SPOTLIGHT ON PEDAGOGY: "WHAT'S YOUR APPROACH TO TEACHING STATISTICS, AND WHY?"

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Some Class Activities in Probability and Statistics

Dave Agard and Gena Foletta – Northern Kentucky University

Abstract

We share several examples and class activities designed for students to understand probability as a relative frequency through experimentation and simulation, and understand the law of large numbers as the bridge to theoretical probabilities. As well, we present some data collection activities used in class for examples of topics in descriptive statistics.

Summary

We offer a course titled Introduction to Probability and Statistics. While there is nothing unique about that name, the composition of students drives this course in that the majority of the students are majoring in elementary education. This course satisfies a general education university requirement, yet also provides a required content course in the area of mathematics for these students. This course is about half probability and half statistics, but our focus in the spotlight session is predominantly on probability.

The Kentucky Department of Education publishes a Program of Studies to help ensure that all students across the commonwealth are provided with a common content and have opportunities to learn at a high level. The Program of Studies also outlines the minimum content required for all students before graduating from Kentucky high schools as well as the primary, intermediate, and middle level programs leading up to these requirements.

Particular to probability and statistics, of the objectives for Primary through Grade 5 in the Program of Studies include, but are certainly not limited to:

- Explore chance as illustrated in games and experiments.
- Explore basic concepts of probability through simple experiments.
- Collect and display data in graphs.
- Pose questions; collect, organize, and display data.

With this backdrop we strive to have our students see the importance of understanding probability at a reasonably deep level. To that end our coverage of probability is introduced and enhanced with experimentation and simulation of activities. We believe this leads to better understanding of experimental probability, the law of large numbers, and theoretical probability. A few examples follow.

Examples

1. “Yahtzee”

   Using a relative frequency approach in a class activity, we attempt to find the probability of achieving “Yahtzee” in the well known dice game.

2. “Hat Check” Experiment:

   Four players turn in their hats; the hats are mixed up randomly and then returned.

   After demonstrating a few times, we use the results of “many” repetitions of the experiment to answer the following questions:

   A. Make a frequency table for the number of hats correctly returned.

   B. What is the relative frequency probability that no one gets their hat returned correctly? (that they all get their hat returned correctly?)

   C. What is the empirical probability player #1 gets his hat returned correctly?

   D. Repeat part C for player 3.

   E. What is the theoretical probability no one gets their hat returned correctly?

   F. How many players would you “expect” to get their hat returned correctly?

Other examples and materials will be available at the conference.

Data Analysis, Probability, and Statistics for Teachers

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This book (to be published by Key College Publishing in late 2006) is a data analysis and probability textbook for prospective and in-service Middle School and High School teachers. The National Council of Teachers in Mathematics (NCTM) has recently established standards in data analysis and probability to be taught to all students from grades K-12. This text is designed to teach the prospective teachers basic concepts in probability and statistics so they have the background to teach the content listed in the NCTM standards. The basic concepts in data analysis and probability will be taught by means of discovery and group interaction on directed activities, both of the hands-on and technology varieties. Technology is implemented by means of the software *Fathom*, *Tinkerplots* and the TI 84-Plus graphing calculator.

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WebAssign® **Fact Sheet**

What Is WebAssign?

WebAssign is a powerful online assessment system that lets you distribute, collect, grade, and record assignments quickly, accurately, and automatically over the Internet. WebAssign eliminates the monotony of grading papers and recording scores, leaving more free time to meet with students and prepare class presentations. Students and teachers can access WebAssign from any computer with a connection to the Internet, so learning can take place anywhere, anytime.

"Again, this is the best tool ever to assist and motivate students in learning chemistry, math and physics. I am a true believer. And you keep improving it so much each year." Carolyn Morse, UNC Chapel Hill

How Does WebAssign Benefit Teachers?

WebAssign changes the way you think about homework. Its instant grading and reporting features take the drudgery out of frequent assignments and transform homework from a time trap into a powerful evaluation tool. You will have more time for guidance, more opportunity for directed discussion, more energy for interactive exploration, more freedom to teach the way you want to teach.

"I teach at a community college with no grading help. Without WebAssign, I simply would not be collecting homework, and the students would ultimately suffer." Independent survey by Iota Solutions

How Does WebAssign Benefit Students?

WebAssign transforms the way students learn. With instant feedback, students know immediately whether or not their answers are correct. With multiple submissions, your students can focus on their mistakes and gain confidence as they learn each topic. Now all students have an equal opportunity to master the material in your course. More frequent assignments offer a greater opportunity to practice skills. They come into your classroom well prepared and ready to learn. Students consistently report that they enjoy using WebAssign, find the immediate feedback helpful, have few problems using the service, and recommend that assignments continue to be offered with WebAssign.

"WebAssign requires students to study every day and not just wait until a weekly assignment or exam. Procrastination is no longer an option for my class." Aaron Titus, High Point U

"WebAssign helps us to do [homework] on a continual basis, which helps me to learn the material, rather than just memorizing it for a short period of time! I love WebAssign!" Student at Linfield College

"You give us exactly what we need to get the job done quickly and correctly. Thanks for the quality." Student at Rochester Institute of Technology

What Are Some of WebAssign's Highlights?

- Pre-coded textbook questions
- Expanding set of powerful tools for creating questions and customizing assignments
- Available 24 hours a day, 7 days a week
- Easy to use
- Scaleable from individual classes to school-wide programs
- Complete easy to use GradeBook
- Integration possible with your institution's password server, registration and records, Blackboard, and WebCT
- Excellent support team

"This is the most useful tool in teaching since the advent of the electronic spreadsheet." Independent survey by Iota Solutions

"The Summary Report feature in WebAssign is priceless." Jay Salon, Palmetto HS

"The speed of response to my questions never ceases to amaze me. I'm impressed." Joe Wilson, U of Kentucky

How Do I Use WebAssign?

Once you login to WebAssign you access your own customized view of your classes and assignments. From your ClassView page you are a click away from managing assignments, class announcements, viewing students' progress, communicating one on one or sending everyone a message, and handling student help and extension requests.

"Just so you don't think Web Assign is unappreciated, I should mention that the performance of the Chemistry 161 class last semester was the best I have had in many years. Although it's hard to prove, I feel very strongly that Web Assign played an important role in their good performance." Robert Boikess, Rutgers U

Class Management

When you first join WebAssign, the account manager will send you a username, school code, and initial password with instructions for setting up your first class. Your school code is unique to your school and is used in the login. The simple class creation wizard will help you create your classes. You will be the teacher in charge of the classes or the "primary" teacher. You can add additional instructors who will have the same privileges as you or TAs with limited privileges.

You can create as many classes as you need, or simply add sections to the first class. You can upload a class roster by pasting a tab-delimited file into the roster form, add your students one at a time, or push your roster over from Blackboard or WebCT.

During class creation you can choose to associate your class with one of the WebAssign textbooks. WebAssign has agreements with leading textbook publishers to provide questions and problems from selected textbooks. Teachers who adopt one of these

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phone: 800-955-8275 fax: 919-829-1516 email: info@webassign.net web: webassign.net

textbooks can make assignments using these pre-coded questions. If WebAssign does not support your textbook, just fill out the request form in the Content tab of the WebAssign homepage. We make every effort to help you get the questions you need into the growing database of WebAssign questions. We have over 100 textbooks' end-of-chapter questions ready for immediate use.

> "Using problems from the textbook [mine is Tipler *Physics*] is a very important feature. WebAssign has been great for my classes and I continue to find new ways to use it." Independent survey by Iota Solutions

Assignment Management

The heart of WebAssign is assignment management. Whether the assignment is homework, a quiz, a test, or an in class activity, WebAssign makes managing the content, feedback, dates, instructions, scores, and value toward the final grade as easy as possible.

Let's imagine you want to create your first assignment. You would click Create, enter the assignment name, a description of the assignment, choose the questions, and save. That is all there is to it. You can also weight each question, choose how to randomize, and pick the feedback to deliver to your students before the due date and after the due date.

Assignments can be scheduled for any of your classes with a click of the Schedule button. Your assignments are always available to you no matter which class or term you are viewing.

> "WebAssign rewards the hard-working student who might not get the answer correct the first time but is willing to keep trying." Dave Corsetti, Broughton HS

Question Management

If you choose to create your own questions, WebAssign has the tools you need. If the textbook you use in your class is one of the WebAssign textbooks, you may never need to visit the Question Editor. You will create your assignments in the Assignment Editor from the prepared questions from your textbook.

However, the powerful tools for creating your own questions are available in the Question Editor. You can start from scratch or duplicate existing questions. You can begin creating your own questions in a matter of minutes.

> "I prefer to construct my own problems. WebAssign makes this very easy." Independent survey by Iota Solutions

Answers to questions can be numerical, symbolic or algebraic, multiple choice, multiple answer, fill-in-the blank, essay, image map, file upload, poll, Java, or any combination of these types. Variables, words, phrases, sentences, paragraphs, graphics, sound files, and video files can all be randomized so that many versions of the question are delivered to your students.

> "The randomization of numerical inputs prevents students from simply copying answers from their friends, and the instantaneous feedback mechanism broadens the role of homework assignments. Instead of simply providing assessment, they are also tutorial instruments." Pete Knipp, Christopher Newport U

Randomization and many other powerful techniques are achieved with a special tag invented for WebAssign. This tag allows WebAssign to interpret Perl code for mathematical and logical expressions, so you have a sophisticated programming language at your disposal.

Questions can have multiple parts. The first part could be multiple choice, the second part numerical, and the third essay. Teachers can change from one question type to another as many times as they like in one question. Questions can be identified with a name, key words, and subject classification. Every question is identified with the author name and a unique serial number.

> "I've used other electronic homework systems, both web-based and non-web-based. WebAssign is by far the most flexible system I've tried. I am especially satisfied with the wide variety of question types, and how easy it is to incorporate a range of difficulty levels in the assignments. I will definitely keep using WebAssign." Brian Gilbert, Linfield College

Score Management

The ScoreView gives you access to a table of scores for all your students and all your assignments. You can drill down to every submission your students make or view a summary of scores with appropriate statistics for each question type. All reports can be displayed on the screen, printed, or downloaded to a file. Typically, teachers access the scores for one assignment for all their students just after the deadline to see if the class is up to date on the material. This feature supports "just in time" teaching. Many use the reports to review the progress of individual students to see if they are keeping up with the class.

> "The best thing about WebAssign is finding out which concepts students **do not** understand by getting a percentage of the choices that were answered." Jay Salon, Palmetto HS

You score essays on the screen either anonymously or with student names appearing on each essay. After grading, the students can view their scores, your comments, and a teacher-provided exemplar.

The ScoreView page also gives you quick access to granting extensions to one or more assignments for one or several students. Warnings appear if the student has viewed the answer key or if there was an additional request for an extension. It is even possible to allow students to request an automatic extension with you deciding on the consequences.

Complete GradeBook

WebAssign includes a complete grade book. All the scores from WebAssign assignments are automatically available to the WebAssign GradeBook, as well as scores you upload. To get you started there is a friendly wizard. During the steps of the wizard you are asked to make basic decisions of how you want your students' final grade calculated. Your assignments are in categories such as homework, quizzes, tests, labs. You can also create your own categories. You decide the weights of the various categories and whether any assignments should be dropped, e.g. the 2 lowest homework scores. You can also decide to upload your own averages for any of the assignment categories. If you would rather use your own method for calculating grades, WebAssign offers a simply way to upload your grades. Whether or not you or WebAssign calculates the grades, you decide what grades and statistics get posted to the student view. You can view and decide to show your students the class average, minimum and maximum, standard deviation, and a histogram for interim and final grades as well as all assignment scores in WebAssign.

Communication Management

Teachers can turn on a wide selection of tools to promote communications, both between teacher and student, and between student and student. The Communication tools include a Message Board often used for homework forums, Private Messages, a Help Desk, an Extension Request hotline, and an Announcement manager. You can choose to turn any of these tools off. However, if you turn on the Message Board, your students will be able to post questions during their work time and help each other with their difficulties. The Help Desk tool delivers student questions to you in the context of their work. You can see what they have been doing and then give personal help in your response.

> "The results of our semester exam showed a measurable difference between those students who used WebAssign and those who did not." Independent survey by Iota Solutions

How Do Your Students Use WebAssign?

Your students will open their browser to the secure login page, https://www.webassign.net/login.html

The login includes links to an online student guide and a technical support area with answers to commonly asked questions and a Student Help Request form for asking us questions. We help the students as much as we can about everything except course content. There will also be boxes for their login information. We recommend that you require your students to read the student guide and give them the Intro to WebAssign assignment. The instructions for creating this Intro are in the online User's Manual.

Before they log on for the first time, you will provide them with the following information:

- Their WebAssign username
- Their school's code
- Their initial WebAssign password

Once the student enters the login information, they are shown every class they have that uses WebAssign. To find their assignments in a particular class, students simply click the class link. They can then select the assignment they wish to work on. For each assignment, students can see their current score, the number of submissions they have made and when the assignment is due. Once the due date has passed, an assignment can still be viewed but not submitted.

> "Students particularly love the feedback that WebAssign gives them during a test. In truth, all of us have been asked by students during a test to give them feedback to an approach they're taking to a question. WebAssign automates this feedback process and levels the playing field for everyone. You'll be hard-pressed to find any student who doesn't endorse this approach." Lavon Page, NCSU

If students need help on a specific assignment and you have enabled the Help Desk, they can send a Help Desk question. You or your 'tutors' will receive the question inside WebAssign with easy access to their work and can provide assistance as you see fit.

> "I really like the way that homework is assigned this semester…I have plenty of time to receive help without staying up really late and pulling my hair out." Student survey

What Does Research Say about WebAssign and Online Assessment?

Web-based assessment and related applications have become a frequent topic in educational research. One paper addressed the significance of using a computer as opposed to a human being in the evaluation process:

> "The bottom line of our investigation is that web-based homework leads to neither a significant improvement nor a significant reduction in student learning: All other things being equal, it doesn't make a big difference whether the computer or a human being is wielding the "red pen." Other factors in a course have a much greater impact on student performance than the *method* of collecting homework and delivering feedback. This supports the viewpoint that technology itself does not improve or harm student learning, but rather that the underlying pedagogy is the critical issue."

S. Bonham, R. Beichner, D. Deardorff. "Online Homework: Does It Make a Difference?" Physics Teacher, 39, 20 (May 2001).

In another article, the advantages and disadvantages of web-based tools are explored:

> "The growth of the Internet, and in particular the World Wide Web, is already influencing the way science is taught and will undoubtedly do so to greater extent in the future. One important facet of this is the development of web-based assessment and testing systems. These systems also provide a valuable new tool to the education research community; a tool that combines the ability of multiple-choice diagnostic tests to handle large numbers of subjects with some of the greater flexibility and additional information that other methods offer…. In this paper, the strengths and weaknesses for education research are discussed, and some suggestions for its use are presented."

S.W. Bonham, A. Titus, R.J. Beichner, L. Martin, "Education Research Using Web-based Assessment Systems," Journal of Research on Computers in Education 33, 28 (2000).

Data support the positive effects of technology-based education tools, as this study shows:

> "The implementation of Asynchronous Learning Network (ALN) technology in a large on-campus course over several years is reviewed, and recent data concerning both educational and cost effectiveness are presented. Even with higher course standards for success, student performance on examinations has improved, a larger fraction of students achieve the goals of the class, and the proportion of students who excel has increased."

D. A. Kashy, G. Albertelli, E. Kashy, M. Thoennessen, "Teaching with ALN Technology: Benefits and Costs," Journal of Engineering Education, 90, 499 (October 2001).

Other studies continue to explore key issues related to the successful implementation of on-line assessment:

> "The present study seeks to identify key issues pertinent to assessment of students' performance in Web-based and Web-enhanced coursework. It constitutes a qualitative case study focused on the Educational Leadership department at the Center for Excellence in Education at Northern Arizona University (NAU) in Flagstaff, Arizona."

M. I. Dereshiwsky, "'A' Is for Assessment: Identifying Online Assessment Practices and Perceptions," Ed Education at a Distance, 15 (Jan 2001) http://www.usdla.org/html/journal/JAN01_Issue/article02.html

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What Are Teachers Saying About WebAssign?

We receive feedback from teachers on a daily basis. Here's what some of them have said about their experiences with WebAssign:

> "Solving homework problems is the main way that students learn physics, engineering, and mathematics, and WebAssign is a very efficient and powerful tool for compelling students to do so." Pete Knipp, Christopher Newport U

> "The immediate feedback has been a great benefit to me and to my students. They don't have to wait for me to grade a set of papers to see what they've done right or wrong. It has helped students to develop a sense of math as units rather than page-by-page exercises. It also gives the curious learner a chance to see what is coming next in the unit and ask informed questions about the connections between skills." John Pritchett, Broughton HS

> "For the record, I really enjoy using WebAssign in my chemistry classes. I can't imagine now what life would be like without it." Bridget Dibble, Ocean Lakes HS

Just-in-Time Teaching with WebAssign

Assessing student understanding just before the class meets is a powerful technique for fine tuning a lecture. As discussed in *Just-in-Time Teaching* by Gregor Novak and colleagues (Prentice Hall, 1999),

> "Just-in-Time Teaching (JiTT) is a teaching and learning strategy comprised of two elements: classroom activities that promote active learning and World Wide Web resources that are used to enhance the classroom component. Many industries use JiTT methods; they combine high-speed communications and rapid distribution systems to improve efficiency and flexibility.... this makes our classroom activities more efficient and more closely tuned to our students' needs. The essential element is feedback between the web-based and classroom activities."

Many teachers are beginning to use JiTT with WebAssign. A few shared their experiences with us:

> "I also use WebAssign to do JiTT in my class. I use 'questions' from the end of the chapter as my pre-class assignments. These can be essay type … or they can be multiple-choice. It depends on the textbook. The advantage to multiple choice is that WebAssign's "Summary" option actually tells you what percent of your class chose which choice [only for multiple-choice questions], so this is a quick way to see what questions were answered correctly and what the most common incorrect answer is. I give my students only one submission for this type of 'assignment,' and I count it for full credit [1/1] as long as they respond." Anne G. Young, Rochester Institute of Technology

> "My evaluation? JiTT is a very enlightening way to teach. Reading students' written responses helps you to know what they are 'really' thinking. It has other benefits as well; for example, it helps to motivate students to read the book before coming to class. Also, seeing their poorly worded answers (poor grammar, spelling, lack of serious thought) displayed in class can motivate students to give better effort on the next JiTT question." Aaron Titus, High Point U

Do You Want to Try WebAssign?

To see what students see when they use WebAssign, go to the WebAssign home page, http://www.webassign.net. Click Demo. You will have a choice of a quick demo of a single class with several assignments or an expanded demo with many classes illustrating the way WebAssign can be used with many different disciplines. There is also a demo of the faculty application.

You can also sign up for 6 free weeks of WebAssign. Just click the Free Trial button. We look forward to seeing you online! Give us a call at 800-955-8275 if you have any questions.

Trashball: A Logistic Regression Classroom Activity

Richard E.Auer and Christopher H. Morrell
Loyola College in Maryland

1. The Activity

The classroom activity involves students attempting to toss a ball into a trashcan. Consequently, the outcome or response variable is whether or not the ball ends up in the trashcan. This binary variable could be termed "ShotMade." Whether or not the student is successful in making the shot likely depends on the distance from the trashcan that the student tosses the ball. A number of additional explanatory variables may be included in the design of the experiment. For example, these four factors may be included in the design: the distance from the trashcan (from 5 to 12 feet), the orientation of the trashcan (a rectangular trashcan was used and the long side can be aimed at or the trashcan may be rotated through 90^o to provide a narrower but deeper target), the gender of the student, and the type of ball used (tennis ball or racquetball). To increase the sample size, each student makes three attempts from varying combinations of distance, orientation, and type of ball.

2. Fitting the One - Variable Logistic Regression Model

The Minitab output below summarizes the analysis of 14 students' data. There were 42 total tosses from distances ranging from five feet to twelve feet.

Binary Logistic Regression: ShotMade versus Distance between the thrower and the trashcan.

```
Link Function: Logit
Response Information

Variable  Value       Count
ShotMade  1              25  (Event)
          0              17
          Total          42

Logistic Regression Table
                                                    Odds        95% CI
Predictor      Coef       SE Coef         Z      P  Ratio     Lower    Upper
Constant      5.204      1.695       3.07 0.002
Distance     -0.5499     0.1842     -2.98 0.003     0.58      0.40      0.83

Log-Likelihood = -22.294
Test that all slopes are zero: G = 12.102, DF = 1, P-Value = 0.001

Goodness-of-Fit Tests
Method                 Chi-Square    DF       P
Pearson                     5.542     6   0.476
Deviance                    6.488     6   0.371
Hosmer-Lemeshow             5.542     6   0.476
```

The goodness of fit tests indicate that the model provides an adequate description of these data. The predicted probability of making a shot as a function of distance x is given by:

$$P(\text{shot made from distance } x) = \exp(5.204-0.5499*x) / (1+\exp(5.204-0.5499*x)).$$

Figure 1 illustrates a fitted linear regression model and the logistic regression model. The fitted linear model clearly shows that predictions can fall outside the allowable range for probabilities. But the two models do agree quite well in the 0.2 to 0.8 range of probabilities. The odds ratio of 0.58 ($e^{-0.54999}$) indicates that the odds of making a shot changes by 0.58 for each additional foot from the trash can.

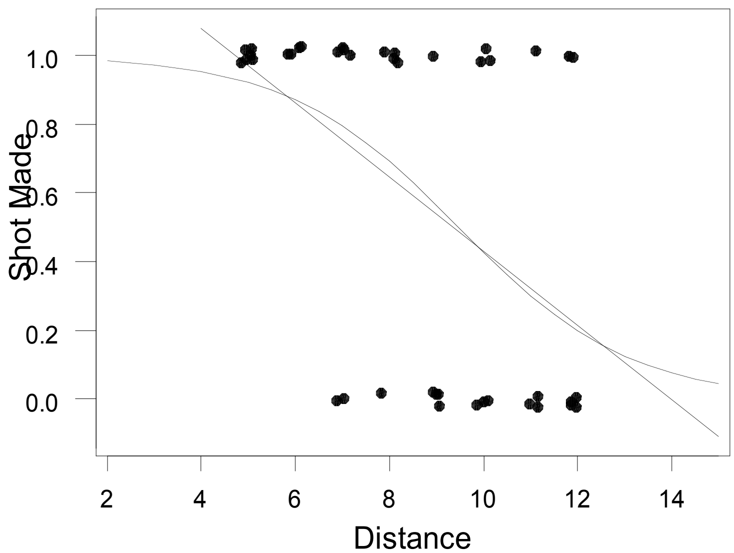

Figure 1. The fitted linear and logistic regression models. Jitter is included in the observed data points.

3. Fitting the Multiple Logistic Regression Model

Once simple logistic regression has been discussed in class and the various concepts of logistic regression have been introduced, the class may move onto multiple logistic regression by incorporating the additional explanatory variables measured during the experiment. After applying a backward elimination process to the multiple logistic models, the final model does not include the variables Gender and Type of ball as they prove to be statistically non-significant. The final model is summarized in the Minitab output below:

Binary Logistic Regression: ShotMade versus Distance, Orientation

```
Logistic Regression Table
                                                       Odds       95% CI
Predictor        Coef      SE Coef          Z      P   Ratio   Lower    Upper
Constant        5.857       1.913        3.06  0.002
Distance      -0.7425      0.2282       -3.25  0.001    0.48    0.30     0.74
Orientation    2.3096      0.9827        2.35  0.019   10.07    1.47    69.11

Log-Likelihood = -18.684
Test that all slopes are zero: G = 19.323, DF = 2, P-Value = 0.000
```

```
Goodness-of-Fit Tests

Method               Chi-Square   DF      P
Pearson                   3.441    8  0.904
Deviance                  3.994    8  0.858
Hosmer-Lemeshow           3.316    7  0.854
```

The goodness of fit tests again indicate that this model provides an excellent description of this data. The estimated parameters indicate that the probability of making the shot decreases with distance and that one has a higher probability of making the shot if the orientation of the trashcan has the narrow/deep target facing the thrower.

The odds ratio for orientation tells us that the odds are 10 times higher to be successful in throwing the ball into the can if one is throwing at the long/narrow target versus the short/wide target. In addition, the odds are .48 times as much for each additional foot from the trash can.

OVERVIEW INFO FOR SPOTLIGHT SESSION: "MANAGING PROJECTS IN THE INTRO. COURSE"

Dan Brick -- University of St. Thomas, St. Paul, MN
dgbrick@stthomas.edu

(additional handouts available at my spotlight session table)

1) NATURE OF MY "PROJECTS"

3-student teams are formed early in the course, and each team chooses its own topic for study (via a written proposal, pending approval from the instructor). The scope of each project calls for collecting data on at least 10 variables (some interval and some nominal-scaled), with a sample size of at least 100.
Each team makes a class presentation of their study/results during the last week of classes, and their grade for the project is primarily determined via a written report submitted at the start of finals week.

2) THE COURSE

This is a 1-semester service course, offered through the Dept. of Quantitative Methods and Computer Sciences. It is a required course for several majors on campus (so the typical section will have about 60% business majors, with the remainder from Psychology, Natural Sciences, Math, Journalism, etc...). There are about 10 sections offered each semester, with enrollment in each section being between 30 and 35. The text for the course is Moore & McCabe, *Intro. to the Practice of Statistics.*
We have a 2nd semester course, but it only attracts approx. 20 per year.
(I should mention that I believe such projects can be successful in many environments, excepting large lecture sections. I use very similar strategy for course projects in our MBA program, in an undergrad course I teach as an adjunct at the Univ. of Minnesota, and in the past at William Paterson Col. and at Seton Hall Univ. in New Jersey)

3) MY PHILOSOPHY BEHIND USING SUCH PROJECTS

As is the case for Statistics instructors at many institutions, we get only 1 shot to help students gain some understanding of Statistics. With this in mind, it has long been my contention that the topical emphasis in many Intro. Stats. courses has been misplaced.
These are outcomes I consider "high priority":

- -- importance of measurement issues (and scales of measurement)
- -- appreciation of what "random" really means
- -- importance of sampling frame vs. population, as well as other sources of non-sampling errors (and the conceptual distinction from sampling error)
- -- describing sample data both graphically and verbally (focus on patterns, rather than just averages)
- -- basic thought process of inference (margin of error, p-value), with consistent logic regardless of context
- -- how to look for/assess relationships between variables
- -- "explaining variation" as the goal of multi-variable analysis
- -- supporting cause/effect (experiments vs. observational studies)
- -- working with software (we use Minitab), and being able to properly verbalize the results

These are the sort of outcomes I consider "very low priority":

- -- a laundry list of statistical tests (e.g. I don't cover 'differences between proportions', tests for variation, or any non-parametrics)
- -- technical details (by my definition, includes 'degrees of freedom', pooling, etc...the small number of students headed in our direction will easily pick these up in a subsequent course)
- -- probability rules

4) PROJECT-RELATED LOGISTICS

I meet an extra 13 minutes for all class sessions for the first 10 weeks of the course, and in exchange we take the following 2 weeks off. This enables us to complete our topical coverage earlier, and thus allows students to focus on analyzing their collected data (and to meet with me, as a consultant) and organizing their presentation and report during this time.

I establish several milestone dates for the project teams, including:

- -- first draft of proposal
- -- final version of proposal, accepted by instructor
- -- first draft of survey (or list of variables for those using secondary data)
- -- final draft of survey, incorporating appropriate cover letter per our IRB
- -- each team must schedule a "progress report" meeting with me, just before our 2-wk. class break period

5) DRAWBACKS TO USING THESE PROJECTS

-- Various aspects of the projects take up some class time, and hence this means some additional topics can't be covered.
But I consider this to be an extremely favorable trade-off, with the project serving to promote the outcomes I consider more important.

-- the project adds to the amount of work in the course for the students. This is true, and while I'm not delusional enough to think they relish the extra work, my sense has been that their perception of the practical nature of the projects is what makes it more than just tolerable. My sections are always the first to fill at registration time, despite the work load.

-- the projects create extra work for the instructor, and extra time demands for meeting with the teams. Undoubtedly true, but again here I consider this a favorable trade-off. The course is far more interesting this way, since the projects are different from one semester to the next. And the 'forced interaction' between students and faculty member provides benefit beyond just the current semester; e.g. we have a big push for more under-grad student research, and this gives students some exposure (even though somewhat artificial) to such a process

Multiple Monte Carlo Methods for Making Sense of Statistical Matters

Contributed Poster presented at the Spotlight on Pedagogy session at the United States Conference on Teaching Statistics (USCOTS) meeting, May 20, 2005, Columbus, OH.

Computer Programs and Presentation by

Gordon Brooks

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Auxiliary Materials developed by

Holly Raffle, Lydia Kyei-Blankson, Marsha Lewis, Valerie Blom, Gibbs Kanyongo, Khaleel Al-Harbi, Abdulbaset Abdulla, Gulsah Gocmen, Hua Gao, Hua Fang, Victor Heh, Gordon Brooks

Abstract

While Monte Carlo methods are valuable research techniques, they also can be useful instructional tools. Instructors can generate data to explore sampling distributions, Central Limit Theorem, Type I error, and power. This presentation will demonstrate several free Windows Monte Carlo programs (created by the presenter) that instructors can use.

