Jazzing Up Statistics with Discussion Questions & Case Studies

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Question:

How many of your students come to class having already read the book?
What We Know

• Students do better (not just in math), if they come to class prepared to learn.

• Most students don’t read the book before lecture...

• Many students may never read their math books at all.
Confession Time

• I was one of those students.
What Makes Reading Math So Difficult?

• Students get the most practice reading prose literature.
• Non-fiction topics like history, which tend to require more reading, read more like prose fiction than technical fields like science and math.
• Strategies students are taught to read in these fields quickly are counterproductive to learning to read mathematics and science.
• The closest analogy is actually philosophy where quick skimming can lead to erroneous impressions of the meaning of a text.
It’s Not Enough to Just Tell Them

• Many math books have introductory sections telling students how to read their books.

• Students need to be shown how.

• Students need to practice these skills.

• They won’t do it on their own.
Goals

• Teach students how to read math books
• Encourage more students to come to class prepared
• Reduce time spent lecturing basic facts
• Increase interactivity: student-student, and student-instructor
• Leave time in class for hands-on activities
• Get students to think more critically about material
Idea

• Import techniques employed in the online classroom to the face-to-face classroom

• Incorporate topics of interest to the students to increase relevance and motivation
Low-Tech Classroom Flip

• Good lectures are how students avoid reading textbooks.
• This develops dependency on others to explain material they could learn on their own.
• Concept-focused classes like statistics need more than a “how-to”: We need to teach students to think.
Discussion Questions

• Can act like “guided notes” for reading the textbook
  • We want students to become independent learners
  • Statistics has much more prose, and is concept-driven, rather than procedure-driven, making it more accessible to students without experience
  • Reading math is a skill that can only be developed through practice
  • We can spend more time on points that are “sticky” and quickly bypass basic facts like definitions and formulas
Discussion Questions

• Discussion questions focus students’ attention on important concepts.

• They ask students to dig deeper into the text than the skimming they learn in other classes.

• Climb the ladder of Bloom’s Taxonomy to ask more than low-level fact and process questions.

• Students may reread the text looking for answers, increasing exposure to the material before class.
Discussion Questions Should…

• Get students thinking about the material.

• Help students focus on definitions and important concepts.

• Highlight any important formulas.

• Encourage students to work together to find answers.
Discussion Questions Should…

• Get students to work through examples similar to examples in the book, or fill in missing steps in worked examples.

• Illustrate concepts with real world scenarios.

• Ask students to compare and contrast.

• Use questions to review old material if it’s needed now.
Climb Bloom’s Taxonomy

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Comprehension</th>
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<tbody>
<tr>
<td>• Definitions:</td>
<td>• The formula for the standard deviation is</td>
</tr>
<tr>
<td>• What is a sampling distribution?</td>
<td>[ s = \frac{\sum (x-x)^2}{n-1} ]. What is this formula telling you</td>
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<td>to do? List the steps in the process.</td>
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Climb Bloom’s Taxonomy

**Application**

- What is the sample space for outcomes when rolling a standard die?
- Give an example of simple event in the sample space $S = \{1,2,3,4,5,6\}$, and an example of a compound event.

**Analysis**

- How is the Student t-distribution different from the Normal distribution?
Climb Bloom’s Taxonomy

Synthesis

• For each of the examples below, say which type of hypothesis test is appropriate?

Evaluation

• Describe a circumstance in which you would not want to use a significance level of $\alpha = 0.05$. 

• Give five examples of qualitative data that you could collect from your coworkers.

• What is the difference between a time series graph and a cross-sectional graph?

• When should a regression model be used to make a prediction? When should it not be used to make a prediction?
• For each of the problems below, determine which counting rule you are going to use (multiplication rule, permutations, combinations), and then find the probability in each scenario.

• Find the shaded area with a mean of 100, and a standard deviation of 15.

• What conditions need to be satisfied to use the normal approximation for proportions?
• What does it mean for a hypothesis test to be statistically significant? How is this different from our everyday notions of “significant”? 

