Some Thoughts About Teaching Statistics to Social Science Students

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Personal Background: Training

Undergraduate Education: University of Delaware

Advisor: H. T. Reynolds

Other influences: B. Guy Peters, Thomas F. James, Dennis M. Wenger

Graduate Training: University of North Carolina

Advisor: George B. Rabinowitz

Other influences: Martin J. Zechman, Forrest W. Young, William C. Reynolds, Stuart Elaine Macdonald

Institute for Research in Social Science

L. L. Thurstone Psychometrics Laboratory

Personal Background: Experience

University of Missouri and Ohio State University, 1980 through 1989

ICPSR Summer Program, 1984 through 2007

University of South Carolina, 1989 through 2002

Michigan State University, 2003 through 2007, 2013

ICPSR Summer Program, 2007 through present

Assumptions About Students

Nascent Social Scientists, NOT Methodologists or Statisticians

- Motivated by substantive issues and questions
- Many (but not all) are in the class because it is required
- Some (but not all) might be encouraged to pursue further study of statistics and methodology
- For many, my Regression Analysis class is the most advanced methodology course they will take

Not Much Background in Statistics, Data Processing, or Mathematics

- Familiarity with (very) basic algebra and geometry
- Minimal use of computers beyond word processing, accessing the web, social networking, and gaming

Students' Orientations Toward the Class

Student Attitudes— the Easier Parts

Most approach the course with good-natured curiosity and a sincere desire to do well in the class

Many (hopefully most!) really want to learn the material

Student Attitudes— the More Difficult Parts

Some are nervous and/or fearful

Some are hostile (often a manifestation of fear)

All are afraid of "looking stupid" in front of their peers

Many are Afraid of, or Intimidated by, YOU!

Objectives for Students, I

You are Not Going to Create Statisticians or Methodologists!

Convey basic skills

Foster appreciation for the utility of statistics and quantitative analysis

Enough information to use statistical tools in order to address straightforward substantive problems

Stimulate interest for learning more about the subject matter

Objectives for Students, II

Students Should be Both Producers and Consumers of Statistical Methods

They need to learn basic concepts and fundamental techniques in order to be good consumers

They cannot become effective “consumers” without some basic experience on the “production side” as well.

Have to “get their hands dirty” by carrying out data analysis tasks themselves

Hopefully, exposure to actual application of statistical methods and reasoning will encourage students to use similar tools in their own work.

Learning Statistics is NOT a Spectator Sport!

Overall Format for Class

Primarily Lecture Classes

Questions are ALWAYS Encouraged!

Separate Lab Sessions for Computing

Review Sessions Before Each Examination

Regular Office Hours

Class Web Site

Utility and Importance of the Teaching Assistant

Responsibilities

Check and grade homework assignments

Create lecture outlines for inclusion on web site

Assistance with computing (including lab sessions)

Regular office hours and general assistance

Integral Part of Instructional Team

Obviously, reduces overall amount of work for me

Another (less intimidating) interface with class

Critical feedback channel so I can evaluate my own effectiveness

What is Statistics?

Endeavor Aimed at Understanding How and Why Objects Vary

Constructing Models of Empirical Phenomena

Model: A simplified representation of some object

A good model focuses on the important structural elements of object, de-emphasizes less critical details

Statistical Models Aimed at Representing Groups of Objects, Not Individual Objects

What is Statistics? (Continued)

Statistical Models are Quantitative Representations

Objectives of a Statistical Model Can Usually be Expressed in Two Questions:

Can we represent the basic (i.e., most interesting) characteristics of the phenomenon under observation using a small set of descriptive quantities or values (called "statistics")?

Can we generalize from the description of the immediate set of objects we observe to the broader class of objects from which our observations were drawn?

What is Statistics? (Continued)

Statistics Involves Four Types of Tasks

Description

Inference

Guide for decision-making

Assessing claims of causality

No Matter How Complex the Immediate Context, Statistical Analysis Always Involves Some Combination of These Four Elements

General Approach to Presenting Class Material, I

Rigorous, But Relaxed

Emphasis on using statistics to address substantive questions

Still need to appreciate (and not be intimidated by) the quantitative tools that are used for this purpose

Early in class, spend time on nomenclature and tools of special relevance for subject matter throughout the term

Avoid Atmosphere in Which Formulas "Drop From Nowhere"

Explain logic underlying statistical tools

Show explicitly how substantive considerations map onto the calculations of descriptive statistics

General Approach to Presenting Class Material, II

Use Specific Examples and Articles to Introduce Topics?

