# Teaching Bits: A Resource for Teachers of Statistics

*Journal of Statistics Education* v.7, n.2 (1999)

Robert C. delMas
General College
University of Minnesota
354 Appleby Hall
Minneapolis, MN 55455
612-625-2076

*delma001@maroon.tc.umn.edu*

William P. Peterson
Department of Mathematics and Computer Science
Middlebury College
Middlebury, VT 05753-6145
802-443-5417

*wpeterson@middlebury.edu*

This column features "bits" of information sampled from a variety of sources that may be of interest to teachers of statistics. Bob abstracts information from the literature on teaching and learning statistics, while Bill summarizes articles from the news and other media that may be used with students to provoke discussions or serve as a basis for classroom activities or student projects. Bill's contributions are derived from Chance News (http://www.dartmouth.edu/~chance/chance_news/news.html). Like Chance News, Bill's contributions are freely redistributable under the terms of the GNU General Public License (http://gnu.via.ecp.fr/copyleft/gpl.html), as published by the Free Software Foundation. We realize that due to limitations in the literature we have access to and time to review, we may overlook some potential articles for this column, and therefore encourage you to send us your reviews and suggestions for abstracts.

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# From the Literature on Teaching and Learning Statistics

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## "Exploring the Birthday Problem with Spreadsheets"

by Lawrence M. Lesser (1999). *The Mathematics Teacher*, 92(5), 407-411.

The author describes a teaching method where students can explore the birthday problem without having to engage in tedious probability computations with a calculator. In the birthday problem, students must determine the minimum number of people needed (in a room, at a party) to make the probability at least 50 percent that at least two of the people share a common birthday, ignoring the year and not including leap year days. A recursive method that involves point-and-click tabular representation in a spreadsheet is described that makes the process manageable for students. Using the spreadsheet approach also helps students to visualize the recursion process by watching the probability grow in the spreadsheet cells or through a graphic representation.

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# "Assessment and Statistics Education: Current Challenges and Directions"

by Joan B. Garfield and Iddo Gal (1999). *International Statistical Review*, 67(1), 1-12.

Abstract: The interaction between new curricular goals for students and alternative methods of assessing student learning is described. Suggestions are offered for teachers of statistics who wish to re-examine their classroom assessment practices in light of these changes. Examples are offered of some innovative assessment approaches that have been used in introductory statistics courses, and current challenges to statistics educators are described.

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# Stats: The Magazine for Students of Statistics
# Spring 1999, Number 25

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## "Making the Grade -- Again
## AP Statistics, 1998"

by Richard L. Schaeffer, 3-5.

In this update to the current status of the Advanced Placement (AP) Statistics examination, the author makes comparisons between the 1997 and 1998 administrations with respect to the number of examinations and the nature of the examination items. Special attention is given to the multiple-choice items which were perceived as much easier than the open-response items in 1997, and a special commentary on the grading of the open-response items is offered.

## "Sampling and the Census 2000"

by Lynne Billard, 6-11.

This is a very readable article that can make many aspects and issues of the Census 2000 accessible to students. The author presents a short historical perspective on the Census, exploring changes that have occurred up through the present Census. A large part of the article explores issues of sampling, different types of sampling, and how they relate to the issue of the undercount. Appendixes are included that discuss simple random sampling and undercount calculations.

## "On the Job: A Day in the Life of a Statistician at the National Cancer Institute"

by Kathleen Cronin, 12-13.

The author describes how her graduate education and postdoctoral experience led her to a government position with the National Cancer Institute (NCI). She goes on to describe a typical work day and the types of projects she is involved in at NCI (simulating the impact of mammography on breast cancer incidence; quantifying behavioral changes related to diet in the general population).

## "Ask Dr. STATS"

by Jerome P. Keating and David W. Scott, 16-22.

Abstract: Questions about graphing data are frequently asked throughout courses in Statistics. The most basic questions deal with "how to" form density estimates. Our students often inquire about how the smooth density estimates are constructed in certain articles and want to know how to produce such smooth graphs. In this article, we review a fundamental approach in density estimation and illustrate the procedure on the lengths of home runs hit by Sammy Sosa and Mark McGwire in the Great Home Run Race of '98.