Software and Auxiliary Materials are available for download at:
http://oak.cats.ohiou.edu/~brooksg/software.htm

Multiple Monte Carlo Methods for Making Sense of Statistical Matters

Monte Carlo computer simulation methods are valuable research methods in applied statistics. They help to provide understanding of problems that cannot be solved mathematically, such as when a statistic's sampling distribution is unknown or when a null hypothesis is not true. Using simulation, the values of a statistic are observed in many pseudorandom samples generated from a population with known characteristics. For example, we may want to test the robustness of a statistic when the null hypothesis is true but the underlying mathematical assumptions of the statistic are violated; knowing that any statistically significant result is a Type I error under a true null hypothesis, a researcher can use Monte Carlo simulation to determine the impact of the violation on actual Type I error.

Monte Carlo methods also have great promise as useful instructional tools -- if made easy to use. For example, it is very important for students in introductory statistics courses to comprehend complex concepts like sampling distributions, the Central Limit Theorem, mathematical assumptions, inflated Type I errors, and statistical power. Computer simulation is an ideal way to present such abstract ideas in a more concrete way. Unfortunately, Monte Carlo techniques have typically been the exclusive territory of statistician-researchers with computer programming skills and have not been used much for instruction.

We are hopeful that this free computer software and the associated guided learning activities will be useful to instructors in all circumstances, but particularly as more and more statistics courses are made available online.

FISH: Friendly Introductory Statistics Help (version 4.60)

Version 3.0.8 presented at the Joint Statistical Meetings, August 2004, Toronto, Canada

Statisfaction Guaranteed (with 95% Confidence)

Copyright © 2003-2005 Gordon P. Brooks

Contact: brooksg@ohio.edu

Web Site URL: http://oak.cats.ohiou.edu/~brooksg/software.htm

MC4G

MC4G: Monte Carlo Analyses for up to 4 Groups (version 4.20)

Version 3.4 was presented at the annual meeting of the American Psychological Society (2004, May), Chicago, IL

Statisfaction Guaranteed (with 95% Confidence)

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Contact: brooksg@ohio.edu

Web Site URL: http://oak.cats.ohiou.edu/~brooksg/software.htm

$(MC)^2$

$(MC)^2$: Monte Carlo Multiple Correlations (version 1.30)

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Contact: brooksg@ohiou.edu

Web Site URL: http://oak.cats.ohiou.edu/~brooksg/software.htm

MC2G

Monte Carlo Analyses for 1 or 2 Groups (Version 5.03)

Version 2.2.3 Presented at AERA 2002, New Orleans, LA

A description of version 3.0.7 of the program has been published:
Brooks, G. P. (2003). Using Monte Carlo methods to teach statistics: The MC2G computer program. Understanding Statistics, 2, 137-150.

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Contact: brooksg@ohiou.edu

Web Site URL: http://oak.cats.ohiou.edu/~brooksg/mc2g.htm

Championing Statistical Thinking

An ASA INSPIRE Project

Student: **Sr. Alice Hess**, Archbishop Ryan High School Philadelphia PA
Mentor: **Prof. Robert Carver,** Stonehill College, Easton MA

Using timed events from summer Olympics, our goal was to identify rich data sets that would engage teenagers taking AP statistics. We set out to use the data sets in lesson plans that would lead teachers and their AP Statistics students to statistical sleuthing. The result was a package of assignments and small datasets that would emphasize the processes of statistical reasoning that are embedded in specific techniques and would afford students the chance to solidify their understanding of some basic, but sometimes elusive, statistical concepts.

Datasets are provided in Minitab format, but Sr. Alice successfully taught these lessons exclusively using the TI-84 Plus Silver Edition. Other instructors can surely use comparable tools and software.

Populations Studied

- Participation in summer Olympics 1900—2004—Numbers and percentages of male and female participants.
- Men and women's Marathon finishing times in Summer Olympics 2004.
- Qualifying Times for 800 m Women's Freestyle Swimming Even from Sydney and Athens Games.

Technique, Topic, or Concept	**Brief description of dataset and assignment**
Describing a distribution (center, shape, spread)	Marathon (Men and Women's) Olympics 2004–descriptive statistics--possibly showing symmetry, skewness, single- and multiple peaks.
Non-linear decay in time series	800 m Women's Freestyle Swimming Event
Uses of data transformation (logs, quadratics, etc)	Participation in Summer Olympics 1900-2004
Confidence Intervals—one & two sample t	**One-sample**: **Two-sample**: Qualifying Times—800 m Woman's Freestyle Event from Sydny and Athens Games.
Tests of significance—one and two-sample t	**One-sample**: **Two-sample**: Qualifying Times—800 m Woman's Freestyle Event from Sydny and Athens Games.
Simple linear regression, including inference for slope	**Do large countries win more medals than smaller countries?** Simple regression for 2004 summer Olympics; X = population of country, Y = # medals won.
Chi-square test of Goodness of Fit	**Participation in Olympics 1900 to 2004**

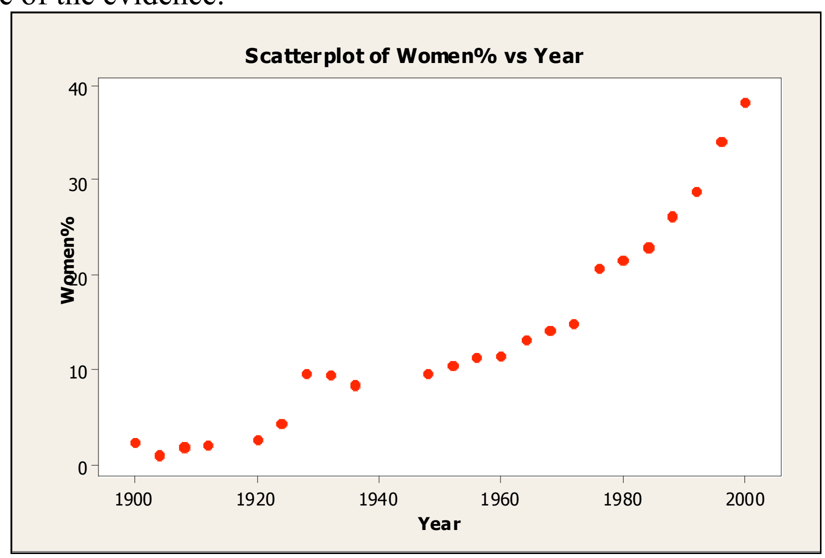
One example:

One dataset contains the total number of female and male athletes participating in the Summer Olympic games from 1900 – 2000. Among other questions, students see this one:

In 1944 the International Olympic Committee (IOC) changed its charter to encourage women in sport.

- Research this topic.
- From a statistical standpoint, what should/could we accept as evidence that the IOC was succeeding or failing in its attempt to encourage female participation? In other words, what kinds of statistical evidence would we want to look at to form a judgment? State your case clearly and then perform a test.

Here is one piece of the evidence:



To download presentation and datasets, visit:
http://faculty.stonehill.edu/rcarver/conference_presentations.htm
Select USCOTS

Corresponding Author Contact: rcarver@stonehill.edu

OUR EXPERIENCE WITH HYBRID AND ONLINE LEARNING IN INTRODUCTORY STATISTICS AT BRIGHAM YOUNG UNIVERSITY

StatTutor lessons (one for each statistical concept in introductory statistics) were developed using Flash Macromedia and QuickTime movies from 1997 through 2004.

What is StatTutor?

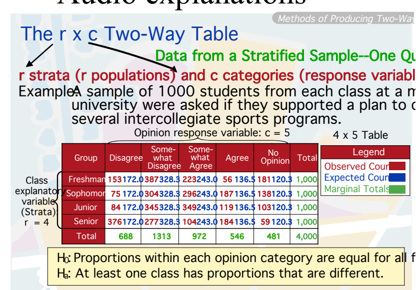
- Animated presentations of statistical concepts with explanations
- Includes:
  - Videos of real life applications help students buy i need to know statistics.
  - Hear — Audio adds one more sense to the learning proces
  - See — Animations give visual explanations not possible in
  - Do — Applets aid understanding.

Videos

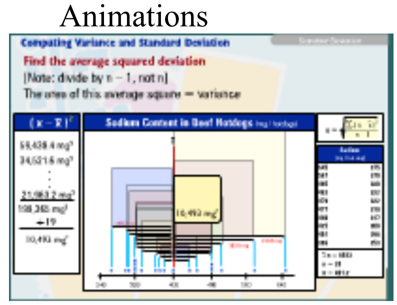
How We Are Using StatTutor at Brigham Young

- Two hybrid sections of introductory statistics (200
  - 75% are Flash lessons presented in class by an inst
  - Remaining are StatTutor lessons viewed online in lie
  - Quiz on Blackboard with deadline for each StatTutc
  - Instructors decided which lessons are best done in
- Two all online sections of introductory statistics (20
  - All are StatTutor lessons viewed online outside of c
  - Quiz on Blackboard with deadline for each StatTutc
  - Activity held in class once a week.
  - Optional question/answer session once a week.
- Four regular sections of introductory statistics (200
  - Students view no lessons online outside of class.

Audio explanations



Animations

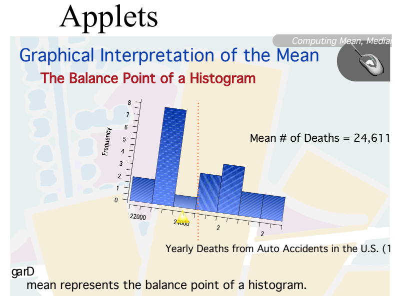


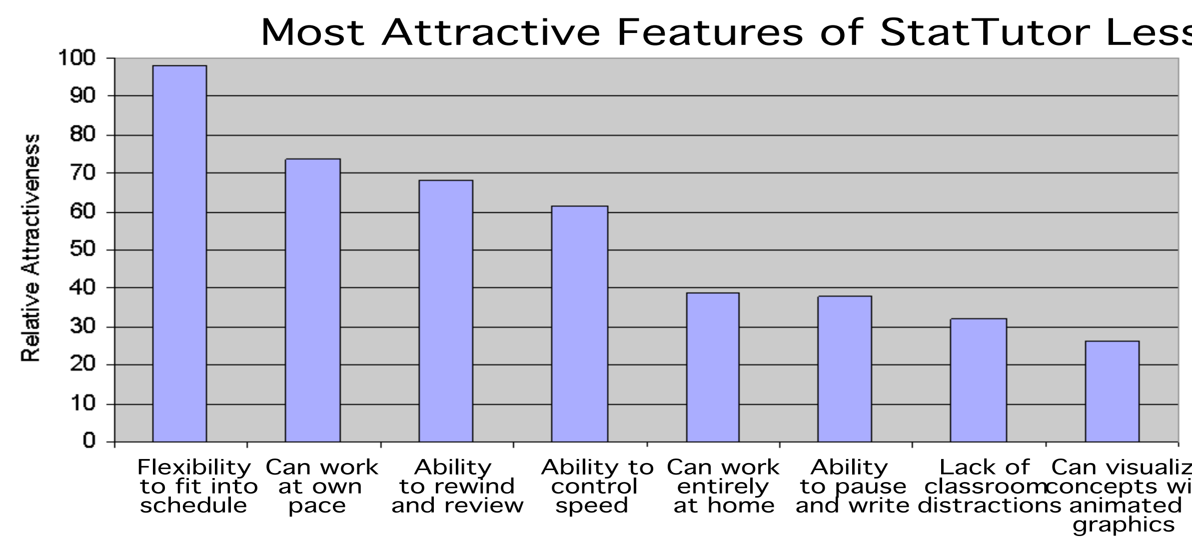
What We've Learned So Far

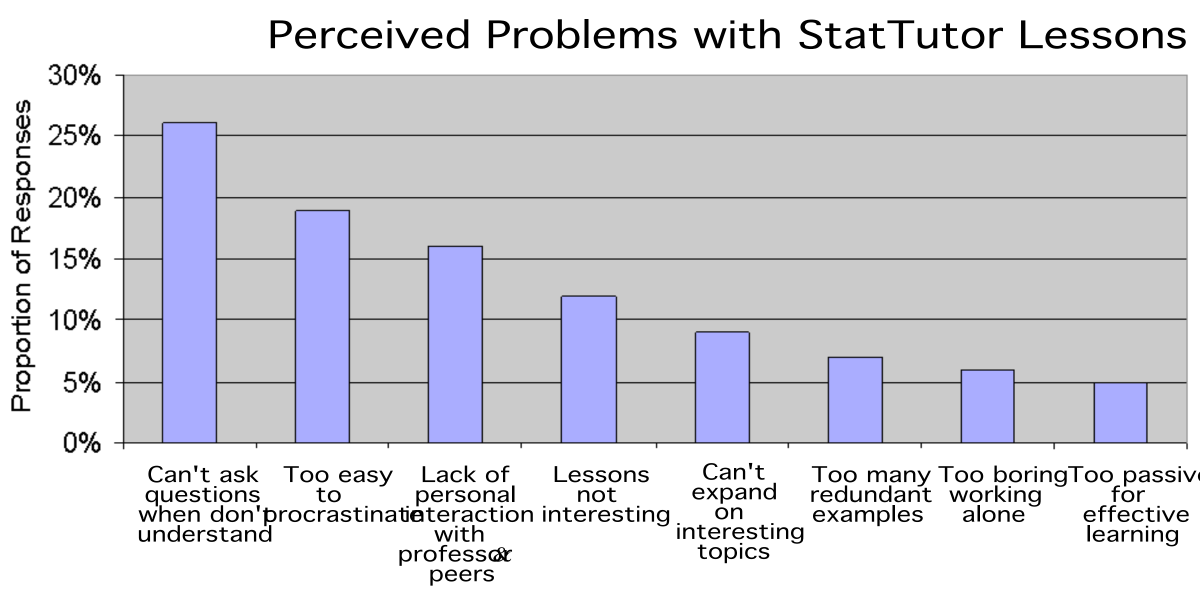
- 79% rate StatTutor as "Good" (58%) or "Excellent
  - Increase from 68% last year with partial online
- Gender mix of 60% males and 40% females.
- 65% listed StatTutor as primary learning source.
- Exam scores higher for good students--lower for pc

	Mean Scores on Stat 221 Exam					
	All Students	A Students	B Students	C Students	D Students	Failing Students
Regular	82.4	93.8	85.3	75.9	66.0	54.9
Hybrid	83.9	94.0	85.5	75.5	66.4	50.7
All online	82.7	94.6	85.6	75.7	65.1	52.0
P-value		0.034				0.018

Applets







Reasons for Using StatTutor

- Free up class time for:
  - activities
  - discussions of real life applications
  - emphasizing statistical thinking instead of det
  - assessment
  - focusing on difficult concepts
- Provide makeup for missed classes
- Give students with English as a second language or having trouble an opportunity to replay audio over

Summary

- 90% favored StatTutor; 20% said StatTutor was
- 89% of students felt they learned "as well" or "be regular classroom lecture.

No significant difference between average test score who viewed lessons online versus those presented les instructor>= NO HARM DONE

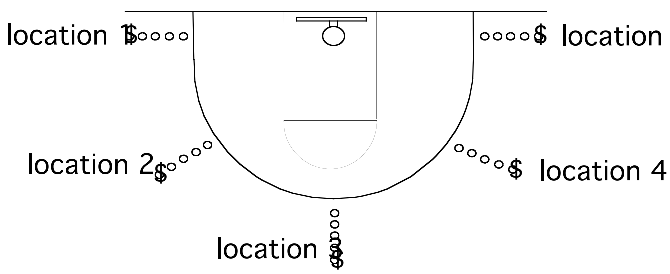
Also no difference within demographics:
- Gender
- Age
- Major

ACTIVITY DEMONSTRATING SAMPLING DISTRIBUTION IN HYPOTHESIS TESTING

by P. B. Collings

1. Record your 25 consecutive random digits here:
   Students are asked to obtain 25 random digits from either their calculator or from a random number table. If they use a random number table, be sure to tell them not to use the top row or else many will. I tell them to pick 25 random digits that no one else is likely to pick.

2. Every year at the National Basketball Association all-star game, a three-point shoot out competition is held. At five locations around the three-point line each player takes five shots. For each ball that goes through the hoop, a player gets one point. That is, except for the fifth of each set of five shots. This ball is called the money ball because the player gets two points if the fifth ball goes through the hoop. The player's score is his total points.



Now you get to simulate playing in the three-point shoot out. Each of your digits represents one shot. If the digit is even, you made your shot. If the digit is odd, you missed your shot. Each even digit counts 1 point except for every fifth digit which represents a money ball shot worth 2 points. Here is an example:

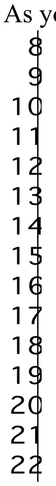
	Location 1	Location 2	Location 3	Location 4	Location 5
Digits	0 0 2 7 6	6 7 2 7 9	8 3 2 9 4	3 7 7 3 8	6 5 5 3 3
Points	1 1 1 0 2	1 0 1 0 0	1 0 1 0 2	0 0 0 0 2	1 0 0 0 0

Total points = 14 points (Note: 0 is an even digit.)

Now it's your turn. For each digit listed in #1 above, record your points for each shot:

What are your total points?

3. As your teacher creates the plot on an overhead, copy and reproduce it here.



After the students have computed their points, I ask them to call out their scores and make a dotplot on an overhead. These values usually work. Once a student got a 7 and another student got a 24—both are very unlikely. If you have fewer than 30 students, I recommend that you have each student do this twice.

4. Using our assignment for random digits, what are we saying our three-point shooting percentage is? *50%*

5. What does the plot tell us? *Plot tells us possible points that could be made in the three-point shoot out for a 50% three point shooter.*

   Does it give a distribution? If so, what distribution? *All possible scores for a 50% three-point shooter and how often each score occurs.*

6. What is the minimum score possible? *0* What is the maximum score possible? *30*
   What is the average score? *15*

7. Suppose a player scores 14, 16 and 17, respectively in three rounds of the shoot out. Could this player have the shooting percentage given in #4 above? Why or why not?

   Yes, because these scores are possible.

8. Suppose a player scores 20, 22 and 23, respectively in three rounds of the shoot out. Could this player have the shooting percentage given in #4 above? Why or why not?

   No, because these scores are not very likely.

9. Describe the hypotheses we are testing in #7 and #8 above.
   One hypothesis is that the player is a 50% three-point shooter. The other is that the player shoots better than 50% in three-point shooting.

10. If a player is a 50% three-point shooter, is he likely to score 14, 16 and 17? *Yes*

11. If a player is a 50% three-point shooter, is he likely to score 20, 22 and 23? *No*

12. If a player scores 14, 16 and 17, can we be fairly certain that he makes **exactly** 50% of his three point shots?
    No, because he might be a 49% or a 51% three-point shooter.

13. If a player scores 20, 22 and 23, can we be fairly certain that he is better than 50% in his three point shooting?
    Yes Are we 100% positive? *No*

14. What is the difference between the following two questions?
    A. *What is the probability that a player is a 50% three-point shooter?*

    B. *If a player is a 50% three-point shooter, what is the probability that he scores 22 or higher in the three point shoot out?*

15. Which question in #14 asks about P-value? *Question B*

Moral: P-value is a conditional probability; it is the probability of getting a test statistic (as extreme as or more extreme than observed) IF the null is true. It is NOT the probability that the null is true.

The Central Limit Theorem: A Group Activity to Die For!

John Daniels – Central Michigan University

STA-282 Group Activity: The Central Limit Theorem

Let X be a random variable representing the roll of a fair 6-sided die. Complete the following table which will represent the **theoretical** distribution of X (Value of the Die and it's corresponding probability).

Table 1

Die Value (x)	Probability that X = x

1. Now we will conduct our experiment:
   a. Roll your die 4 times and calculate the average of these 4 rolls ($\bar{x}$) in the first box (Roll #1) in the table provided below.
   b. Now repeat step "a" 40 times. You have 40 $\bar{x}$ in Table 2

Table 2

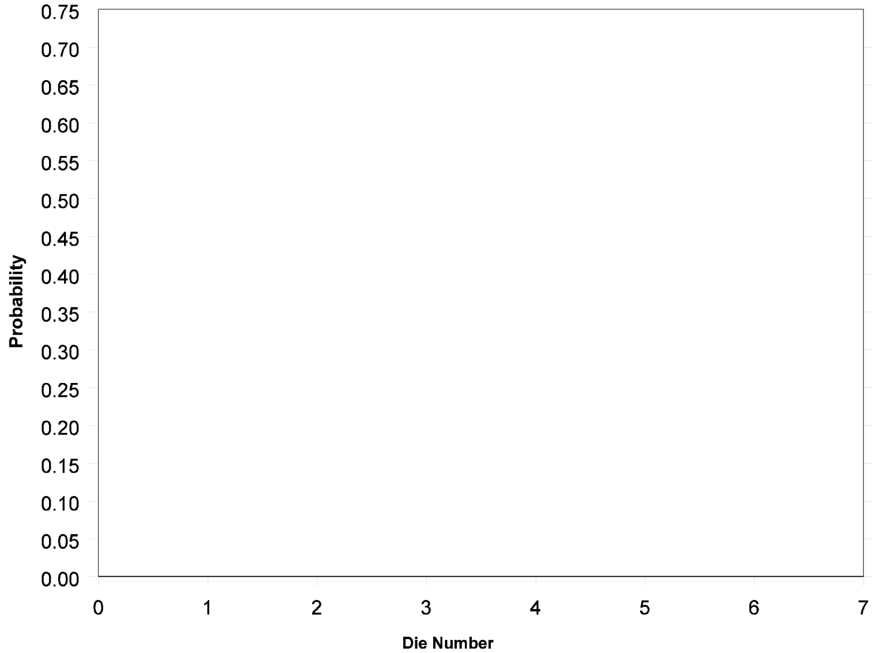
Roll #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
$\bar{x}$										
Roll #	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
$\bar{x}$										
Roll #	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
$\bar{x}$										
Roll #	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
$\bar{x}$										

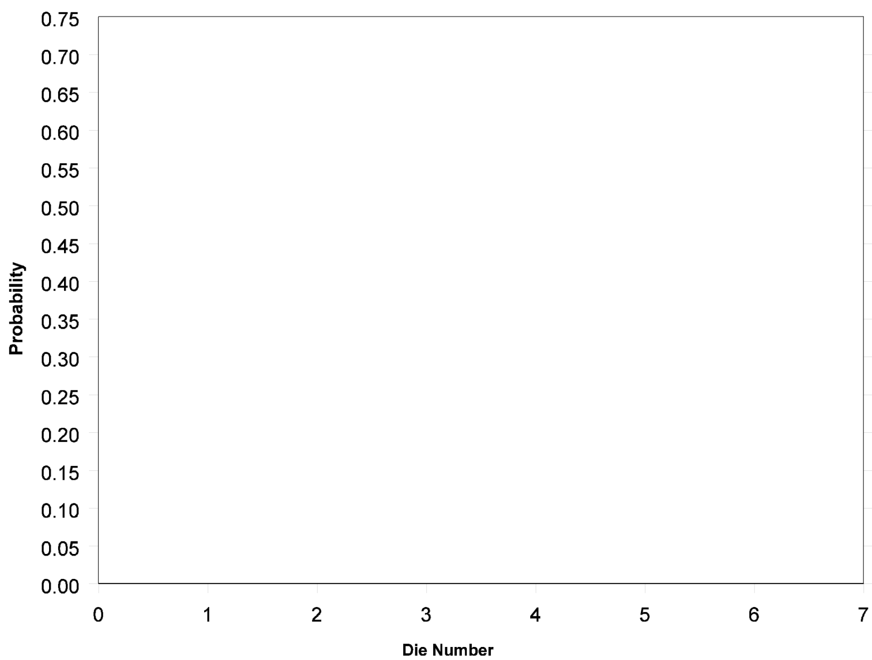
   c. Now sort your 40 values of $\bar{x}$ and complete Table 3 given below.

Table 3

Interval	Number of Rolls	Proportion out of 40 (Probability)
1 but less than 2		
2 but less than 3		
3 but less than 4		
4 but less than 5		
5 to 6		

2. We will now construct two histograms on the top and bottom of this page: Table 1 (single roll of a die) on the top and Table 3 (mean of 4 rolls of a die) on the bottom. Remember, the horizontal axis represents the values of x (or $\bar{x}$) while the vertical axis represents the probability of getting the particular value.





Exercise Questions

Recall the premise of the Central Limit Theorem: The mean of a random sample will approximately follow a normal distribution with mean υ and standard error $\sigma/\sqrt{n}$, regardless of the distribution of the population. The theory requires a sample size of at least 30 if the population distribution is unknown. However, because we know the distribution of the die and this distribution is symmetric, we can get away with a much smaller sample size (n=4) and still see how the Central Limit Theorem works.

We will now compare the results of rolling one die versus the experiment you performed: the mean of 4 rolls of a die.

1. Comment on the difference in shape between the top and bottom histograms.

2. Do you believe that there is a Central Limit Theorem effect working with regards to the shapes of the bottom distribution?

3. If the population has a standard deviation of σ and the mean of a random sample has a standard error of $\sigma/\sqrt{n}$ (according to the Central Limit Theorem), which one of these two values will be lower if n>1? Hence, which one of these two distributions do you expect to have lower variability: the population or the mean of a random sample taken from this population?

4. Looking at the top and bottom histogram, which one appears to have less variance: the population or the mean of the random sample?

5. Do you believe that the Central Limit Theorem is working here with regards to the standard error of the mean?

Statistics in the News

E. Jacquelin Dietz – Meredith College

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Article Collection – ST101

During the semester, you will assemble a collection of 16 articles from newspapers and magazines that relate to specified topics in this course. You may use either the print or the online versions of reputable newspapers and magazines. The articles must be news stories — they cannot be course materials designed to teach statistical methods!

For each topic below, turn in the following:

1. The article or a copy of the article.
2. A reference showing where you found the article. (Include the name of the publication, the date, and the page number. If you found the article on the web, include the url.)
3. The requested explanation or calculation.

You must use a different article for each topic. Arrange the articles in the order listed below and label each one clearly. **Highlight the relevant passages of each article!** The article collection is worth a total of 60 points.

- 4 points for neatness and format. Is your collection in a folder or cover? Are the articles in the correct order? Are the relevant passages of each article highlighted?
- 4 points for each article — 2 points for finding an appropriate article and 2 points for the requested explanation or calculation. There are 16 articles, but I'll drop your lowest two grades out of the 16.
- To summarize, the article collection is worth a total of 4 + (14 × 4) = 60 points.

Do not leave the article collection until the last minute! You should keep an eye out for suitable articles every time you read a newspaper or news magazine.

---

1. **Voluntary response:** Find an invitation to participate in a voluntary response sample. Are the results of this poll likely to be biased? Explain why or why not. If you think there is likely to be bias, what is the probable direction of the bias?
2. **Margin of error:** Find an article that reports the value of a sample statistic and its margin of error. Use the information in the article to make a confidence statement about the corresponding parameter.

3. **Pre-election poll:** Find an article that describes a pre-election poll and that provides answers to at least five of the eight questions on page 61 of *Statistics: Concepts and Controversies*. Answer the five questions.
4. **Experiment:** Find an article that describes an experiment. Explain clearly what makes the study an experiment rather than an observational study.
5. **Ethical issues:** Find an article about an experiment that raises ethical issues. Describe briefly what makes the experiment controversial. Make sure that your article is about an experiment!
6. **Rates:** Find an article that reports a rate at which something occurs. Explain clearly why it makes sense to measure this variable using a rate, rather than a count.
7. **Percent change:** Find an article that reports a percent increase or decrease in some variable. Your article must provide enough information for you to verify whether the percent change was calculated correctly. That is, the article must report three numbers — the starting value, the ending value, and the percent change. Show clearly how to calculate the percent change.
8. **Graphs:** Find examples of three graphs — a pie chart, a bar graph, and a line graph. For each of the three graphs, comment on whether the graph type is appropriate for the data and comment on anything that is misleading or confusing about each graph.
9. **Measure of center:** Find an article that reports a mean or a median. If your article reports a mean, explain why the mean is — or is not — a better measure of center than the median for this variable. If your article reports a median, explain why the median is — or is not — a better measure of center than the mean for this variable.
10. **Scatterplot:** Find an article that reports data that could be displayed in a scatterplot (if the full dataset were available). (Remember that scatterplots are used to show the relationship between two quantitative variables.) Specify clearly what variable would be plotted on the horizontal axis and what variable would be plotted on the vertical axis. Specify clearly what each point represents (the data for one person? for one city? for one company?). Describe what you think the pattern of points on the scatterplot would look like.
11. **Causation:** Find an article that makes a questionable claim about causation. That is, find a description of a relationship between two variables x and y that could be explained by other variables lurking in the background. Explain clearly how the lurking variable(s) could result in the observed association between x and y. As part of your explanation, draw a diagram like (b) or (c) on page 294 of *Statistics: Concepts and Controversies*. Label the circles in your diagram with the names of the variables, not just with the letters x, y, and z.
12. **Using the CPI:** Find an article that reports the price of some good or service in some past year. Use our updated version of Table 16.1 on the Consumer Price Index to convert the price to 2004 dollars. Show your calculations clearly.
13. **Probability:** Find an article that talks about the probability of some event. (The article should actually use the word "probability.") Does this probability have the interpretation on page 348 of *Statistics: Concepts and Controversies* (a number between 0 and 1 that describes the proportion of times an outcome would occur in a very long series of repetitions) or is it a personal probability (a number between 0 and 1 that expresses an individual's judgment of how likely an outcome is)? Explain your answer.
14. **Lotteries:** Find an article that discusses several reasons why North Carolina should or should not have a state lottery. Summarize the arguments pro and con.

