Teaching Bits: A Resource for Teachers of Statistics

From the Literature on Teaching and Learning Statistics

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Research and Resources on Teaching and Learning Statistics

"Curriculum Guidelines for Undergraduate Programs in Statistical Science"

American Statistical Association (2000).
http://ww2.amstat.org/education/Curriculum_Guidelines.html

Part of the mission of the American Statistical Association Undergraduate Statistics Education Initiative (USEI) included the establishment of Curriculum Guidelines for Undergraduate Programs in Statistical Science. This document provides guidelines for development of curricula for undergraduate majors, minors, and concentrations in statistical science, and includes information on principles, skills, and curriculum topics (statistical, mathematical, computational, probability, computational, and other skills).

"The Best of Teaching Statistics"

Originally published by The Teaching Statistics Trust (1986).
http://science.ntu.ac.uk/rsscse/TS/bts/contents.html

This anthology of the best articles published in the journal, Teaching Statistics, was originally published in 1986. It has been out of print for several years. Over the next few months the journal will be publishing some of the articles online for use by teachers. You are free to download them and make use of them in your teaching. Topics included in this online resource include: Statistics in the Classroom, Practical and Project Work, Pupils' Understanding, Teaching Particular Topics, Visual and Other Aids,
"Manipulatives: One Piece of the Puzzle"

Mary Kay Stein and Jane Bovalino (2001), *Mathematics Teaching in the Middle School*, 6(6).

While this article is written in the context of a mathematics lesson at the middle school level, its message is important and applicable to any instructor who uses hands-on activities in their statistics classrooms, K-12 and beyond.

**Abbreviated abstract:** Getting students to think about mathematics in ways that go beyond using procedures to solve routine problems is an important goal of mathematics reform. Increasing numbers of teachers are becoming eager to create hands-on activities, and manipulatives (such as pattern blocks, tiles, and cubes) can be important tools in helping students to think and reason in more meaningful ways. Simply using manipulatives, however, does not guarantee a good lesson. In this article, we identify factors that are present when teachers create strong, mathematically sound lessons using manipulatives, then paint a portrait of a successful lesson and how those factors influenced it.

"Making Sense of Graphs: Critical Factors Influencing Comprehension and Instructional Implications"

Susan Friel, Frances Curcio, and George Bright (2001), *Journal for Research in Mathematics Education* [Online], 32(2). [http://www.nctm.org/jrme/issues/2001/03/124-158.html](http://www.nctm.org/jrme/issues/2001/03/124-158.html)

This article provides a very comprehensive look at the theory behind student learning about statistical graphs. It also contains a very nice bibliography.

**Abstract:** Our purpose is to bring together perspectives concerning the processing and use of statistical graphs to identify critical factors that appear to influence graph comprehension and to suggest instructional implications. After providing a synthesis of information about the nature and structure of graphs, we define graph comprehension. We consider 4 critical factors that appear to affect graph comprehension: the purposes for using graphs, task characteristics, discipline characteristics, and reader characteristics. A construct called graph sense is defined. A sequence for ordering the introduction of graphs is proposed. We conclude with a discussion of issues involved in making sense of quantitative information using graphs and ways instruction may be modified to promote such sense making.

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**Teaching Ideas and Applications**

"Dinosaurs, Dinosaur Eggs, and Probability"
This article offers an activity that employs simulation (both by hand and using a programmable calculator) and the concept of distribution to address a research problem that has come up recently in the area of paleontology: nesting behavior of dinosaurs. Researchers in Montana recently discovered a nest of twenty-two Troodon eggs. The placement of the eggs within the nest appears to have some sort of pattern. The question: was the placement of the eggs the result of purposeful behavior, or just a random event?

"Big Box-Office Bucks"

Robert A. Powers (2001), *Mathematics Teacher*, 94(2), 112-118.

Students can examine trends within the motion-picture business by exploring data from the hit movies of 1998. Ideas for data analysis go from simple tables and charts to trying to fit a non-linear model predicting earnings based on number of weeks in the top ten, or earnings over time (students discover the graph exhibits exponential decay characteristics). A nice worksheet for students is provided.

"Connecting Independence and the Chi-Square Statistic"

Wes White (2001), *Mathematics Teacher*, 94(2), 134-136.

An example of how one AP Statistics teacher presents and leads a class discussion to help students discover the concept of independence as it relates to a two-way table and the chi-square statistic. The example the author provides is a basketball team's performance at home vs. away.

