Numbers in Everyday Life: A Short Course for Adults

Addressing a key need

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Building a statistically literate society is unquestionably one of our profession's major responsibilities and challenges, as emphasized by numerous ASA presidents, including Bob Mason (2003), Richard Scheaffer (2001), and Katherine Wallman (1992). David Moore (1998), another former ASA president, distinguishes statistical literacy—"what every educated person should know about statistical thinking"—from statistical competence—"roughly the content of a first course for those who must deal with data in their work." The need to build statistical literacy is also reflected in the ASA's strategic plan, with an objective to "stimulate public awareness of the role of statistics and statisticians in issues that affect public life."

Many, including Deborah J. Rumsey in her *Journal of Statistics Education* article, "Statistical Literacy as a Goal for Introductory Statistics Courses," have urged that statistical literacy concepts be included in introductory statistics courses. Recent texts have worked toward this, and college courses devoted to statistical literacy have been developed.

We must, in addition, reach those who have already completed their formal education. Such people might regard a full-fledged course as overbearing and requiring a greater commitment of time and effort than they are willing to make. This vast potential audience can often be best reached by short, less formal courses through lifelong learning programs (see *http://usm.maine.edu/olli/national* for a partial listing) or adult education offerings at high schools and colleges.

We were invited by the Union College Academy for Lifelong Learning (UCALL) in Schenectady, New York, to develop and offer such a course in five two-hour lecture sessions during the spring of 2008. Although taken principally by retirees, the course material we developed has general applicability for adult audiences.

In this article, we briefly describe our course. Our comments should help others who might have the opportunity to teach a similar course or who might wish to promote the creation of such a course.

Course Organization and Start-Up

Scoping the Course

All who took the course had a high level of intellectual curiosity and interest in the subject. There were, however, some appreciable differences. Some had never taken a statistics course; others, in addition to having training in statistics, might have used it in their work. (Typical registrants included a one-time supermarket manager, a librarian, a social worker, a research biologist, and a psychology professor.) We needed to strike a balance between confusing some participants and boring others.

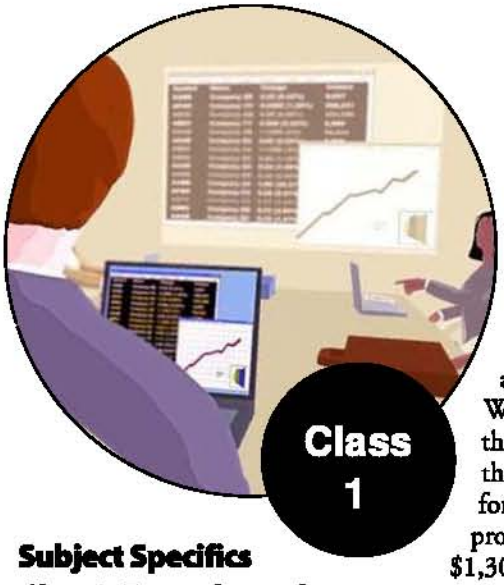
Most participants did not want a mini-course in statistical methods and theory. Few were likely to perform statistical analyses, but all were exposed daily to statistics in the media and wanted to understand these better. We therefore needed to focus the course on the use and abuse of statistics in specific application areas and only introduce technical concepts when absolutely necessary.

Course Topics

The first class laid the foundation via a general introduction to the topic, a few thought-provoking examples, and a discussion of key concepts. The next three classes were dedicated to three important application areas: public opinion polls (especially relevant in an election year), health studies, and business and industrial applications. The final class provided additional examples and a course wrap-up. The five of us took turns teaching the classes.

Course Title and Description

Our course coordinator gently advised us that the use of the word "statistics" in the course title would be a turn-off. We settled on Numbers in Everyday Life and developed a course description for the UCALL brochure. See the sidebar "Title and Description."



Subject Specifics

Class 1: Examples and Basic Concepts

Course goal and overview: We reviewed the major goals of the course and mentioned that we would not be discussing accounting numbers (or giving investment advice), government statistics, or statistical methods, per se.

Studies of marriage on longevity and impact of New York State Clean Indoor Act: To differentiate correlation and causality, we examined studies linking marriage to longevity and the assertion that "fewer New Yorkers have been treated for heart attacks since the state's wide-ranging no smoking law took effect four years ago."

Study of impact of prayer on outcome of bypass surgery: This first example of a planned study was triggered by a local newspaper headline (incorrectly) asserting that "study finds prayer may make patients worse."

That magical bell-shaped curve: We described when one might expect observations to follow a normal distribution—and when not. This was illustrated by the time-tested example of having class participants compare histograms of their birthdates within a month (a number between 1 and 31) with the averages of their birthdates and those of their two closest relatives. This led to class discussion of common phenomena one would and would not expect to be normally distributed.

Beware of "on the average": We differentiated between the median and mean with examples dealing with family income and President George W. Bush's 2005 claim that "[O]n the average, the folks who sign up for the prescription drug program are going to save $1,300 per year."

