Monday, June 12, 2000

William Jennings Bryan: I do not think about the things that I do not think about.

Clarence Darrow: Do you ever think about the things that you do think about?
—Inherit the Wind

THE TOP TEN (13) WAYS TO IMPROVE AN INTRODUCTORY STATISTICS COURSE

13. Respect your students
12. Teach science, not math
11. Don’t pretend that math is science
10. Teach design
9. Celebrate diversity (variation)
8. Emphasize the importance of a reference group
7. Acknowledge limitations
6. Present statistical illusions
5. Always be precise; except when you are being imprecise
4. Teach students to interpret answers
3. The computer: Use it wisely
2. Use humor and pop culture
1. Increase active learning

Lane Bishop:

\[
\frac{3}{4} + \frac{5}{6} = \frac{8}{10}
\]

Why are innovative, creative, and effective teachers so often labeled EASY?

Introductory Statistics as Mud Crawling.
Graduation requirement: Must Complete Mud Crawling 499
Lecture 1. Professor X: Every student must crawl through 100 yards of mud to pass this course.
Lecture 2. Professor Y: Every student must crawl through 10 yards of mud to pass this course.
How does X characterize Y’s class? EASY.
How does X characterize students who prefer Y’s class? LAZY.

• Most students will work hard to master material if they perceive the material to be worthwhile.

• The goal of a Statistics text is to teach the students how to do the problems at the end of the chapter—a reviewer of my text.

• The danger of teaching students methods for analyzing data is that they might misuse them—a Statistics professor.

Relevant movies:

• Stand and Deliver
• Music of the Heart

12. Teach science, not math

I don’t seek answers; I seek better understanding of the questions—David Carradine in Kung Fu.
On page xvii of Moore and McCabe:
Statistics is the science of collecting, organizing and interpreting numerical facts, which we call data.
According to The American Heritage Dictionary: Second College Edition, science is

1.a. The observation, identification, description, experimental investigation and theoretical explanation of natural phenomena.

3. An activity that appears to require study and method.

The fundamental goal of my course is:
To enable my students to discover that Statistics can be an important tool in daily life.
• Students do not learn by proving theorems. Unless I can demonstrate (not prove) that something makes sense, they don’t believe/understand it.

THIS DOES NOT MAKE THEM INTELLECTUALLY INFERIOR.

• Students do not aspire to become mathematicians.

RESIST THE TEMPTATION TO (TRY TO) CHANGE THIS.

Why focus on science?

• Science is rooted in the world, not the rules of logic.

• Students come to a university to learn about their social, political, and natural worlds. They need to discover that Statistics can help them.

• Math: Focuses on methods; data sets are trolled-out to illustrate the method. (Subliminal message: If you really understand the material, you don’t need data sets.)

Science: Focuses on questions about the world. Questions lead to experimentation or observation, and the resultant collection of data. Statistical methods help us learn from the data.

• Math: Constructs an elaborate structure in which only one or a few quantities are unknown. Then the uniformly most wonderful procedure (the unique correct answer) is obtained.

Science: There is not a unique correct answer. Different statistical methods reveal different features of the data set. Occasionally, a student will analyze a data set better than I will.

• Many adults fear children and worry that respect for authority is all that keeps them from running amok. So they teach them to respect authorities whom adults themselves do not respect—James W. Loewen in Lies My Teacher Told Me.

• Many [Statistics teachers] fear [students] and worry that [knowing the correct assumptions] is all that keeps them from running amok. So they teach them to [believe assumptions that Statistics teachers] themselves do not [believe].

11. Don’t pretend that math is science

The road to Hell is paved with good intentions—Karl Marx.

Later.

10. Teach design

Later (But see the last page).

9. Celebrate diversity (variation)

Why does a response vary from unit to unit?

The response is influenced by or associated with factors. There is a factor of interest (study factor), and there are many background factors.


By emphasising factors, students learn the importance of randomization and why studies with randomization differ fundamentally from studies without randomization.

8. Emphasize the Importance of a Reference Group

Why do I believe that

• Arnold Schwarzeneggar is strong?

• Gwen Torrence is fast?

• Sylvester Stallone is a lousy actor?

Because . . . I have reference groups that give reference distributions for appropriate numerical criteria. In short, the above superlatives are relative statements, not absolute.

For a statistician, the reference group is everything that might have happened.
7. Acknowledge limitations

A man’s got to know his limitations—Clint Eastwood in Dirty Harry.

OK. Suppose that we are tentatively willing to behave as if we have a random sample from a population and we want to make an inference about the population.

Start with a dichotomous population because a dichotomous population is the single number $p$. We are very good at obtaining a confidence interval for $p$.

For a numerical population, the population is a picture. Admit it; we are lousy at obtaining a confidence region for a picture.

As a result, we pretend that it is the center (mean, median) that really is of interest. Books typically act as if the leap from a picture to a number is a most natural transition.

I don’t think we are fooling anyone. In fact, we lose credibility.

- The statistician standing in water
- Three statisticians go hunting

The following item appeared in Newsweek magazine. It was attributed to having appeared in “A memo to flight attendants on United Airlines—whose DC-8s and DC-10s all show their date of manufacture on a metal plate in the frame of the forward passenger door”:

To avoid increasing a potentially high level of customer anxiety, please use the following responses when queried by customers.