### "Outlier...s"

by Allan J. Rossman, 28-29.

If you want to provide the more entertaining side of statistics to your students, have them read this column. The author poses many "assignments" for students that ask them to use real world knowledge and their intuition to match statistics to entities such as newspaper editorials, text selections from his favorite authors, and Scrabble points for the names of famous statisticians.

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## The American Statistician: Teacher's Corner

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### "The Ruin Problem via Electric Networks"

by José Luis Palacios (1999). *The American Statistician*, 53(1), 67-70.

Abstract: Using the electric network approach, we give a closed-form formula for the solution of the ruin problem in the case that the probabilities of winning a particular game depend on the amount of the current fortune.

### "Necessary and Sufficient Condition for Nonsingular Fisher Information Matrix in ARMA and Fractional ARIMA Models"

by A. Ian Mcleod (1999). *The American Statistician*, 53(1), 71-72.

Abstract: It is demonstrated that a necessary and sufficient condition for the Fisher information matrix of a causal and invertible ARMA to be nonsingular is that the model not be redundant; that is, the autoregressive and moving-average polynomials have no roots in common. This result is also extended to fractional ARIMA models.

### "One-Factor-at-a-Time Versus Designed Experiments"

by Veronica Czitrom (1999). *The American Statistician*, 53(2), 126-131.

Abstract: Many engineers and scientists perform one-factor-at-a-time (OFAT) experiments. They will continue to do so until they understand the advantages of designed experiments over OFAT experiments, and until they learn to recognize OFAT experiments so they can avoid them. A very effective way to illustrate the advantages of designed experiments, and to show ways in which OFAT experiments present themselves in real life, is to introduce real examples of OFAT experiments and then demonstrate why a designed experiment would have been better. Three engineering examples of OFAT experiments are presented, as well as designed experiments that would have been better. The three examples have been successfully used in an industrial workshop and can also be used in academic courses.

### "Community Service Statistics Projects"

by Jon E. Anderson and Engin A. Sungur (1999). *The American Statistician*, 53(2), 132-136.

Abstract: Statistics instructors know that interesting, real-world problems are crucial to motivate student learning. As an extension of our efforts to build student interest and ownership in applications, we recently incorporated service learning into our statistics courses. Service learning provides an active-learning experience associated with a community service application. In this article we describe our experiences using service learning in our statistics courses. We give examples of projects used at the University of Minnesota-Morris, a public, liberal arts college.

### "Three Tools for Interactively Visualizing Some Distribution Theory Concepts"

by Peter K. Dunn (1999). *The American Statistician*, 53(2), 137-139.

Abstract: In this article, three Matlab functions are introduced to help students visualize some concepts in distribution theory. The functions allow the students to experiment with the parameters and views to see the effects immediately. The three tools cover the area of the central limit theorem, the normal approximation to the binomial, and the bivariate normal distribution. Some notes on using the programs in the classroom are also given.

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## Teaching Statistics

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A regular component of the Teaching Bits Department is a list of articles from *Teaching Statistics*, an international journal based in England. Brief summaries of the articles are included. In addition to these articles, *Teaching Statistics* features several regular departments that may be of interest, including Computing Corner, Curriculum Matters, Data Bank, Historical Perspective, Practical Activities, Problem Page, Project Parade, Research Report, Book Reviews, and News and Notes.

The Circulation Manager of *Teaching Statistics* is Peter Holmes, Peter.Holmes@ntu.ac.uk, RSS Centre for Statistical Education, University of Nottingham, Nottingham NG7 2RD, England. *Teaching Statistics* has a website at http://www.maths.nott.ac.uk/rsscse/TS/.

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## Teaching Statistics, Summer 1999
## Volume 21, Number 2

**"The BioSS Challenge -- A Demonstration of Sampling Bias"** by Trevor S. Smart, 36-38.

A sampling problem is described which was given to the general public as part of the Macaulay Land Use Research Institute's Open Day to illustrate the problems of bias and the need for randomization when sampling. The task is a variation on the random rectangles exercise with which many readers may have familiarity. The simulation involves the random placement of clover patches in a field, and participants must select a sample of eight to estimate the average area of a patch. The distribution of patch sizes has a marked positive skew so that small patches are much more prevalent the larger ones. Results demonstrate that the participants' mean estimates were positively biased when compared to the true population mean and mean estimates based on simple random samples.