What is data mining?: We illustrated the basic concepts by discussing how coaches in the National Basketball Association use the Advanced Scout data mining software to formulate and assess game strategies.

Class 2: Public Opinion Polls and Election Forecasts

What is a poll?: We discussed why we need polls, described a poll as a process from constructing a questionnaire to communicating the results, considered different interviewing methods, gave examples of improperly phrased questions, and described the 1936 Literary Digest poll and its deficiencies.

How polls are conducted: We differentiated between the sampling frame and population and described various participant selection methods. We illustrated the difficulty in conducting polls with an example from the 2008 presidential primaries in which two polls conducted by the same organization at the same time disagreed.

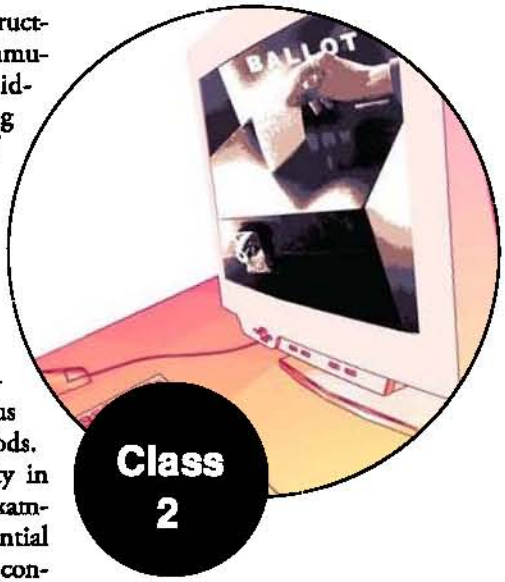
Why polls work: We defined and illustrated margin of error, polling precision, accuracy, and the effects of sample size and nonrespondents. We then described problems induced by the change from land-based to cellular phones.

Statistical Literacy Course

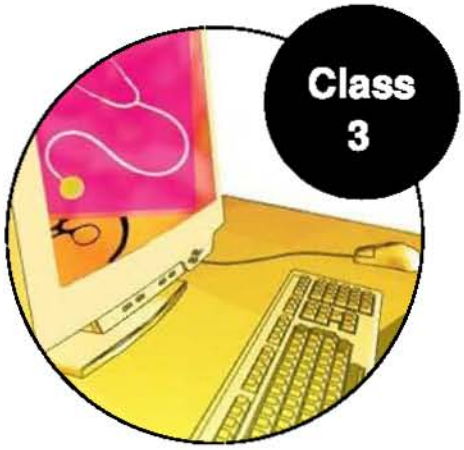
Title and Description

Course Title:
Numbers in Everyday Life

Course Description: Open a newspaper or turn on a TV—numbers are everywhere, from political polls to health studies to sports. They can provide valuable, even life-and-death information, or mislead. This course will provide insight into interpreting numbers and being well-informed citizens. Seasoned experts (all PhDs) will help you understand the latest statistics from medical studies, public opinion polls, business, and industry to this week's media and more.



When to trust a poll: We summarized problems inherent in pre-election polls and used a *New York Times* sidebar, "How the Poll Was Conducted," to review key components of a well-constructed poll. We cautioned that polls, no matter how well-executed, may produce results that differ from the eventual outcome.



Class 3: Health Studies

This session, taught by geneticist and science writer Ricki Lewis—the only nonstatistician among the five of us—examined sources of science news and feature stories.

Anatomy of a medical journal: To get a flavor of how medical journals use and present statistics, we examined a February 2008 issue of *The New England Journal of Medicine*. The eight articles illustrated such concepts as the value of negative evidence, confusing correlation with causation, the use of the odds ratio to evaluate cancer risk, and sample size requirements.

The drug approval process: We described the drug approval process in the United States and its implications, as well as some health studies in the news.

Sources of distortion: We used news releases (mostly from *www.eurekalert.org*) to illustrate statistical errors and misinterpretations.

Class 4: Business and Industrial Applications

The first part of this session illustrated common pitfalls and misuses of statistics in business and industry, providing the following recommendations:

Find out how numbers are defined: The discussion was illustrated by the Mars Climate Orbiter—lost during entry into Mars' orbit due to the team's failure to convert measurements to the metric system.

Graphic displays are highly useful, but can also mislead: A lively discussion of potential pitfalls in graphs used to display financial data was triggered by a simple example that showed how scale differences can lead to differing conclusions.

Be wary of advocates with numbers: This was illustrated by ad campaigns in which various cell phone providers used different criteria to allow each to claim to be the "most reliable."

