature Activity
 - Focus is on reading and understanding an article from the medical or public health literature

Proportion of Smokers Concept Activity

The goal of this activity is to explore the concept of sampling variability and use it to explain what a confidence interval means.

The sample proportion that you obtained is automatically added as a dot to the dotplot, the large plot window entitled Sampling Dotplot of Proportion.

Let's **pretend** you were to take another random sample from the same population.

5. Would you expect your new sample proportion to equal the population proportion of US males who smoke? Why or why not?

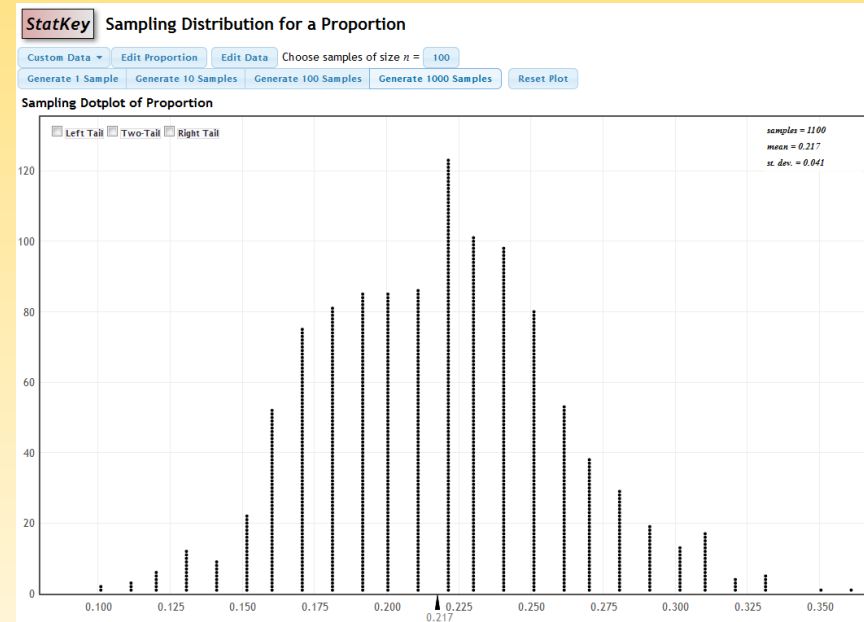
6. Would you expect your new sample proportion to equal your last sample proportion? Why or why not?

- Click on the *Generate 1 Sample* button.

7. In your second random sample, what proportion of the 100 men are smokers?

8. Why is your second estimate different than your first estimate?

9. Why is your second estimate different than the population proportion of US men who smoke?



Hypoglycemia and Risk of Death Literature Activity

The goal of this activity is to gain practical experience with interpreting the results of logistic regression and proportional hazards regression analyses.

RESULTS

Table 1: Risk Factors for Hypoglycemia

- What statistical method was used for the analyses in this table? Write out the regression model equation the authors would have used. (You only have to include the first few predictors.)
- Which factors are most strongly associated with risk of moderate hypoglycemia? Cite results from the table to support your answer.
- For each factor cited in the previous question, use numbers from the table to explain how much and in which direction that factor affects the risk of moderate hypoglycemia.
- Are the factors most strongly associated with moderate hypoglycemia the same as the factors most strongly associated with severe hypoglycemia? Cite results from the table to support your answer.

Table 1. Results of Multivariate Analysis for Factors at Baseline That Were Independent Risk Factors for Subsequent Moderate or Severe Hypoglycemia.*

Variable	Moderate Hypoglycemia		Severe Hypoglycemia	
	Odds Ratio (95% CI)	P Value	Odds Ratio (95% CI)	P Value
Age, per 1-yr increase	1.00 (1.00–1.01)	0.04	1.00 (0.99–1.01)	0.6
APACHE II score, per 1-point increase†	1.01 (1.00–1.02)	0.01	1.01 (0.99–1.03)	0.5
BMI, per 1-point increase‡	0.97 (0.96–0.98)	<0.001	0.96 (0.94–0.99)	0.003
Blood glucose, per increase of 1 mg/dl§	—	—	1.00 (0.99–1.00)	0.009
Sex				
Female	1.00	—	1.00	—
Male	0.78 (0.67–0.90)	0.001	0.88 (0.66–1.17)	0.4
Postoperative status				
No	1.00	—	1.00	—
Yes	0.82 (0.71–0.96)	0.01	0.78 (0.56–1.07)	0.1
Severe sepsis				
No	1.00	—	1.00	—
Yes	1.28 (1.08–1.53)	0.006	0.92 (0.66–1.29)	0.6
Trauma				
No	1.00	—	1.00	—
Yes	1.28 (1.03–1.59)	0.02	0.77 (0.46–1.28)	0.3
Diabetes¶				
No	1.00	—	—	—
Yes	1.24 (1.01–1.52)	0.04	—	—
Prior insulin treatment				
No	1.00	—	1.00	—
Yes	1.61 (1.14–2.28)	0.007	1.46 (0.85–2.52)	0.2
Prior glucocorticoid treatment				
No	1.00	—	1.00	—
Yes	1.09 (0.88–1.34)	0.4	1.51 (1.05–2.18)	0.03
Cardiovascular failure				
No	1.00	—	1.00	—
Yes	1.24 (1.07–1.44)	0.005	1.41 (1.04–1.92)	0.03
Treatment group				
Conventional glucose control	1.00	—	1.00	—
Intensive glucose control	24.19 (20.98–27.88)	<0.001	16.39 (9.32–28.81)	<0.001