**"Who's the Winner? An Exercise in Measurement"** by Kathleen M. Shannon and William S. Weber, 42-45.

The authors describe an activity designed to sensitize students to the idea that the measurement of an object, such as the distance between two points, is not always uniquely defined. Students are asked to list, from memory, the

ten largest U.S. states in order from largest to smallest by land area. The student who comes closest to the correct answer wins a prize. The main task for the students is to determine a method for deciding the winner. Students typically generate several methods. Discussion of the pros and cons for each method helps to demonstrate that a measurement method is not always uniquely defined for a situation, and careful consideration of drawbacks is needed to make a good choice.

**"The Graphics Calculator as a Teaching Aid in Statistics"** by Gillian Iossif, 45-48.

The author presents some imaginative ways to use a graphics calculator to aid students' understanding of how to collect data, measure variability, and make data comparisons. In each of these areas the graphics calculator is used to teach statistics in an interesting way, promote understanding, make use of real data, and make some aspects of statistics less tedious.

**"Where do You Stand? Notions of the Statistical Centre"** by James A. Hanley and Abby Lippman, 49-51.

The authors describe a simple thought experiment they call "The Elevator Problem" which is used to illustrate to students the decision-theoretic properties of various centrality measures.

**"Overlap Probabilities and Delay Detonators"** by Neil T. Diamond, 52-53.

Summary: A problem in mining engineering concerning detonators for rock blasting is considered. Simple probability calculations give very useful information about the detonation sequence.

**"The 'Ys' and 'Why Nots' of Line of Best Fit"** by Larry Lesser, 54-55.

The author offers suggested responses to students' questions about why we minimize the squared deviations to find the line of best fit instead of other measures such as the perpendicular deviations, vertical deviations, or absolute deviations. The suggested responses are not calculus based and are intended to offer heuristically motivated explanations that should be accessible to a variety of students.

**"Rendezvous of the Poisson and Exponential Distributions at the World Cup of Soccer"** by Singfat Chu-Chu-Lin, 60-62.

The author provides time-series data for goal occurrences from the 1998 World Cup of Soccer tournament and discusses how the measurements can be used to illustrate characteristics of Poisson and exponential distributions.

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# Topics for Discussion from Current Newspapers and Journals

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## "Getting the Goat"

*The Economist*, 20 February 1999, p. 72.

This article was motivated by a recent scare in Britain over the safety of genetically modified foods. But its theme is really the difficulty that people have more generally when evaluating risks. It focuses on three classic examples of the counterintuitive nature of probabilities: the birthday problem, the Monty Hall problem, and the false-positive problem.

The version of the birthday problem presented here asks for the chance that in a group of 25 randomly selected people, two or more will have the same birthday (correct answer: about 0.57). One respondent at *The Economist*

reportedly said: "I know this. It's much bigger than you think. One in four."

We will assume that everyone by now knows the statement of the Monty Hall problem. Here is *The Economist*'s explanation for why it makes sense to switch doors when Monty offers. "The point is, your chance of winning the car was one in three to begin with -- and after Monty reveals a goat, the probability that your box has the car is still just one in three. Because Monty's choice was not random (he didn't open just any box, he revealed a goat) the remaining probability of two-thirds gets squeezed, as it were, into the third box." But, noting that "discussions of this point sometimes prove violent," the article provides a tree diagram at the bottom of the page.

Finally, here is the article's statement of the false-positive puzzle. "You are given the following information. (a) In random testing, you test positive for a disease. (b) In 5% of cases, this test shows positive even when the subject does not have the disease. (c) In the population at large, one person in 1000 has the disease. What is the probability that you have the disease?" The article states that most people answer 95%, when the answer is really 2%. The article explains that in a population of 1000 people, one will really have the disease, but another 50 will also test positive.

