The
Statistics Teacher Network

Number 29 February 1992

Hands-on Training

QL Workshops for Teachers

Virtually every report on the status of mathematics education in the United States urges the inclusion of statistical and probabilistic skills and concepts for all students. In response to this need, the American Statistical Association (ASA)—through its Center for Statistical Education—offers aid to school districts, colleges, universities, and other groups in organizing and presenting Quantitative Literacy (QL) Workshops for teachers in grades 7-12. The ASA workshops are designed to promote professional development among secondary school teachers of mathematics and science while preparing them for the instruction of statistical and probabilistic concepts in the classroom.

No previous knowledge of statistics is required of the workshop participants. The material, used extensively by classroom teachers, is based on the publications of the NSF-funded QL Project and covers exploring data, probability, simulation, and an introduction to inference through sampling and surveys. Techniques for teaching the topics are modeled by the QL team members. Time is provided to discuss the integration of the materials into the mathematics curriculum. Participants work on projects and are given opportunities to explore computer software and the use of calculators.

The workshops are presented by teams of statisticians and classroom teachers who have worked with the QL Project. Professional statisticians often participate. Workshops are tailored to meet the special needs of different audiences in terms of both content and scheduling. A variety of schedules can be used depending upon the school district's needs and interests, including three- or five-day sessions, sessions split over two time periods, or some combination of these.

In addition to coordinating the entire instructional phase of the workshops, ASA will provide assistance with local arrangements. For more information regarding a QL workshop in your area, including specific details and cost, contact: Kathryn Rowe, Center for Statistical Education, American Statistical Association, 1429 Duke Street, Alexandria, VA 22314-3402, or call (703) 684-1221.

Statistics in the Classroom

A Student-Constructed Probability Problem

As part of a year-end project, students in my Probability and Statistics class had to construct three probability problems relating to something that interested them. Here is a nifty problem that was produced by a student. (Apparently there are recorders that can do what is described below.)

The Problem: A recorder can hold seven tapes at once. It can be set to choose randomly a song from any of the seven tapes and play continuously until it has played every song on the seven tapes exactly once. Assume each tape contains ten songs. *What is the probability that the*

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first 10 randomly selected songs will include at least 1 song from each of the 7 tapes?

The student and I struggled a bit with this exercise. (I admit that it fooled me for a bit.) We believe we finally arrived at the correct solution. The students initial attempt at a solution produced

$$\frac{7\binom{10}{1}\binom{63}{3}}{\binom{70}{10}}$$

For those who like mathematical challenges, I present you with two questions:

(1) Why doesn't the expression above represent the correct solution?

(2) What is the correct solution?

Good luck! (I'll gladly accept any proposed solutions.)

—Sanderson M. Smith

Book Review

Statistics, 2nd ed.

Freedman, Pisani, Purves, and Adhikari, W.W. Norton & Co., 1991.

Those familiar with the first edition of this book will find little difference between the editions. Those who are unfamiliar with the text should use the publication of a new edition as an excuse to obtain the book. This is an exceptionally well written text with a number of unique approaches to statistical topics. It is a book that should be on the shelf of anyone who teaches statistics.

The Second Edition offers a fourth author and some new material but the primary focus of the text remains, along with its strong points and flaws. The authors do an excellent job of discussing the histogram (Chapter 3) but never mention the use of a stem and leaf plot—a method of displaying data that has gained popularity since the First Edition was published. In Chapter 4 the mean is introduced in a very clever fashion. In this same chapter the standard deviation is introduced without any attempt to use median based statistics to develop the concept of a measure of variability. For those who teach a class where computation of the standard deviation is important, this book does not offer examples of that computation for large sets of data using a frequency distribution.

There is a very brief chapter devoted to the equation of a line. Slope is introduced as rise over run instead of using data to present a more concrete idea of what slope is. The use of units in the determination of the meaning of slope is never used. The use of cricket chirps versus temperature would have been a good example to demonstrate that slope has a very important meaning.

The book uses a graphical representation of correlation before attempting to compute a correlation coefficient. The graphs displayed on pages 119 and 121 are quite useful. The computation of the correlation coefficient is handled in an interesting fashion yet the authors never reveal the computation formula for the Pearson *r*.