15. **Two-way table:** Find an article that reports counts that can be arranged in a two-way table (similar to the one on page 465 of *Statistics: Concepts and Controversies*). Make two tables — one containing the counts and another showing appropriate percentages based on the counts. Label both tables clearly.
16. **Confidence interval:** Find an article that uses information from a sample to estimate a population proportion. Pretend that the sample was a simple random sample, and use the formula on page 424 of *Statistics: Concepts and Controversies* to calculate a 95% confidence interval for the population proportion. Note that your article must report both the estimated proportion and the size of the sample on which the estimate is based.

Dynamism and Humor in Statistical Presentation: Fresh not Frozen

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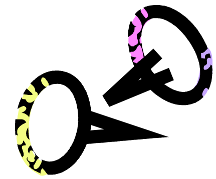
The primary goal of any successful education initiative must be the transmission of knowledge to the student. With this in mind, it is imperative to understand the platform that best characterizes the knowledge base of the student body. Educators often focus on extensive journal study to learn new methods of instruction when the answer is as near as the front row of students in the classroom. To achieve our goals, two important steps must be accomplished: breaking down student resistance to the material and then the actual explanation. I propose that the defenses the students erect in statistics class are actually the result of a self-fulfilling prophecy that has permeated the mathematically oriented fields. In my experience, many professors begin difficult topics with a standard disclaimer: "Now I know you don't want to do this, but we have to because it will arise on the test." Instead of promulgating a negative attitude towards the material, we as teachers must present the concepts in a positive light. Whenever one tries to explain a foreign concept, a common technique is the use of metaphor. I prefer to use this technique by relating statistical concepts to real world ideas <u>that are familiar to the students</u>. Also, an aspect of humor within the construct of the presentation goes far in the breakdown of a resistant attitude toward the subject.

What do I mean by presenting the concepts through <u>familiar</u> examples? Most examples provided in textbooks follow a standard formula of 'real world example'. Unfortunately, most students in the class will never be posed a question concerning the weights of African Elephants on the plains of Nigeria so they tend to devalue the details. Sure it may be real data, but how does this affect me here and now? What is its personal relevancy? While it is important to provide practice situations to the students, the instructor (if he/she has formed a repoire with his/her students) is in the prime position to produce questions that may be of interest to the students.

How can you incorporate these practices? Take an active interest in your students. This can be accomplished by simply learning their names as well as what is happening on the university or world stage. By incorporating current events into your presentation, the students will grasp and remember the concepts more often than not because it is presented in a framework to which they can relate. Sports are an excellent way to garner new found interest in your lecture. Representing a school with a nationally recognized football team (as well as being an avid fan myself); I find the students are apt to pay close attention to a football related example because it is something they enjoy. It also provides an easy outlet for a little humor at a rival school or player. I also find it useful to incorporate a little flair of humor to keep the students focused on task. For example, when presenting an example about El Niño (weather phenomenon), I prefaced it with a brief showing of Chris Farley's SNL skit about El Niño. The students' defenses retracted instantly with the laughter and they proceeded to take the example to heart. Overall, while the curricula dictate the material, allowing the students interests to determine the method of conveyance is the best way to keep the material fresh, not frozen.

ACTIVITIES TO ENHANCE YOUR STATISTICS CLASSROOM



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We are pleased to describe for you a variety of activities that we have found useful in our Advanced Placement Statistics classrooms to enhance student learning and, at the same time, provide a variety of methods of assessment.

We have described 12 activities/assessments you can use throughout your statistics curriculum. If you are an AP Statistics teacher, you are well aware of the four themes of our curriculum. If you are not familiar with these themes, they are as follows:

- Theme One: Exploring Data: Observing Patterns and Departures from Patterns.
- Theme Two: Planning a Study: Deciding What and How to Measure
- Theme Three: Anticipating Patterns: Producing Models Using Probability Theory and Simulation
- Theme Four: Statistical Inference: Confirming Models

We have described a number of activities for the various themes. Of course, some themes lend themselves to create hands-on explorations more easily than other themes. You can certainly change the questioning to meet the needs of your curriculum and even move some of these investigations into other areas of your curriculum. A number of the activities can be modified to use with several themes. For example, you may focus on design during theme 2, and analysis during theme 3.

Most importantly have fun with them!

Please feel free to talk with us or email us at a later date if you have any questions about them.

DESCRIPTION OF ACTIVITIES TO ENHANCE YOUR STATISTICS CLASSROOM

1. Flying Gummi Bears
   Design and implement a study to investigate the flight of a gummi bear using a catapult.

2. How Random Are You?
   Create an investigation of human selection versus machine selection. Are humans able to think randomly?

3. How Much Tape
   Create an investigation to predict the amount of tape left on the roll. Use regression to develop an equation.

4. It Makes "Cents"
   Create an investigation to observe the distribution of the mean age of pennies for different sample sizes.

5. The Cookie Correlation Caper
   Design and implement a study to compare features of various brands of cookies.

6. How Long Will the Candy Last?
   Design and implement a simulation to investigate half-life decay. Use transformation and regression to model the behavior.

7. Random Toss
   Design and implement a study to estimate probabilities for thumbtacks, plastic pigs, or monopoly houses.

8. Penny Toss
   Design and implement a study to investigate if people can toss pennies more accurately with one hand versus the other.

9. Tack Toss
   Design and implement a study to investigate if there is a difference when tacks are tossed individually or all together.

10. Quick Grab
    Design and implement a study to investigate if people can grab more pennies with one hand versus the other.

11. Double Dice
    Design and implement a study to investigate if these unusual dice give different results than standard dice.

12. All-Star Baseball
    Design and implement a study to investigate if this fun board game gives results close to the actual player's performance.

Using Paideia Seminars to Encourage Intellectual Discussion and Discovery in the Statistics Classroom

Kay Endriss – Cape Fear Community College

What is a Paideia seminar?
Paideia seminar is a collaborative, intellectual dialogue about a text, facilitated by open-ended questions. The teacher serves as facilitator, guiding the discussion with questions, while students are the primary contributors to the discussion. Students respond to the questions posed by the facilitator, state their opinions, ask each other questions, agree and disagree with each other, change their opinions based on what they learn during discussion, preempt the faciltator's questions, and generally surprise you and each other with what they come up with!

What are the goals of a Paideia seminar?
Combined with pre-seminar and post-seminar activities, the Paideia seminar represents a unique opportunity to improve students' communication skills and social skills, while tackling some of the deepest intellectual content of statistics. Students should walk away having learned something from the group discussion, not from you the teacher.

What makes a great text for Paideia seminar?
Keep an open mind. You can use a cartoon for a seminar text; I find they work particularly well. AP exam questions, graphs, paragraphs from your introductory textbook, advertisements or news stories using statistics are all strong possibilities. Don't forget books you can find on the public library shelves, written for the general public! When you think about creating a seminar, look for texts that contain the big picture ideas of statistics. Variation, association & causation, scientific method, type I and II error, etc. Any text you would select must be rich with these ideas.

How do I conduct a Paideia seminar?
First, I highly recommend the training offered by the National Paideia Center (see How do I learn more about Paideia seminars). During their training you will learn all about the Paideia seminar, participate in a Paideia seminar yourself as a participant (student role), and you will be able to practice seminar facilitation (teacher role).
Text selection for your seminar is key. Once the text is identified, you will need to think of questions that have many possible answers. I was truly surprised at the variety of answers provided to the first seminar question I posed. Word to the wise: prepare more questions than you can possibly use; participants often preempt some of them. Also, during the course of a seminar you may decide one question is more appropriate than another for the discussion that is unfolding.

How do I learn more about Paideia seminars?
Please contact the National Paideia Center at

400 Silver Cedar Court	Phone: 919-962 3128
Suite 200	Fax: 919-962 3139
Chapel Hill, NC 27514	www.paideia.org

Tell them Kay sent you!

Simulation Station

Activities

Martha Frank
Central Michigan University
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48859

Martha.frank@cmich.edu

U.S. Conference on Teaching Statistics (USCOTS)
Columbus, OH
May 19-21, 2005

Simulation Station: Martha Frank, Central Michigan University
This one is by Christie LeBlanc and Karri Sanders, CMU students

Muffin Mania

Dr. Frank makes one dozen homemade blueberry muffins each week to pass out to her neighbors. She has been putting 48 blueberries in the muffin batter because she wants each muffin to have at least four blueberries in it. Why is her reasoning incorrect? What advice would you give to Dr. Frank?

Dr. Frank has a new idea. She decides to think about her muffin batter as all 12 muffins packed together. She has been studying simulation and knows that each blueberry added to the batter has an equally likely chance to end up in any of the 12 muffins. She also knows she wants each muffin to have at least 4 blueberries. To figure out how many blueberries she should add, she will make a simulation by generating random integers from 1 to 12 on her TI-73 (a TI-83 calculator will also do this). When a 1 is generated, she will add a blueberry tally to muffin 1. Similarly, when a 12 is generated, she will add a blueberry tally to muffin 12. She will continue generating random integers until all 12 muffins have at least 4 blueberry tallies, and she will add the tallies to determine the final number of blueberries. Complete this simulation to help Dr. Frank decide how many blueberries she needs to add. **When you are finished, Dr. Frank will put the stems for a stem and leaf plot on the board: add your leaf to the appropriate line on the plot.**

Muffin 1 ________________
Muffin 2________________
Muffin 3________________
Muffin 4 _______________
Muffin 5________________
Muffin 6________________
Muffin 7 _______________
Muffin 8________________
Muffin 9________________
Muffin 10 _______________
Muffin 11_______________
Muffin 12________________ Total blueberries _________

Dr. Frank wants to make sure every muffin gets 4 blueberries but doesn't want to wasted money. Based on the stem and leaf plot, how many should she add? Explain your reasoning.

Simulation Station: Martha Frank, Central Michigan University

Too many boxes of cereal?

A cereal manufacturer includes a plastic toy in each box of SuperSugar cereal. There are 6 different toys. How many boxes of cereal will you have to buy to get a complete set of toys??

Manipulative Model: 6-sided die

Trial: Roll the die until you have rolled all 6 numbers. Keep track of how many rolls this is. Is there an upper limit on how many times you have to roll the die?

Data for ______Trials:

# of rolls: 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

#of roll, cont: 24 25 26 27 28 29 30 31 32 33 34 35 more than35

Which average is best? Mean, median, or mode? Why?

Can we do it on the TI-73?

1. Press APPS and select ProbSim. Select Roll Dice. Under "set" (zoom) select 1 six-sided die and press OK (graph). Press enter to roll one die once. Keep pressing enter and watch the bars on your histogram until you have at least one roll for each number. Press the right and left arrows to see how tall each bar is. How many rolls did you have for your trial?
2. Or you could press MATH, and then PRB and then dice(. Enter a 1 after the (and just keep pressing enter until you get all six numbers.

Can we do it on the TI-83?

1. If your TI-83+ has the ProbSim App, follow the directions in #1 above.
2. Press MATH, and then PRB and then randInt and press enter.
   Enter a 1, a comma, and a 6, close the parenthesis, and press enter, for one roll of a die. Keep pressing enter until you get all six numbers. Note that this also works on the TI-73.

Simulation Station: Martha Frank, Central Michigan University

Simulation with RandInt on the TI-73 and TI-83

Pick any of the simulations below. Collect data (see bold type at bottom of the page) for 5 trials and pool your data with your group. Then compute the simulation answer. See the bottom of the page for how to make your calculator generate random integers.

1. Weather in Michigan: Suppose that in the month of November in central Michigan there is a 25% chance of having bad weather (rain, sleet, snow, fog, etc) on any given day. How many nice days can we expect to have the first week in November? (We have instructions for doing this simulation with Fathom, also).

2. The Speed Trap: Dr. Frank commutes from Big Rapids to Mt. Pleasant 4 days a week. She has determined that there is a 1/8 chance that a state trooper will be parked behind the barn near Remus (the speed trap) on any given trip (Big Rapids to Mt. P or Mt. P to Big Rapids) at the times that she commutes. What is the probability that she makes it through an entire week without getting stopped?

3. Too Many Babies?: Mr. and Mrs. Bigfamily have decided that they will keep on having children until they have a boy. How many children can they expect to have?

4. Random Ties: Mark Mathbrain is a first-year teacher. He has 10 ties. If he chooses a tie at random to wear to work each day, what is the probability that he wears the same tie to work more than once during his 5-day work week?

5. It's a Gusher!!!: The probability that an exploratory oil well will strike oil is .20. Each exploratory well costs $5000 to drill. How many wells can you expect to have to drill BEFORE finding oil? What is the mean cost of exploration, including the first successful well drilled?

To make your calculator generate a list of random integers between any two endpoints, decide how many random integers you want—let's say, 5. Then decide what your endpoints of the range are—let's say I want random integers from 1 through 6, so my endpoints are 1 and 6. Enter MATH, select PRB, and then arrow down to randInt(and press enter. For the example of generating 5 random integers between 1 and 6, you need the command randInt(1,6,5), so fill in the numbers and close your parentheses and then press enter to see your 5 random integers.

Advising the Queen:
Simulating Real World Significance Testing in about an Hour

Ann Cannon and Jim Freeman
Cornell College

Abstract: Students doing significance testing homework are often confused by the sample data included in the statement of the problem (data yielding large p-value, for example). This laboratory exercise takes students through the process of determining the question to examine, experimental design and collection of data, sampling, analysis, and reporting results.

Students have trouble grasping significance tests. The complete process, from design to data collection to data analysis, is time consuming and requires different intellectual processes. In addition, a test of significance does not ask for a definitive answer which is very unsettling to students, and most homework problems in texts on significance testing tend to be to prescriptive in their statement. This is not surprising as the sample data is included with the statement of the problem. The confusion this causes is most apparent when the sample data yields a large p-value, which most students interpret as meaning they had their hypotheses set up wrong. This is less of a problem if the hypotheses are decided upon before any sample information is presented. This is very hard to do in a problem presented in a book. Simulating the actual real-life experience of doing significance testing is more effective.

A group oriented exercise called "Rectalinea" attempts to address these issues. The students act as the statistical advisor to the ruler of Rectalinea, Queen Quadra Lateral. She has three counties for which she must decide on what actions to take. Students provide a written report to the Queen advising the actions to take and why. Students must decide on the size and sampling method to use, then sample the residents of Rectalinea through a web interface, analyze the data and make written recommendations to the Queen. Students can complete the sampling through data analysis in around an hour and write up their report outside of the laboratory environment if they wish. Once all groups report their advice to the Queen a lively classroom discussion can occur as students see that different groups may come up with different conclusions. The instructor is also able to have students discuss how they designed the sampling protocol, bringing together many ideas from the course in one exercise.

This exercise has been used either to introduce students to the concept of significance testing or as a capstone type of experience. By manipulating the simulated data, the instructor has control over the results likely to be found by students. The current data being used at Cornell yields p-values which tend to be small for one question for the Queen, large for the second and moderate for the third. The web interface to the data is easy to implement on any web server with minimal programming expertise. The web interface slows down sampling, so there is a cost to students for taking a large sample.

Welcome to Rectalinea, a province of the world of Flatland, a two dimensional world. The inhabitants of flatland are planar figures like triangles and rectangles. Rectalinea is a region entirely inhabited by rectangles. Queen Quadra Lateral rules the three counties of Rectalinea, namely Alpha, Beta and Gamma. You are the chief advisor to Queen Quadra Lateral and have been ordered to give expert advice on three issues that she must decide.

Before describing the issues, you will need to know a unique aspect of Rectalinea. It is a communal land, where the well being of a county is determined by the mean area of all the inhabitants of that county. So, the greater the mean area of the inhabitants, the more prosperous the county.

Queen Quadra Lateral is facing three issues, one for each county, and needs a written report by the end of the class period.

Issue One: Any county whose mean area of its inhabitants is less than 68 is considered impoverished and will receive special government subsidies for as long as its mean area remains below 68. At the last census, 5 years ago, Alpha had a mean area of 63 and has been receiving subsidies ever since. Queen Quadra Lateral believes that these subsidies have succeeded in improving the conditions in Alpha to the point that the subsidies are no long necessary. The next census is not for another 5 years. She wants to know today whether or not it is reasonable and fair to stop the subsidies now.

Issue Two: The greater the mean area, the greater the prestige of the county and the more political clout the county has. In fact, if a county has a mean area of 140 or greater, it is law that they receive special representation in the governing council for Rectalinea. Beta was the most prosperous county in the last census with a mean area of 140 thus achieving the level necessary for the special representative. Quadra Lateral is tired of dealing with the representative from Beta and hopes that Beta is not as prosperous as it once was. She wants to know if she can safely send the representative home.

Issue Three: Gamma is a bit of a hypochondriac county. At the last census, their mean area was 95. They do not like to change anything in their county and are always pestering Quadra Lateral for help in maintaining the status quo. She believes there is no evidence that the status quo has changed in Gamma. Does her belief appear to be correct?

So those are the issues on which Quadra Lateral is expecting a written report by the end of the period. She expects you to clearly argue how she should address each of these issues and to explain exactly how you obtained your conclusions.

Before you go, one other item. The next census is not for five more years and could not be accomplished in the time you have today, so you will have to sample. Be sure that you have discussed how you will sample, the size of your sample, and your sampling techniques before starting this project. You have been given a list of the social security numbers of all of the residents of each county. You can use this list to choose your sample, but then you must actually contact each resident to find out his or her size. Residents from county Alpha can be contacted using the address www.cornellcollege.edu/perl/stat/alpha.pl. The residents of the other two counties can be contacted through their pages by substituting beta or gamma for the alpha in the address given above.

Queen Quadra Lateral is waiting impatiently for your report. You know how rulers can get and the consequences to those who disappoint them.

Stories and Statistics: Using Historical Examples in the Teaching of Applied Statistics

Mark C. Fulcomer, Jennifer Lyke, Merydawilda Colon, Marcia M. Sass, and S. David Kriska.

This presentation describes the use of historical data and bibliographies in applied statistics courses in several disciplines, including public health, psychology, social work, and business. With some examples dating back to 1877, topics such as data acquisition and utilization of results continue to have relevance for current-day undergraduates.

Examples demonstrating the development and use of bibliographic sources for the classroom:

1. Discriminant functions and classification.
2. Adverse reproductive outcomes.
3. Historical health statistics.
4. Reliability, validity, and other special topics in health services research.

Some examples of "stories" and historical data:

Year	Page	Description
1877	1	Title Page
1877	22	First Report by Ezra M. Hunt
1877	74	Act to Establish a State Board of Health
1877	75	First example of an index
1878	3	Transmittal letter to Governor George B. McClellan
1878	7	Registry Law as to Vital Statistics
1878	17	Report on the Disposition of Insane Criminals
1878	34	Report on Hatting
1878	97	Early Cross-tabulation of Births by Municipality
1878	105	Early Cross-tabulation of Causes of Death by Location
1881	128	A Review of English Statistical Reports
1882	59	Sanitary inquiries into the conditions of charitable and penal institutions
1886	67	The Relation Between Drinking-Water and Typhoid Fever
1886	79	The Hygiene of Occupations
1886	187	Heredity
1886	197	Infant Mortality
1887	161	The Passaic River As Related To Water-Supply and Death-Rates
1887	192	First use of color in a graph
1887	204	Proportionate Mortality in Color
1890	54	Sewer Plan for Trenton (in color)
1891	22	Anthrax, Rabies, and Pasteur
1891	52	Notes on Mental Hygiene
1892	54	Tobacco and Its Effects on Youth
1898	218	Thematic Map (in color)
1899	49	Map locating sanitary districts
1900	46	Color map
1930	80	Deaths Under Age 5 for 51 Years
1999	8	County Map (in color)
1999	9	Trend Graph

Incorporation of materials into lectures and student projects.

1. Examples of homeworks.
2. Examples of lecture materials, including central tendency and digit preference.

Implications for improving student interests and scholarly abilities.

1. Reinforcing the use of APA citational style.
2. Examples of student-initiated projects.

Spotlight Session: Normal of Not?
Presenter: Christy Gillespie
Email: gillespiemath@yahoo.com
School Affiliation:
Community School of Naples

Abstract: After studying the empirical rule and normal calculations, students often mistakenly apply these procedures to nonnormal distributions. To highlight this fallacy, I created an activity in which a college professor grades on the "normal curve." Students quickly realize the dangers of assuming normality while increasing their understanding of normal procedures.

Author Notes: The normal distribution activity is located below. Specific notes and comments follow at the end of the document.

NORMAL DISTRIBUTIONS: GRADING ON THE BELL-CURVE

Professor Blue at the University of Central Boondockia has never taken a formal statistics course; however, he has heard about the bell-shaped curve and has some knowledge of the empirical rule for normal distributions. Professor Blue teaches an Honors Sociology class in which he grades on the bell-curve. He assigns grades to his students' tests by assuming a normal distribution and utilizing the empirical rule. Professor Blue reasons that if IQ and SAT scores follow a normal distribution, then his students' scores must do so also. Therefore upon scoring his Sociology tests, he determines the mean and standard deviation for his class. He then uses the empirical rule to assign letter grades so that 68% score "C," 95% score "B - D," and 99.7% score an "A –F."

The following test grades occur on his mid-term exam.

78	85	93	62	82	76	74	73	91	66
89	88	86	94	65	90	84	92	94	92
82	85	80	77	52	84	78	83		

You are working as Professor Blue's graduate assistant and he has asked that you use the empirical rule to determine which of these grades he should assign as "A," "B," "C," "D," and "F." To get started, enter the test scores into your calculator and complete the following. *(Round all answers to the nearest tenth.*)

Mean Score:__________ Median:__________ Standard Deviation:________

Use the above data to complete the following table and sketch.

Sketch and label a normal curve of this distribution.

Distance from the Mean	Test Score
-3 sd	
-2 sd	
-1 sd	
Mean	
1 sd	
2 sd	
3sd	

Using the guidelines given by Professor Blue and your data from the previous table, determine the test grades that will qualify for each letter category. Organize your answers in Table 2. Then referring back to the original test scores, compute the number of students to earn each letter grade on this particular test and enter that data into Table 3.

TABLE 2

Letter Grade Assigned	Test Score Interval
A	
B	
C	
D	
F	

TABLE 3

Letter Grade Assigned	Number of Students Receiving this Grade
A	
B	
C	
D	
F	

As a student of statistics, you have some concerns about Professor Blue's use of the normal distribution in this context. Prepare a report, (or letter,) to Professor Blue explaining your concerns. You need to include any evidence that supports why his practice may not be statistically sound. Use your knowledge gained throughout this chapter to prepare your argument. Include at least one sketch of the data with your discussion.

You will need to submit a copy of these completed pages with your written report/letter. Reports should be typed. There is no minimum or maximum assigned length; however, your arguments need to be backed up by both logic and statistics. Appropriate grammar is required.

Author Notes:
The worksheet pages may be completed during class or assigned as homework. I usually assign this as an out-of-class project and allow two weeks for the entire project to be completed. I also allow students to work with a partner on this project as discussing their work with a fellow student often leads to both a

greater understanding and a better final product. I like to give each student his/her own set of data. I achieve this by changing one or more of the numbers above. This leads to differing graphs and conclusions and enhances our follow-up discussions in class.

For the final report, it is essential that students graph the original data. I require at least one sketch, but I always encourage my students to use a number of different graphing tools to examine the data. Frequent graphical displays that my students like to use are NPP plots, modified boxplots, histograms, and stemplots. This particular set of data shows an outlier if students perform a modified boxplot in their TI-83 – some years I include the outlier and other years I change that data value. The NPP Plot for this data is also interesting for students to examine.

Aside from graphing the data to check for normality, I want my students to question the appropriateness of applying the empirical rule in this situation. Even if we don't include the outlier in the data and are willing to consider the data as approximately normal, what are the consequences to the students in the class? Students will quickly pick up on the "unfairness" aspect in this scenario, but again I want them to utilize statistics to convince me that it is unfair. Comparing percentile scores of a "B" test grade to a "D" grade is an excellent, and easy, way for students to strongly argue against this method of grading.

Even if you use this activity outside of class, spend a few days discussing the results and teaching your students how to use their knowledge of statistics to write appropriate arguments.

Module Assisted Statistics Courses

By
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This project began as an attempt to deliver a course in quantitative methods entirely by modules. These units would contain basic lectures, applications to be used in this course and again in later business courses, review units for standard topics to be used as needed, and motivational or challenge topics to be selectively used in the course.

The project has evolved into the development of supplementary modules to be used with a standard text to deliver courses in business statistics and quantitative methods. These units would improve the delivery of these courses, but a standard text would enhance the course with a wealth of background material and problems.

Below is a listing of modules that have been developed at this time:

1. The Birthday Problem
2. Introduction to Decision Analysis---A Challenge Problem
3. The Monty Hall Paradox
4. A Medical Diagnosis Problem
5. Randomized Response Surveys
6. Organization of Data I
7. Organization of Data II
8. Organization of Data III
9. The Exponential Distribution
10. Applications of the Exponential Distribution
11. Graphical Approach to Linear Programming
12. Computer Solutions for Linear Programming Problems
13. Introduction to Decision Theory
14. Decision Trees
15. Bayes Theorem for Decision Theory
16. Decision Theory Applications for Bayes Theorem
17. Utility Theory
18. Introduction to Correlation and Regression

Many of these units began as class examples or part of class lectures and evolved into useful units with follow-up problems for homework.

Over the past four months I have visited with colleagues at several universities and have invited them to join in this project. The payoff will be a large set of units that will be helpful to all of us in our teaching of basic statistics and quantitative analysis. At the next stage we would take each other's modules and modify or revise them to better serve our own needs. Presently, seven colleagues have joined me in this effort and others have shown interest.

With other partners joining the project we will all gain favorite presentations of difficult topics, interesting data sets with analysis, interesting applications, and carefully written review units. The careful and complete development of these units will add depth and clarity to presentations of topics that can be difficult to grasp or that are only superficially covered in standard textbooks.

Also, we have found that collaboration with colleagues in business (or other application areas) has improved our communication, has helped develop a mutually satisfactory notation, and has fostered better working relations with these departments. Previous lack of communication has penalized students at my university with needless repetition of the same topics in different courses. Also, with a common understanding of what we are doing we can provide appropriate applications in statistics to make more advanced applications possible at the next level.

If you are interested in this project, please contact me by e-mail (gramsw@erau.edu) so we can begin a dialog and work together in the development and use of modules.

Using Random Numbers to Introduce the Central Limit Theorem

James Guffey
Truman State University

Abstract: Random numbers can be used as a quick way to introduce students to the effect of sample size on the shape of the sampling distribution of the sample mean. The parent distribution and effect of the Central Limit Theorem can be visualized as the sample size is changed.

Outline:

A) Statement of Central Limit Theorem
B) Quick Overview of Theoretical Parent and Associated Sampling Distributions for the Sample Mean
C) Illustration of Obtaining Observations
   1) From the Uniform (Parent) distribution
   2) From associated sampling distributions for n=2 and n=4.
D) Comparisons of the Three Distributions
E) Comparisons of Statistics by Theory and for the Data
F) Final Remarks

Practical Considerations:

A) Need access to a random number table.
B) Easier for moderate class sizes. Too small or too large would not be so workable.
C) Though it takes some time, the overall demonstration takes 10 to 15 minutes. Obviously, more if more extensive discussion happens.
D) Good active participation exercise that seems to help students understand that something does happen in the sampling distribution as the sample size changes. They also better understand that each observation in the sampling distribution represents n observations from the parent distribution.

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PowerPoint Screens

Using Random Numbers to Introduce the Central Limit Theorem

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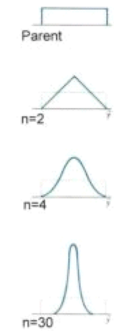
The Central Limit Theorem

Let $\overline{X}$ be the mean of a random sample of size n from a parent population that has mean μ and standard deviation σ. When the sample size, n, is sufficiently large, the sampling distribution of $\overline{X}$ will be approximately normally distributed with mean μ and standard deviation (or standard error) $\sigma / \sqrt{n}$.