"Exploring the Birthday Paradox Using a Monte Carlo Simulation and Graphing Calculators"

Matthew Whitney (2001), *Mathematics Teacher*, 94(4), 258-264.

This article describes an activity using the TI-83 graphing calculator to explore the birthday problem. The TI-83 the random-integer generator is used, with the proper commands, to create lists of random birthdays that can serve as data for students to explore. Students can then run simulations to discover that more than 50% of the time, when groups of "random" strangers are assembled, only twenty-three persons are needed to find a matching pair of birthdays. This activity would be especially useful for small classes, where instructors may be reluctant to try the birthday problem on their class for fear that it won't pan out.

"Points on the Path to Probability"

James Kiernan (2001), *Mathematics Teacher*, 94(3), 180-183.
To quote from this author: "Many students are under the misapprehension that all mathematical knowledge is the result of some single brilliant idea rather than a cumulative process of successes and failures." This article presents a historical examination of the "problem of points" along with an examination of the various attempts to solve the problem, giving students insight into the nature of mathematical discovery. The problem of points was originally defined by Luca Pacioloi as the following: "A team plays ball in such a way that a total of 60 points is required to win the game, and each goal counts 10 points... By some incident they cannot finish the game and one side has 50 points and the other 30. What share of the prize money belongs to each side?"

"Using Attribute Blocks to Develop a Conceptual Understanding of Probability"

Robert Quinn (2001), *Mathematics Teaching in the Middle School*, 6(5).

Abstract: Activities using attribute blocks can help middle school students construct knowledge about, and develop conceptual understanding of, probability.

"Statistics Fever"

Linda Russo and Marian Passannante (2001), *Mathematics Teaching in the Middle School*, 6(6).

Abstract: Students learn to use statistics to determine factors related to their health.

"The Possibility of Perfection"

Leonard Masse (2001), *Mathematics Teaching in the Middle School*, 6(9).

Abstract: Draws on recent events in Major League Baseball to illustrate the relationship between experimental and theoretical probability.

"Graph Explorer"

Alan Cooper (2001), *Journal of Online Mathematics and its Applications* [Online], 1(1). [http://www.joma.org/more/coopermore.html?content_id=12848](http://www.joma.org/more/coopermore.html?content_id=12848)

This activity appears in the first issue of the new journal, Journal of Online Mathematics and its Applications (JOMA). This journal takes advantage of technology in its format, including links to items such as JAVA Applets, of which this activity is one example.

Abstract: This applet draws graphs of user-defined functions. It can handle multiple polynomial, exponential, logarithmic, and trigonometric functions (including inverse trigonometric functions). All graphs can be panned, zoomed and recentered. There is also a detailed introduction to using the applet, and a version of the applet with the instructions in a separate frame, as well as a help file, list of
"The Average Speed on the Highway"
Larry Clevenson, Mark Schilling, Ann Watkins, and William Watkins, (2001), The College Mathematics Journal, May, 2001.

Abstract: You are driving on the highway and adjust your speed until the number of cars that you pass is equal to the number of cars that pass you. So your speed is the median speed, right? Wrong!

"Dotplots and Stemplots in Excel"
Neville Hunt (2001), Teaching Statistics, 23(1), 2-3.

The controversy over the place of spreadsheets in the statistics classroom continues! In this article, the author disputes criticisms of MS Excel's ineptness at exploratory data analysis, and demonstrates how to make dotplots and stemplots using MS Excel 97.

"Exploring a Queuing Problem Through Human Simulation"
Peter Barbella and Murray Siegel (2001), Teaching Statistics, 23(1), 4-7.

This article describes a simulation activity involving a real-world problem that offers opportunities for open-ended solution methods. The problem is to determine which of two types of lines (or queues) is better for customers waiting for service by a bank teller. Generating and analyzing data is the object of this activity.

"Generating Multivariate Normal Pseudo Random Data"
Terry Moore (2001), Teaching Statistics, 23(1), 8-10.

The author presents a method that uses Microsoft Excel arrays to generate data from a multivariate Normal distribution more easily than traditional methods, avoiding the difficulty of finding the conditional distributions when the number of variables is greater than three. His method involves generating independent Normal variables and then applying a linear transformation. The process involves using a Choleski Decomposition, which he has written a program in Visual Basic (provided) to accomplish.

"Learning About the Normal Distribution With a Graphics Calculator"
To what extent should we allow students to use calculators (particularly graphics calculators) to learn and/or practice statistical concepts? This article describes ways in which a graphics calculator can be used to practice statistics, and compares these methods to the traditional methods that do not use a graphics calculator.