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# "Bottom Line: Is It Good for You? Or Bad?"

by Monika Guttman, *USA Weekend*, 26-28 February 1999, pp. 8-9.

How is the public to deal with the many conflicting health claims that appear in the media? (A sidebar to this article is entitled "Would you like a contradiction with your coffee?") A meeting between journalists and researchers was organized by the Harvard School of Public Health and the Society for Epidemiological Research to discuss this problem. The attendees identified many sources of blame:

1. Some peer-reviewed journals now use public relations firms to promote their latest issues. Similarly, universities have an incentive to hype their own research in order to attract more funding.

2. The media feel compelled to present what Richard Harris of NPR calls the "news-you-can-use angle." As a result, "...every little twitch like oat bran becomes a huge trend. Science moves more slowly."

3. Scientists may be seduced into overstating their cases when they find their work featured in headline news.

4. The public's obsession with new medical facts causes incremental findings to be blown out of proportion.

The article concludes that scientists, media, and the public all need to be educated about the problem. And while a balanced diet and moderation may not be the stuff of exciting headlines, they are probably the most important message for consumers to hear.

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# "Doctors Criticize Placebo Testing: Mentally Ill Patients Worsened After Use"

by Dolores Kong, *The Boston Globe*, 21 March 1999, A1.

Although viewed as the "gold standard" in medical research, placebo-controlled trials are certainly not free from ethical controversies. This article describes the unfortunate results of placebo use in three studies of new anti-psychotic drugs over the last decade. Overall, more than 850 seriously schizophrenic patients were given sugar pills instead of existing drugs that were known to be effective. Up to 70% of these patients experienced deterioration in their condition severe enough that they had to be removed from the trial. One patient committed suicide while on a placebo. Critics have objected that the mentally ill are being used "like lab rats." According to

Dr. Charles Weijer of Canada's Dalhousie University, "This is probably the most harmful ongoing research abuse in North America."

In fact, for tests of new drugs, the current FDA policy requires the use of placebos rather than existing drugs. But a Boston Globe investigative report last November highlighted the problems with this policy in the case of psychiatric research. In particular, it was found that many of the patients enrolled in the study were not mentally competent to give "informed consent," since they could not understand the implications of being treated with placebos. The Massachusetts Department of Public Health has responded by suspending two studies involving placebos. Meanwhile, The American College of Neuropsychopharmacology, an international research group, has begun a debate on drug-testing practices in general.

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## "Whitman Says Troopers Used Racial Profiling"

by Iver Peterson, *The New York Times*, 21 April 1999, A1.

## "Profiling Debate Hinges on Issue of Experience vs. Bias"

by Jodi Wilgoren, *The New York Times*, 9 April 1999, B1.

After a long controversy, New Jersey Governor Christine Todd Whitman and Attorney General Peter Verniero have now admitted that some state troopers did use racial profiling to single out black and Hispanic drivers on the highway. Verniero released results from a study of the 87,489 motorists who were stopped along the New Jersey Turnpike by troopers from the Moorestown and Cranbury barracks during the 20 months ending in February 1999. Of these, 59% were white, 27% black, and the rest "other" (this includes Hispanic and Asian). Data on the population using the road were not given. However, police actions after the stops show a more serious pattern of discrimination. Of 1,193 vehicles searched after stops during 1996-1998, 53% were driven by blacks, compared to only 21% by whites and the rest "other." And of the 2,871 motorists arrested, 62% were black, compared to 33% white and the rest "other."

The second article shows that the practice of profiling is not unique to New Jersey nor to highway patrols. New York City's Street Crime Unit employs an aggressive maneuver known as "stop and frisk" in its efforts to find illegal drugs and guns. Only a "reasonable suspicion" is required for the police to justify such a search. Critics argue that minorities are disproportionately singled out for such searches. The controversy heated up two months ago when Amadou Diallo, an unarmed West African immigrant, was shot to death by four white New York officers. The case has led to federal and state investigations into police behavior in New Jersey and New York.

