TEACHING AN INTRODUCTORY STATISTICS CLASS BASED ON SPORTS EXAMPLES

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We discuss our initial experience with offering a version of our standard introductory statistics course that focused primarily on sports related examples, rather than a more traditional selection of applications. This special sports section was offered in parallel with a regular section, covering the same statistical topics, with the same instructor, at the same pace. We examine how the students enrolling in the sports section might differ from the regular, illustrate how we converted material from the regular section to the sports equivalent, compare the performance of students between the two sections and reflect on the effectiveness of the sports-based approach.

INTRODUCTION

As much as statisticians enjoy doing statistical analyses, it is probably true that students in our introductory courses don't share quite the same level of enthusiasm for such endeavors (at least before they take the course). However some students come to us with a passion and great enthusiasm for participating in and/or watching sports-related activities. Would it be feasible to tap into that spirit to generate interest in learning about statistics, while still teaching a bona fide introductory course? In the fall semester of 2005, I was scheduled to teach two sections of our standard introductory statistics course (Math 113) in back-to-back time slots 8:30-9:30 am and 9:40-10:40 am every MWF. As a quasi-experiment, we decided to give one of those sections a special "sports-related" designation and advertise it as a version of the regular course that would primarily feature examples drawn from sports data and applications. Both sections would cover the same statistical topics, in the same order, and at the same pace. We offered three other sections of the introductory course that semester, so students who were not interested in a sports version had plenty of other options to choose. Since students chose a section of the course based on their own interests and class schedules, rather than being assigned at random, we must take care in what follows to avoid interpreting the results as if they come from a proper statistical experiment.

Our introductory statistics course at St. Lawrence University (an undergraduate liberal arts college of about 2000 students) is for a general audience, taken mostly by students in their first or second year, from a wide variety of majors with biology, psychology, economics and "undecided" being the most common. The class meets for three sixty minute sessions each week for a fourteen week semester. Both the sports and regular sections met in a computer classroom with each student at one of 29 individual workstations, forcing an enrollment cap on both sections. Base class notes were provided via PowerPoint slides (to which the students had access in and out of class) with additional examples being worked out on the board. *Fathom* and *Minitab* were used as computer packages for statistical computations and simulations.

Other authors (e.g., Albert and Cochran, 2005) have advocated using sports examples in the teaching of statistics. Some (like Gallian, 2001) teach a special seminar-type course based on sports examples, while others use a particular sport (see Albert, 2002 for a baseball case) throughout the course. In many such cases, the sports applications are the driving forces that determine the statistical topics covered, rather our approach which was to start with the statistical concepts and then look for sports related questions and data to illustrate them. Other instructors (such as Cochran, 2001) use sports as a motivating theme for a specific portion of a traditional course. We wanted to take an entire course and use sports examples exclusively for all topics.

CLASS CHARACTERISTICS

Table 1 shows the breakdown by year in school (1=first year, 4=senior) and gender for the sports section, my regular section and the three sections of Math 113 taught by other instructors. Not surprisingly, the sports section attracted a higher proportion of men, but it also had a disproportionate number of first year students. This latter fact may be due to the (intentional) placement of the sports section in the 8:30 am time slot - our earliest and generally least popular with students. The upper class students, who have priority in registration, often tend to fill up the more popular time periods, leaving the less attractive times for first year students. So, despite our thinking the sports theme might counterbalance the early hour, this appears to not have happened the first time it was offered. In fact one upper class student, who originally signed up for the sports section, switched to the regular section, reporting that she was "interested in the sports approach, but more interested in having an extra hour of sleep in the morning."

Table 1: Year in school and gender by section of the course

	1	*2*	*3*	*4*	*F*	*M*
Sports	19	5	1	2	8	20
Regular	6	14	4	5	11	17
Other three	35	43	5	11	50	43

Students in the sports class filled out an information card the first day of the semester which asked whether they were a member of a St. Lawrence sports team and what sports they enjoyed both participating in and watching as a fan. Twenty-three of the twenty-eight students were members of SLU varsity teams including (number and gender): basketball (2M), crew (1F, 1M), field hockey (2F), football (10M), golf (1F), ice hockey (3M), lacrosse (1F, 1M), Nordic skiing (1M), soccer (1M), and swimming (1F). Two other students played for St. Lawrence club teams, rugby (1M) and ultimate frisbee (1M), and one more was a student from the local high school who played on the soccer, ice hockey and golf teams. So the class included mostly athletes who also reported playing lots of other sports in less organized settings and were fans, especially following baseball, ice hockey, football and basketball. For comparison, a survey given in the regular section later in the semester showed eleven of the twenty-five respondents in that section were members of St. Lawrence collegiate sports teams. University-wide about a third of St. Lawrence students play an intercollegiate sport, so the proportion in the regular section was higher than typical, but not nearly so high as the sports section.