Illustrates Broad Relevance of Statistical Reasoning

Can be Very Tricky

Difficult to find simple and "pure" examples of basic statistical concepts

Use of many different examples can be confusing (especially when juxtaposed against new statistical concepts and the associated unfamiliar mathematics)

I prefer to point students toward additional examples *after* covering concepts and techniques in class.

General Approach to Presenting Class Material, III

Present a Single Substantive Question to Motivate Statistical Material

Content must be reasonable, readily comprehensible, and interesting to students from a variety of substantive backgrounds

If possible, articulate a simple theory (or even better, two competing theories) in question form

Utility of the Single Substantive Question

Provides a unifying theme for the class

Each new topic or technique can be illustrated by reference to a familiar question

Be Sure to Emphasize that Principles Generalize to Other Substantive Contexts!

General Approach to Presenting Class Material, IV

Obtain or Create a Dataset to Test the Theory (and Use for Example Calculations)

Relatively small— entire dataset should fit on one page, in tabular form

Dataset should include each kind of situation that will be encountered in the class

Such Datasets are Difficult to Find!

Often necessary to modify data from original form in order to remove “tricky” or “messy” details

Be sure to issue appropriate disclaimers to avoid inappropriate use after class is finished!

Many Instructors Use a Class Survey to Create the Dataset

Three Ways to Present Statistical Information

Verbal Language (i.e., Words)

Pro: Familiarity and real-world relevance

Con: Imprecise and limited vocabulary

Mathematical Language (i.e., Equations)

Pro: Precision and efficiency

Con: Unfamiliar and intimidating; not connected to substantive motivation

Pictorial Language (i.e., Graphs)

Pro: Relatively intuitive and aesthetically interesting

Con: Sometimes difficult to link graphical elements to statistical quantities

Combining the Three Presentation Modes

Pros

Increases chances of “hitting” each student’s preferred style of learning new information

Varied presentations provide additional insights about concepts

Forces students to bring several perspectives to bear on a problem

Cons

Takes a great deal of classroom time to use all three presentation modes

Students may focus on the one mode they like best, and ignore the others.

Potential for generating confusion and frustration

Computing, I

I Do NOT Use the Computer in the Introductory Class

Too easy for computing to become the focus of student activity

Emphasize the importance of having a good calculator and knowing how to use it.

Even in Higher-Level Classes, I Begin with Hand Calculations

Encourages familiarity with the formulas and more effective learning about the concepts

At the very least, makes students appreciate the computer as a labor-saving device

Computing, II

Choice of Software Package

Point and click menus are okay for introductory classes

I prefer command lines for anything after the first course

Instruction in Computing

Devote one class session to a lab introducing the software package

One or more additional (optional) lab sessions

Use handouts showing complete computing sessions to illustrate commands and functions needed for the course

Preparing Lectures

Always Use a Formal Outline!

Begin with substantive motivation

"Translate" from a substantive question to a statistical concept

Operationalize the statistical concept with one or more specific techniques

Provide Calculation Examples!

Work out each example *fully* before class.

Keep "calculation" notes on separate pages from "conceptual and technique" notes.

Make text large, keep steps simple, do not abbreviate.

Teaching Tools in the Classroom, I

I Do Not Use PowerPoint or Slides

Class sessions become too tightly tied to slides

PowerPoint encourages a passive presentation style

I Do Not Give Out My Notes

Too easy for students to rely solely on notes, and stop paying attention in class

The act of listening and recording information I provide in lectures is integral to process of learning

Teaching Tools in the Classroom, II

I Do Use the Blackboard (or Whiteboard or Overhead Projector, etc.)

I want as much writing room as possible (e.g., sliding blackboards)

Be careful with handwriting— writing large on a vertical surface is different from writing on a normal sheet of paper positioned horizontally.

Write Material in Relatively Short "Chunks"

Often, tell students to wait and only write it down after I am done with the whole thing (i.e., equation, derivation, etc.)