Police argue that blacks and Hispanics are statistically over-represented in prisons and with convictions on serious charges, so it is only logical that they are stopped more often. Critics from groups including the ACLU counter that this a "self-fulfilling prophecy." Stopping and investigating a higher proportion of minorities directly contributes to be a higher proportion convicted, perpetuating the stereotypes. Still, police maintain that they are not stopping people merely because of race, but are keying on situations where an individual matches the description of a suspect or a known criminal pattern.

There have been no nationwide studies analyzing the rate of stops and searches by race, but several smaller surveys have turned up patterns that critics charge can only be explained by profiling.

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## "Finance and Economics: A la Mode"

*The Economist*, 27 March 1999, p. 80.

Here is a nice piece on the distinction between the mean, median, and mode. Like the Federal Reserve in the United States, the Bank of England sets interest rates to achieve the Government's target for inflation (currently 2.5%). The Bank illustrates its inflation forecast with a so-called "fan chart," which shows the inflation rate for the past five years with the next two years. The uncertainty associated with the forecast is indicated by various levels of shading around the trend line. The darkest shading indicates a 10% probability range, and the overall shading is intended to cover 90%. The shaded region fans out to show greater uncertainty farther out in time, giving the plot its name. You can view the most recent chart at http://www.bankofengland.co.uk/ir.htm

While this may seem like a logical way to illustrate a probability distribution, a controversy has erupted as to how best to draw the fan. The Bank's procedure has been to make the bands as narrow as possible for the stated probabilities. To do this, the bands are centered on the mode of the probability distribution. Why not the mean or the median? If the distribution is symmetric, of course, it doesn't matter. But if the risks are more on the high side -- as the Bank's own data showed them to be in August 1997, for example -- then the mode would typically be lower than the other measures. Indeed, for the month in question, there was a 57.4% chance inflation would fall above the central (10%) band, but only a 32.4% chance it would fall below.

Kenneth Wallis, a well-known British economist, has criticized the Bank's presentation and advocated instead the use of "central prediction intervals." The article presents a chart for August 1997 redrawn to Wallis's specifications, using the median and symmetric quantiles for the shadings on the fan. While the Bank's fan is centered at the goal of 2.5% inflation, Wallis's is centered close to 3.0%. The Bank insists that "policy is unaffected by how the fan chart is drawn." But the article does not mince words in declaring Wallis's chart to be more informative.

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# "To Tell the Truth, It's Awfully Hard to Spot a Liar"

by Erica Goode, *The New York Times*, 11 May 1999, F1.

People tend to be overconfident about their ability to detect lying. The difficulty of this task was illustrated in research by Psychology Professor Paul Ekman and his colleagues at the School of Medicine at the University of California in San Francisco. Ekman made videotapes of 10 men, each of whom appears for two minutes stating his opinions on a social issue such as capital punishment. Some of the men are telling the truth, and some of them are lying. In Ekman's experiment, subjects viewing the tapes were asked to identify the liars. Most subjects performed only at chance levels or slightly higher. Even professionals who might be expected to perform well, such as law enforcement officials and forensic psychologists, did not clearly distinguish themselves. These findings are consistent with other research in the area. In a meta-study of such experiments, Dr. Bella DePaulo at the University of Virginia found that in 120 such experiments, only two reported subjects' accuracy to be greater than 70%.

Ekman has a special interest in "high-stakes" lies. He has identified some people, who he refers to as his "Diogenes sample," who can regularly score close to 100% in such experiments. He has also found one occupational group -- United States Secret Service agents -- who score significantly above average. The best lie-catchers seem to use groups of verbal and nonverbal signals to identify liars, rather than keying on a single clue such as eye contact.

One downside noted by Ekman is that some of the groups who were the best at detecting lies did not do much better than chance in detecting truth-tellers. This suggests that they may be overly sensitive to the possibility of lies. Ekman notes that this is problematic in law enforcement "because...if you guessed everyone was lying, you'd be right about 80% of the time. The real issue is how can I teach people not to make mistakes on those truthful people, who are accused incorrectly..."

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# "Beating Anger: Blowing Your Top Isn't the Same as Blowing Off Steam"

by Judy Forman, *The Boston Globe*, 3 May 1999, C1.