• Which of the following hypothesis tests are set up correctly? If they are not set up correctly, what is wrong with them?
  - $H_0: \mu = 100, H_a: \mu > 100$
  - $H_0: p = 20, H_a: p \leq 20$
  - $H_0: p \neq 0.25, H_a: p = 0.25$
  - $H_0: \mu = 25, H_a: \mu = 100$
  - $H_0: p = 0.6, H_a: p \neq 0.6$
<table>
<thead>
<tr>
<th>Incorporating Case Studies</th>
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</thead>
<tbody>
<tr>
<td><strong>Use daily:</strong> keep them short, 1-2 pages</td>
</tr>
<tr>
<td><strong>Use weekly:</strong> 3-5 pages</td>
</tr>
<tr>
<td><strong>At the end of each chapter:</strong> 4-7 pages</td>
</tr>
<tr>
<td><strong>Projects:</strong> can compare and contrast</td>
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</table>
Example

The legal and ethical issues behind Facebook's massive psychological experiment -
Result

Discussion Questions + Case Studies = Understanding
Discussion Questions and Case Studies Don’t Need to…

• Be Hard
  • Students don’t need to get all the answers on their own, just get exposure

• Be Graded
  • Get students to look at the material when the pressure is off. Give them credit for trying, then use discussion time in class to fill in the missing pieces. If you do grade, grade for reasoning not correctness.

• Cover absolutely everything
  • Save lecture time for “pain points”, demonstrations, and collaborative work
Discuss the Answers in Class

• Students won’t get all the answers right, and that’s okay.
• Bring in related material and help connect the dots.
• Develop critical thinking skills.
• Use the book to point out where some of the answers are to help students know where to look next time.
• Model what you want from students, especially early in the semester.
Help Students Develop Good Habits

• Don’t miss days
  • Every day you cover new material, they should have at least a few questions to prepare, even if it’s just 3-4 short ones.

• Can use completed ones to review, or prepare extra questions so students don’t waste a review day (hour).

• Can lead sessions in class periodically to guide students in developing their reading skills.
Bring Consistency to Traditional and Online Delivery

• Students can work out answers in threaded discussion boards led by students as much as by instructor.

• Give students options to get answers from online videos, but then cite sources in textbook.

• Easy to give pointers without giving answers as students dig for solutions.

• Bring in outside resources and articles to help illustrate concepts.
Don’t Expect Perfection

• Not all students will complete the discussion questions in advance without prompting.

• Students that do, however, will be better prepared. In my experience, more students will do it than would read the book otherwise. Weak note-takers can use them as guided notes and still benefit.

• Students may complain at first (of course), but they get used to it.

• Well-chosen questions can make excellent review guides for exams.

• If a student misses a class, they know what they need to learn.
Develop Skills Needed for a Final Project

• Want your students to do a final project for the class?
  • Discussion Questions and Case Studies give them examples and experience of the kind of questions to ask.

• May find a topic discussed in class leads them to want to know more.

• Math students often seem shocked that they might have to explain math in words.
What Kind of Classes Can This Be Used for?

• Courses with a lot of concept-oriented material work most easily.
  • Spending too much time going over basic definitions?
• Is some of the material in the course remedial or review?
  • Students have seen it before, it’s easier to recall and piece together.
• Can be adapted to learning computation & procedures.
  • Use to do just-in-time remediation.
  • Explain steps shown in text, or where is the error?
• Can work for any level course.
  • I’ve used it for statistics (freshman and sophomore-level courses), and “liberal arts math”. I think it can be adapted for all areas.
• The more students are familiar with the material, the more they see it, the less afraid of it they will be.
Some Feedback
• “I enjoyed this course more than I thought I would! Betsy, you were an amazing instructor, and I learned a lot!! Thank you!! :)

• What elements of the course did you find most beneficial?
  • “Discussion questions”
  • “Discussion questions and labs”
  • “Discussions questions that you work on at home and go over in class”

• “…it was great to get to see first hand examples of statistical concepts.”
Questions?
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