Pause briefly between chunks to explain what you've put onto the board

At the end, recapitulate what you have written, what it means, and how they should use it

Teaching Tools in the Classroom, III

Advantages of the Blackboard

Facilitates an active presentational style

Slows down the presentation, makes it easier for students to follow

Provides flexibility in exact coverage of presentation

Potential Disadvantages of the Blackboard

Handwriting can be difficult for students to interpret and follow

Potential for “dead air” in the classroom while writing

Potential to improvise or ad lib (which is usually a disaster!)

Teaching Tools in the Classroom, IV

Equipment for yourself

Writing implements, electronic pointers, computer, etc.

ALWAYS bring a calculator!

Handouts for Students

I use MANY handouts— at least one (and often more) per class

Handouts reiterate major points and provide examples

Animated Presentations

Dynamic graphics illustrating statistical concepts

Show how assumptions affect models

Illustrate how varying parameters affect model content

Teaching Tools in the Classroom, V

Your Own Demeanor— Most Important Classroom Tool

How you present yourself in class has a profound effect on how students will react to both you and to the course material.

Convey a sense of excitement and deep interest in what you are doing— if you enjoy it, they probably will, too.

Your feelings about the material must be sincere; superficiality or play-acting will be obvious

Be Mindful of Your Classroom Setup

Arrange your materials for easy and immediate access in front of the class

Be familiar with computing and projection equipment

You want to be able to move smoothly and rapidly from one task to the next, with minimal amount of “dead air.”

Teaching Tools in the Classroom, VI

Follow a Regular Progression in Each Lecture

Explain how the topic for each day relates to the “big picture”

Introduce new ideas (probably no more than a small handful in each class)

At the end of class, explain how you have added to what students already knew about the subject matter

Three steps for each new idea

This is what we are going to do (and why we would want to do it)

This is what we are doing (and how you should do it)

This is what we have just done (and why it is important)

Preparing Handouts

At Least One Handout for Each Major Concept

Help students understand which concepts and ideas are most important

Full set of handouts provides an outline of subject matter covered throughout the course

Utility and Purpose

Summarize tedious and lengthy calculations

Handouts *support* lecture content, they do not *substitute* for it!

Give students physical objects that they can take away from the classroom

Course Website

Essential Resource for Information and Course Materials

All Course Materials Should Be Available on Website

- Course location/times, instructor contact information
- Syllabus
- All handouts
- Lecture outlines
- Computing resources (including Stata DO files, R scripts, etc.)

Evaluating Student Performance

I Do Not Assign a Research Paper in Introductory-Level Classes!

Not enough time to cover statistical concepts and applications

But, do emphasize that proficiency requires practice!

Statistical work is a "translation" process

Begin with a verbal statement of a substantive problem

Produce a mathematical (statistical) representation of the problem

Evaluating Student Performance

Frequent Homework Assignments

At least one per week, sometimes more

Some are “pure calculation” but most require students to apply concepts, techniques, and tools from class

Homework is reviewed and corrected to provide direct feedback to students

Homework is *not* graded for content— only completion

This is the students’ chance to “get things wrong without penalty”

Emphasize that students should work neatly and show all of their work

Examinations, I

Use two or three examinations

- Smaller number in higher-level courses
- Final examination is take-home and open-book in upper-level courses
- Content is cumulative, due to nature of subject matter

Generally include two types of questions

- Three short answer questions
- Three or four longer calculation questions
- *Maybe* one derivation or simple proof
- Most questions framed in terms of a substantive application

Examinations, II

Strive for Consistency in Grading

Begin by writing out your own version of a “perfect” answer

Evaluate student performance relative to your own answer

Try to determine how many points are associated with each component of the perfect answer

Go Over Exam in Detail, Ideally in Next Class

Always Use a Curve to Assign Grades

Numeric score for examination reflects comparison of their own work relative to a “perfect” examination

Letter grade reflects each person’s standing relative to the rest of the class

Some Online Resources Useful for Teaching Statistics

Online Portal for Social Science Education in Methodology, opossem.org

ASA Committee on Advancing Undergraduate Statistical Education, CAUSEweb.org

Rice Virtual, Online Statistics Education: An Interactive Multimedia Course of Study, onlinestatbook.com

The Data and Story Library, lib.stat.cmu.edu/DASL

Journal of Statistics Education, http://www.amstat.org/publications/jse/