The book is written to be read, which is not the rule with most texts. The authors create a discussion between Fermat and Pascal as they look into the Paradox of the Chevalier de Mere. The book's look at the Law of Averages could be used to motivate student experiments. Binomial probability, with expected outcome and standard error, is introduced utilizing a win/lose gambling situation. Throughout the book quotes and cartoons are used to maintain the high level of interest.

This book can serve two purposes. It would be an excellent resource for anyone teaching a high school statistics course or teaching a college elementary statistics course. As a text it would be useful for a course where the typical student was a liberal arts major. The readability of the book would be a strong factor in a class of this type.

—Murray Siegel

Personal Experience

Statistics in My School

Cate School is an independent college preparatory secondary school with an enrollment of 240 students located in Carpinteria, California, 10 miles south of Santa Barbara. Three years of mathematics is required and all students must complete two years of algebra and a year of geometry. There are presently five full time teachers in the mathematics department.

Prior to the 1988-89 academic year, students who wished to study mathematics beyond second year algebra were "forced" into a calculus track. It became clear to us that not all students are "designed" for calculus—and we did feel that it was necessary that all students take calculus. However, we wanted to offer a realistic and practical mathematics alternative for stu-

dents who wanted to study mathematics beyond second year algebra. Among other things, we are a college preparatory school—and colleges do look favorably upon four years of secondary school mathematics.

We were familiar with the goals and objectives of the NCTM Standards that we knew would be released within a short period of time. As a result of considerable exposure to the *Quantitative Literary Series* (Dale Seymour Publications) through participation in Woodrow Wilson National Fellowship Foundation Institutes at Princeton, we decided to develop a year-long course called *Probability and Statistics* based on the QL series. We knew that we would have to provide many supplements to the QL materials because (1) the materials were not designed for a year-long course, and (2) our college bound students were capable of dealing with some theoretical aspects of probability and statistics not included in the QL materials.

Basically, we adhered to the four broad topics (Exploring Data, Probability, Simulation, Survey Sampling) covered in the QL series. We "expanded" these topics in the following ways:

■ Exploring Data

(1) We make heavy use of computer software, including

—Data Insights (Sunburst Communications, Inc.)

—EXCEL (Spreadsheet for Macintosh).

—Software packages.

(2) We emphasize report writing.

(3) We spend three to four weeks on the mathematics of finance. This offers multiple applications for data display and spreadsheet use. Students get to a point where they can produce a complete installment payment schedule using a spreadsheet.

(4) We put emphasis on team projects (a team usually consists of two or three students).

■ Exploring Probability

(1) We introduce permutations and combinations and make extensive calculator use of these concepts.

(2) We develop theoretical probability to a greater degree than is done in the QL Series.

(3) We emphasize report writing. That is, any numerical response to a probability problem must be written in complete sentence form.

■ Simulation

(1) We made use of computer simulation software developed by Sanderson Smith (public domain) to support empirical results produced through classroom simulations. (Computer simulations can involve thousands of trials as contrasted to the limited number that can be performed during class time.)

(2) Whenever possible, we use the theoretical probability developed in the probability segment of the course to produce a theoretical result (which usually is very close to the computer-generated empirical result.)

(3) We make extensive use of a computer software package that generates random integers over a specified range, avoiding the somewhat tedious use of random number tables.

(4) As is true in the other segments of the course, we emphasize report writing.

■ Exploring Surveys and Information from Samples

(1) We make use of a software package to produce the 90% box plots.

(2) We develop the statistical concepts of confidence intervals, hypothesis testing, normal distribution curve, t-test, Chi Square test, beyond that which what is presented in the QL series.

(3) We do a variety of surveys using samples of students chosen randomly from our student body.

(4) We emphasize report writing.

—Sanderson M. Smith

Video Review

Review of Episode 26

Probability of the Annenberg/CPB Series
College Algebra: In Simplest Terms

This program (about 30 minutes in length) was reviewed without seeing any of the other programs in the series. It makes no formal use of algebra, but ties the probability developed to algebra by discussing functions and by using algebraic graphs.