Theoretical Distributions



Parent Distribution

23212	74483	36590	0 ••
17639	96252	95649	1 ••
74197	81962	48443	2 ••••
04429	31308	02241	3 ••••
59109	88976	46845	4 •••
93458	42161	26099	5 •••
55212	33360	68751	6 •••
25906	64708	20307	7 ••
66449	32353	83668	8 •••
96372	50277	15571	9 ••••

Sample Mean, n=2

23212	74483	36590	0
17639	96252	95649	1 •••
74197	81962	48443	2 ••••
04429	31308	02241	3 ••••
59109	88976	46845	4 ••••
93458	42161	26099	5 ••••••
55212	33360	68751	6 •••
25906	64708	20307	7 •••••
66449	32353	83668	8 •
96372	50277	15571	9

Sample Mean, n=4

23212	74483	36590	0
17639	96252	95649	1 ••
74197	81962	48443	2 •••
04429	31308	02241	3 ••••••
59109	88976	46845	4 •••••
93458	42161	26099	5 ••••••••••
55212	33360	68751	6 ••••
25906	64708	20307	7
66449	32353	83668	8 •
96372	50277	15571	9

n=1	n=2	n=4
0 ••	0	0
1 ••	1 •••	1 ••
2 ••••	2 ••••	2 •••
3 ••••	3 ••••	3 ••••••
4 •••	4 ••••	4 •••••
5 •••	5 ••••••	5 ••••••••••
6 •••	6 •••	6 ••••
7 ••	7 •••••	7
8 •••	8 •	8 •
9 ••••	9	9

n=1

0 ••
1 ••
2 ••••
3 ••••
4 •••
5 •••
6 •••
7 ••
8 •••
9 ••••

Pop	Sample
$\mu = 4.5$	$\bar{x} = 4.70$
$\sigma^2 = \frac{99}{12}$	$s^2 = 8.14$

$$DU(0,N): \mu = \frac{N}{2}; \sigma^2 = \frac{N(N+2)}{12}$$

n=2

0
1 •••
2 ••••
3 ••••
4 ••••
5 ••••••
6 •••
7 •••••
8 •
9

Pop	*Sample*
$\mu = 4.5$	$\bar{x} = 4.51$
$\sigma^2 = \frac{99}{24}$	$s^2 = 4.2($

n=4

0
1 ••
2 •••
3 ••••••
4 •••••
5 ••••••••••
6 ••••
7
8 •
9

Pop	*Sample*
$\mu = 4.5$	$\bar{x} = 4.44$
$\sigma^2 = \frac{99}{48}$	$s^2 = 2.56$

Final Remarks

- Theory *predicts* "reality"
- Theory *becomes* reality
- Concept becomes less of a mystery
- Students are involved
- Activity is fairly quick and very easy to do

Infuse Simulations into Probability and Mathematical Statistics
Melinda Harder

I created the lab "Confidence Intervals for Proportions" for my mathematical statistics students so they could experimentally compare approximate, exact, and "plus four" intervals for a proportion. The lab was inspired by Christopher Lacke's e-mail "Teaching a method that isn't used" (12/06/2005 on the isostat list) and by the flurry of responses to it.

The poster shows the results from my class of twenty-four students. Each student was assigned three values for p "the probability of success", four values for n "the sample size", and instructed to do 400 simulations for each combination of n and p. I randomly assigned four students to each of the following groups

			p			p			p	
		.1	.4	.7	.2	.5	.9	.3	.6	.8
	5									
n	15									
	30									
	70									
	10									
n	20									
	50									
	100									

The group assignments were done in class using a deck of cards containing A, K, Q, J, 10, 9 in all four suits. Students selecting an ace were assigned to group 1, p = .1, .4, .7 and n = 5, 15, 30, 70, and so on. So there are1600 simulations per combination, and if we assume a success rate of approximately 95% (success occurs when the true value of p is contained in the interval) then the error is approximately 0.5% for the estimated coverage probabilities.

This is just one example of the labs I've created. Many of the students who take mathematical statistics at Bates College are computer savvy and enjoy using simulations to do experiments. They were surprised that such a strange method (adding four observations, two successes and two failures) would give better coverage probabilities (closer to 95%) than the exact or approximate methods.

Reference A. Agresti and B.A. Coull "Approximate is better than 'exact' for interval estimation of binomial proportions", *The American Statistician*, 52 (1998), pp. 119-126

From your text, to find a $100(1-\alpha)\%$ confidence interval for a binomial proportion p compute

$$\hat{p} \pm z_{\alpha/2}\sqrt{\hat{p}(1-\hat{p})/n}$$

where $\hat{p}$ is the sample proportion of "successes" and $z_{\alpha/2}$ is the $1-\alpha/2$ quantile of the standard normal distribution. This interval is an approximate interval, and the accuracy of the approximation depends both on the sample size n and the value of p. To avoid approximation, some texts recommend exact intervals. (These are the intervals that Minitab computes by default.) In practice these intervals are conservative because the coverage is always $100(1-\alpha)\%$ or more, the "more" due to the fact that the binomial distribution is a discrete distribution. Another method suggested by Agresti and Coull (1998) is to add "two successes" and "two failures" to the sample, and then construct a confidence interval as described above for the approximate interval. That is, instead of using $\hat{p} = y/n$ where y is the number of "successes" in a sample of size n, use $\tilde{p} = (y+2)/(n+4)$ as the estimate of the sample proportion, and use $\tilde{n} = n+4$ as the adjusted sample size. The $100(1-\alpha)\%$ interval for p is

$$\tilde{p} \pm z_{\alpha/2}\sqrt{\tilde{p}(1-\tilde{p})/\tilde{n}}\,.$$

To illustrate the three methods, here is an example. Suppose you want to estimate the average proportion of blue M&Ms that are put into every bag of plain M&Ms. You have a sample bag containing 56 candies, and 7 of them are blue. Find a 95% confidence interval for the theoretical proportion of blue M&Ms.

Method 1 (approximate normal interval) The sample proportion is $\hat{p} = 7/56$.

$$\frac{7}{56} \pm 1.96\sqrt{\frac{(7/56)(49/56)}{56}}$$

The 95% confidence interval for p is (.03838, .21162).

Method 2 (exact)

$$\sum_{k=7}^{56}\binom{56}{k}p_L^k(1-p_L)^{56-k} = .025$$

Solving for the lower endpoint, $p_L = .051765$.

$$\sum_{k=0}^{7}\binom{56}{k}p_U^k(1-p_U)^{56-k} = .025$$

Solving for the upper endpoint, $p_U = .240733$.

The 95% confidence interval for p is (.051765, .240733).

Method 3 ("plus four") The adjusted sample proportion is $\tilde{p} = 9/60$.

$$\frac{9}{60} \pm 1.96\sqrt{\frac{(9/60)(51/60)}{60}}$$

The 95% confidence interval for p is (.05965, .24035).

Which of these methods for constructing 95% confidence intervals works best in practice for finding intervals that actually contain p ninety-five percent of the time? You will investigate this question in Minitab using the attached macro. Before running the macro, you will need to specify the sample size (i.e. the number of trials, n), the probability of "success" p, and the number of experiments. The macro will construct the three types of intervals for each experiment and check to see whether p is in the interval. If the intervals are 95% confidence intervals, this should happen in approximately 95% of the experiments.

A copy of the macro is saved in webct. To copy it into your Paris folder do the following. From the internet or netscape type in the web address
http://webct.bates.edu
Log in with your user id and password. Click on our class and click on class files. Click on **macro for ci lab**, and select the tab marked **View** to see the file. To copy the file into notepad click on the screen. Select **Edit** and select **Select All**. The macro file should be highlighted. Then click on **Edit** and select **Copy**. Click on **Start**, select **Programs>Accessories>Notepad**. Click on **Edit** in notepad and select **Paste**. The file should appear in notepad. Press **File** and click on **Save As**. Select **Network Neighborhood**, **Paris**, and **your folder**. Type in a filename **ci**.

In Minitab type
let k1=n
let k2=p
let k3=400
where n and p are numbers you assign (for example 5 and .2). Then run the macro.
%**Paris****username****ci.txt**

What you will hand in
Hand in a table of results for all the combinations of n and p (12 combinations per person) containing the observed proportion of times that each of the three intervals contained p. I will assign sample sizes and values of p in class, and show you how I would like the tables so that I can compile your results in a larger experiment. Write a paragraph describing your results. Which type of interval contained p a proportion of the time closest to the target of 95%? Do you notice any trends with sample size n or with the value of p?

```
gmacro
ci
random k3 c1;
binomial k1 k2.
erase c2 c3
do k4=1:k3
let k5=c1(k4)
let k6=k5+1
let k7=k1-k5+1
let k8=k1-k5
if k5=0
  let k9=0
else
invcdf .025 k9;
beta k5 k7.
endif
let c2(k4)=k9
if k5=k1
  let k10=1
else
invcdf .975 k10;
beta k6 k8.
endif
let c3(k4)=k10
enddo
let c4=c1/k1
let c5=1.96*sqrt(c4*(1-c4)/k1)
let c6=c4-c5
let c7=c4+c5
let c8=(c1+2)/(k1+4)
let c9=1.96*sqrt(c8*(1-c8)/(k1+4))
let c10=c8-c9
let c11=c8+c9
let c12=(k2>=c2&k2<=c3)
let c13=(k2>=c6&k2<=c7)
let c14=(k2>=c10&k2<=c11)
let k4=sum(c12)/k3
let k5=sum(c13)/k3
let k6=sum(c14)/k3
name k4 "exact"
name k5 "approx"
name k6 "plus4"
print k4 k5 k6
endmacro
```

UNITED STATES CONFERENCE ON TEACHING STATISTICS (USCOTS 2005)

PEDAGOGY SPOTLIGHT SESSION

ROSSI A. HASSAD[1]

LISTENING TO OUR STUDENTS

USING REAL, RELEVANT, AND INTERESTING DATA TO TEACH STATISTICAL CONCEPTS

This information is based on feedback[2] from 45 (forty-five) students who took an introductory statistics course for psychology and behavioral sciences majors (four-year college).

Of the 45 students, 43 (96%) indicated that they prefer the use of **REAL** (rather than **made up**) data for class exercises. Their reasons (verbatim) encompassed the following:

[illegible]	9	[illegible]
[illegible] e	[illegible]	[illegible]
[illegible] d t	4	9
[illegible] g	[illegible]	[illegible]
[illegible] [illegible]	4	9
[illegible]	[illegible]	[illegible]

[illegible]	2	5
[illegible]	2	5
[illegible]	2	[illegible]
[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]

[1] Mercy College (Social & Behavioral Sciences) & Hunter College (Psychology)
[2] Routine information for course update and development

WHY DO STUDENTS PREFER DATA ON SEX? VERBATIM REPSONSES AND COMMON THEMES:

- ✓ "Sex is a subject that interests college students and allows them to want to learn more about it"
- ✓ "It is interesting, and applies to a lot of people"
- ✓ "It is something that is all around us and we deal with everyday"
- ✓ "[It is] more interesting and motivating. It helps us put ourselves into the real world"
- ✓ "It is very relevant to psychology as well as to young adults"
- ✓ "This [is] a very important topic that affects young people and also easier to relate to"
- ✓ "Because with the increase in AIDS and STDs it is something that affects all of us"
- ✓ "We have to deal with [sex] daily"
- ✓ 'It is always interesting to hear or talk about what is going on with sex"
- ✓ "Why men think more about sex than women"
- ✓ "I am always curious about it"

DATA ON SEXUAL BEHAVOR DOES APPEAR TO MAKE A DIFFERENCE

A group of nine students taking a course in research methods for the behavioral sciences was given two graphs[3] (almost similar distributions) at different times (same session), and asked to provide a brief description. The first graph represented a distribution of examination scores, and the second, a distribution of reported number of sex partners. Earlier in the semester, a presentation was given on basic statistics (primarily descriptive, with emphasis on center, spread, and shape of distributions).

In general, almost all students gave more scientific, meaningful and appropriate descriptions for the distribution of number of sex partners. In particular, most students who did not seem to understand what the labeled axes represented for the distribution of examination scores (1st graph), demonstrated correct understanding (reasoning) of these for the distribution of number of sex partners (2nd graph).

ROSSI HASSAD - PEDAGOGY SPOTLIGHT SESSION

[3] The data were NOT obtained from these students.

Lab Activities for an Introductory Statistics Course

Sarai Hedges – University of Cincinnati

Abstract:
Come test and review a selection of activities that synthesize materials available in numerous locations on the internet with hands-on exercises that give students the opportunity to apply statistical concepts in a collaborative setting. The intent is to guide students step-by-step through activities that lead them to a deeper understanding of statistical concepts and force them to face common misconceptions.

Details:
Instructional goals in introductory statistics education are changing to emphasize statistical reasoning skills and deemphasize calculations (http://www.amstat.org/publications/jse/v5n3/chance.html). The trends are using computers, using real data, collaborative learning, and written presentation (Holcomb and Ruffer, (2000) "Using a Term-Long Project Sequence in Introductory Statistics," The American Statistician, Vol. 54). The American Statistical Association's curriculum guidelines for undergraduate programs in statistical sciences states "Undergraduate statistics programs should emphasize concepts and tools for working with data and provide experience in designing data collection and in analyzing real data…The detailed statistical content may vary, and may be accompanied by varying levels of study in computing, mathematics, and a field of application" (http://www.amstat.org/education/Curriculum_Guidelines.html). Further, statistics education research has found that "…statistical ideas are often misunderstood by students and professionals. In order to develop better statistical reasoning, students need to first construct a deeper understanding of fundamental concepts." And that "An activity that asked students to test their predictions and confront their misconceptions was found to be more effective than one based on guided discovery" (delMas, *Journal of Statistics Education* v.7, n.3, 1999).

A multitude of materials are publicly available online, such as java applets and data sets, that are intended to improve students' understanding of statistics. Until recently, these resources were not easy to find as they are not centrally located. Thankfully, individuals such as Professor Robin Locke and organizations such as CAUSE have organized and shared them with statistics educators. What remained for me was to create materials for my students that use these wonderful resources. I set out to build a collection of hands-on activities, many around java applets, with the following goals:

- to better students' understanding of the topics covered in class
- to help correct common misconceptions about statistical concepts
- to involve students with minimal guidance from the instructor
- to incorporate the latest research in the best practices in statistics education

The activities that I designed are currently being used in an introductory business statistics course. The class meets 3 hours per week in a "regular" classroom and once a week in a computer lab, which is where the activities are done. Students work in groups. I also envision the activities being used in a distance learning environment and/or as out-of-class exercises for the more independent learner.

Preliminary analysis suggests that the labs are generally successful in meeting the goals I had set for them. While I was initially concerned that the level of computer skills necessary to complete the labs may be too challenging, 60% of the students rated the skill level necessary as "rather basic" and the other 40% deemed it "at about the right skill level." The first run through the labs brought to my attention some places for me to clarify the instructions. The activities will continue to evolve and improve as more students work through them. All students (100%, n = 10) strongly agreed or agreed that the labs were generally helpful in bettering their understanding of the topic covered in class and 90% strongly agreed or agreed that the labs were generally helpful in correcting misconceptions (e.g. the mean is always the best measure of average and correlation means causation). Results of the final exam would somewhat contradict some of the students' assertions on misconceptions as 25% (3 out of 12) incorrectly answered that the correlation shown in the exam question proved that one variable caused the other to happen. A similar question was given on the final exam the previous quarter (autumn 2004) to students in the business statistics sequence without the lab component. Sixteen out of 29, or about 55%, answered incorrectly. This may suggest that the labs are successful in bettering students' understanding but I am cautious in considering this first class to be representative either of future students who will take the course or of past students who took the business statistics sequence without a lab component because this first class is much smaller than usual (12 versus about 30) and because this course was offered as a trailer in a program that is in the process of being placed in another college. Further assessment is necessary.

I welcome your suggestions for further assessment of the lab activities and on improving them. Please contact me with your comments.

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Low-Tech Demonstrations

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One can do some great demos (and simulations) with applets, Fathom, etc. but not all classrooms are technology equipped. I present some of the low-tech demos and activities I have used for such topics as p-values, the Central Limit Theorem, and Expected Value.

Our classrooms are equipped only with a chalkboard and overhead projector. Thus, our technology of choice is the TI-83/84 (with viewscreen).

Some of the demonstrations and class activities I use are:

1. P-values and Power – a simple demonstration that requires two identical decks of cards, and TI calculators to simulate the probability.

2. Expected Value – the Hermit's Epidemic is simulated by each student using one die for each. Each student simulates several "epidemics" and computes their own mean number of sick hermits. The class as a whole then determines the probability distribution for the number of hermits to become sick, then the theoretical value of the mean. We also collect each student's mean and graph them to demonstrate the unbiasedness and smaller variance of the mean.

3. Central Limit Theorem – Demonstrated by revisiting the Hermit's Epidemic, as well as through graphing calculator programs for various distributions.

4. Labs – each semester we do four mandatory "data collecting" in-class lab exercises with an "extra credit" optional lab done completely out of class. The labs are designed to model "real world" uses of statistics using real data. These were modeled after some of the Labs in Spurrier, et al, Elementary Statistics Laboratory Manual, Duxbury, 1995, but were modified to fit our technology as well as the desired outcome of each lab. The five labs are

a. Variability and Heart Rates. Requires only a stopwatch for the instructor. Purpose is to investigate the impact of additional measurement time on average heartrate, as well as on the variability of the measurements. Students use one-variable graphics and descriptive statistics.

b. Real and Perceived Distances. Requires several long tape measures. Students guess the distance to each of 13 landmarks. They then measure (in groups) the actual distance to the first twelve, compute a linear regression based on their guesses for the first twelve, and use the regression to calibrate their guesses to the last landmark (which the instructor has pre-measured).

c. A Question of Taste – a version of the classis Coke vs Pepsi taste test. Requires two versions of at least one type of product (generally a name brand vs store brand). Students discuss the merits of the experimental data collection method and compute binomial probabilities to decide brand "preferences."

d. Variability in Manufactured Products – we use bins of roofing nails and vernier calipers to investigation natural variability of "assembly line" products. Students measure the length and head diameters of a random sample of nails from their bin, and use inference procedures to determine whether or not the nails "meet specs." This lab is intended as a "capstone" exercise, so they also produce one- and two-variable graphs, and investigate whether or not there is a linear relationship between length and diameter.

e. Automobile Preferences – the out-of-class data gathering consists of taking a random sample of cars in a parking lot, and determining whether the car was Japanese-made or not. They also choose two attributes which may help our "domestic" car dealer sell additional cars. The emphasis is on inference for proportions.

I will be provide some copies of student handouts. All materials are also available from www.cs.georgiasouthern.edu/faculty/humphrey_p/.

Training Environmental Statisticians – Tomorrow's Problem Solvers

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How could a win-win strategy be used to train young people in environmental statistics and at the same time analyze environmental data for Federal, State and local agencies, that have not been analyzed until now? This presentation will discuss two courses that I have developed to train undergraduate students in environmental statistics and the impact the courses have had. The courses are entitled: Environmental Statistics Practicum and Special Topics in Environmental Statistics. This training comes in support of a National Science Foundation Grant, **Collaborative Research: Training Environmental Statisticians Using Complicated Data Sets to Make More Informed Environmental Decisions.** A collaborative effort is being undertaken with Spelman College, a historically black college for women in Atlanta, Georgia. This collaborative effort has shown that this approach is portable to other universities and colleges with an undergraduate statistics program and at those without, as long as there are some courses in statistics and a statistician with an interest in environmental statistics. The collaborators has demonstrated that the environmental statistics program can be modified, adapted and enhanced at Spelman College, which represents those colleges without a formal undergraduate statistics program. The objectives of the environmental statistics courses are: (1) to provide a consulting opportunity for the students with Federal, State or local agencies; (2) focus on the application of the student's technical skills to a real problem; (3) have the students gain consulting experience; and (4) develop their oral and written communication skills. The students learn how to prepare a final report, brief clients at the client's office, present poster papers at technical conferences and write papers for publication. Students have done work for ten clients: (1) the Southern Oxidant Study at North Carolina State University (NCSU); (2) the U. S. Environmental Protection Agency's (USEPA) National Exposure Research Laboratory; (3) the USEPA's Office of Air Quality Planning and Standards; (4) the USEPA's Office of Environmental Information in Washington, DC; (5) the North Carolina Department of Environment and Natural Resources (NCDENR); (6) the Forsyth County Environmental Affairs Department; (7) the U. S. Department of State; (8) Environment Canada; (9) the University of Texas; (10) the Texas Council on Environmental Quality; (11) the State Climate Office of North Carolina, NCSU; (12) the NCDENR Water Division; (13) the USEPA Region 4; (14) the Georgia Department of Natural Resources and (15) the Mid –Atlantic Regional Air Management Association. In addition to briefing their clients and providing the client's with final reports, they have presented papers at 34 professional meetings and university sponsored undergraduate research symposia. The meetings they participated in are:

(1) the Southern Oxidant Study Data Analysis Workshop, Research Triangle Park, NC, March 9, 2000;
(2) NCSU Undergraduate Research Symposium, McKimmon Center, Raleigh, NC, April 27, 2000;
(3) USEPA Technical Workshop on $PM_{2.5}$ Monitoring, Quality Assurance, and Data Analysis, Cary, NC, May 22-25, 2000;
(4) Future Directions in Air Quality Research, Ecological, Atmospheric, Regulatory/Policy and Educational Issues, Research Triangle Park, NC February 12, 2001; and
(5) NCSU Undergraduate Research Symposium, McKimmon Center, Raleigh, NC, April 19, 2001.
(6) NC Department of Environment and Natural Resources Data Analysis Colloquium, Raleigh, NC, May 23, 2001.
(7) Second Annual NC State University Minority Graduate Education (MGE) Summer Research Program Poster Session, July 23, 2001.
(8) Mathfest 2001, sponsored by the Mathematical Association of America and Pi Mu Epsilon, Madison, Wisconsin, August 2-3, 2001.

(9) 2001 Sigma Xi Student Research Symposium, Raleigh, North Carolina on November 10, 2001.
(10) NCSU Undergraduate Research Symposium, McKimmon Center, Raleigh, NC, April 18, 2002.
(11) North Carolina Department of Environment and Natural Resources Data Analysis Colloquium, Raleigh, NC, May 23, 2002.
(12) First Annual NC State Undergraduate Summer Research Program Symposium, August 9, 2002.
(13) Joint Statistical Meetings, New York City, New York, August 11 - 15, 2002.
(14) Air & Waste Management Association's Annual South Atlantic States Section Meeting, Research Triangle Park, NC, December 4, 2002.
(15) NCSU Undergraduate Research Symposium, McKimmon Center, Raleigh, NC, April 10, 2003.
(16) NC Department of Environment & Natural Resources Data Analysis Colloquium, Raleigh, NC, May 23, 2003.
(17) 96th Annual Air & Waste Management Association Meeting, San Diego from June 22-26, 2003.
(18) Second Annual NC State Undergraduate Summer Research Symposium, Raleigh, NC. August 9, 2003.
(19) Triangle University Undergraduate Research Symposium, Duke University, Durham, NC, Nov. 1, 2003.
(20) Water Resources Research Institute 2004 Annual Conference, Raleigh, NC. March 31, 2004.
(21) NCSU Undergraduate Research Symposium, McKimmon Center, Raleigh, NC, April 22, 2004
(22) 97th Annual Air & Waste Management Association Meeting, Indianapolis, IN from June 22-25, 2004.
(23) Third Annual NC State Undergraduate Summer Research Symposium, Raleigh, NC. August 5, 2004.
(24) Joint Statistical Meetings, Toronto, Ontario, Canada, August 8-12, 2004.
(25) OPT-ED Alliance Day Meeting, Raleigh, NC. September 24, 2004.
(26) Annual Meeting of the South Atlantic States Section of the Air and Waste Management Association, Virginia Beach, VA, November 4-5, 2004.
(27) Triangle Undergraduate Research Symposium, North Carolina State University, Raleigh, NC. November 6, 2004.
(28) Statistics/Biomathematics/ Bioengineering Undergraduate Poster Session, North Carolina State University, Raleigh, NC, February 4, 2005.
(29) Meredith College: Mathematical Association of America, Southeastern Section, 84th Annual Meeting, Raleigh, NC, March 11-12, 2005.
(30) 24th Annual National Conference on Managing Environmental Quality Systems, San Diego, California, April 11 - 14, 2005.
(31) Capital Research Day, North Carolina State Legislature, Raleigh, NC, April 12, 2005.
(32) USEPA Earth Day Celebration, Research Triangle Park, NC, April 21, 2005.
(33) NCSU Undergraduate Research Symposium, McKimmon Center, Raleigh, NC, April 28, 2005.
(34) The First United States Conference on Teaching Statistics (USCOTS), Ohio State University in Columbus, Ohio, May 19-21, 2005.

After six years at NCSU, 56 percent have gone on to graduate school. An even greater percentage (69%) of students taking both statistical classes goes onto graduate school. Nine students graduated with a master's degree in statistics and four are continuing on for a Ph.D. Seventeen students have gone onto graduate school programs in statistics**.** Seven students are employed at the Research Triangle Institute as an environmental statistician and ten students have worked part time at the USEPA as statisticians. One student has been hired by the U. S. Environmental Protection Agency. The students have given 112 professional presentations and have written 36 reports for their clients and scientific and technical papers. The students have won $24,975 in awards for their work. In summary, these classes have created a win-win situation for the students, the clients and the university and provide an alternative way to complete environmental data analysis. Examples of their work will be presented in the paper.

Statistics Before Your Eyes: Photographs of Statistical Concepts

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Observing patterns of use in everyday life allows for the illustration of many statistical concepts. I will present several photographs with analysis demonstrating the statistical concepts of discrete probability distributions, normal distributions, skewed distributions, bivariate distributions, and regression.

What Ideas Worked for Me, What Didn't, and How to Make Them Work

Brian Jersky, Sonoma State University

The State universities in California have undergone budget cuts in the last few years, which has resulted in changes to the class sizes of our introductory Statistics class sections.

In the past at Sonoma State University (SSU), each instructor was responsible for about 30-35 students, and undergraduate readers were available to grade homework problems or meet with students to answer their questions.

Recently, our classes have ranged in size from 125 students to about 55 students per section. Clearly, this has necessitated changes in the way we teach our courses. The most important change in Intro Stats is that weekly homework has become electronically graded instead of hand graded.

In order to make this possible, instructors have had to find a system capable of handling this task, as well as find appropriate problems to be graded, in addition to finding ways of grading more traditional homework problems in a way that most efficiently uses the instructor's time.

At SSU, we typically have taught about 300 Introductory Statistics students each semester, in about 10 sections, with each instructor receiving 4 units for the 4 hour per week class. Our most efficient (from a money point of view) change was to teach 2 sections of 125 students each, with each instructor receiving 6 units of credit. Because of the miserable pass rate in those classes, we have moved to a "compromise" situation.

Now, we teach about 6 sections of 50 students, with each instructor receiving 4 units of credit. The 6 instructors also have 4 TAs to assist in grading and they hold office hours as well.

The electronic system we found to best meet our needs was the MyMathLab tutorial series, which is tied to the textbook we use, namely De Veaux and Velleman's "Intro Stats".

There were many teething problems with the use of the system, which I will display and talk about in the session. These ranged from merely getting the instructors up to speed on the use of the system to problems with the software that needed to be addressed before we could use the system with confidence.

Surprisingly, the student audience for the program seemed to divide into two groups in terms of their computer proficiency – a group that was immediately able to use and benefit from the program, and a (smaller) group that was very computer resistant and that had great difficulty following even the simplest instructions.

We found the technical support for the program very helpful, so luckily we were able to change things, sometimes in mid-semester, to make things work. One of the notable features of using a program like MyMathLab is that students can no longer buy used books, without paying an additional fee to use the program. We found that this was not too much of a problem, as were able to negotiate a reasonable package with the distributor of the program.

Now that the initial problems have been dealt with, to a large extent, we think that the sections are working well, and we are pleased with our ability to teach larger sections with what we hope is the same quality as what we did before.

Using Simulation to Explore the Power of Hypothesis Tests

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Partial support for this work was provided by the National Science Foundation's Course, Curriculum, and Laboratory Improvement program under grant 0410586.

The exercise outlined below is one I used in a new Biostatistics course at Sweet Briar College this past fall. Its purpose is to use simulations to demonstrate how the probability of a Type II error depends on sample size, the population mean, and the population standard deviation. Students work in a classroom equipped with desktop computers. In the class meeting after this activity, I developed some sample size formulas. Students commented that they were glad they had done the lab exploration first.

