

## **NUMBERS IN EVERYDAY LIFE: A SHORT COURSE FOR ADULTS**

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### **ABSTRACT**

Building a statistically literate society is one of our profession's major responsibilities and challenges. Short courses for adults provide important vehicles to help achieve this.

We describe such a five-session offering on *Numbers in Everyday Life*.

**KEY WORDS:** Communications, introductory statistics course, statistical literacy, statistics for consumers, teaching statistics.

### **ADDRESSING A KEY NEED**

In recent years much emphasis has rightfully been placed on teaching statistics in K to 12 education. Also, many college students take an introductory course in statistics. Such courses typically teach students methods for analyzing data. However, they frequently fail to focus on the use (and abuse) of statistics in *everyday life*.

Helping build a statistically literate society is unquestionably one of our profession's major responsibilities and challenges, as emphasized by recent ASA Presidents, including Mason (2003), Scheaffer (2001), and Wallman (1993). Moore (2001), 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").

Many (e.g., Rumsey (2002)) have urged that statistical literacy concepts be included in introductory statistics courses and recent texts have worked towards this. Also, college courses devoted to statistical literacy have been developed. One such course, offered at Augsburg College, is described at the website

<http://www.statlit.org/pdf/2007SchioldGST200.pdf>

We need, in addition, try to reach those who have already completed their formal education. Such people might regard a full-fledged course over-bearing 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) to develop and offer such a five two-hour session course. Although this course was principally for retirees, the material we developed has general applicability for adult audiences

## **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, also some appreciable differences. Some had likely 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 of the participants with too advanced material and boring others by too elementary presentations.

One thing that most participants did *not* want was a mini-course in statistical methods and theory. Few were likely to perform statistical analyses themselves in the future, but all are exposed daily to statistics in the media—and wanted to understand better what these really meant. We therefore needed to focus the course around the use and abuse of statistics in specific application areas and introduce technical concepts only when absolutely necessary.

**Course topics.** The first class would lay the foundation via a general introduction of the topic, a few thought-provoking examples, and a discussion of some key concepts. The next three classes were dedicated to three important application areas: public opinion polls (particularly pertinent in this election year), health studies, and business and industrial applications. The final class would provide additional examples and a course wrap-up. The five of us would take turns in teaching the classes.

**Course Title and Description.** Our course co-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 (Figure 1) for the UCALL brochure.

## **SUBJECT SPECIFICS**

We now summarize some of the course material. Copies of our Powerpoint presentations can be obtained from [gerryhahn@yahoo.com](mailto:gerryhahn@yahoo.com).

### **Class 1: Some 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 (not enough time) and statistical methods per se.

**Studies of impact of NY State Clean Indoor Act and of marriage on longevity:** We examined 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” and studies linking marriage to longevity.

**Study of impact of prayer on outcome of bypass surgery:** This example was triggered by a recent local newspaper headline (incorrectly) asserting that “Study finds prayer may make patients worse.”

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

**Beware of “on the average”:** We differentiated between the median and the mean with examples dealing with family income and President Bush’s 2005 claim that “on the average the folks who sign up for the (then new) 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 the population, described various participant selection methods, and illustrated the difficulty in conducting polls with an example, from the 2008 Presidential primaries, for 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 and accuracy, and the impacts of sample size and non-respondents. We then described problems induced by the change from land-based to cellular phones.

**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 differ from the eventual outcome.

### **Class 3: Health Studies**

This session, taught by a geneticist and science writer (Lewis)--the only one of us not a statistician--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 recent issue of The New England Journal of Medicine (2/28/08). 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:** The steps of the drug approval process in the US and its implications, and how health studies enter the news were described.

**Sources of distortion:** We used news releases (mostly from [www.eurekalert.org](http://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, and provided the following recommendations:

- **Find out how numbers were defined:** The discussion was illustrated by the Mars Climate Orbiter—lost during entry into Mars’s orbit due to the team’s failure to convert measurements to the metric system.
- **Graphical 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:** Illustrated by ad campaigns in which various cell phone providers each claimed to be the “most reliable.”
- **Find out how numbers were obtained:** The selective use of data on O-ring failures, 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 provided examples of how statistics is used in business and industry:

- **Identifying differences and seeking their causes:** Illustrated by a comparison of key performance characteristics at two manufacturing plants.
- **Improving operations:** Illustrated by a TV network’s efforts to improve the quality of its closed captions (i.e., subtitles for the hard-of-hearing).
- **Preventing fraudulent activities:** Illustrated by a study of the effectiveness of sending warning letters to Internet users that were illegally sharing copyrighted files.

### **Class 5: Further Examples and Wrap-Up**

**Quantifying the subjective:** Illustrated by the U.S. News and World Report yearly college rankings.

**Testing in schools:** How New York State assesses conformance to the 2001 No Child Left Behind Act and its limitations, and an introduction to the more statistically refined “added value assessment.”

**More on data mining:** How Wal-Mart uses data mining and its massive data warehouse to help its bottom line, the use of data mining to assess pollution in Lake Champlain, and personal privacy issues.

**Diagnosis of a “one-in-a million” chance event:** An assessment of a dubious media claim that the odds of Clinton and Obama each getting 6,001 votes in the Syracuse, NY Democratic primary (as they did) “are less than one in a million.”

**Sports applications:** Overviews from baseball, basketball and football.

**Good and bad graphics:** A compilation of misleading graphics mostly taken from Best (2001 and 2004).

**Number studies that further knowledge:** To end on a positive note, we described various applications, such as assessing gender and race discrimination, identifying archeological finds, and evaluating global warming.

**Some good reading and surfing:** We provided a categorized handout, highlighting various books, such as Best (2001 and 2004) and Peck et al (2006), 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 Figure 2.

### **SOME FINAL OBSERVATIONS**

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

We felt that 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 exactly how one constructs such intervals, we responded “This is what is taught in introductory statistics courses.”

Finally, giving this mini-course together exposed the class participants to different perspectives and allowed each of us to focus on the topics that we knew most about. Hearing the same concept (e.g., correlation versus causation) repeated by various instructors in different contexts reinforced important points.

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**Figure 1**

**COURSE DESCRIPTION: NUMBERS IN EVERYDAY LIFE**

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 insights to interpreting numbers and being well-informed citizens. Seasoned experts (all Ph.D.'s) will help you understand the latest statistics from medical studies, public opinion polls, business and industry, to this week's media and more.

**Figure 2**

**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
- Before and after comparisons
- Remember news media seek newsy/surprising numbers
- Appreciate limitations of observational studies and differentiate correlation from cause and effect
- Gold standard is controlled (randomized) experimentation—but often not attainable
- Recognize uncertainty: Nothing is certain, but death and taxes (Benjamin Franklin)
- Let numbers help you gain understanding--not intimidate you!

CLASS MOTTO: Numbers are highly useful, but can be readily abused—handle with care!