Research reported in the *Journal of Personality and Social Psychology* contradicts the popular wisdom that venting anger is better for you than holding it inside. Brad Bushman of Iowa State University, the lead author of the study, constructed a series of experiments to investigate this.

The article does a good job describing the series of three experiments. The first involved 360 male and female college students. Half were randomly selected to read a fake news article explaining the beneficial effects of catharsis (i.e., when you are angry, venting your anger in a harmless way will make you less inclined toward excessive aggression later). The others read an article explaining that catharsis doesn't work. All were then asked to write an essay expressing their position on abortion.

Students were then randomly assigned to receive either positive or negative comments on their essays, with the negative comments designed to provoke anger. In the final step of the experiment, the students were asked to rank ten activities -- including hitting a punching bag -- that they now felt like doing. Those who were not provoked did not want to hit the punching bag, regardless of which article they had read about catharsis. However, of those who were provoked, those who had read the pro-catharsis article were twice as likely to want to hit the bag as those who had read the anti-catharsis article.

In a second experiment, 600 male and female students were again randomly assigned to read articles pro and con. This time, all of them were given negative comments on their essays, and they were then given the chance to actually hit a punching bag. Seven women declined, but all the others hit the bag! Each subject was then paired with an "opponent" (one of the investigators) for a competitive task. The subject had the opportunity to behave aggressively by blasting the opponent with a loud noise. The students who read the pro-catharsis article were reportedly "twice as aggressive" as the others. The more they had liked hitting the bag, the more aggressively they now behaved. Thus the previous venting had apparently not defused their anger.

In a final experiment, 100 students read pro-catharsis messages and were then provoked. This time, instead of hitting the bag, they were told to sit quietly for two minutes prior to the competitive task. Their subsequent behavior proved to be much less aggressive than that of the students in the previous experiment.

The *Globe* article states:

> The research, published recently in the *Journal of Personality and Social Psychology*, shows that catharsis -- verbal or physical venting -- is "worse than useless," says the lead author, Iowa State University psychologist Brad J. Bushman.

All of this sounds very reasonable, until one checks the original research article ("Catharsis, Aggression, and Persuasive Influence: Self-Fulfilling or Self-Defeating Prophesies?" *Journal of Personality and Social Psychology*, March 1999, vol. 76, no. 3, p. 367). There the authors note that previous studies have already shown catharsis to be ineffective; their interest in the present study was to find out why catharsis theory is still so generally believed. One possible explanation is that catharsis is so often portrayed by the media as being effective that some people may find it beneficial through a self-fulfilling or placebo-type effect. The study was designed to see if this is true, and concluded that it is not. The researchers wrote:

> Our findings suggest that media messages advocating catharsis may be worse than useless.

It is curious that the *Globe* article completely overlooked the media focus of the study!

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# "Election Had Too Many Polls and Not Enough Context"

by Harvey Schachter, *The Ottawa Citizen*, 5 June 1999, B7.

Schachter complains that newspapers confuse the public with their reporting of polls. He starts by commenting that polls are "crude instruments which are only modestly accurate." The truth is in the margin of error, which is "ritualistically repeated in the boilerplate paragraph that newspapers plunk about midway through poll stories (and the electronic media often ignore)."

He observes that when the weather forecaster reports a 60% chance of rain tomorrow, few people believe the probability of rain is exactly 60%. But when a pollster says that 45% of the voters will vote for Joe Smith, people latch on to this number and feel that the poll was wrong if Joe gets only 42%. They also feel that something is wrong when two different polls do not agree exactly. Schachter gives examples to show that news reporters, by trying to supply reasons for small chance fluctuations in the polls, often wind up missing the real reason voters change their minds.

He concludes by saying:

> It's amusing to consider what might happen if during an election one media outlet reported all the poll results as a range. Instead of showing the Progressive Conservatives at 46 per cent, for example, the result would be shown as 44-50 per cent.
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> That imprecision would silence many of the pollsters who like to pretend they understand public opinion down to a decimal point. And after the initial confusion, it might help the public to see polls for what they are: useful, but crude, bits of information...

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