DEVELOPING THE COURSE

As we went through the semester, the basic procedure for developing the sports version of the course was to first prepare materials (*PowerPoint* slides, examples, quizzes, activities, etc.) for the regular section and then convert as much as was feasible to sports themes for the sports section. Both sections used the same textbook (Moore, 2003) with the same readings and same practice problems assigned. Below we give a sample of some typical conversions that occurred during the semester.

- *Correlation activity*. In the regular class we used a dataset with data on car models (miles per gallon, engine size, weight, etc.) to look at lots of scatterplots, guess at relationships and see how the correlation coefficient behaved (Lock, 2005). For the sports section we used data on National League baseball starting pitchers (innings pitched, strikeouts, earned run average, runs allowed, batters faced, etc.) for the 2004 season. For the activity to work well, we needed examples of a strong positive association (innings and strikeouts, r=0.82), a negative association (strikeouts and earned run average, r=-0.60), a very strong association (innings and batters faced, r=0.99) and correlation near zero (earned run average and runs allowed, r=0.02). The last relationship sparked some interesting discussion, since many students automatically assumed there would be a strong positive relationship between the average earned runs allowed per nine innings (ERA) and total number of runs allowed. After examining the scatterplots (including ERA vs. innings pitched) students recognized that poor pitchers (with high ERA) don't get to pitch as many innings as the good pitchers (with low ERA), so the effects on total runs allowed of low ERA but more innings pitched tend to counterbalance and leave no significant association.
- *Experimental Design*. We devoted a couple of classes a third of the way into the semester to discussing issues involved with designing statistical experiments. In the regular class, we

designed several mock experiments to investigate whether playing music (or the type of music) during a class would affect the performance of students taking a quiz. For the sports section, we replaced that problem with a golf example to determine experimentally which club (wedge, 7-iron or putter) gave the best results when a golfer needed to chip the ball from a short distance off the putting surface (see Lock, 2001 for more details). The golf example had the advantage of being able to simulate some data collection through a computer golf game and brought in issues of order effects that did not occur in the music/quiz setting.

- *Quiz #5*. As an example of how we tried to use similar, but thematically different quizzes, the fifth quiz occurred at the midpoint of the semester, after we had been doing sampling distributions and starting confidence intervals. For the regular class the questions dealt with data from a course survey:

  (1) Find a 95% confidence interval for the proportion of students who smoke cigarettes.

  (2) Compute a probability that the mean number of cigarettes smoked per day for a sample of 35 smokers would exceed a specified amount (given assumptions on the mean and standard deviation of amounts smoked for the population).

  (3) Interpret an 80% confidence interval based on the number of hours of TV watched per week for the class sample (n=153).

  (4) Decide if the interpretation in (3) should be adjusted when shown a boxplot for the sample with a right skew in TV watching times.

  (5) Determine a sample size needed to estimate the mean amount of space used to store music on students' computers to within 20 MB with 99% confidence (given an assumption on the standard deviation).

  For the sports class, since it was near the start of the National Hockey League (NHL) season, we substituted the following:

  (1) Find a 99% CI for the proportion of shots saved by the Buffalo Sabres' goalie (who had faced the most shots, 137, through his first four games and saved 125 of them).

  (2) Compute a probability that a random sample of 40 NHL players would have a mean age over 30 years old (given assumptions on the mean and standard deviation of ages for all players in the league).

  (3) Interpret a 90% confidence interval for average scoring rates, based on the number of goals scored in the first 48 games of the NHL season.

  (4) Decide if the interpretation in (3) should be adjusted when shown a boxplot for the sample with a right skew in goals scored.

  (5) Determine a sample size needed to estimate the mean number of penalty minutes in NHL games to within 3 minutes with 95% confidence (given an assumption on the standard deviation based on small sample of games).
- *Introduction to hypothesis testing*. In the regular course we used a hypothetical example for introducing and motivating the logic of hypothesis testing that involved sampling from a pumpkin patch to see if the average weight of pumpkins was less than what a farmer claimed. For a parallel example in the sports section we used another hypothetical example (inspired by a real study) to see if hydrotherapy could help athletes with a grade II ankle sprain return to action more quickly than the standard land-based therapy that had an average recovery time of about 21 days. If a sample of thirty athletes treated with hydrotherapy had an average recovery time of 20.3 days with a standard deviation of 5 days, would we have evidence that hydrotherapy significantly reduces the average recovery time for such sprains?
- *Final Exam.* Just before the final exam period, we were sent a job advertisement from the Philadelphia Eagles of the National Football league who were looking for a team statistician. We converted the questions from a different previous final exam to use data from the current Eagles' season and situations that would arise in a football context, attached the job advertisement, and gave the exam to the sports section under the guise of a job placement exam for the team statistician position. As with all the sports examples, we needed to be sure that terms were clearly explained so that ability to answer a question did not depend on familiarity with the sport. Because the final exams were offered on different days (sports went first) we gave students from both sections the option to take either exam. Four students

from the regular section took the sports version and didn't report any difficulty with dealing with the football theme; one sports student switched to take the regular exam.