The content of this program is elementary probability. It is divided into four parts: (1) The language of probability; (2) Probability calculations; (3) Use of combinations to get answers to probability situations; (4) The logic of probability, with some discussion of coincidences.

The videotape begins with some gamblers discussing the chances of winning. It then cuts to a rainy day in Atlantic City, with a bus full of hopeful gamblers arriving at a casino. Casino managers discuss the slight house advantage (they claim less that 1 percent in most games—

an underestimate) and the need to keep gamblers gambling. Discussion of the casinos indicates that the profit runs about $700,000 per casino per day. Gamblers have a real chance of winning in the short run, but time gives the casinos a bigger edge.

Following this introduction, Solomon Garfunkel appears, using a crap table, a large die, and a slot machine as props. He introduces the vocabulary of *sample space, event, outcome, random, non-random.* He illustrates basic probability using coin tosses, rolling of a die, and betting on a roulette wheel. A graph of successive coin tosses shows the relative frequency tending to .5 heads. Roulette is used to illustrate the house edge on a red or black bet. This leads to a discussion of mathematical expectation. (The house keeps about $5 per $100 bet.)

Slot machines are shown to have a much worse payoff for the gambler, and lotteries give a terrible payoff. With lotteries, it isn't just that the probabilities of winning are bad, but that the jackpots are extremely small relative to the chance of winning. In lotteries, the state keeps about $40 of each $100 bet. Combinations are used to calculate the probability of picking the correct 6 numbers in the lottery. (It sounds like combinations have been developed in some other episode.)

Independent outcomes are described. Sequences of coin tosses are compared to show random vs. non-random sequences.

Gambling is finally left behind. (Almost half the videotape deals with gambling situations. Is this too much? Do we want to give the impression that this is the most common or most motivating application of probability?)

We move on to the Boston Celtics, to discuss the phenomenon of "streak shooting" in basketball. Tom Gilovich is cited as having made a study of Philadelphia Seventy-Sixers data for a year, from which he concluded that shots taken are independent.

Garfunkel goes walking and runs into an old acquaintance. This allows a discussion of coincidences and their probabilities, which leads to a nice discussion of the "birthday problem". The value of calculating the complement of the probability you want is demonstrated here.

The last application of probability discussed is the probability of dying in a car accident. There are about 50,000 auto deaths per year, out of roughly 150 million drivers in the U.S. This yields an approximate probability of 1/3000 of dying in a car accident in a given year. However, risk accumulates over time (the probabilities are additive year by year), so over a 60-year span of driving, one's probability of dying in a car accident is roughly 1/50. This discussion of risk is the main tie-in with algebra: "Risk is a function of time". A brief discussion of improving auto safety—for example, by reducing speed —concludes the lesson.

Overall, the videotape is appealing. The applications are well-selected. However, there is a lot of vocabulary and several important concepts are introduced in a short time. the videotape could be used effectively as an introduction of probability for a class that will take a more thorough look at the subject. It could also be used to show the importance of probability to a general audience. It does too much too fast, and some of it too sketchily, to be considered more than a surface exposure to the subject. Since this episode is embedded in an algebra series, this is probably all that was intended.

People wanting information about the program or the series can call or write the Annenberg/CPB Project. Phone number: 1-800-LEARNER; Address: P.O. Box 1922, Santa Barbara CA 93116-1922.

—Albert P. Shulte

International Outreach

The United Kingdom Centre for Statistical Education

This centre, based at the University of Sheffield and the Sheffield City Polytechnic, in England, has been working in the field of statistical education since 1975. The present director is Peter Holmes and Margaret Rangecroft is the deputy director.

There have been many projects based at the Centre. Mary Rouncefield was the project officer for a two-year project on using practical work to teach A-level Statistics. This is equivalent to about the last two years of high school and first year college course in statistics. The outcome of this project was a textbook *Practical Statistics* by M. Rouncefield and P. Holmes published by Macmillan (ISBN 0-333-47344-2). This is available through bookstores, not directly from the Centre.