The Biostatistics course is designed to be a "second" statistics course. For more information about the course, and for the full lab activity, please visit the website:

http://www.faculty.sbc.edu/bkirk/Biostatistics/

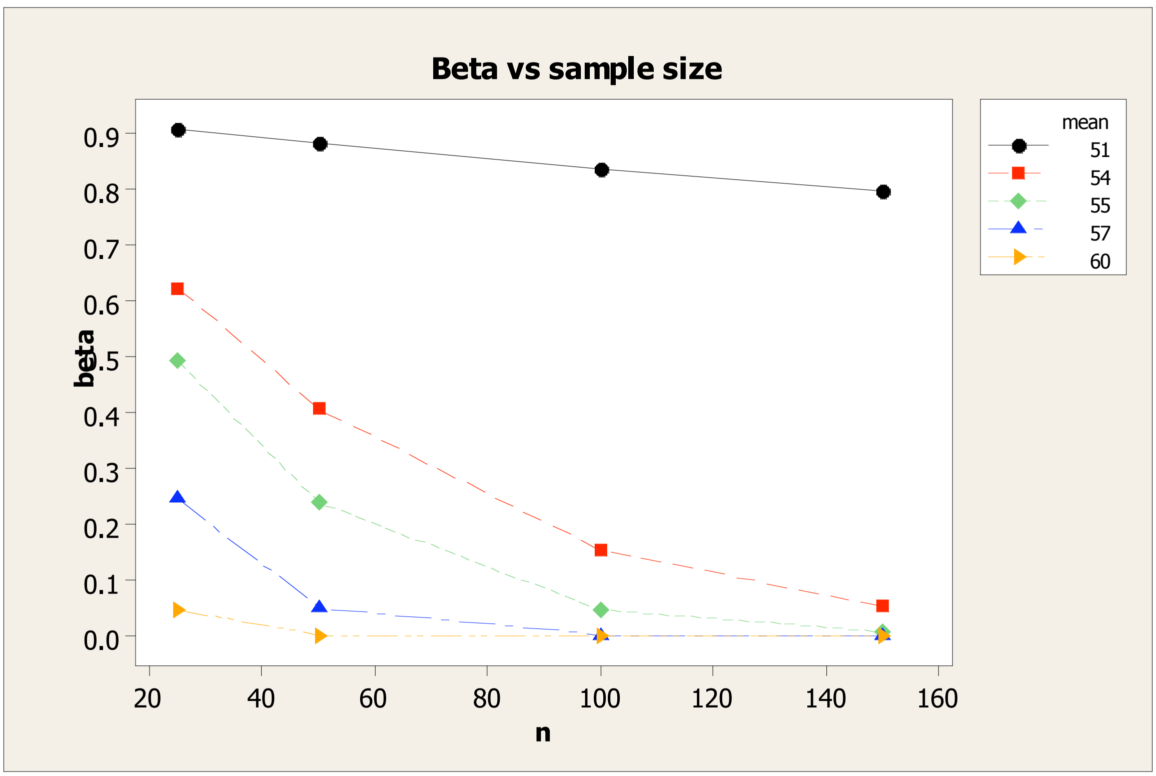
Although students can compute the power of a test of hypotheses about the mean without resorting to simulations, they can get so involved in the calculations that they lose sight of the main ideas. Simulations reinforce the idea that hypothesis tests result in errors randomly, but with known probability.

Outline of the activity:

The class is divided into teams of two or three students. Each team carries out 5 simulations using MINITAB commands provided in the handout. They sample from a normal distribution with a fixed standard deviation, using a different specified mean for each simulation, and using a sample size assigned to the team. The simulations count the number of times that a one-sided hypothesis test results in a Type II error, thus obtaining approximate probabilities of a Type II error. Teams report their results to the class and everybody creates plots of the results. An example plot is shown below.

In a second set of simulations, mean and sample size are fixed while the standard deviation is varied.

In a third set of simulations, students explore the relationship between the significance level and the probability of Type II error.



Helping Students Navigate Their Way Through Technology in the Intro Stat Class

Jessica Kohlschmidt, The Ohio State University

I am exhibiting how to guides that we have written for the use of students in our intro stat courses. We have created various guides for the topics covered in an intro stat course. The technology sources that we focused on are Excel, Minitab, and TI calculators.

In the introductory statistics course, we usually expect our students to be able to implement some software for data analysis. There are several options as to how to approach this. We can leave it up to the individual student to use whatever they feel comfortable with. The responsibility can be given to TA's (if you have them) to teach the students some useful technology skills. Alternatively, we, as the instructor, can spend class time teaching computing skills.

If we leave it up to each student to figure out some technology to use, then it is likely that students will simply skip those problems or ask for help learning to use a technology that they think they should know. The situation quickly occurs in which we spend a great deal of time with students outside of class helping them learn to utilize technology instead of being able to focus on material they are struggling with. Many students prefer to ask questions via email which proves to be time consuming and usually not very helpful for the student.

Our goal is to provide some materials to the student that are easily understood and implemented so as to allow the student to choose the technology they feel is the best for them. This will hopefully allow them to learn one of the technology methods well enough that they feel comfortable enough to use it for any problem they encounter in our class. Ideally, they will learn enough about the technology of their choice that they can use it in other classes and in their jobs in the future.

We have developed what we call How To guides that are self explanatory materials from which the student can learn to use Excel, Minitab, or a TI calculator. Our goal is to provide the students access to these materials, either on a webpage or in a packet, so they can teach themselves how to use technology to solve problems they encounter. This will enable us and our TA's to focus on teaching material in the classroom without penalizing the students who are unfamiliar with technology.

We hope that students will find these How To guides helpful and informative. They are intended to be stand only materials so that a student can pick up the How To guide and teach themselves what they need to know. So far, this has drastically reduced the number of questions that the students have about how to implement technology into their problem solving. This allows us to spend more time with our students helping them understand the material instead of having to focus on getting a problem completed for a homework assignment using technology.

Activity-based Learning Using Real-Time Online Hands-on Activities

Carl Lee and Felix Famoye – Central Michigan University

Do you use hands-on activities in your class?
Would you like to share your hands-on activities?
Would you be interested in using data collected by students from different classes in different institutions?
Would you be interested in sharing your students' data with others?
Does it take more time than you would like to spend in your class for hands-on activities?
Do you have to enter the hands-on activity data yourself after the class period?

If your answer to any of the above questions is "YES", then, this Real-Time Online Database approach should be beneficial to your class. The following are the real-time online hands-on activities that are currently available on the web site at http://stat.cst.cmich.edu/statact/ .

Activity	Title
Distance	How far are you away from home?
Hand_Size	Is hand size a good predictor of height?
Exercise	How does one minute of exercise affect your pulse rate?
Raisins	How many raisins are in a 1/2 oz box?
College_Life	Are you satisfied with your university?
Left_Right_Hand	Are you left handed or right handed?
Sampling	Random sampling vs. subjective sampling. Which is better?
Vote	Which party will you vote for?
Draw_Line	Can you draw a straight line without a ruler?

This Real-Time Online Database is the result from an NSF/CCLI project under the grant #0310932. The goal of the project is to adapt, implement and evaluate an **A**ctivity-Based, **C**ooperative learning and **T**echnology (*ACT*) curriculum in statistics courses for non-majors and prospective K-12 teachers at Central Michigan University.

The guiding principles include:

- People learn better by constructing knowledge themselves through guided processes.
- Practice and feedback are essential ingredients for understanding new concepts.
- Active problem-solving through teamwork promotes active learning.

The online activities are related to students' everyday life. The data are collected from students and owned by students. Data collected from different classes and different schools are shared globally. Instructors can use the data for classroom activities as well as homework or projects. Together with the use of the WebStat, an online statistical analysis tool, or any statistical software available, the instructor can spend the valuable classroom time on leading students to learn the important concepts and the process of statistical investigation. The only requirement is the access of internet.

In this presentation, we plan to demonstrate how to use the real-time online database to teach statistics and demonstrate how the process of statistical investigation is applied in class using the real-time online activities.

The need for reforming statistics education is well documented by Statistics & Mathematics organizations and in the NCTM standards. The areas of suggested reform include (a) the need for data and data production, the importance of variability, and the importance of written and oral presentations, and (b) the need for changing teaching strategies, using technology, and developing an active learning environment. The general principles on how students learn statistics are by constructing knowledge, active involvement in activities, practicing, and informed consistent assessment. Technology has become essential in the teaching and practice of statistics. Recent studies show that an activity-based learning strategy enhances students' conceptual understanding of statistics and mathematics and engages students with different learning styles.

Our ultimate goals of this project include helping students to develop (1) problem-solving and statistical reasoning skills, (2) teamwork spirit and an ability to work as a contributing team member; (3) positive attitudes towards the increasingly quantitative world, (4) the ability of developing and facilitating activities-based curriculum in their future classrooms for prospective teachers, and (5) better written and presentation skills.

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Felix Famoye, 989-774-5497 (felix.famoye@cmich.edu)

Roller Coaster Stats: Riding All Semester

Mike Long Ed.D. (Math Ed.)
Assistant Professor of Mathematics, Shippensburg University

MATH 102: Introduction to Statistics is a general education mathematics class at Shippensburg University that many students take simply to fulfill the math requirements of the general education curriculum, while others take it as a statistics class to prepare them for a second more focused statistics class within their discipline.

School Science and Math once devoted an entire issue to the effectiveness of using thematic units in mathematics and science classes. In order to engage a larger number of students in this class, *a thematic approach*, which infused a particular topic into the teaching, activities, and assessments throughout the semester, was used. Given the personal liking for roller coasters, I choose to use roller coasters a theme.

- Teaching…all of the lessons revolved around roller coaster statistics for amusement parks around the region…for example…to study the t-statistic…we examined advertising claims about the coasters;
- Activities…students engaged in group activities in class that used the statistics from real and K'Nex model roller coasters;
- Assessment…all of the assessments revolved around one set of data for the coasters at an amusement park;
- Technology Portfolio…students collected a set of data about the roller coasters at a particular park of their choice and used EXCEL to explore the statistics about their particular park.

Why did this seem to work?

- Students were enthusiastic about working with coasters;
- Students were engaged by the data and were actually working with it;
- The material was something they could relate to and make the statistics content more clear;
- Students clearly knew

A Web Centric Course

Deborah Lurie
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USCOTS May, 2005

This handout is distributed to students in an introductory level statistics course on the first day of class. It describes the layout of course web-page built using the BLACKBOARD® course management software. The students become familiar with the features of the web-page by completing the assignment. The site is used almost every class.

For more information on designing web-centric course see Malone, Christopher, *Statistics Course Web Sites: Beyond syllabus.html*. **Journal of Statistics Education** Volume 9, Number 2 (2001)

For more information on BLACKBOARD®, visit www.blackboard.com.

MAT 1281 APPLIED STATISTICS
SAINT JOSEPH'S UNIVERSITY
FALL 2004

NAVIGATING THE COURSE WEB PAGE

Most of the communication for this course will be done through the course web-page. You should check the web page for messages every day. It is recommended that you use Internet Explorer. To access this web page,

1) Go to the SJU web-page at www.sju.edu ;
2) Click on the icon "My SJU";
3) Log in using the user name and password given to you by the registrar;
4) Select the tab that is labeled "My Courses" (Note if you registered late, you may not be able to do this on the first day of class);
5) From the list of courses in which you are enrolled, selected MAT 1281 Applied Statistics.

The course web-page is organized into the following sections:

Announcements – Section where I will post daily messages

Faculty Information – Contact information for your professor

Course Policies – Policies on attendance, grading, honesty, etc.

Syllabus – Goals and content of this course

Class Log – Notes on objectives and activities for each class

Power Point Resources – These lecture notes, power point slides in pdf format, were provided by the publisher of your textbook. They are a useful study guide.

Assignments – Homework and projects

Exams – Schedule, practice, solutions

SPSS/ Data Sets – Instructions for installation and use of SPSS Student Version. Links to data files.

Applets – Links to interactive JAVA applets we will use to enhance learning

In the News – Links to studies in the news that use statistics

CELLS – BIO 1011 – Used to link information from the Cellular Biology course

Groups – Useful tools for communicating within student project groups

Communication – Tools for group communication

Discussion Board – Used for on-line class discussions

Tools – Student tools such as calendar, online grade book, etc.

External Links – Links to interesting sites related to Statistics

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Assignment # 1 – DUE DATE- Tuesday September 7, 2004

To help you learn how to use the web-page, please find the answers to the following questions. Your answers should be typed directly in the dialog box in the assignment link (ASSIGNMENTS) or attached as a WORD document

1. Jane missed 6 classes this semester. How will this affect her grade? (COURSE POLICIES)
2. Joe is eating a bagel in class this morning. What do the class rules say about this behavior? (COURSE POLICIES)
3. Where is your instructor's office? (FACULTY INFORMATION)
4. Is this a course that involves a great deal of computation? (SYLLABUS, COURSE OVERVIEW)
5. Name at least three resources you could use if you have questions/problems with this course? (COURSE POLICIES, LEARNING RESOURCES)
6. When is the first exam? (EXAMS)
7. What were the objectives of the first classes?(CLASS LOG)
8. Peruse the power point resources for Chapter 1. How could they help you learn the course material?
9. Enter a comment on the discussion board (DISCUSSION BOARD, Choose NAVIGATING THE WEBPAGE, reply)
10. You have been put in a group for this assignment. Find the group you are in. How many people are in your group? Send each member an e-mail telling them your home state (GROUPS). Bring your responses to class.

The Sum of Independent Normals Is Normal

Submitted by: Dr. Daniel G. Martinez, California State University, Long Beach
Professor of Mathematics and Statistics
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My approach to teaching statistics is to use the activity based approach. I usually start class by performing an experiment illustrating the ideas we have studied. Then I discuss a new idea, say confidence intervals, and I finish off by performing another experiment that illustrates the new concept. I use the TI 83. Each student in the class has one. I don't require it, but I strongly recommend it. This is sufficient.

I like the activity based approach because I learned a long time ago that students feel more comfortable when they gather data themselves and analyze it. This is a good way to get students involved in the course. As the following Chinese proverb states: I hear, and I forget. I see, and I remember. I do, and I understand.

I introduce the normal distribution by means of in class experiments. For example, I have the students take their pulse and we do a histogram of the data. It is usually bell shaped. I also have a quincunx that vividly demonstrates that the binomial distribution can be approximated by the normal distribution.

I introduce the central limit theorem in two ways. I use the TI 83 to calculate a lot of means by sampling from a uniform distribution, say the numbers, 1 through 20. We then graph these sample means on the TI 83 and they are usually bell shaped. Another way to do it is by means of an urn and numbered discs. I construct one hundred discs that follow the Chi Square Distribution. We then sample from the urn and construct about thirty sample means. The result will be the normal distribution.

I am enclosing a summary of experiments that I do in class. I hope they will be useful.

l. Experiment: Deming Beads
Objective: The students will understand that a random sample mimics an entire population.
2. Experiment: Average Height Experiment
Objective: The students will learn how to select a random sample from a class of 30 students.
3. Experiment: Random Rectangles
Objective: The students will be able to draw a stratified random sample.
4. Experiment: Babe Ruth vs. Mark McGuire
Objective: The students will be able to compare two samples by means of a stem and leaf plot.
5. The water drop experiment.
Objective: The students will estimate the number of water drops that a nickel will hold by means of a dot plot. The student will learn that there is usually variability in data.
6. Experiment: The Birthday Problem I
Objective: The student will be able to understand the difference between categorical data and quantitative data.
7. Experiment: The Scatter Plot Experiment

Objective: The students will plot and analyze two variables at once. This is an example of bivariate data.

8. Experiment: Dice
   Objective: The student will be introduced to the meaning of probability.
9. Experiment: Card Experiment I
   Objective: The students will be able to randomize before starting and experiment and then how to calculate the probability when the word **or** is involved.
10. Experiment: Card Experiment II
    Objective: The students will learn how to sample with replacement and calculate probabilities.
11. Experiment: Card Experiment III
    Objective: The students will learn how to calculate conditional probabilities.
12. Experiment: The Meteor Problem
    Objective: The students will be able to do a probability problem by means of simulation.
13. Experiment: Advanced Quincunx
    Objective: The student will understand how the normal curve approximates the Binomial Distribution and how increasing the variability in the experiment changes the normal curve.
14 Experiment: The Capture Recapture Problem
   Objective: The students will be able to estimate the number of fish in a lake.
15. Experiment: What is the most popular letter in the alphabet?
    Objective: The students will be able to analyze categorical data and determine which letter is most used in the English alphabet.
16. Experiment: Birthday Problem II
    Objective: The students will be able to calculate the probability of an event by calculating the probability of the complement of the event.
17. Experiment: The Monte Hall Problem
    Objective: The students will solve a difficult problem by means of simulation.
18. Experiment: The Helicopter Experiment
    Objective: The students will model a physical problem by means of linear regression.
19. Experiment: The Catapult
    Objective: The students will model the distance a catapult can throw a ball by means of linear regression.

Getting a Taste for Sampling: Using a Popsicle Stick Population to Illustrate Sampling Distributions

Robert J. Padgett and Kathryn A. Morris
Butler University
Indianapolis, IN 46208

Many texts fail to illustrate the critical role of sampling distributions in statistical inference. In our exercise to explore sampling distributions, students in basic and advanced courses use a population of 5000 popsicle sticks to learn about key statistical concepts related to sampling, sampling distributions, statistical power, and errors.

Purpose:

In our session we present a technique to introduce to students, in a tangible way, arguably the most central concept of inferential statistics -- the sampling distribution. Despite the centrality of the concept, few introductory statistics texts devote much attention to how sampling distributions provide the conceptual rational that underlies virtually every reject/fail to reject statistical decision. Texts that do present the concept usually do so by providing the mathematical derivations and descriptions of the properties of sampling distributions with little explanation of the relationship between the theoretical distribution and the process of sampling used in empirical research. We have developed a population of 5000 popsicle sticks that we use in basic and advanced statistics courses to demonstrate this and many other key statistical concepts.

In our courses, we typically utilize this population when we first introduce the concept of a sampling distribution, which enhances student learning by allowing them to actively select samples from the population and observe how the calculated sample statistics result in the values expected on the basis of mathematical theorems. Once students have had this direct experience with sampling, we believe it is easier for them to conceptually grasp sampling distributions created via computer simulation. For example, we initially build a frequency distribution of sample means by plotting the sample means from 20 samples selected from the population. Then, we move to computer simulations that create a sampling distribution by simulating repeating that same sampling procedure 20,000 times. Thus, we believe that a combination of hands-on sampling and computer simulation affords students with a strong foundation on which to build their knowledge of sampling distributions.

Example Applications of the Popsicle Stick Population
There are a variety of ways to use the popsicle stick population in class. Below are some ways that we have found to use the population to illustrate various statistical concepts.

1. **Create a sample and compute sample statistics:** Have students each draw a sample of 20 sticks, record the numbers and calculate the mean, standard deviation and other descriptive statistics. They can also use the numbers to create histograms and other graphic displays of data.
2. **Compute z-scores of individual data points in the population:** Use the population to calculate z-scores and the probabilities associated with sampling individual observation greater than, less than, or between some range of scores.
3. **Compute z-scores associated with particular sample means:** Have students calculate a z-test using their sample and construct a confidence interval for the true population mean.
4. **Demonstrate Type I error rates:** Have all students report their sample mean to the instructor and look for the number of Type I errors that occur. We reliably find that the Type I error rate of this procedure is right at stated alpha.

5. **Demonstrate how sample size affects standard error of the mean:** Have students draw 5 samples where the sample size is 5, and then 5 samples where the sample size is 15 and compute the mean of each sample as well as how much the means of each of the samples of 5 and 15 vary from each other. Have students compare that number to the theoretically expected standard error of the mean.
6. **Introduce t and F tests:** Use the population to illustrate drawing two samples from the population to introduce independent t-test, and paired t-test procedures. This same procedure can be used to illustrate within and between group variance with more than two groups (e.g., one-way ANOVA models).
7. **Illustrate correlation:** Have students draw paired samples and calculate the correlation between items. This process can be used to illustrate how the Person Product Moment Correlation captures the relationship between two variables and can be used to illustrate hypothesis testing with correlation (e.g., Ho: $\rho = 0$).
8. **Illustrate statistical power:** Have students assume that they are testing the null hypothesis Ho: μ=20 and then have them draw various samples from the population to see how many times they reject Ho based on the observed sample mean. We reliably find that the rate of rejecting Ho in this procedure is equal to the true power (1-B) of the test based on the sample size and alpha level.

Creating the Popsicle Stick Population:

Although it would be relatively easy to create a population of numbers printed on slips of paper, it was our goal to create a population of numbers using a durable product that is easy to handle and difficult to lose. We originally sought to create the population by writing numbers on poker chips. However, this proved to be too expensive. After investigating various options, we came across popsicle sticks, which are sold in bulk at arts and crafts stores for very minimal price. In fact, the total cost for 5000 popsicle sticks was approximately $35.

After purchasing the popsicle sticks, we created a program in SPSS to generate a normally distributed set of 5000 numbers having a particular mean and a particular standard deviation. Because we did not want students to consider the population to have any particular meaning, we specifically avoided using population parameters that are otherwise meaningful (e.g., intelligence test scores with a mean of 100 and a standard deviation of 15). Although we developed a population with a mean of 28 and a standard deviation of 5, any population parameters could be used.

Finally, we had student assistants write the data points on each popsicle stick, and we store the popsicle sticks in a plastic container large enough to allow manual mixing to ensure random sampling. Although we have not done so at this time, one could conceivably use the same popsicle sticks to create multiple populations by writing numbers in different locations along the sticks and/or using different colors of ink. Doing so would allow instructors to demonstrate sampling from normal versus non-normal distributions (e.g., skewed distributions or rectangular).

For further information about how to construct or use the "Popsicle Population" to illustrate statistical concepts please feel free to contact us via email. Robert J. Padgett may be contacted at rpadgett@butler.edu and Kathryn A. Morris may be contacted at kmorris@butler.edu

Statistics for Everyone

Robert Peterson
Macomb Intermediate School District

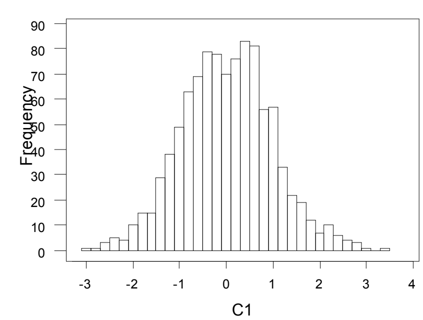
The Detroit Chapter of ASA has received a Strategic Initiative Grant to expand the training of secondary teachers to teach a "Statistics for Everyone" course. The high school course was developed at the Macomb (Michigan) Intermediate School District with input from statisticians at Ford Motor Company, GM, and Merck. The course gives students a clear notion of the existence of variability in any process and how to identify, quantify, and deal with it in making decisions. There is also an emphasis on graphics and good communication skills. The course is completely activity-driven.

The course, which is a course for any high school student, rather than an AP stat course, is currently being taught in 9 Macomb County schools, and 8 other schools are offering parts of the course in current math or science courses. One of these schools has made a semester of statistics a requirement for graduation and they estimate that 75% of their students will take this course.

There are teacher manuals, student manuals and assessment manuals available for teachers who take the training course. There is also a Blackboard course available as support, with interactive on-line activities available for the students.

Of particular interest to science teachers is the fact that besides basic statistical procedures, we explore the multivariate experimentation procedures prevalent in industry. We have had both math and science teachers take the training course.

We will have the equipment and manuals that we use in the course on display. We will also have a computer available to view the Blackboard course available. On the following page is a typical schedule from the 4 hours a week, 16 week training program for teachers. Teachers who take the program can earn 4 semester hours of credit from Oakland University or 12 CEU's.



--Bob and Kathy Peterson
kabob41@comcast.net

Sixteen Week Schedule for the Training Program for "Statistics for Everyone"

Greed Activity	Descriptive Statistics/Graphics
Cereal Activity	Descriptive Statistics/Graphics
Ruler Activity	Standard Deviation/Normal Distribution
Squares Activity	Sampling Distributions
Popcorn Activity	SPC/Boxplots
Bathroom Scale Activity	Paired Data/ Scatterplots
Cartoons Activity	Correlation
Ways of Knowing/Cube Day	What is an Experiment?/3-D Graphing
Crater	A One Factor Experiment with a Continuous Independent Variable.
Eye-Hand (Ergonomics)	A One Factor Experiment with a Categorical Independent Variable
One Factor Funnel	Another One Factor Experiment /Precision and Accuracy
Introduction to Two Factor Experiments	Using a Cube to Visualize the Results of a 2x2 Factorial Experiment; Predictor Equations and Model Adequacy
Iodine Clock	A 2x2 Factorial Experiment
2x2x2 Helicopter/Algorithmic Method	A 2x2x2 Experiment and Analysis
Helicopter Day 2	Using the Algorithmic Method with the Ti-83 and Minitab
Presentations	Teachers present experiments that they have designed for their classrooms

Looking at the Big Picture of Statistics

Nancy Pfenning University of Pittsburgh

Students may manage to solve statistics problems *in context*, but otherwise they often have trouble identifying the appropriate tools to even get started. To help students keep material in perspective throughout a statistics course, they can, from the very beginning, be taught to identify (A) which specific stage in the general four-stage process applies; and (B) which of five variable-type situations applies. Then, as the course progresses, they can be reminded of how the new material fits into the "big picture" of statistics.

This table presents examples within each of the four basic processes, classified according to five possible variable situations.

Situations in the "Big Picture"	Data Production	Displaying, Summarizing	Probability	Statistical Inference
1 categorical variable	Before surveying people about whether they had a permanent tattoo on their body, pollsters had to decide whether to offer response options yes/no or yes/no/unsure.	In a survey of drivers, 62% admitted fiddling with the radio dial while driving in the past 6 mos.; 57% reported eating, and 44% tried to pick something up from the floor. Can we use one piechart to display this information?	If 35% of all workers call in sick at least once a year when they're not really sick, what is the chance that more than half in a random sample of 50 workers take off work for a "phantom illness"?	Before a weekend in NFL football season, 49 of 234 injured players suffered from knee problems. Can we conclude that overall at least a fifth of all injuries are knee problems?
1 quantitative variable	Thousands of 12th-graders were surveyed about how often they cut class in a month. Would the fact that the survey was conducted in class create any bias?	Some families with epileptic children said their dogs showed evidence of anticipating a seizure. Researchers want to report what is typical, based on a variety of anticipation times mentioned by the families.	Age of mothers at the time of delivery has mean 27 and standard deviation 6 years. If the distribution were normal, what would be the probability of a 59-yr-old woman giving birth? (This happened in Dec.2004.)	An AARP survey showed that on average, people wanted to live to the age of 91. Based on their survey data, we'd like to determine if on average people in general want to live to be at least 90.
1 categorical, 1 quantitative variable	Researchers stated that men's actual amount of sexual activity tends to be less than claimed amount. It's easy enough to measure what's claimed, but how can researchers find out the actual amount?	Grades of students who roomed with weak students (bottom 15% of SAT scores) averaged a tenth of a grade point lower than the ones with roommates who were stronger students. How do we graph the data?	Half of students taught dental anatomy over a 3-day period were assigned to chew gum during classes, while the other half didn't. Gum-chewers scored higher on the test; what is the chance of this happening, if gum-chewing makes no difference?	Based on weights of 24 incoming female freshmen (mean 122 lbs) and 172 female sophomores (mean 132 lbs) we want to see if there is evidence for or against the theory of the "Freshman Fifteen".
2 categorical variables	Anthropologists studied gender differences in public restroom graffiti, noting if it was in a men's or women's room, and if it was competitive/ derogatory or advisory/ sympathetic. What criteria are used for this classification?	10 out of 67 teenage boys interviewed in 1962 believed it was OK to have sex during high school. 34 years later, 29 of them "remembered" believing sex in high school was OK at the time. How much of a discrepancy is this?	A bear at a Washington lake resort finished 36 of 36 cans of Rainier beer found in coolers, but drank only 1 of 36 cans of Busch. Could this have happened easily by chance if the bear really had no preference for Rainier?	9 of 15 stroke patients treated with vampire bat saliva had an excellent recovery, compared with 4 of 17 untreated stroke patients. Should this convince us that bat saliva makes a difference?
2 quantitative variables	Computer simulations indicated that as temperatures increased with global warming, rice crops decreased. Researchers wanted to design a study to gather data on the relationship using actual rice crops in the Philippines.	Sociologists studied family size and IQ, and had to decide whether to report how IQ decreased as number of siblings increased, or how number of siblings decreased as IQ increased.	In a study of only 8 countries, the percentage of left-handed people increased with homicide rates. What is the chance of seeing such a relationship in the sample of countries, if being left-handed really isn't related to homicide in general?	Scientists measured age and ear length of a sample of people and concluded that in general, our ears grow about .01 inches a year.

(A): Statistics as a Four-Stage Process

In general, statistics is used to take information from a sample and use it to draw conclusions about the larger population from which the sample came. To accomplish this goal, we

1. Learn about **Data Production**: how to take a sample that truly represents the larger population of interest, and how to gather information so that it accurately reflects what is true about the variables or relationships in that sample.

2. Learn how to **Display and Summarize** single quantitative or categorical variables of interest, or relationships between variables if there are two variables involved.

3. Learn about the science of **Probability**: assume we actually know what is true for the entire population; what is likely to be true for a sample drawn at random from that population?
4. Learn how to perform **Statistical Inference**: Use what we have discovered about variables of interest in a random sample, and draw conclusions about those variables for the larger population.

(B): Five Possible Variable Situations

Another crucial part of the statistical picture is what kind of variable or variables are involved. In introductory statistics, we are almost always concerned with one of just five possible situations: either a single categorical or quantitative variable, two categorical variables, two quantitative variables, or one of each.

"Where Am I?" "You Are Here..."

This game has players pick a scenario from a sample like those in the table above, and then identify what type of variables are involved, and what basic statistical process is being addressed. (At the lower level of play, the scenario can be chosen from a list. At the more challenging level, it is picked at random from a box.)