COMPARING RESULTS BETWEEN SECTIONS

By most objective measures, the students in the regular section performed better, on average, than their counterparts in the sports section. Graded work included eight quizzes (15 points each), two exams (50 each), three projects (20 each), two labs (10 each) and a final exam (100). Although the versions of the quizzes and final exams differed between the two sections, the students all took the same two exams (E1 and E2 - with E2 using sports themes) at a common time. Table 2 shows a comparison of average quiz and exam grades (and standard deviations) for 27 students in the sports section (one dropped the course midsemester) and 29 students in the regular section. The distributions of the course averages (a percentage based on all graded work) for the two sections are compared more explicitly in Figure 1.

Table 2: Average grade comparison between sections

	Q1	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*E1*	*E2*	*Final*	*Course*
Sports	12.4 (1.8)	12.4 (2.9)	12.3 (2.7)	11.5 (2.0)	11.5 (3.6)	11.4 (2.7)	10.8 (2.7)	11.3 (2.4)	40.7 (5.9)	36.7 (7.4)	75.8 (9.5)	2.61 (1.16)
Regular	13.3 (1.4)	13.4 (1.9)	13.2 (1.7)	12.2 (2.0)	12.1 (3.4)	12.2 (3.1)	11.5 (1.8)	12.4 (2.4)	44.2 (3.5)	41.5 (4.5)	83.4 (9.1)	3.27 (0.65)

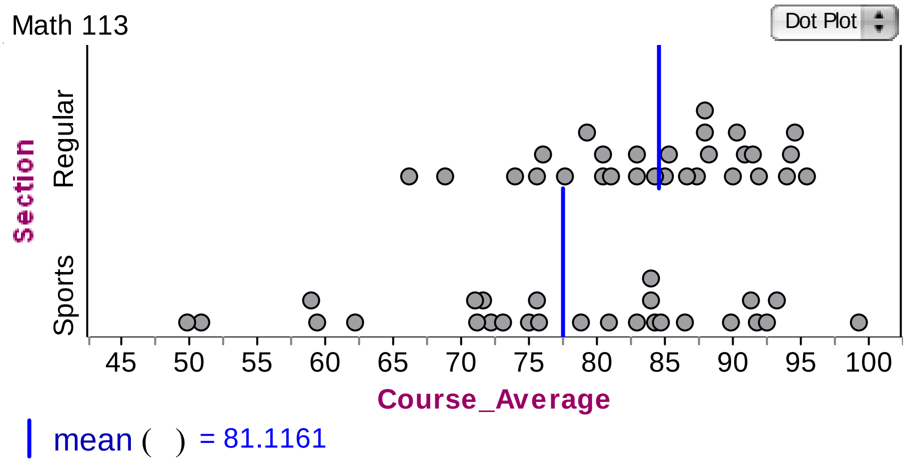

Figure 1: Comparison of course averages between sections

Possible reasons for the differences in student performance between the two sections:

- The sports section might have attracted some students who otherwise might not have even considered taking statistics. Such students might have weaker mathematical backgrounds, less confidence in their abilities, poorer academic habits and be less motivated to do the necessary work outside of class.
- The sports section had a much higher proportion of first year students who sometimes tend to struggle in adjusting to doing the level of work required to succeed in a college course.
- Anecdotal evidence indicated that a few very able students avoided the sports section out of concern that the sports designation might be viewed less favorably when they apply for admission to a graduate program or medical school.
- There was a perception by many students that the sports section would be more "fun" which for some translated into "less serious" - thus possibly being more attractive to less serious students and less attractive to more serious students.
- Many of the examples/activities used in the regular section had been developed, tested and revised over many past semesters. Most of the sports equivalents were new to this semester and had not gone through previous iterations.