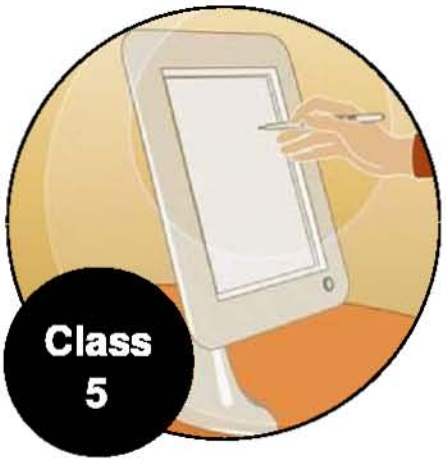
Find out how numbers are obtained: The failure to recognize censored O-ring failure data—resulting in the disastrous decision to launch the NASA space shuttle *Challenger* on an unusually cold Florida morning in January 1986—was discussed.

The second part of the session briefly described the Six Sigma initiative and provided the following examples of how statistics is used in business and industry:

Identifying differences and seeking their causes: We illustrated this by a comparison of key performance characteristics at two manufacturing plants.

Improving operations: This was illustrated by a TV network's efforts to improve the quality of its closed captions (i.e., subtitles for those with hearing difficulties).

Preventing fraudulent activities: This was illustrated by a study of the effectiveness of sending different warning letters to Internet users who were illegally sharing copyrighted files.



Class 5: Further Examples and Wrap-Up

Quantifying the subjective: We used the *U.S. News and World Report* yearly college rankings as an illustration.

Testing in schools: We described how New York assesses conformance to the 2001 No Child Left Behind Act (and some of the limitations) and the more statistically refined "added value assessment" method.

More on data mining: We discussed data mining to assess pollution in Lake Champlain, personal privacy issues, and how Wal-Mart uses its massive data warehouse to help its bottom line.

Diagnosis of a "one-in-a-million" chance event: We scrutinized a misleading media claim that the odds of Secretary of State Hillary Clinton and President Barack Obama each getting 6,001 votes in the Syracuse, New York, Democratic primary (as they did) "are less than one in a million."

Sports applications: We provided overviews from baseball, basketball, and football.

Good and bad graphics: We presented various examples, mostly taken from *Dammed Lies and Statistics: Untangling Numbers from the Media, Politicians, and Activists* and *More Dammed Lies and Statistics: How Numbers Confuse Public Issues*, by Joel Best.

Number studies further knowledge: To end on a positive note, we described insightful studies to assess gender and race discrimination, identify archeological finds, and evaluate global warming.

Some good reading and surfing: We provided a categorized handout, highlighting various books—such as Best's and *Statistics: A Guide to the Unknown*, by Roxy Peck, George Casella, George W. Cobb, and Roger Hoerl—and the Chance News and Carl Bialik (*Wall Street Journal* Numbers Guy) web sites.

We concluded the course with a summary of major "take-aways." See the sidebar "Course Take-Aways."

Copies of the presentations can be obtained from *gerryhahn@yahoo.com*.

End of Class

More than 60 people took the course. The end-of-class survey indicated that almost everyone enjoyed it and felt it increased their knowledge.

We were a little disappointed to receive essentially no suggestions about how the class could be improved and no responses to our request for participants to bring in their own examples from the media. But, we were pleased with the extensive class discussion that each of the topics generated and we encouraged. Two participants commented to us privately that, because of the sensitive nature of the subject, we should not have included the example dealing with the impact of prayer on the outcome of bypass surgery.

Statistical Literacy Course
Course Take-Aways

Numbers are an essential and highly valuable element of numerous human endeavors—you can't escape them.

Always ask:

- Who is taking/reporting the numbers?
- How were they obtained?
- Have they been peer-reviewed?
- What are the underlying assumptions?

Be wary of:

- Advocates' numbers
- Cherry-picking data selectively to support a cause
- Simple before and after comparisons

Remember that the news media seek newsy/surprising numbers

Appreciate limitations of observational studies and differentiate correlation from causation

Controlled (randomized) experimentation is the gold standard, but is often not attainable

Recognize uncertainty: Nothing is certain, but death and taxes (Benjamin Franklin)

Let numbers help you gain understanding, not intimidate you

We succeeded in limiting the technical discussion to essentials. The most complex idea presented was that of a confidence interval, a concept that, not unexpectedly, some participants found difficult. When asked (by one advanced class participant) exactly how one constructs such intervals, we sidestepped the question by responding "[T]his is what you learn in an introductory statistics course."

Finally, having five instructors give this mini-course together exposed the class participants to different perspectives and allowed each of us to focus on topics with which we were most familiar. Hearing the same concept (e.g., correlation versus causation) repeated by various instructors in different contexts reinforced important points. ■

Gerry Hahn and Necip Doganaksoy are (retired) manager-applied statistics and principal technologist-statistician, respectively, at the GE Global Research Center. Ricki Lewis is a geneticist and science writer. Jane Oppenlander and Professor Emeritus Josef Schmee are associated with Union College. *We thank Jim Comly for inviting us, on behalf of UCALL, to teach this course, for serving as course coordinator, and for many useful inputs. We also thank Valerie D'Amario and Nancy Mancini for their valuable support.*