The following table reminds users of statistics about the various display, summary, and inference tools to be applied, depending on which situation is at hand. These are encountered gradually throughout an introductory statistics course, until a student has accumulated enough tools to handle any of the situations in the "Where Am I?" table.

Tools for Handling Various Situations	Displaying, Summarizing	Statistical Inference
1 categorical variable	Display with pie chart or bar graph. Summarize with counts or (usuallly prefereable) proportions or percentages in category of interest.	Set up confidence interval for unknown population proportion, or test hypothesis that it equals a proposed value. Under the right conditions, standardized sample proportion follows normal (z) distribution.
1 quantitative variable	Display with stemplot, histogram, boxplot, or (especially when normal) smooth curve. Summarize with 5 No. Summary or (more often) mean and standard deviation.	Set up confidence interval for unknown population mean, or test hypothesis that it equals a proposed value. Under the right conditions, standardized sample mean follows z distribution, or t if sample is small and population standard deviation is unknown.
1 categorical, 1 quantitative variable	Matched pairs: display differences with histogram and summarize with mean and standard deviation. Two- or several-sample study: Display with side-by-side boxplots. Summarize by comparing 5 No. Summaries or (more often) means and standard deviations.	Matched pairs: set up confidence interval for unknown population mean of differences, or test hypothesis that it equals zero, using z or t procedure. Two-sample: set up confidence interval for unknown difference between population means, or test hypothesis that it equals zero, using z or t procedure. Several-sample: test hypothesis that population means are equal, using F procedure.
2 categorical variables	Display with bar graph (explanatory variable graphed horizontally). Summarize with proportions or percentages in response categories of interest.	If each variable has just two possibilities, set up confidence interval for difference between population proportions in category of interest, and use z test to see if they could be equal. In general, test if row and column variables are related using a chi-square procedure.
2 quantitative variables	Display with scatterplot. If linear, summarize with correlation and equation of regression line.	Set up confidence interval for unknown slope of population regression line, or for individual response or mean response to given explanatory value. Test hypothesis that population slope of regression line is zero (equivalent to claim that the variables are not related) using t procedure.

The Hot Hand: Comparing Sports Performances to Chance

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Statistical testing often involves comparing obtained data to what could have occurred by chance. The sports world provides many examples, as athletes' or teams' streaky performances can be assessed for their likelihood of being chance phenomena. My "hot hand" website helps introduce students to probabilistic analyses of streaks.

Link to access my website: http://www.hs.ttu.edu/hdfs3390/hothand.htm

Ways that instructors can use these materials:

The key is for instructors to analyze actual sports performances that appear to be "streaky" in terms of their likelihood of occurring by chance. Instructors have many options: they can stage their own athletic events (e.g., taking the class to a school gym to shoot baskets), conduct new analyses of recent college or professional sports events, or go over with their students some of the existing statistical case studies on my website. The website provides thorough instruction on how to conduct hot hand analyses in a variety of ways, such as runs tests, sequential analyses (p[hit | hit] vs. p[hit | miss]), binomial calculations, and computer simulations.

How I have used the materials in ways that might work for others:

I have found a spinner model based on the children's board game *All-Star Baseball* (suggested by Albert & Bennett in their book *Curve Ball*) to be effective. Each disk (which is inserted into a spinner) represents a real Major League Baseball player, with different batting outcomes (e.g., single, home run, strike out) displayed along the circumference of the disk. The sizes of the different outcome zones on a given disk are proportional to the player's actual statistics. The key phenomenon is that repeated spinning of the same disk (thus guaranteeing a constant underlying true probability of a hit throughout the series of "at bats") can still yield what appear to be protracted "hot" and "cold" stretches. An actual *All-Star Baseball* board game can be a useful classroom tool (if interested, go to: http://www.cadaco.com/press/press-allstarbaseball.html).

Juarez Lincoln Marti Project: An Example of International Co-operation in Statistics Education and Research

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1. Introduction and problem statement

Modern world has shrunk: technology, communications, economics, everything brings us closer to each other now. Hence, modern statisticians, as all other scientists and professionals, need to work internationally. Many public and private organizations (including IASE) help to internationalize statistical work. But there are two main drawbacks: language barrier and lack of resources. To successfully address these problems in Iberoamerica, the Juarez Lincoln Marti International Education Project (http://web.cortland.edu/matresearch/) was created.

Our Project (which, for its educational goals could have also been named Sierra-Dewey-Luz Caballero) is completely dedicated to fulfilling four specific objectives. First, teaching faculty development workshops in science and statistics; second, finding scholarships for faculty; third, donating educational materials to universities; and fourth, maintaining an email list service to distribute news and information about Education and technology issues.

We have provided these (and other) programs, in Spanish, for nine years, mainly to small, public universities in remote provincial areas, where other international organizations have had difficulties providing these services, for lack of language skills or for lack of resources. In addition, our Project has successfully addressed their technical problems. For, having worked extensively under the same constrained material conditions of these institutions, we can suggest educational solutions that are both, affordable and feasible, for them to implement.

Through its work (http://web.cortland.edu/matresearch/history.html), our Project strives to build a better US-Ibero American understanding and to help forge stronger relations among their academic and research communities, as well as among their peoples. The Juarez Project also strives to promote and develop international professionals that will help consolidate such stronger links between peoples of different nations and cultures. The reasons behind our Project efforts are described in several newspaper articles (http://web.cortland.edu/romeu/mexus.html) written during our work abroad and published in the US, Mexico and Spain.

2. Project Main Programs

Our first and most successful program has been finding faculty scholarships. Seventeen Mexican professors (http://web.cortland.edu/matresearch/becarios.html) have participated in the SUNY Conference on Instructional Technology. In addition, a Venezuelan professor spent a month in an Internship at our SUNY Institution (http://web.cortland.edu/matresearch/pasantia.html), practicing new educational methods, modern technology and learning about American institutions.

Our second most successful program is teaching faculty development workshops to small, poorly endowed, provincial institutions that had difficulties finding instructors to provide them (http://web.cortland.edu/matresearch/newprog.html). We teach how to teach statistics and science using new technology and the pedagogical methods that accompany them. And we also teach how to survive the infusion of curriculum technology and how to administer a new course while technology is being infused, so the instructor does not perish or give it up. Workshop support comes from Grants provided for a target institution abroad. We then take this opportunity to teach a second course, on our own, saving the cost of the airfare (our largest ticket item). Other times, cooperatives with several institutions are formed, that share the transportation and other costs. We then teach several workshops in the same trip. A list of institutions visited and of workshop topics covered is provided in (http://web.cortland.edu/romeu/talks.html).

Our third most successful program is donating materials and textbooks. Here, we have had to solve two problems: obtaining the textbooks and sending them abroad. We have had the solidarity of many colleagues from SUNY, the American Statistical Association and Isostat, among others, who have donated material. Then, we have taken them in our trips abroad as part of our luggage. Or the US Embassy in Mexico has allowed us to send them to Texas, and they transport them to their destination. Or the Juarez Project has simply absorbed the cost. To date, many boxes of statistics and science textbooks, with scores of books, have been sent to eight universities in Mexico, as well as institutions in Venezuela, Argentina, Spain and Brazil.

Our fourth most successful program is maintaining an email list for faculty and researchers in Latin America, Spain and Portugal (http://web.syr.edu/~jlromeu/boletin.html). Every month, the Project emails news about opportunities in research and study abroad, conferences, web pages with educational materials, work announcements, etc. The Project also maintains a Web Page with educational information and materials (http://web.cortland.edu/matresearch/edsources.html).

3. Educational and Research Materials Developed

The Juarez Project develops most of the educational materials it uses in its workshops. Some of these have found their way into scholarly journals (http://web.cortland.edu/romeu/research.html).

Our main courses are on the use of (GPSS) simulation as a tool for teaching intermediate and advanced statistics courses. Labs developed using GPSS, and modeling mid complexity systems, allow students to obtain "real" data for projects on regression, ANOVA, for designing experiments, etc. Several papers on these subjects (e.g. Romeu, 1986, 1997) have been published in RSS, ASA and other journals, and on the web (http://web.syr.edu/~jlromeu/urlstats.html).

Workshops on the uses of the Minitab statistical software, as a tool for the introductory and intermediate statistics course, are also taught. Labs developed in Minitab, using macros and lis files, provide practical examples that are then emailed to students, or are posted in the Web. A research paper on this topic appears in http://www.minitab.com/resources/whitepapers/pizza.htm.

Courses on the use of technology in teaching, research and administration have been taught in several countries. Our research on assessing the effects of technology in science teaching, via a method vs. control experimental design, appears in (http://www.oswego.edu/cit96/proc/romeu.pdf).

The use of Projects and Cooperative Learning methods has also been among our workshop topics. Projects, by goups of four to six students, allow greater student interaction and learning (http://web.cortland.edu/romeu/groups.html) and leave more time for faculty to dedicate to teaching the subject matter. Two papers on this topic were presented at two education conferences.

Course administration, one of the greatest problems of technology infusion, is a topic we have dealt with at length. When introducing so many new techniques we are taxing the instructor's time. We must also provide them the means to survive this experience, so it takes a hold and flourishes. A paper on this topic (Romeu, 2002) was also recently published.

A complete MS in O.R. Curriculum was totally developed for the University of Comahue, in Argentina, via the Internet, by a group of international faculty. This extraordinary experience is the proof that international cooperation, via Internet, can achieve highly at a very low cost. This graduate program is currently in full operation in Neuquen, the Argentinian Patagonia.

A key goal of our Project is the development of International Professionals, who can get off an airplane and "hit the ground running", when working abroad. We have described the necessary conditions in several international forums and in a journal article (Romeu, 2001).

Finally, our Project has also developed several research proposals (in Education and the ecology) submitted to the U.S. Depts. of Education and State, FIPSE and NSF, among other organizations. They are outlined in http://web.cortland.edu/matresearch/proposals.html.

4. Critical Assessment

The Juarez Lincoln Marti Project accomplishments, achieved in its nine years of existence, constitute its best assessment. Eighteen faculty have obtained scholarships through the Project, to attend conferences abroad. Many boxes, with scores of textbooks, have gone to institutions in Mexico, Venezuela, Argentina, Brasil and Spain. We have taught, under Fulbright, the US State Department grants, or cooperative arrangements between the institutions receiving it and the Juarez Project, a dozen faculty development workshops in Mexico, Venezuela and Spain.

An email list provides technology and educational information to over two hundred faculty in Latin America, Spain and Portugal. And all of this has been achieved with a shoestring budget, voluntary work of our Project personnel, donations from private and public institutions (e.g. Fulbright, Fulbright Alumnus, Comexus, SUNY FACT and UUP Union, ASA, US Embassy in Mexico, Mexican Consulate in NYC) as well as with private citizens donations.

In addition, several other parameters help us assess the quality of such achievements. Our Project receives more workshop requests than we can meet. Papers and materials developed from our work and research experiences are published in peer-reviewed journals. We are in the Fulbright Speakers Specialist Roster that will provide funds to deliver more workshops, etc.

But the ultimate assessment is in the genuine warmth with which our work is received and appreciated, by these institutions, and the feeling of accomplishments they provide us all.

5. Summary and Future work

The Juarez Lincoln Marti International Education Project is here to stay. We are constantly looking for new opportunities that allow us to make even more contributions to education in Iberoamerica. Some of these new opportunities include the following:

We seek to develop additional programs and workshops in the area of statistics, math and science education as well as in uses of technology. We are also starting to develop other areas, such as teaching in secondary education, where another Project member has already given short presentations during our workshops abroad.

We are looking into becoming a Non Profit Foundation, in order to be able to submit NSF proposals and to receive grants and donations from foundations and public organizations. With these additional moneys, we can support other instructors with different offerings, more travel and workshops abroad, and send more educational material to Iberoamerica.

Finally, the reader or anyone else wants to find out more about our Juarez Project, provide suggestions, make a donation of books or materials, or just let us know how you feel about our work, they can contact us via the email, postal address or web page given in this paper.

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RESUMÉ

Le Project Éducationnel “Juarez Lincoln Marti” (http://web.cortland.edu/matresearch) est voué au développement de courses de formation professionelle pour des professeurs des institutions provinciales ou de l’État, dans les pays de l’Amérique Latine et de l’Espagne, qui autrement, auraient de difficultées pour obtenir ce type de services. En outre, notre Project se propose de trouver des bourses pour que des professeurs de ’Amérique Latine puissent venir aux États Unis pour participer a des conférences sur l’éducation. Jusaqu’à présent, des bourses ont été octroyées à dix-huit professeurs. Le Project envoie également des manuels aux universités de ces pays et a mis sur pied une liste éléctronique internationale pour l’échange d’information sur des programmes d’enseignement.

The Role of Daily Quizzes in an Introductory Probability and Statistics Course

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In this spotlight session we report on our experience teaching an Introduction Probability and Statistics course to freshmen at Babson College. Babson, a business oriented college located near Boston, has about fifteen hundred undergraduate students. For a number of years we have been giving daily paper quizzes at the end of each class. We use these quizzes to focus attention on important topics, review the class, and to test student understanding of the material. Although we have small classes, there is significant overhead in administering, collecting, grading, and returning the quizzes.

At Babson College all freshmen are now issued laptop computers with built in internet capabilities. Our wired class rooms allow all students to have internet access. For several years we have been requiring students to bring their lapstops to class, so that they can access materials on the Internet, take notes, and perform statistical calculations using Minitab. Last year we began experimenting with giving with web based quizzes using the EDU platform.

We want our quizzes to both assess and to assist student learning. Therefore, we design our quizzes with random parameters. Each time a student accesses a quiz they are given a slightly different version. This prevents casual cheating and allows students to retake a quiz until they demonstrate mastery.

During the last ten minutes of a ninety minute class, we activate the quiz. After each student takes the quiz and submits their answer, they receive immediate feedback. They have until 8 AM the next morning to retake the quiz as many times as needed. Students are encouraged to help each other with the quizzes. The quizzes are graded on a ten point scale. Each time a student takes a quiz one point is subtracted from their best grade on that quiz. We give over twenty quizzes during a semester, but only about half have been converted to an electronic form. The others are still paper based.

It is very interesting to observe the difference in student behavior at the end of classes having electronic quizzes and those that don't. There is significant amount of enthusiastic animated interaction between the students as they try to explain to each other how to do a quiz. When there is no electronic quiz, this interaction is missing.

During the first few classes, there is some hostility towards the electronic quizzes by a few students. The quizzes require that the students pay attention during the class and then demonstrate their understanding. After a few weeks of quizzes, the students appreciate their value and express dissapointment should some technical problem prevent access to the quizzes.

The major difficulty in using this type of quiz is the work required to program the quiz. Once a quiz is programed and debugged, it of course can be reused. We are in the process of expanding our quizz coverage and by next year we hope to have complete course coverage.

Two sample quizzes are given below. During the spotlight session, we will demonstrate how the quizzes change each time they are generated dynamically, how students enter their answers, and how the quizzes are graded. We will also illustrate the admininstrative tools used to track the results of multiple retakes for about thirty students in each of several sections.

Histogram of C1 **N = 50**

Midpoint...	Count ...	
190	7	*******
230	7	*******
270	2	**
310	8	********
350	9	*********
390	5	*****
430	8	********
470	4	****

This question is based on the character histogram above. The data has been put into 8 categories and the midpoint of each interval is as shown. One of the intervals with a midpoint of 390 is shown below. Complete the cells using the information in the character histogram above. For the interval with midpoint 390 determine the missing values and enter them in the cells provided.

Enter the numerical values. Do NOT enter the % sign.

This question is composed of ten parts.

An employee of Consolidated Industries has been instructed to authorize payment for a shipment of peaches if he finds evidence with 98 % confidence that the average weight of the peaches in the shipment is greater than 60 grams . A random sample of 20 peaches is selected from the truck load of peaches . The weights are normally distributed with a known standard deviation of 8.57 grams . The mean weight of the 20 peaches in the sample is 62.96 grams .

1) Formulate the null hypothesis Ho
2) Formulate the alternative hypothesis Ha
3) Identify the rejection region and determine the critical value of Xbar
4) Find the observed value of Xbar
5) Determine the critical value of Z
6) Determine the observed value of Z
7) Determine the probability, p, that we will get a value as extreme as the test statistic, assuming that Ho is true
8) The significance level, alpha, is
9) The correct conclusion concerning Ho is
10) The correct conclusion concerning authorization is that the shipment

Formulate each hypothesis using the two menu choices and the text box.
When you enter a numerical value, it must be correct to two decimal places (0.01).

The work associated with the electronic was made possible by a grant from the Davis Educational Foundation.

Introducing Undergraduate Students to Spam Filtering, Internet Traffic Data and WWW Clickstream Data Analysis: Three Activities that Work.

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Introduction

In the Spotlight Session, I illustrate the numerical and graphical analysis for the three activities that I summarize below.

1.- Describing and modeling web browsing behavior. ***Activity appropriate for the Introductory Statistics service course during (a) the descriptive data analysis part of the course, including the correlation/regression part, and (b) sampling theory.***

Here is what your requests for web pages of the Statistics Department web site look like in the web server logs. Your IP address, the time when you clicked, your request, a code saying it is ok, the bytes you are requesting and where you are coming from and operating systems, Internet Service providers and software are recorded for every single click you make.

```
61.149.137.109 - - [01/Jun/2004:00:00:12 -0700] "GET /index.php?vol=2 HTTP/1.1" 200 32896
"http://www.jstatsoft.org/index.php?vol=1" "$
64.68.82.14 - - [01/Jun/2004:00:00:21 -0700] "GET /~cochran HTTP/1.0" 200 2991 "-" "Googlebot/2.1
(+http://www.googlebot.com/bot.html)"
127.0.0.1 - - [01/Jun/2004:00:01:30 -0700] "GET /server-status" 200 17082 "-" "-"
80.232.169.174 - - [01/Jun/2004:00:02:22 -0700] "GET /v06/i06/codes/mingcv.m HTTP/1.1" 200 1806 "-"
"tfqsgmsnnpurmbwmgjdyglyogxdpwe"
212.247.91.99 - - [01/Jun/2004:00:03:10 -0700] "GET / HTTP/1.1" 200 21029
"http://members.aol.com/johnp71/javasta3.html"
"Mozilla/4.0 $
```

How can you learn from this observational time data about the behavior of visitors to this web site? Whatever your questions, the web logs have to be cleaned and processed accordingly, and the visitors' clickstream has to be determined. Once that is done, we can process the data further to make them easily managed by students. Suppose we are interested only in having a data set containing which page each visitor has clicked on, the length or total number of pages (including repeats), the first page clicked and the number of unique pages visited. With this data set your students in the Intro Stats class can find out a lot of things. For example, let's see first a few lines of this data set for the msnbc web site.

User session 1: 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 1 Entered page 1, clicked twice p1
User session 2: 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 1 Entered page 2, clicked once p2
User session 3: 0 5 3 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 9 3 Entered page 3, visited 3 pages, 9 clicks.

From this, students can find the distribution of length and depth, the most common gate of entry, the popularity of pages, the correlation between depth and length. The datasets are very large and can also be used to illustrate the CLT and other sampling concepts.

2.- Fitting distributions to Internet Packet Traffic Data. *Activity appropriate for (a) the descriptive and probability modules of the introductory statistics course, lower and upper division, and (b) mathematical statistics class.*

Logs of packet traffic arriving to mail, login or ftp servers have formats similar to those of the web server logs above. Processing the data for our students is necessary. Important questions in this area that are relevant in the introductory courses are: what distributions fit the variables "packet size," "number of packets per unit of time" and "time between arrivals of packets? With voice traffic, such as telephone, the last two were consistently Poisson and Exponential respectively, but that is no longer the case with internet packet traffic.

Students can compare the distributions of the data with known simulated distributions with the same parameters , do q-q plots, goodness of fit tests, mle. But more importantly, they learn to appreciate thick tail distributions, models not usually studied such as power laws, which are very prevalent in internet data analysis. Then they can look at the behavior of traffic over time to try to explain the distributions, and learn to distinguish between outliers and thick tail behavior.

3.- Using Bayes Theorem to predict whether a mail message is spam or not. *Activity appropriate for the introduction to probability part of the Introductory Statistics service course, and the part where we summarize categorical variables or do chi-square tests.*

Give students a training corpus (a set of randomly chosen messages known to be spam or good and ask them to determine the proportion of times a word appears in spam messages, and proportion of times a word appears in non-spam messages (including the headings). That is the empirical P(word|spam) and P(word|not-spam). Chi-square tests can be done to determine if the frequencies differ significantly for spam and good mail. But to filter spam, it is more important to determine what is the probability that a mail message arriving to our mail server is spam.

$$P(Spam \mid message) = \frac{P(message \mid spam)P(spam)}{P(message)}$$

$$P(message) = P(mess \mid spam)P(spam) + P(mess \mid not - spam)P(not - spam)$$

P(message|spam)=P(first word|spam)P(second word|spam)…….P(last word|spam)
P(message|not spam)=P(first word|not spam)P(second word|not spam)…….P(last word|not spam). Once this is computed, give students a random sample of email messages and ask them to classify them as spam or good. Compute the false positives. Discuss limitations of approach.

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Green Route or Red Route? A Statistics Project

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The AppalCART operates several routes that serve ASU and the Boone area. As a relatively newcomer in this town, I am interested in knowing a lot of things about its operation. Your task in this project is to help me figure out some of the things that would help me learn about AppalCART. You will need to write a written report with at least 3 pages. Your report should address at least the following issues/topics:

1. Some general background information about the AppalCART (a little bit of history and possibly a description of its basic operation)

2. Which route (red route, green route, etc) is the busiest route? (give your definition of what busy could mean) Which is the next busiest route? And so on until the least busy. Cite statistics and present graphs that would support your answer. Think of a situation where this information might be useful.

3. Which route takes the longest time to complete one full cycle (the time it takes a bus to get back to a starting point A)? Which takes the second longest and so on? Cite statistics and present graphs that would support your answer. Think of a situation where this information might be useful.

4. Suppose someone told me that Green route buses are better at following their schedule than Red route buses. Collect and analyze data that can be used to verify or refute this claim. Explain how you collected the data and describe the data that you collected. Present graphs and statistics that would support your answer. Also, explain the potential significance of your findings.

5. Think of a reasonable question of interest about AppalCART (but **not** about the drivers or any AppalCART employees) that can be answered either by collecting your own data or by using the data located at the AppalCART website. Then either answer your question or explain a procedure for getting an answer to your question (your explanation should be clear and detailed enough that I should be able to follow and carryout your procedure).

6. A paragraph that gives a summary of what this project is all about. You can include recommendations on how you can improve your arguments on some or all issues you tackled.

7. Finally, a paragraph about how this project helps (or does not help) you in appreciating the relevance of this course. You can include some recommendations on how this project can be improved.

Evaluation - A model for evaluating the project is given at the ARTIST website http://data.gen.umn.edu/artist/glossary.html. This type of project falls under the category "Performance Task" described in the website as follows:

"A performance task is a type of authentic assessment, in that it is modeled after a real life statistical problem or task. In the ARTIST database, a performance task is an item that gives students the opportunity to demonstrate their ability to integrate and apply statistical knowledge and skills in analyzing information. It is a way for students to demonstrate their ability to think statistically and construct a solution to a problem that includes relevant information about a statistical question and is accompanied by either raw data, summary statistics, and/or discussion of design issues. The problem challenges students to select an appropriate statistical procedure, use evidence to support a statistical conclusion, consider all relevant aspects of a statistical problem, or knowledgeably critique and evaluate a problem solution. These items are best scored using a holistic rubric that focuses on the overall approach and communication as well as the problem solution. Here are some questions to consider when evaluating students' answers:

1. Was an appropriate statistical procedure used to solve this problem?
2. Were necessary assumptions tested?
3. Were statistical analyses carried out correctly?
4. Were appropriate graphs used?
5. Was the conclusion stated appropriately and in terms of the problem context?
6. Was appropriate evidence supplied to justify the conclusion?
7. Were the explanations thorough and consistent?

Each of these components could be scored on the following scale:
0 (missing or completely incorrect/not relevant to the problem)
1 partially correct
2 mostly correct
3 essentially correct"

This model can be tailored to this project as follows: In placed of the 7 questions above, the 12 items below and the scoring scale can be used.

1. The introduction clearly explains the purpose of the project.
2. The data collection methods were clearly described.
3. Appropriate graphs and numerical summaries were used.
4. All the issues were addressed.
5. Appropriate statistical procedures were used.
6. Statistical analyses were carried out correctly.
7. Conclusions were stated appropriately and in terms of the problem context.
8. Appropriate sets of evidence were supplied to justify the conclusions.
9. The explanations were thorough and consistent.
10. Technical terms were used correctly.
11. The statements were grammatically correct.
12. The project demonstrated sufficient integration of statistical knowledge.

Each of these components could be scored on the following scale:
1 Strongly Disagree
2 Disagree
3 Neither agree nor disagree
4 Agree
5 Strongly agree

Using Monte-Carlo Simulations and an Interactive White-Board for Teaching Sampling Distribution Characteristics

Presented at the United States Conference on Teaching Statistics (USCOTS)
Spotlight Session on Pedagogy
May 19th – May 21st, 2005 • Columbus, Ohio

By

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This presentation shows a practical guide for using Monte-Carlo simulation studies and an interactive white-board for the teaching and learning of sampling variability, sampling distribution characteristics, and the central limit theorem. The presenter will show the use of both SPSS and Stata statistical software for performing Monte Carlo simulations. Below is an outline of the presentation. First, a definition of Monte Carlo simulations will be given; second, there will be a brief discussion about the role of simulations in statistics; and third, two examples of Monte-Carlo simulation studies will be demonstrated.

1. Definition of Monte Carlo simulations.

2. Importance of Monte Carlo simulations in statistics.

3. Example #1. Use of Monte Carlo simulations for investigating properties of location estimates.

   Here we compare the sample mean $\theta^{(1)}$, sample 20% trimmed mean $\theta^{(2)}$, and sample median $\theta^{(3)}$ as estimates of the mean μ of a specified distribution (normal or skewed). We follow the Monte Carlo simulation procedure indicated below to make the comparison.
   - Generate independent draws $X_1, \ldots, X_n$ from the distribution.
   - Compute $\theta^{(1)}, \theta^{(2)}$, and $\theta^{(3)}$.
   - Repeat the first two steps B times (i.e. $B = 1000$) to obtain
     $\theta_1^{(1)}, \ldots, \theta_B^{(1)}$; $\theta_1^{(2)}, \ldots, \theta_B^{(2)}$; $\theta_1^{(3)}, \ldots, \theta_B^{(3)}$
   - For $k = 1, 2, 3$, calculate

$$\bar{\theta}^{(k)} = \frac{\sum_{i=1}^{B} \theta_i^{(k)}}{B} \qquad S_{\hat{\theta}^{(k)}} = \sqrt{\frac{\sum_{i=1}^{B} (\theta_i^{(k)} - \bar{\theta}^{(k)})^2}{B-1}}$$

$$\widehat{BIAS} = \bar{\theta}^{(k)} - \mu \qquad \widehat{MSE} = \frac{\sum_{i=1}^{B} (\theta_i^{(k)} - \mu)^2}{S} \approx \widehat{BIAS}^2$$

- Compute the relative efficiency of estimate j to estimate i for $i = 1 \wedge j = 2, i = 1 \wedge j = 3, i = 2 \wedge j = 3$.
  a) If $E(\theta^{(i)}) = E(\theta^{(j)}) = \mu \Rightarrow RE = \frac{\text{var}(\theta^{(i)})}{\text{var}(\theta^{(j)})}$
  b) If the estimates are not unbiased, compute the relative efficiency by using the formula $RE = \frac{MSE(\theta^{(i)})}{MSE(\theta^{(j)})}$

     If $RE < 1$, then estimate i is more efficient than estimate j.
- Investigate the sampling distributions of these estimates of μ through the use of sample histograms.

4. <u>Example #2</u>. Use of Monte Carlo simulations for investigating the sampling distribution of a sample mean.

Here we investigate the behavior of the sample mean $\bar{x}$ as described by its sampling distribution. First, we consider that the underlying population of x-values is normally distributed with parameters μ and σ. The Monte Carlo simulation procedure to do the investigation follows below.

- Generate independent draws $X_1, \ldots, X_n$ from the population under consideration.
- Compute its sample mean.
- Repeat the first two steps B times (i.e. $B = 1000$) to obtain $\bar{X}_1, \ldots, \bar{X}_B$.
- Calculate $\bar{X} = \frac{\sum_{i=1}^{B} \bar{X}_i}{B}$; compare this value to the population mean μ.
- Calculate $\sigma_{\bar{X}} = \sqrt{\frac{\sum_{i=1}^{B} (\bar{X}_i - \bar{X})^2}{B}}$; compare this value to the population standard deviation σ.
- Construct a sample histogram of the $\bar{X}$ - values (i.e. $\bar{X}_1, \ldots, \bar{X}_B$). Because B is reasonable large, the sample histogram should rather closely resemble the true sampling distribution of $\bar{X}$ (obtained from an infinite sequence of $\bar{X}$ - values).
- Repeat the experiment for several values of n to determine how the choice of sample size affects the sampling distribution.
- Repeat the experiment for a skewed distribution with parameters μ and σ.
- State the central limit theorem based on the above observations.