Active Learning Classroom Benefits

- Biostatistics is **scary**; active learning allows students to do the hard parts in a supportive environment, with classmates, instructors nearby to help.
 - vs. traditional approach: students wrestle with the hard parts alone at home doing the homework.
- More challenging material can be used, since the instructors are on hand to help.
- It keeps students engaged.
- Learning is enhanced and reinforced by explaining to / arguing with classmates.
- Plus it is **way** more fun!

Active Learning ‘Classroom’ Online

- Students work independently or in groups to complete the activities (using Skype, etc.)
- Students work collaboratively as a class to create the answer keys for the activities via Google Documents.
 - “Collaborative keys”
- Instructor(s) and TAs monitor the developing keys throughout the week.

Ways to Contribute

- If blank, post an answer to a question.
- If a question has a correct answer, but you think there are alternative correct answers, add your alternative.
- If a question has an answer, but you think it is incorrect, add a comment and/or post what you think is the correct answer.
- If a question has an answer, but you think the concept is confusing or needs additional explanation, ask a question OR provide a clearer explanation.
- Post any additional thoughts you had while answering the question.
- Answer additional questions posed by the instructor or TAs.

4. What group of people were the authors interested in finding out about? What people were actually surveyed for this study? In what ways do these two groups differ?

First part of the ?- fellows and associate fellows (surgeons in their first year of practice) in the ACS (Student #1)

Was this the group the authors were interested in finding out about? or the group they used? (TA)

The authors were interested in finding out about alcohol abuse and dependence among practicing surgeons in the United States (and members of the American College of Surgeons). Those actually surveyed included fellows and associate fellows (surgeons in their first year of practice) in the ACS at the time of the survey. All surgeons in the US (practicing surgeons) are very different than fellows and associate fellows (being in their first year of practice has a higher likelihood of being much more stressful, and thus potentially leading to more alcohol abuse). (Student #2)

Student #2, you only have part of description for the group of people who were actually surveyed. Does anyone else want to add to her description of the sample? - Instructor

The group sampled are practicing surgeons. According to the ACS site: "Members of the ACS are referred to as "Fellows." The letters FACS (Fellow, American College of Surgeons) after a surgeon's name mean that the surgeon's education and training, professional qualifications, surgical competence, and ethical conduct have passed a rigorous evaluation, and have been found to be consistent with the high standards established and demanded by the College. There is also another category of membership known as "Associate Fellow." This category was established to provide an opportunity for surgeons who are beginning surgical practice and who meet specific requirements to assume an active role in the College at an early stage in their careers." This provides a larger potential study sample size who might be at risk of alcohol abuse. (Student #3)

So, a follow up question is, do you think it's reasonable to try to make statements about all practicing surgeons in the US, when that was not who they had in their sample? - Instructor

1 I do not think that based on their sample they are able to make statements that are generalizable to all U.S. surgeons. It reminds me of the "healthy worker bias"....if you survey people at work about their health to try and make generalizations about an entire population you may not get a true sense of the prevalence of

Student Feedback: Collaborative Keys

- “Most helpful to me in my learning process was the back and forth on the collaborative learning documents - that was great to see what other people thought and what the professor's answers were.”
- “The concept and literature activities, **it was almost like being in a class setting** where students raise their hands and give their answers, the answers may not be correct all the time but the professor and TAs and other students correct as needed which is very helpful.”

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- Our awesome Biostatistics teaching group
- Our School of Public Health's Office of E-Learning Services, led by Dr. Sara J. Hurley

Abstract

- The flipped classroom model, in which the passive parts (e.g. lectures) are moved outside of class and the active parts (e.g. assignments) are moved into class, is typically used in face-to-face classes. We have successfully used it online in a large introductory biostatistics course. Students in both in-person and online sections are required to prepare for the unit by reading the textbook or listening to recorded lectures. In-person students spend the in-class time working individually or in groups to complete learning activities in which they explore and apply the concepts. In an effort to reproduce the active learning classroom online without face-to-face meetings, we implemented two modifications. First, the online students are encouraged to work on the learning activities in pairs or groups using tools such as Skype or FaceTime. Second, class discussion is carried out through “collaborative keys” in which students work collaboratively to create the answer key for each learning activity, monitored and guided by the instructor team. This talk will describe our approach and provide some preliminary evidence about its effectiveness and ability to engage students.