"A New Least-Squares Regression Model"

Chris du Feu (2001), Teaching Statistics, 23(1), 17-19.

When finding the estimators for the slope and intercept of a simple linear regression line, the typical thing to do is use the mathematical approach. But can we do better than that, or supplement that with an intuitive explanation that students can discover in a hands-on way? This article provides a practical demonstration that intuitively illustrates these formulas and ideas. Materials needed include fiberboard, a compass, a scatter plot, elastic bands, a rod, and some pins.

"Ups and Downs on the Roads"

Sidney Tyrrell (2001), Teaching Statistics, 23(1), 20-21.

The road casualty figures for successive years supplied by the Dept of Environment, Transport, and the Regions (Great Britain) are described by the author as "a set of grisly but interesting data". This article discusses a number of ways that this data can be explored, examining charts, time series, and correlation issues.

"The Toothless Bathing Beauty and the t-test"

Marie Revak and David Porter (2001), Teaching Statistics, 23(1), 22-23.

The authors describe a simple experiment comparing the effect of visual imagery and word repetition on memory involving a series of twenty "silly sentences" and questions related to those sentences. The exercise is used to introduce two sample t-tests.

"How Many Excellent Grades Should be Tolerated?"

Henrik Dahl (2001), Teaching Statistics, 23(1), pp. 24-25.

The author gives an interesting scenario for students to study hypothesis testing. Students are placed in the shoes of a Norwegian schoolteacher, who wonders how many "excellent" grades (defined as being in the top 4% of the population) can be given out before he/she is suspected of being soft. (The teacher's class size is 25.)
"Investigating Randomness via Simulation Using the TI-83"

Roger Johnson (2001), *Teaching Statistics*, 23(1), 27-31.

The author's premise is that some probability topics should not be eliminated from the statistics syllabus: investigations into random phenomena via simulation; discussion of binomial coefficients, what they count, and their applications; and computation of the probabilities of false-positives and false-negatives in drug/disease testing without using two-way tables.) The author demonstrates how these topics can be at least informally addressed using the Monty Hall Problem, Runs in Coin-flipping, Long Leads and Crossings in Coin-flipping, and the Birthday Problem.

"Using Technology to Reinforce Data Display and Analysis"

Vicky Jackson and J.D. Smith (2001), *The Statistics Teacher Network*, 56, 6-7.

In a seven-day unit introducing the field of statistics, seventh grade middle school students research peer opinions to generate, organize, analyze and display data. Student learning is enhanced through the implementation of technology (MS Excel, MS Word). The authors describe which each day of this curriculum involves. A handout for making bar graphs and circle graphs using MS Excel, and for importing them into MS Word is included.

"Sequencing Topics in Introductory Statistics: A Debate on What to Teach When"

Beth Chance and Alan Rossman (2001), *The American Statistician*, 55(2), 140-144.

The authors discuss and debate their perspectives of what to teach when on the introductory statistics syllabus. Some of the issues for debate include: Descriptive statistics for bivariate data-should it come immediately after univariate data?; Inference - should we cover means or proportions first?; and the ultimate question, "Which comes first, the confidence interval or the hypothesis test?"

"Sex, Drugs, and Rock & Roll Survey in a First-Year Service Course in Statistics"

W.M. Boldtad, Lyn Hunt, and Judith McWhirter (2001), *The American Statistician*, 55(2), 145-149.

These three "hot" topics are used to motivate the learning of statistical thinking in a first-year Introduction to Statistical Methods course. The authors have designed a class survey that uses randomized responses, and gives students a concrete situation where randomization removes the motivation to give false answers to sensitive questions. Privacy issues, and survey protocol are discussed, as well as data analysis.
"Visualizing the Median as the Minimum-Deviation Location"

James Hanley, Lawrence Joseph, Robert Platt, Moo Chung, and Patrick Belisle (2001), *The American Statistician*, 55(2), 150-152.

There are three elevators available, unequally spaced along a wall. Where is the optimal place to stand? The minimal average distance to an elevator is in fact achieved by standing at the median. How do we bring students to really understand this property of the median? The authors use a Java Applet that can help.

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**Reviews**

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**Software Review: *Fathom Dynamic Statistics Software***

Ruth Carver (2001), *The Statistics Teacher Network*, 56, 1-4.

Carver gives a favorable review of this in-class statistics teaching software package, and gives examples of how she has used it in her AP Statistics class to move beyond what she could do before with graphing calculators.

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