Using Hybrid Teaching in Undergraduate Statistics Education

F. Michael Speed, Eric Hintze, Kathleen D. Speed
Texas A&M University

Abstract: Students are exposed to classroom instruction before they come to a lab session by accessing course content via the web or cd. The classroom instruction on the web or cd was recorded in a previous semester. All course materials and the instructor's voice was captured for play back later.

In the Spring Semester of 2004 two introductory statistics classes were taught with each class having about 37 students. The first class, the 8 am class, was taught in the traditional manner i.e. Mondays and Wednesdays were dedicated to lecture material, while lab work was required on Fridays. Lecture material was delivered by presenting and discussing PowerPoint slides, with skeletal slides available for downloading and printing prior to each lecture. The labs were based on the lecture material of the previous two lectures. During each lab, students were asked a series of questions via WebCT which required knowledge of the lecture material and/or the use of the statistical computer program SPSS to summarize and evaluate data sets. To reduce the stress of the labs, students were permitted to repeat each lab with the first attempt graded. Homework was assigned and turned in on a weekly basis. The due date for homework was planned in such a manner so those questions could be asked during the labs. Three "midterm" exams and a final exam were given through WebCT. Previous to each exam, a lecture was dedicated to the review of the corresponding material. Following each exam, the exam questions were evaluated and questions discussed.

The second class met **only** Mondays at 10:20 – 11:10 am. During the first day of class, each student was given a CD which contained the course materials and recorded videos of the lectures of Fall 2003 organized into modules. Labs were held each Monday during the scheduled time and were identical to the Friday labs of the 8 am class. The materials on the CD essentially replaced the other two lecture days each week. With the CD, students could elect to watch (or not watch) any of the class lectures at any time. The recorded videos contained voice and all materials of what could be seen on the instructor's computer screen. This is what the in-class students saw and heard in Fall 2003. Students' questions were repeated when recording in 2003. The students were responsible for turning in the homework, completing the labs and taking exams on dates that corresponded to the 8 am class. Questions about material could be answered by direct email, a WebCT discussion board (with the option of anonymity), or by an office hour visit. Most students elected to ask questions about course material over the internet and about grades in person. Throughout the semester, focus groups were organized to further solicit feedback. Exam questions were not identical for both classes, but were written to be comparable, with perhaps slight changes in the numbers used, available answers, or question wording. A lecture involving the evaluation of exam questions was not held for the Monday only class, except that students were invited to ask questions about the exam in the following lab. Lab attendance gradually decreased toward the end of the semester in both classes. Lab attendance was not required and labs could be completed from any computer with access to WebCT.

Exams results from these two classes will be presented in this session along with the multimedia material.

Teaching Graphical Excellence
Using Media Mistakes

Presented at the

Spotlight Pedagogy Session
2005 USCOTS Conference
Ohio State University
May 19-21, 2005

By

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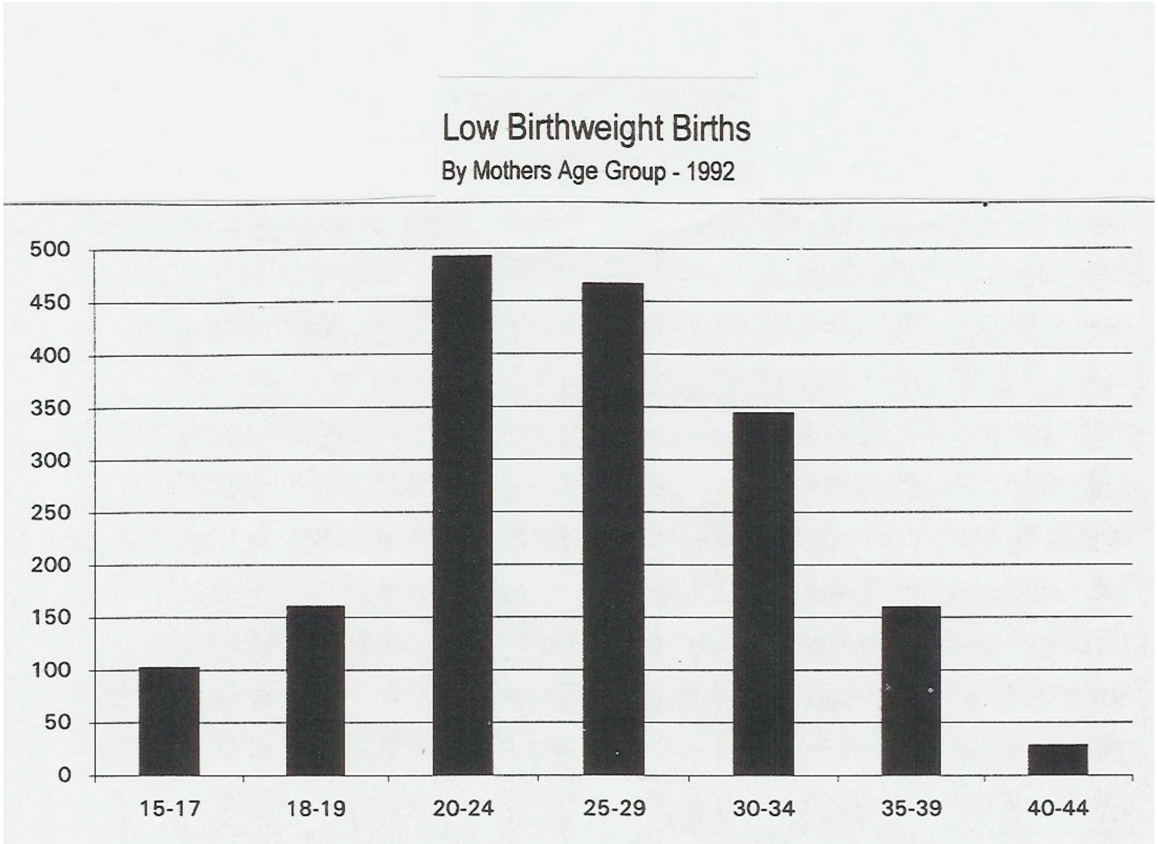
Abstract: The development of graphical software makes graphical Presentation easier than ever. However, inaccurate and sometimes bizarre presentations are widespread in the media. Students can learn a great deal about excellence in data presentation by viewing and critiquing graphical mistakes, and comparing appropriate graphical presentations against graphical mistakes.

Contents of Handout: There are several presentations of graphics used in media articles that are critiqued – each with varying problems. The examples are used for student class assignments and lecture presentation.

Poster Session: The poster will compare a revised graph against the inappropriate graphs selected from the media and other publications.



Source: *State of Nevada Statistical Abstract*, 1994.

1. What problems do you see with this graph?

Answer: There are several problems with this graph:

a) The class widths are not equal.
b) The variable "age" is really continuous. The data may be better represented by a histogram.
c) The data should incorporate the number of births per each age group (per capita) and not be represented by absolute count.
d) The x and y axis are not labeled.

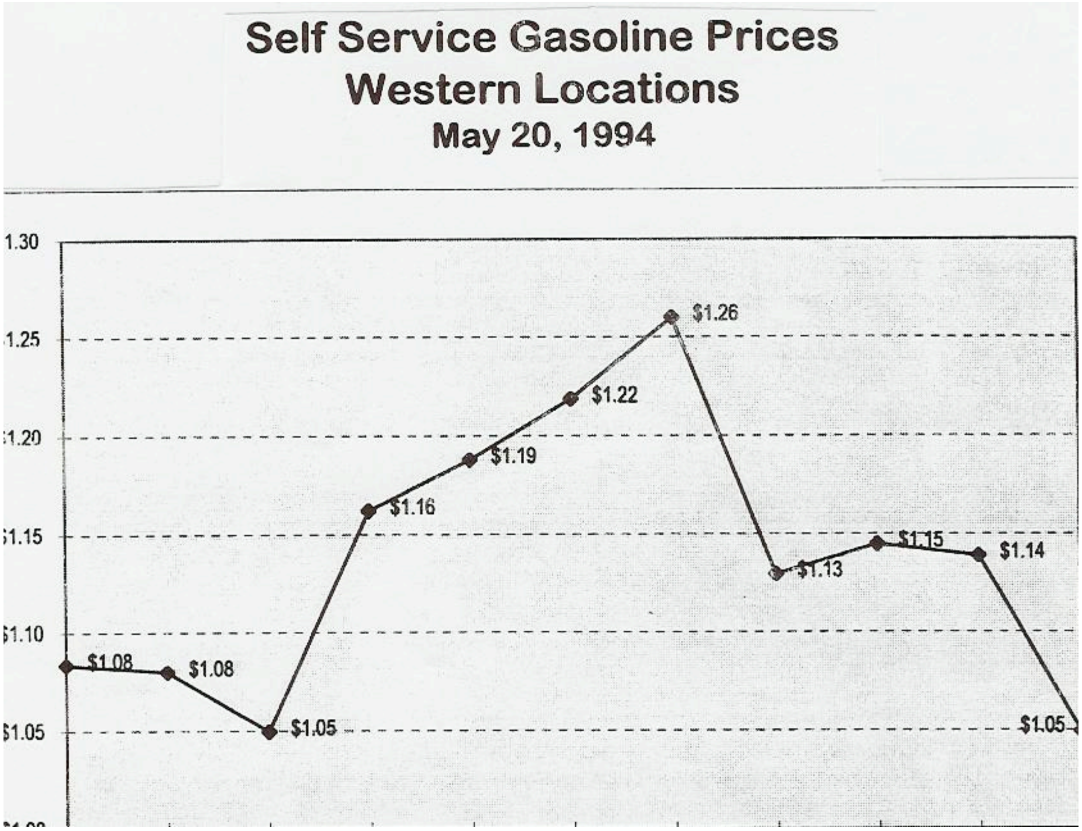
2. How do the problems distort the data presented?

Answer: We cannot make true comparisons about low-birth weight incidence because it is very likely that a larger number of births are to women in the 20-29 year age group. Similarly – we cannot make true comparisons about low-birth weight incidence when classes are of unequal length.

3. How would you fix the problems?

Answer: A histogram would be more appropriate for this data since ages are really continuous. Make sure class widths are equal. Determine per capita low-birth rates.

4. Produce a graph that is appropriate for this data.



Source: *State of Nevada Statistical Abstract*, 1994

1. What problems do you see with this graph?

Answer:

a) The x and y axis are not labeled. It is difficult to tell exactly what is being graphed. After examining the text associated with the graph, the data on the x-axis was found to represent different cities.
b) The line graph with connected points appears to be showing gasoline prices over time. However, the data is cross-sectional (taken on a single date) and not time series.

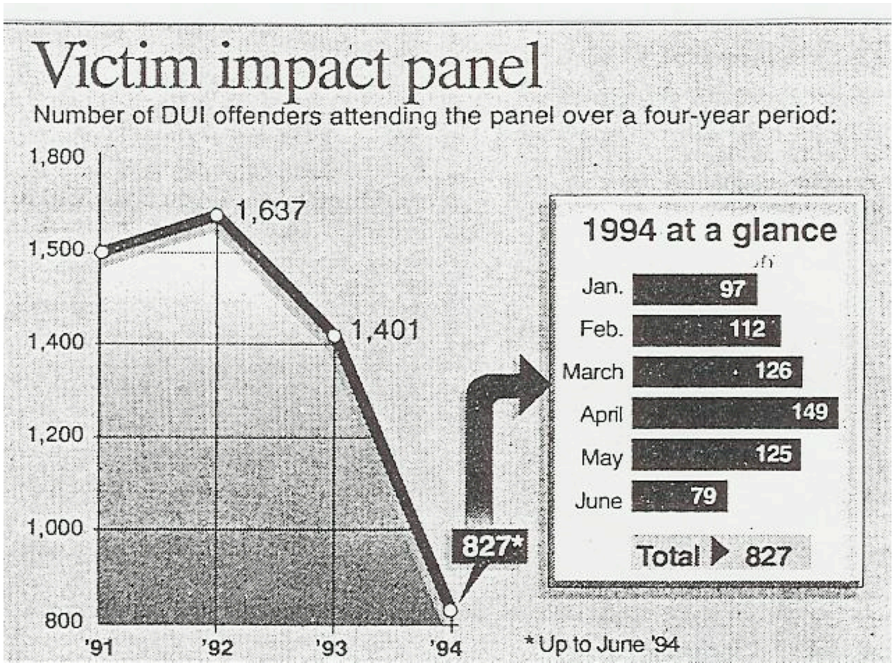
2. How do the problems distort the data presented?

Answer: The use of a line graph portrays the data as a trend of prices. The x-axis data represents different cities and the data is cross-sectional, therefore, a "trend" does not exist.

3. How would you fix the problems?

Answer: A bar graph would more appropriately show the simple comparison of gasoline prices among the various cities.

4. Produce a graph that is appropriate for this data.



Source: *Reno Gazette Journal*

1. What problems do you see with this graph?

Answer:

a) The time-series graph uses unequal time widths for the classes. The data for the year 1994 is for 6 months, while the data for the years '91 through '93 are for 12 months.
b) The y and x-axis are not labeled.

2. How do the problems distort the data presented?

Answer: Using only 6-month data for the year '94 (although footnoted in the graph) results in the appearance of a dramatic drop in the number of DUI offenders attending a victim impact panel. The number may, in fact, be higher for the entire year.

3. How would you fix the problems?

Answer: When presenting time series data use equal intervals of time. To make accurate comparisons of the attendance, 6-month intervals through June of each year would be more appropriate.

4. Produce a graph that is appropriate for this data.

1. What problems do you see with this graph?

Answer: Expenditures shown on the graph vary widely. This produces a result on the graph where one of the bars appears as a "flat line".

2. How do the problems distort the data presented?

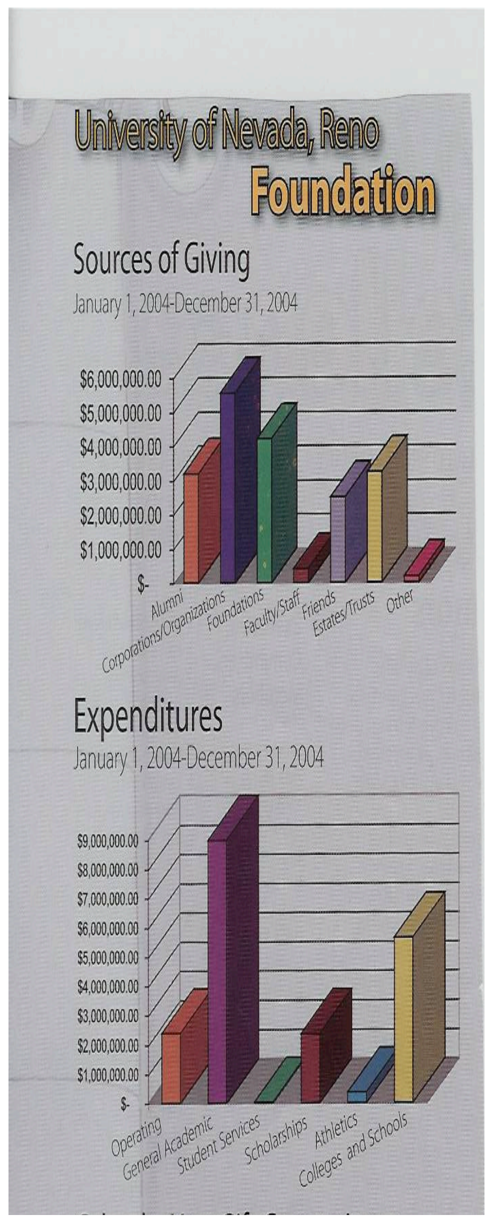
Answer: One cannot really estimate the frequency or count for the "flat" class. It appears that the frequency is 0 for Student Services Expenditures.

3. How would you fix the problem?

When confronted with this problem, it is often appropriate to delete the classes that are outlying and footnote the information so that the entire graph is not distorted.

Note: Consider whether a 3-D presentation really enhances the data presentation.
A two-dimensional graph may be easier to read.

4. Produce a graph that is appropriate for this data.



Student Service Expenditure appears to equal 0 ►►►►►

Source: *Nevada Silver and Blue*, The University of Nevada, Spring 2005

1. What problems do you see with this graph (below)?

Answer: There is nothing "incorrect" about this presentation. However, there is a tendency, especially with today's graphics capabilities, to over-do a presentation. Too much information on one page can obscure the point being made. Refer to the 2 bars shown under the headline International Appeal. At first glance, it is difficult to determine what the author is attempting to report because count and percent show on a single bar.

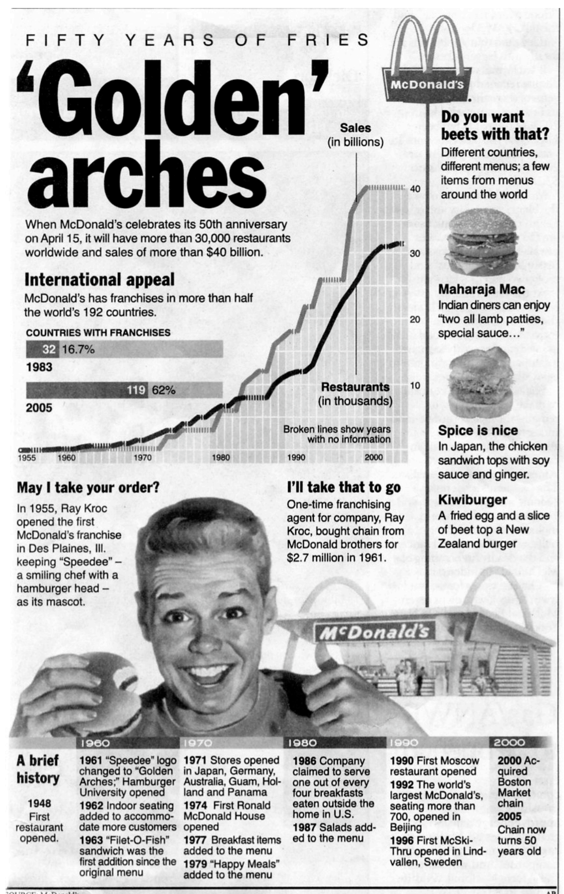
2. How do the problems distort the data presented?

Answer: The presentation is "busy" and difficult to read.

3. How would you fix the problems?

Answer: While the presentation may be acceptable in a newspaper article, avoid over-loading for a presentation. Separate the information into two or more presentations.

Source: Reno Gazette Journal 4/25/2005



Teaching an Entirely Online Statistics Course

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As with other courses, the pedagogy of teaching statistics courses has been changed, enhanced, and sometimes made poorer with the inclusion of web-based capabilities. Most all would agree, though, that online capabilities have enabled richer courses to be offered.

Statistics, like many of the scientific courses, requires a considerable amount of "telling" and "showing" to be effective. Teaching a statistics course online is clearly different from just taking a regular onground course and putting all the materials online. Most of the telling and showing would be missing with such a strategy.

Students, particularly students in statistics service courses, find it very difficult to learn the material on their own. I have found that many online students struggle even more than traditional onground students, not just because of the absence of telling and showing activities, but because many online students are non-traditional students and have not had any mathematics courses for quite a while. Some of my online students, for example, have not had any mathematics courses for 25 or 30 years.

Thus online students, even more than onground students, need the telling and showing. This greater need conflicts with the reduced capability in online statistics courses. My spotlight session highlights some online techniques that I have used to address these shortcomings.

My main area of new teaching methods investigation has been to provide telling and showing activities that can be asynchronously accessed by online students. Asynchronous discussion boards synchronous chat sessions are commonly used tools for online classes, but which are insufficient to learn statistics. In addition to those, I have used pre-recorded lectures, pre-recorded examples, recorded live lectures, and just-in-time videos to assist the students in their learning. I am currently on my 6th version of my video internet help site.

I have had a reasonable level of success with these techniques. At a minimum, I receive student comments in every class that they would never have been able to pass the course without my additional materials. Receiving those comments has motivated me to continue to try additional methods.

I have a set of recorded video lectures and examples at http://newaiu.zenterprise.com for one of my online courses. Recorded live lectures for that course are not accessible (for privacy reasons, by request from that school).

A summary and comparison of various functions is listed below, including basic online methods and my own practices.

Activity / Function – lectures on new topics

Onground: In-class lectures 2 or 3 times per week at fixed times.

Basic online: Sometimes CD's come with the textbook. Otherwise most students are left to fend for themselves.

My additional online: I have found that online students hunger for lectures. I accomplish this through a program of recorded video lectures and some synchronous lectures through chat rooms. Students appreciate their own instructor lecturing rather than an anonymous other instructor.

Activity / Function – working through examples and homework in class

Onground: Done in class, flexible but within the regular class hours.

Basic online: Some done in synchronous chats at the discretion of the instructor.

My additional online: Many or most students learn best through examples. I have recorded video solutions for examples in each course unit and do some additional ones in the synchronous chats.

Activity / Function – classroom assessment

Onground: Done in class, during and/or at the end of lectures or via homework.

Basic online: Difficult because of a lack of real-time interaction. Limited assessment can be inferred from discussion boards and student questions.

My additional online: I offer to do a preliminary grading of assignments if the student turns it in 3 days early. That allows the student to fix errors and gives me an earlier view of student progress.

Activity / Function – office hours, individual assistance

Onground: Fixed times, times by appointment, and hit-and-miss stopping by the office

Basic online: Fixed times for the instructor to be available

My additional online: I announce to the class that I am often accessible via various Instant Messaging services for real-time help.

Activity / Function – homework

Onground: Typically synchronously assigned and asynchronously done

Basic online: Also typically synchronously assigned and asynchronously done. All students are usually working on the same assignments each week.

My additional online: I follow each university's guidelines, usually weekly homework.

Activity / Function – tests and quizzes

Onground: Done in class (synchronously) or at home (hopefully asynchronously)

Basic online: Often no tests or quizzes, usually grades are entirely based on homework and projects. Validating student identities for tests is difficult.

My additional online: I follow each university's guidelines, often no exams.

The impact of religious faith on statistical use and inference

Nathan Tintle, Ph.D., Assistant Professor of Mathematics, Hope College, Holland, MI

Abstract

Individuals with strong religious beliefs often find it difficult to accept statistics as an information gathering and decision-making tool. I present a couple of key concepts and corresponding learning activities not typically incorporated into an introductory statistics class that help students understand the co-existence of statistics and their religious beliefs.

Introduction

I have noticed that religious organizations and people with strong religious beliefs can have difficulty accepting statistics as an information gathering and decision making tool. My experience is not an isolated case. Recently, the editor of the Journal of the Association of Christians in the Mathematical Sciences stated that "Relatively little has been done thinking through a Christian perspective on probability and statistics."[1] To address this need for understanding, I present material which I have found to be helpful in addressing concerns about statistical use.

Understanding what statistics is really doing

Statistics is merely a systematized form of inductive reasoning: a logically sound form of reasoning practiced daily by most people, which is not contradictory to Christian and other faiths.

Induction is "inference of a generalized conclusion from particular instances."[2] More clearly stated, when we induce, we observe the world around us, and then draw conclusions which are based on our knowledge of how the world typically works. For example, I may observe that Jane just came in from outside and is wearing a hat and gloves. Past experience tells me that people who wear hats and gloves do so when it is cold outside. Thus, my induced conclusion is that it is cold outside. Am I right? Not necessarily, but this is the nature of induction. Three common fallacies that occur in induction are[3]:

1. The fallacy of hasty generalization, which occurs when you induce from insufficient information.
2. The fallacy of exclusion, which occurs when you exclude an important piece of evidence from the inductive process.
3. The fallacy of a non-representative sample, which occurs when the evidence used to make the induction does not accurately represent the group the induced conclusion is meant to apply to.

Statistics presents a systematized form of inductive reasoning, which hopes to address common pitfalls of inductive reasoning. Statistics does this by preventing one from making a hasty generalization (through an understanding of standard errors and hypothesis testing). By demonstrating when to include and exclude information (through an understanding of outliers and confounding and lurking variables). And by knowing how to obtain a representative sample (through an understanding of random sampling techniques). These are only a few of the examples of how statistics addresses fallacies of inductive reasoning, for more see Bradley's "Two ways of knowing"[4]. This paper is freely available, and also contains helpful study questions for students, in fact it was written in order to "*facilitate the integration of faith and learning in an introductory, non-calculus based statistics course*."

Examining when induction and systematic quantification are used in the Bible
In the past, individuals with a Christian faith will cite the census taken in 2 Samuel 1 (and it's concurrent account in 2 Chronicles 21) as an example of how surveys (more generally statistical observation) in religious settings are in conflict with God's will. However, examination of the text shows that this census was taken in clear disobedience of God's will. Further confirmation is seen in Numbers 1 when a census was taken by the direct order of God.

When Joshua and Caleb scouted the Promised Land in Numbers 13, 14 and when Jesus fed the 5,000 in Mark 6:38, the Bible shows that quantification of a situation is not inherently wrong. What was induced differed depending on whether or not one was in tune with God (Joshua and Caleb vs. 10 other scouts and Jesus vs. disciples). In other words, the need for statistical assessment is not inherently wrong. However, we can run into problems when we interpret that information in a way that is incongruent to the truth as God sees it.

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1. Journal of the Association of Christians in the Mathematical Sciences. 2004. Letter from the Editor. www.acmsonline.org/letterfromeditor.htm.
2. Merriam-Webster's Collegiate Dictionary. 10th Edition. 1993.
3. "Deductive and Inductive Arguments." http://webpages.shepherd.edu/masutin/rhetoric/deductiv.htm
4. Bradley, James. "Two ways of knowing." http://www.acmsonline.org/Bradley-2waysofknowing.pdf 2004

Reduce the Fear Factor with Online Materials

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Background:

I reviewed every written comment on the end of semester course evaluations that I received during 10 semesters of teaching an online introductory statistics class at UNC. Two things that really stood out in those comments were the students' high level of comfort and satisfaction with the materials and the students' references to a reduction in their fear of taking a statistics class.

Having recently moved to Maine, I find myself teaching introductory statistics to undergraduates in a small college. The fear factor here is intense. Most of the students need to work outside of class to learn the materials enough to pass the course. However, a lot of the students are not comfortable using a textbook as a learning tool, nor are they use to going to the professor for help. These same students are very comfortable surfing the web and reading materials over the internet. This thinking led me to the following hypothesis.

Research Hypothesis:

I propose that an introductory statistics course use online materials as secondary supporting materials. I hypothesize that the use of these materials will exceed the use of the textbook as a secondary source of learning and it will reduce the fear factor of taking a statistics class. In addition, it may lead to less dropouts and better grades.

Description of Online Materials:

The online course was broken down into 7 units and each unit was broken down into 3 to 6 lessons (one lesson is similar to one or two traditional lectures). Each lesson consisted of a list of objectives, readings, tutorial slides with audio and written notes, practice quizzes and a list of exercises. Any one component could be presented online or in hard copy for a traditional course. I suggest making the tutorials with audio, the written notes and the quizzes, available online for all traditionally taught students. Come by and see student's comments on these online materials as well as what percent of students prefer online learning.

Differences between online learning and traditional learning:

According to the students there are three major differences between taking a course face-to-face versus completely online: "the flexibility of the course", the ability to "replay the lectures over and over", and the "fear factor" is greatly reduced. Taking statistics online appears to lower the student's anxiety level. One student wrote, "And by the way, I just wanted to let you know how very frightened I was of taking statistics, but the way you organized the course made it interesting and enjoyable and I actually feel like I grasped most of the concepts and your teaching methods definitely reduced my anxiety and fear." Or as another student put it, "I cannot believe how much I have enjoyed a course I started off being terrified of!"

So why not take this positive feedback and apply it to a traditionally taught course?

Positive aspects of providing online materials in a traditional course:

1. Help students feel more relaxed, less rushed. Reduce fear of not catching all the materials. They now have a second chance to go over materials.
2. Online materials more informative, more course specific, more entertaining than textbook.
3. Easier to follow than many textbooks.
4. Students could study ahead and be better prepared for class. (yeah, right!)

Negative aspects and limitations:

1. Lots of extra work if do not already have online materials
2. Students skip class and just use online materials?
3. ?

I plan on providing online materials to a traditional class in the future and look at the use of the online materials, textbook, office hours, and other students, and how use relates to the fear factor.