- Perhaps the students in the sports section came into the course with weaker backgrounds and previous knowledge of statistical concepts? We had students in both sections take the ARTIST Comprehensive Assessment of Outcomes in First Statistics Course (CAOS) as a pretest the first day of the semester. The students in the sports section averaged 44.5% correct, while the students in the regular section were only slightly higher at 47.8%.
- Perhaps athletes, who made up most of the sports section, are weaker students in general than non-athletes? This is not true in general at St. Lawrence where athletes as a group tend to have as high or higher average grade point average (GPA) when compared to non-athletes. In the regular section the eleven athletes had an average grade of 3.36, compared to 3.21 for the 18 non-athletes. So there would appear to be little evidence to show that athletes tend to get poorer grades, in general or in statistics, than non-athletes.
- Students in the sports section tended to miss more classes, probably due more to the 8:30 time slot more than commitments to sporting events.
- By random chance the five weakest students in Figure 1 happened to all enroll in the sports section.

We also had students from both classes fill out a supplemental evaluation on the last day of class that asked a number of course-specific questions. One asked students to give their GPA (although first year students - most of the sports section - could only give an estimate since they had received no grades yet). The results showed a slightly lower (but not statistically significant) average GPA in the sports section (3.09) than the regular (3.25). Another question asked students to estimate the grade they thought they would receive in the Math 113 course (with the final exam yet to come). The difference in expected grade was wider (sports mean=3.03, regular mean=3.36), but still not quite significant. Note that students in both classes tended, as they generally do, to overestimate the grade they actually receive, but that those in the sports section (actual mean=2.61) tended to do so more than the regular (actual mean=3.27). We also asked students to reverse roles and give a grade to the course (using the usual 0.0 to 4.0 grading scale). The results were very similar for both sections (sports mean =3.51, regular mean=3.58). Finally, we asked students in the sports section what they thought about the approach of using all sports examples. Every student answered this question with a positive response ranging from a simple “I liked it” to “I thought it was great - I was able to relate to the material a lot easier and it was a lot more interesting that way;” “Way better than the other class would have been, especially for athletes;” “Definitely a good idea, keeps interest / uses applicable examples” and “Good! That’s the only reason I took this course.”

REFLECTIONS

We didn’t do as effective a job as we would have liked in explaining to students at pre-registration the nature of the sports-related section. Thus some students thought they might be taking a course where they would learn things like how to compute a batting average and others avoided the section because they wanted to learn “real” statistics. Now that the course has been offered once, we hope that a more accurate picture is already a part of the student network that supplies much of the real information for course selections.

Coming up with an entire new set of examples for the whole course turned out to be quite time consuming. It was very tempting before some classes to just go with what we had already set for the regular section - especially when it was one of our favorite examples. Fortunately, fresh sports data is readily available on the web so it was generally not too difficult to find data that illustrated a point we wanted to make, similar to what was in the regular course, and still stay within the sports context. Partly because we were developing all new examples, in many cases the sports versions were more current, e.g., using data from the previous weekend’s National Football league games or comparing the New York Yankees to the Boston Red Sox when they were involved in a pennant race that was closely watched by many class members.

We have long believed, especially at a liberal arts college such as St. Lawrence, that a student’s first statistics course should include applications in lots of fields showing the breadth of utility of statistical methods rather than just a discipline specific introduction in a single field such as psychology, biology or business. Were we violating this principle by offering a sports-based introductory course? In theory no, since the sports field allows examples that illustrate the uses of statistics in biology (exercise physiology, sports medicine), psychology (motivation, home field advantage), economics (ticket pricing, salary structure), etc. In practice, we did not do as effective a job as we would have liked in finding good examples (especially with real data and motivating questions) that explicitly illustrated applications to many diverse fields.

While the academic performance in the sports section was a bit disappointing, the regular class actually did better than typical classes in recent years. This may be due in part to students from the "left tail" of the grade distribution being attracted to the sports section while the "right tail" might have been more likely to choose the regular version. However, we also found that going through the process of creating new examples for all the topics in the course for the sports section forced us to pay fresh attention to the existing examples in the regular course, tweaking and replacing them where needed, possibly improving the teaching in that section as a result.

CONCLUSION

Given that the academic performance (as measured by any of the grading scales) was weaker in the sports-based section, should we consider offering it again? For now we'll answer with a qualified yes. We suspect that student self-selection played a large role in the distributions of academic abilities and motivations between the two sections. In some cases students might have been attracted to the sports section who otherwise would not have considered taking a statistics course at all. Even if they performed somewhat less ably than the students in the regular section, they learned more about statistics than they would have if they weren't enrolled in any statistics course. With subsequent offerings, we hope to refine the examples, illustrations and applications so they move towards the time-tested quality of those in the regular section and do a better job of illustrating applications to other fields. Finally, we should not ignore the importance of having a little fun in a course where "fun" is not always high on the list of descriptors. Fun for students to play with examples, data and questions that are appeal to their strong interest in sports and fun for the instructor to discover and create examples to help them make those connections

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