**Question:** How old is this aircraft?

**Answer:** I’m unaware of the age of this particular aircraft. However, the average age of United’s Aircraft is 13.5 years.

6. Present statistical illusions

“That’s not an optical illusion; it just looks like one.”

Walt Whitman: “Make much of negatives:”

Stephen Jay Gould (Debunking as positive science in The Mismeasure of Man):

The popular impression that disproof represents a negative side of science arises from a common, but erroneous, view of history. The idea of unilinear progress . . . suggests a false concept of how science develops. In this view, any science begins in the nothingness of ignorance and moves toward truth by gathering more and more information, constructing theories as facts accumulate. In such a world debunking would be primarily negative . . . But the barrel of theory is always full; sciences work with elaborated contexts for explaining facts from the very outset. . . . Science advances primarily by replacement, not by addition. If the barrel is always full, then the rotten apples must be discarded before better ones can be added.

Statistical illusions:

- Simpson’s paradox
- The regression effect
- The ecological fallacy

5. Always be precise; except when you are being imprecise

Certain terms in Statistics have very precise meanings:

randomization, at random, normal, . . .

Other don’t:

large sample, good approximation, bad approximation, linear, curved, . . .

Emphasize which are which!

4. Teach students to interpret answers

The most important thing in science is not so much to obtain new facts as to discover new ways of thinking about them—Sir William Bragg.

We should (and generally do) spend a great deal of time explaining what it means to be 95 percent confident (Math), but

It is also important that students learn how to properly interpret the scientific meaning of a confidence interval (Science) (controlled versus observational studies).
3. The computer: Use it wisely

X: I have every episode of Gilligan’s Island on videotape.
Y: What a waste of time!
X: You don’t understand; I have taken out the commercials.
A fundamentally flawed course + a computer = A faster version of the flawed course

Simulation don’ts:

• Don’t be a math elitist:
  Simulating binomial probabilities for small \( n \)
• Don’t simulate as an alternative to data collection:
  In the population of married couples with two children, what proportion have one girl and one boy?

Simulation do’s:

• Do present simulation as a tool for studying problems that are inaccessible mathematically:
  Finding the exact sampling distribution of a test statistic.
• Do present simulation as a tool for studying robustness of interval estimation procedures.

2. Use humor and pop culture

• The mathematician in the kitchen
• The Karate Kid: Perseveres
• The Princess Bride: Selects an alternative hypothesis
• Monty Python and the Holy Grail: and \( n! \)
• Ground Hog’s Day: obtains a reference distribution
• Titanic: The fate of female passengers (women and girls) on the Titanic, by ticket-class. The source is page 200 of Lies My Teacher Told Me by James W. Loewen.

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<thead>
<tr>
<th>Class</th>
<th>Survived</th>
<th>Died</th>
<th>Total</th>
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<tbody>
<tr>
<td>First</td>
<td>139</td>
<td>4</td>
<td>143</td>
</tr>
<tr>
<td>Second</td>
<td>78</td>
<td>15</td>
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<tr>
<td>Third</td>
<td>98</td>
<td>81</td>
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</tr>
<tr>
<td>Total</td>
<td>315</td>
<td>100</td>
<td>415</td>
</tr>
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</table>

• Bob Wardrop a.k.a. Brad Pitt

1. Increase active learning

Do not try to satisfy your vanity by teaching a great many things. Awaken people’s curiosity. It is enough to open minds; do not overload them—Anatole France.

From the preface to Allan Rossman’s book, Workshop Statistics: Discovery with Data:

Statistics teaching can be more effective if teachers determine what it is they really want students to know and to do as a result of their course, and then provide activities designed to develop the performance they desire.

I prefer active learning via small student projects

• Students decide what to study
• Easy to incorporate writing into assignment

A final thought: Statistics teaches us where to stand.

Random, Leaphorn thought. Random. When he was . . . a junior at Arizona State . . . . He had been full of the mathematics he was studying, and of his own wisdom, and he had talked to his old uncle of probabilities and randomness.

“You think these raindrops are random?” his uncle had asked. And Leaphorn had been surprised. He’d said of course they were random. Didn’t his uncle think they were random?

And then he had said, and Joe Leaphorn still remembered not just the words but the old man’s face when he said them: “I think from where we stand the rain seems random. If we could stand somewhere else, we would see the order in it.”
### Allocation of Units to Groups

<table>
<thead>
<tr>
<th>Selection of Units</th>
<th>By Randomization</th>
<th>Not by Randomization</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Random</td>
<td>A random sample is selected from one population; units are then randomly assigned to different treatment groups</td>
<td>Random samples are selected from existing distinct populations.</td>
</tr>
<tr>
<td>Not at Random</td>
<td>A group of study units is found units are then randomly assigned to treatment groups.</td>
<td>Collections of available units from distinct groups are examined.</td>
</tr>
</tbody>
</table>

Figure 1: Statistical inferences permitted by study designs (from *The Statistical Sleuth* by Ramsey and Schafer). For the designs in the first row, inferences to populations can be drawn; for the designs in the first column, causal inferences can be drawn.