Seeing the forest through the trees: Overarching principles to help struggling students

Julie Turchin
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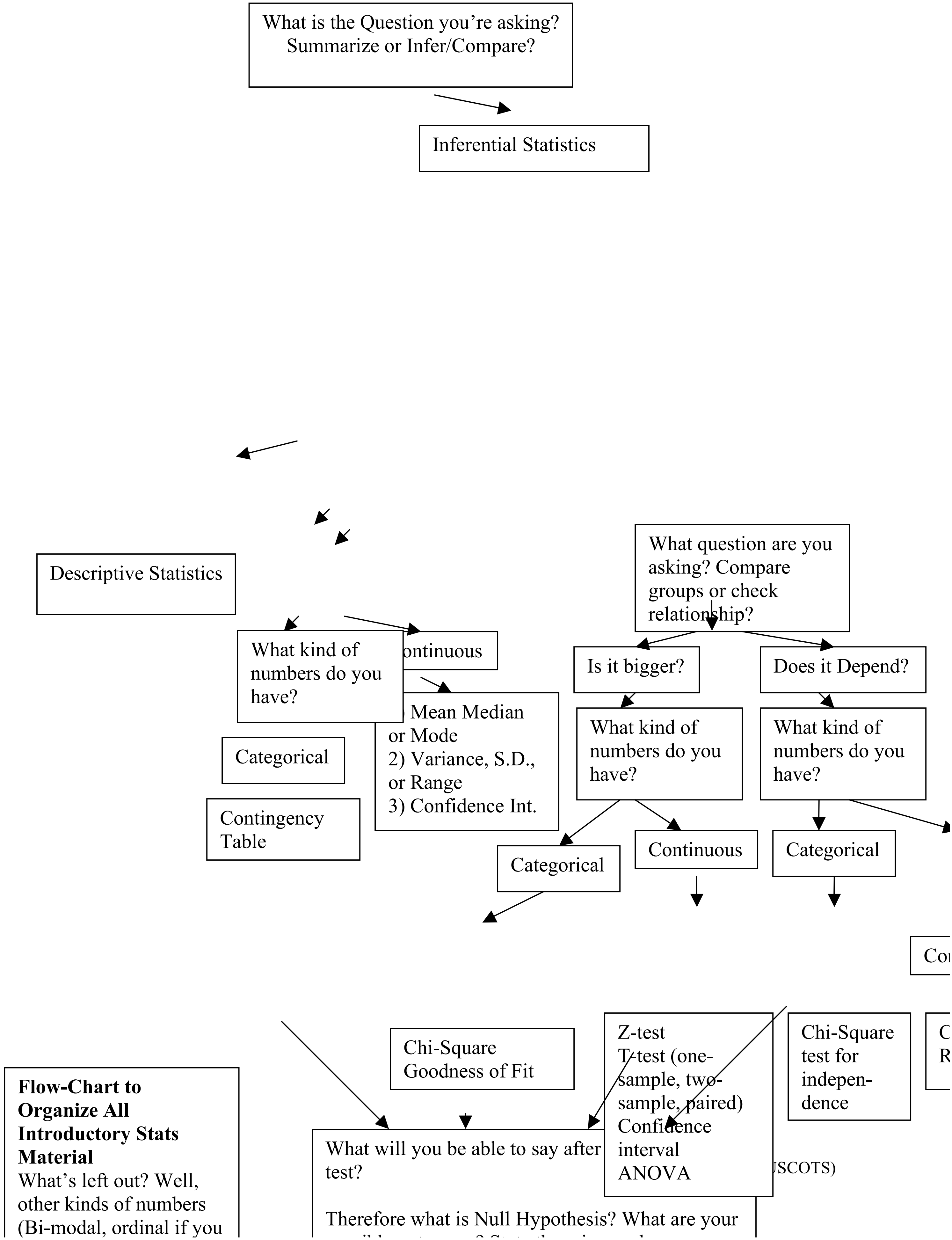
In my experience the most important thing is to encourage students to talk through the whole problem without using a single number or equation, so they can say, for example: "We want to know if group A is bigger (significantly bigger) than group B. The numbers are interval or continuous, and there are different people in each group (they're independent) so we're going to use a t-test for independent samples, and if we get a big number (positive or negative) for t (and therefore a small number for p) that will mean that it's very unlikely that we got such different means by chance, so we will reject the hypothesis that nothing's going on (the groups are the same) and instead say that group A is in fact bigger than group B".

The above sentence incorporates 90% of what they need to have mastered. There are two sections—the part where the student decides which test to use (organization) and the part where they describe what they're testing and why. The nice thing is, *what* they're testing and *why* is 99% the same for all tests, so once they get those concepts, each test, while it requires different inputs, should be clear in its output.

Topic:	They Learn:	I emphasize:	Catch Phrase
Null hypothesis	Start to search problem for Null hypothesis—often confuse Null and Alternative, or conclude opposite of what they've found	Figure out in words what you want to know first. Either one is really bigger than the other, or it's chance. Chance is the Null hypothesis.	"Nothing interesting is going on" or "What's the Boring option?"
Tests for categorical and continuous numbers	Lists of equations Students tackle each equation separately, and soon they are overwhelmed.	Make it clear that they are making the same steps, and coming to the same conclusions, for, say, a Chi-Square and a regression, just with different numbers.	"What kind of numbers are these?
All statistical tests	Lists of Equations	In introductory statistics, all inferential statistics we teach cover basically two questions: 1) Is there a mean difference between groups? 2) Are two variables related to each other?	"Is it Bigger? How much Bigger?" and "Are they related? Does it depend?"



What is the Question you're asking?
Summarize or Infer/Compare?
Inferential Statistics
Descriptive Statistics
What kind of numbers do you have?
ontinuous
) Mean Median or Mode
2) Variance, S.D., or Range
3) Confidence Int.
Categorical
Contingency Table
What question are you asking? Compare groups or check relationship?
Is it bigger?
Does it Depend?
What kind of numbers do you have?
What kind of numbers do you have?
Categorical
Continuous
Categorical
Co
Chi-Square Goodness of Fit
Z-test
T-test (one-sample, two-sample, paired)
Confidence interval
ANOVA
Chi-Square test for indepen-dence
C
R
USCOTS)
What will you be able to say after test?
Therefore what is Null Hypothesis? What are your
Flow-Chart to Organize All Introductory Stats Material
What's left out? Well, other kinds of numbers (Bi-modal, ordinal if you

Flat Earth Guide to Probability and Statistics

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We should include principles from mathematical modeling in the teaching of probability and statistics.

Example: Trajectory of a thrown ball.

Choices: (1) Parabola, (2) portion of a circle, (3) portion of an ellipse.

Parabola fits basic physics and the coefficients are easily related to g, v0 and x0. It also allows the calculation of max height, range and hang time. If our trajectories appear to be asymmetric, we can adjust the formula to allow for wind resistance.

Scope of the model: Can we apply the model in all cases? Not for objects with high v0 because they go into orbit.

What went wrong? We ignored the assumptions behind the parabola, mainly the assumption that the earth is flat. However, for many purposes, the earth is flat. We use maps instead of globes in our cars, for example.

George Box: "All models are wrong. Some models are useful."

Probability distributions are like the parabolic model for the trajectory. They are based on assumptions and must be reasonable models.

Statistics is based on probability models. What are the underlying probability models? Are these models reasonable? Do these models lead to useful conclusions about the original problem? If our probability model is flawed, how does this impact our conclusions?

Impact on teaching:

(1) Assumptions – it is not enough to state the assumptions behind a distribution. It is certainly not enough to say only that when these assumptions are not met, the distribution is not the correct one. The assumptions are never met, so we should not be doing probability at all? We should consider the extent to which the assumptions are met. We should also consider at least the direction of the effect on our results caused by failure to satisfy the assumptions.

(2) Estimation – The parabolic model depends on g, v0 and x0. These will have to be measured (estimated). What is the effect on our results of this estimation? What is easy to estimate and what is hard to estimate?

(3) Why did we do this? – The models – both probability and statistics – are constructed for a purpose. How does the model help answer the original problem?

Visualizing Bivariate-Normal Distributions

Daniel Wang
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Abstract

Graphs for one variable probability, density and distribution help students understand both of the concepts and applications. Students usually have difficulties to learn multivariate random variable due to unpopularity of multivariate graphs. Some issues of using bivariate graphs are discussed with examples of using Maple to graph bivariate normal distributions.

Unlike most of one-variable distributions, a graph of the probability density function of a bivariate-normal is not easy to construct. Students may have difficulties because of the lack of visual assistance and the geometric interpretation when studying multivariate distributions. However, as the advance of the computing technology, now making a bivariate graph is not as hard as it used to be. Based on a class project used for a mathematical statistics course for the past five yeas, giving such project helps students understand the bivariate-normal distributions better with the visual support.

The project does not require students to have experience in using the computer software, such as Maple, Matlab or MathCad. This is because most of these programs have included enough self-learning materials with sufficient examples. The instructors just need provide them with one even less than one class time period tutorial of the software. Then assign students into 3-5 student groups or have them grouped as their wish. Through the discussion among the students with the suggested group size, students can share their learning how to use the software and more importantly they can also share their learning about the concept and the nature of the distributions. The project is presented as the following:

Use Maple to construct 3D graphs for the joint pdf of X and Y with the following cases.

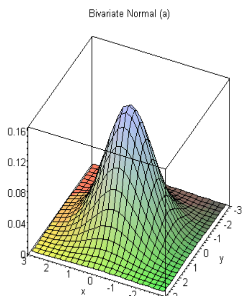
$$f(x,\, y) = \frac{e^{-\frac{1}{2(1-\rho^2)}\left[\left(\frac{x-\mu_1}{\sigma_1}\right)^2 - 2\rho\left(\frac{x-\mu_1}{\sigma_1}\right)\left(\frac{y-\mu_2}{\sigma_2}\right) + \left(\frac{y-\mu_2}{\sigma_2}\right)^2\right]}}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}}$$

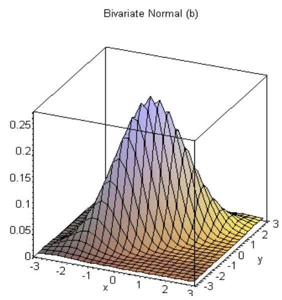
a. Graph $f(x,\, y)$ with $\mu_1 = \mu_2 = 0$, $\sigma_1 = \sigma_2 = 1$ and $\rho = 0$.
b. Graph $f(x,\, y)$ with $\mu_1 = \mu_2 = 0$, $\sigma_1 = \sigma_2 = 1$ and $\rho = 0.8$.
c. Graph $f(x,\, y)$ with $\mu_1 = 1$, $\mu_2 = 3$, $\sigma_1 = 2$, $\sigma_2 = 3$ and $\rho = -0.8$.
d. Graph $f^*(x,\, y)$ with $\mu_1 = \mu_2 = 0$, $\sigma_1 = \sigma_2 = 1$ and $\rho = 0$ where

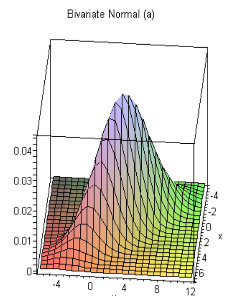
$$f^*(x,\, y) = \begin{cases} 2f(x,y) & \text{Inside square 2 and 4 of Figure 6.10} \\ 0 & \text{Inside square 1 and 3 of Figure 6.10} \\ f(x,y) & \text{Otherwise} \end{cases}$$

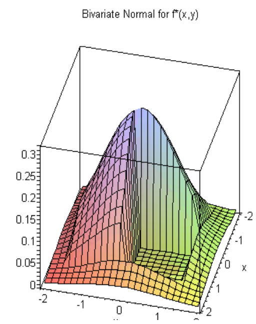
Show that the marginal distribution of X and marginal distribution of Y are both standard normal.

Part a. (see graph a.) shows a standard bivariate-normal pdf with no correlation between X and Y. Part b. (see graph b.) shows what will happen when correlation is added. Part c. (see graph c.) shows the bivariate-normal pdf with different means, different standard deviations for X and Y, as well as correlation between X an Y. Part d. (see graph c.) shows how two standard normal distributions are jointed as a non-bivariate-normal distribution from which students can understand well that if joint normal then the marginal distributions must be normal, but the reverse is not true. Such important fact is little hard to learn from the proof with the definition and calculus, but the graph especially made by themselves is easy to understand and to remember.









Most of the students who worked the project feel comfortable of using Maple even they never had any experience with the software. And very surprisingly, they can come up with the same results using different way to graph part d, which is a piecewise function. For them the first experience in writing such kind of function and graph it in a computer software they never used before makes them feel confident and creative. To me it is important that they learn something in a better way and more importantly they learn how to learn.

Statistics in Song

Sheila Weaver – University of Vermont

Stat 51: I Will Survive

accompaniment

At first I was afraid; I was petrified.
I just hadn't realized my data was skewed to one side.
And now I'd spent so many hours finding the mean and the SD,
But now I see, just how misleading they can be.

So now I'll go; walk out the door.
I'll get an F in here; I may not stay in college anymore.
I should have dropped this (stupid) class; I should have bought the answer key.
I should have thought for just one second, office hours were for me.

But no, I'll try, a new technique.
I'll rank the data, and the middle is the median I seek.
The middles of the halves are called the Quartiles 1 and 3,
Add the min and max – that's the five number summary.

Stat 51, I will survive
As long as I can pass this class, I know I'll be alive,
I've got all my life to live,
One semester's time to give:
I will survive, I will survive,
Hey, Hey....
-------------Dance Interlude----------------------
To put it in a graph, I'll draw a number line.
Make spacing even or interpretation's undermined.
Draw vertical lines at each number and connect the middle three,
And a boxplot will result to show the lack of symmetry.

And now I'll find the IQR.
It's Q3 minus Q1. If it's big, the data spreads out far.
If a number's more than 1.5 IQR from the box,
It gets a star, and you can call it an outlier.

And now I'm done. My summary,
Is more appropriate for data that is lacking symmetry
The mean and the SD may be affected by the skew.
But my way's strong: It's more robust and it's not wrong....

Stat 51, I will survive
As long as I can pass this class, I know I'll be alive,
I've got all my life to live,
One semester's time to give:
I will survive, I will survive,
Hey, Hey....
-------------More Dancing----------------------

Distribution 1 ***(sing to the tune of Revolution 1 by the Beatles)***
accompaniment

You say you've got a distribution
A bell, you know
We all want to know its name.

You draw the 2 points of inflection,
Both sides, you know,
It's where the curvature will change.

The middle's the mean and it's the median,
The area under the curve is exactly one.

And you know it's gotta be .... Normal ....
And you know it's gotta be .... A bell..... ..... Normal ......

You find the standard deviation
And on each side
One, two and three s from the mean.

One sd out falls at the inflection,
And sixty-eight
Percent of the area's in between

And within two sd's you can find ninety-five,
99.7% are within three.

And you know it's gotta be .... Normal ....
And you know it's gotta be .... A bell..... ..... Normal ......
---------Bridge--------------

A value on a distribution,
A bell, you know,
We all want to know its place.

The standard score gives its position
A Z, you know.
Just minus the mean and divide by S.

It's unusual if it's farther than 2 sd's,
If it's an outlier, you may want to count it out (in)

And you know it's gotta be .... Normal ....
And you know it's gotta be .... A bell.....

Ho (sing to the tune of Hey, Jude)
accompaniment

Ho, Assume you're true
Take some data; Compute a p-value
The number may be less than .05
Then we decide, Ha is better.

Ho, you're called the null.
The alternative, Ha, is not so dull.
It's greater, less than or unequal to,
We'll reject you, if Ha's better.

So find a t or find a z, and you will see
How many sd's Xbar is from mu.
Significance is found by p, the chance you'll see
Some data that's more extreme, assuming you.

Ho, we could be wrong.
False rejection's an error of Type I.
The error of false acceptance of you
Is called type II, sometimes it's better.

Before you test hypotheses, make sure you see,
Your sample is big, Your data's random, too.
And well you know that it's a fool, who'll use this tool,
And not check assumptions that must all be true.

Ho, Assume you're true
Take some data
Compute a p-value
The number may be less than .05
Then we decide, Ha is better.

Is Your Class In *Jeopardy!*?

Adam Weimer, The Ohio State University

Abstract:
Occasionally a change of pace in the classroom is nice. The use of pop culture trivia shows is ideal for this purpose. Using Jeopardy in the classroom is not a novel idea. The idea here is to make it realistic, adaptable, easy to use, and readily available to other instructors.

Discussion:
The format of Jeopardy! has been used in classrooms for a long time. The first encounter I had with the game was in a 7^{th} grade algebra class. I remember immediately being intrigued because it was something different. However, I was not the only one whose interest was piqued. Many of my fellow classmates were interested in playing, even several students that had shown no interest in the class before. A couple of years ago while trying to think of something different to do with my class, I recalled this memory. This was to be the birth of Statistics Jeopardy!

There have been many iterations of the game over the past few years. The first game utilized little more than a dry erase board and some index cards. I immediately found that not only did the students have fun, but I did as well. The only problem at this point was that it was a bit cumbersome from my perspective, and not visually interesting. Having some experience building web sites, I knew both of these problems could be fixed by making the game into a webpage. One-hundred seventy-three web pages later I had what I was looking for.

For me, the second time around was even more exciting than the first. This was probably the result of many hours spent in front of the computer. As soon as the students saw the game board on the projector, they got as excited as well. I couldn't discern whether the students' reaction was a result of my own enthusiasm to try out the new edition, or if it was due to the new graphics that added a touch or realism. Nonetheless, the day went off without a hitch. Some students even went so far as to thank me, saying that had a great time and actually learned a thing or two along the way. This made it more than worth the while.

After playing the second version of Statistics Jeopardy! with the class, I was approached by a couple other teaching assistants asking to get a copy. After they used it in their own classrooms, one of the first questions they asked was; how can questions be added or changed? I knew that for other instructors to be able to tailor the game for their own classrooms, and to make it easier to use, Statistics Jeopardy! was going to have to evolve once more.

Intent on making Statistics Jeopardy adaptable and easy to use, I turned to PowerPoint. The main advantage in using PowerPoint over the web based version is that it is very easy to change questions and categories to suit one's own needs. This helped to solve the issue of adaptability. In addition, only one file is needed for the PowerPoint version, whereas the web based version required one hundred seventy three. This makes it much more manageable and more easily transferred to other people for their own personal use. Finally, the PowerPoint version is the most visually interesting adaptation of Statistics Jeopardy! to date. The effect is a much more realistic game.

Future Improvements:

One of the goals in working on this project has always been to make Statistics Jeopardy! adaptable to different situations while keeping it readily accessible. In the future, I envision creating a database of different categories, clues, and questions, so that when an instructor wants to use it, they need only select the topics they'd like to cover. Then, their own personalized version of Statistics Jeopardy! will be generated for them. I believe that for this to happen, a web site linked to this database will need to be created. Then instructors will have a list of categories, questions, and answers to choose from, as well as the option of adding their own. After inputting and submitting this information, a PowerPoint presentation could be generated and downloaded.

Example of a Typical Game:

1. Open the file STATISTICS JEOPARDY!.ppt
2. Click Slide Show > View Show
3. Begin the game with "Hello everyone and welcome to Statistics Jeopardy! Here we go, round one. Subjects will appear on the board in these categories."
4. Click the mouse to advance to the categories.
5. Read the categories. (Slides are spaced equally in three second intervals so you do not need to click the mouse at this point.)
6. Choose a team to go first and let them pick a category and dollar amount.
7. Select the chosen dollar amount with the mouse.
8. Read the answer.
9. If a team phrases the correct question, tally their score in whatever way you prefer. If wrong, deduct the points.
10. Click on the home button in the lower right corner to return to the board. The selected question will be invisible on the board when you return.
11. Continue in the manner until no questions are left.
12. Final Jeopardy will appear. (If a second round in desired, one can be added easily.)
13. The game ends and a winner is declared.

Notes:

a. If after an answer/question sequence, if it becomes clear that student's are not comfortable with the material, pause and discuss the topic. The whole point of the game is so that students have fun while learning.
b. Sometimes it's nice to give a reward for correct answers or to the winning team.
c. Occasionally, one student may begin to dominate the game. It may become necessary to ask that student to refrain from answering for a few minutes.

Adding Your Own Categories/Questions:

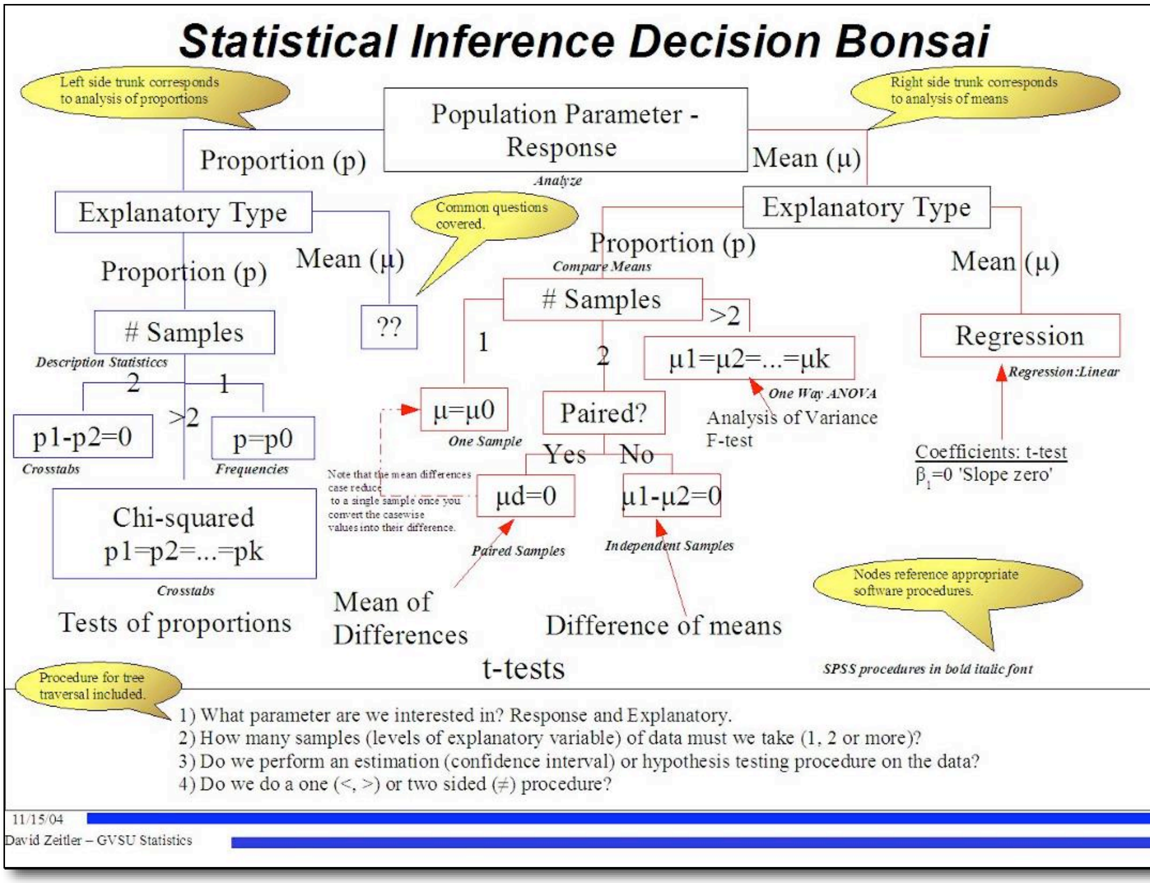
1. Open the file STATISTICS JEOPARDY!.ppt
2. Select the category/question slide you would like to change.
3. Double click on the text. A test box will appear.
4. Edit the text.

Contact Information:

If you'd like a copy of Statistics Jeopardy! email me at weimer.44@osu.edu.

Decision Bonsai Provide Students a Glimpse of Structure

Many of us recall the flash of insight when we began to see the structure behind the forest of equations and parameters that our first statistics course often seemed to be. With a little pruning, this forest can become a Decision Bonsai, providing students a first critical glimpse of structure.

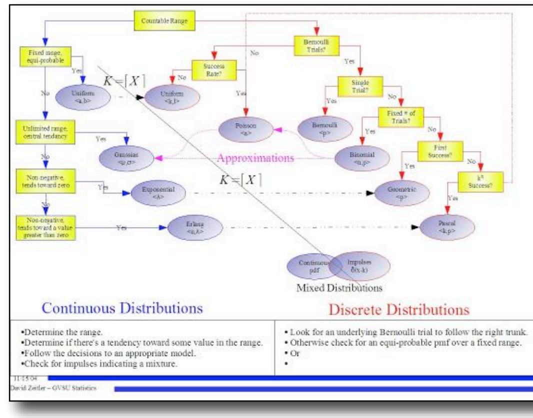


Attempting to help students in an introductory statistics course sort through the sea of equations and statistical software procedures lead naturally to the idea of developing a decision tree to aide them. Initial attempts at the decision tree resulted in a decision bush! The complexity was far too great to be of any use. Pruning of the bush was clearly called for and the idea of the Japanese art of Bonsai came to mind.

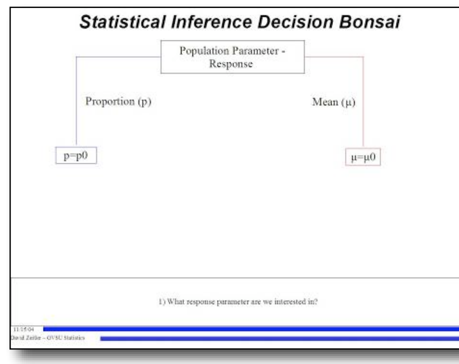
Like the Bonsai tree which is carefully pruned as it grows, we can grow an image of the structure and process of statistical inference in the student's minds. The full grown decision bonsai is a mixture of decision tree and concept map, providing both a view of conceptual relationships and at the same time a decision structure which the student can use to arrive at an appropriate inference procedure.

Major trunks of the tree correspond to major concepts with branching occurring at points where the student needs to make decisions about classes of inference procedures.

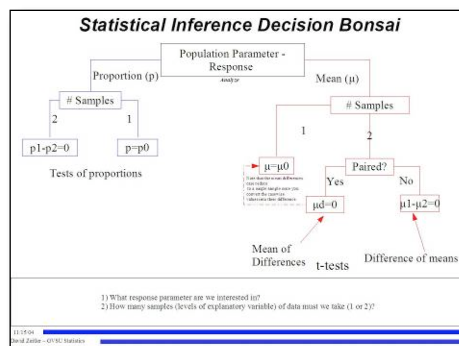
A similar approach illustrated to the right uses more concept map characteristics to illustrate probability models, including model relationships and approximation paths.



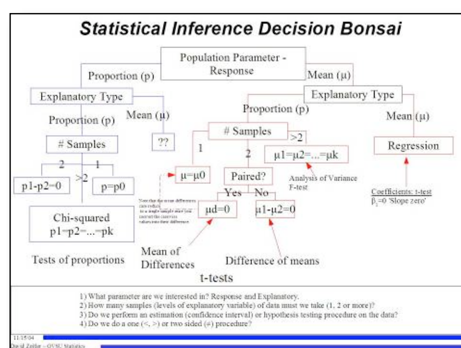
Both of these full grown diagrams are initially too complex for a student (or instructor☺) to grasp in one glance. As the instructor develops the Decision Bonsai, it grows in a fashion similar to the Bonsai tree. Growth is carefully kept in check to bring out the intended structure of the tree. An early mistake was to present the full Bonsai without allowing it to grow with the students understanding. Later use grows the tree gradually on the whiteboard with the final tree provided in PDF format only after it has been drawn and discussed on the board and in notes.



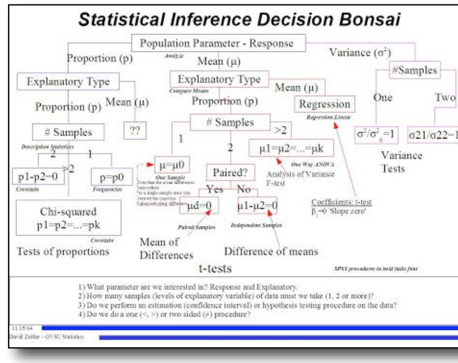
An example of this growth process is illustrated in the sequence at the right. The tree starts from a simple bifurcation between single parameter proportions and means testing. The second tree has grown, both in the two trunks by adding examination of the number of samples of interest and correspondingly in the minor branches and leaves which represents the original single parameter inference as well as now two parameter inference.



Growth continues at a pace determined by the students grasping of the concepts and can progress breadth first as shown or depth first. In depth first, the proportions trunk might be fully grown before budding out the means trunk of the tree. The third illustrated tree is the full tree used for an introductory statistics course, including multi-parameter inference in proportions and means.



A final illustration shows the budding growth of a third major trunk along the right side of the tree which begins to address inference on variance along side that of proportions and means. This last tree is used in a quality methods course which has the introductory course as a prerequisite.



Conclusions:

- Decision Bonsai provide a useful tool for developing, articulating and retaining structural relationships in statistical concepts and procedures.
- The complexity of the Bonsai is controlled, but best understood through the analogies of the process of growth.
- Growth and structure of the tree can easily be tailored to course objectives and planning.
- Like true Bonsai, the Decision Bonsai is a living thing, growing and changing continually over time with proper care of the instructor.
- While not replacing standard tabular representations of formulas, the Decision Bonsai provides a critical means for many students to understand and remember the reasoning behind choices from the sea of formulas and statistical software procedures necessarily presented to them in an introductory statistics course.

Contact Information:

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Decision Bonsai web resources:
http://faculty.gvsu.edu/zeitlerd/DecisionBonsai
-- *And Bonsai web resources thanks to Google of course!*
Introduction to Bonsai - http://www.bonsaisite.com/
A Bonsai Primer - http://www.bonsaiprimer.com/
A little fun with Bonsai - http://www.bonsaipotato.com/