Mary then went on to work on a project looking at how to improve co-operation between teachers at secondary school in teaching statistics across the school curriculum. The outcome of this was an A4 ring back file of practical help

and support in encouraging different levels of co-operation up to full co-ordination between subjects. This file, called *From Co-operation to Co-ordination*, is available from the Centre. It includes overhead projector transparencies for an individual teacher or course director to use at meetings about cross-curricular co-ordination.

Mary is now a Lecturer in Mathematical and Statistical Education at Chester College. Her place as Project Officer was taken by Glyn Davies who worked on a project to produce practical material to teach data-handling for pupils aged 5 to 16. This material is to be published by Hodder and Stoughton and not by the Centre.

Currently Mike Hammond is Project Officer on work to use databases and spreadsheets in teaching data-handling in mathematics and across the curriculum for pupils aged 11 to 16. Some of this work will be published by Hodder and Stoughton, and some by the Centre.

Over the years the Centre has produced many booklets to help with teaching statistics. It has also produced its own software called *Understanding Statistics*, which is one of the few sets of programs clearly designed to help teach statistics and not just do statistics. Although originally designed for Acorn machines, there is now a version for IBM pc and compatible machines (with VGA or enhanced EGA screens).

The Centre is also the Administration Office of *Teaching Statistics* and for the United Kingdom *Annual School Statistics Prizes*.

If you want to know more about the activities and publications of the Centre, and to be put on the mailing list to receive the free newsletter *Random News* please write to the Director:

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Book Review

Statistics: Concepts and Controversies

Third Edition, by David S. Moore, W.H. Freeman and Company, 1991

An old adage states: "If it isn't broke, don't fix it!" In the case of *Statistics: Concepts and Controversies*, David Moore "fixed" a book that was already an excellent statistics book. First published in 1979 and updated in 1985, the third edition of *Concepts and Controversies* again proves to be a book that should be read by anyone wanting a source that emphasizes concepts, not just techniques in the analysis of data.

In this edition, David Moore updates many of the examples with additional data that makes the examples current and relevant. Over 150 additional exercises appear at the end of each section and additional review exercises at the end of each chapter. As in past editions, many of the exercises require the teacher and student to discuss issues and questions, not just to find numerical answers to problems.

The book is divided into three sections: collecting data, organizing data and drawing conclusions from data. The first chapters deal with the key ideas of sampling and experimental design. Important issues such as opinion polls, ethics, and validity are covered in such a way that the reader begins to see and understand the need for statistics.

One of the highlights of the book is the excellent section on the use and design of a simulation to further enhance the students' knowledge of probability.

The second section, dealing with the organization of data, has been expanded to include more graphical techniques, such as stem-and-leaf plots and box plots. The author also presents some standard statistical topics, such as the measures of variability, normal distribution, correlation and an expanded section on the least squares regression line. Even though these sections include techniques on how to calculate various statistics, Moore goes to great length to insure that the student understands the meaning of each formula and how to interpret the results.

The final section of the book includes such topics as probability, confidence intervals and significance tests. The design of the probability chapter gives the reader some basic notions of probability and discusses some of the fallacies that people have about probabilistic reasoning,

like the "law of averages." One of the highlights of the book is the excellent section on the use and design of a simulation to further enhance the student's knowledge of probability. The book concludes with a chapter on statistical reasoning. This section has been expanded from the first edition and includes an excellent explanation of confidence intervals and hypothesis testing.

This reviewer has used many of the ideas and exercises with his high school students with great success. The book is designed for students of varying degrees of sophistication and interest in statistics; in *Curriculum and Evaluation Standards* the NCTM has stressed the importance of statistics to contemporary society. *Statistics: Concepts and Controversies* is an example of a textbook that shows how statistics can be presented so that it is accessible for all students. This book, along with the video series, *Against All Odds, Inside Statistics* provides a teacher with the material necessary to make a student's first statistics course a successful experience.

—Patrick Hopfensperger

Historical Overview

Activities that Led to the QL Project: A Brief Historical Look

American Statistical Association
Atlanta, Georgia, August 1991

I. Early Activities

Persons have long recognized the value of instruction in topics relating to statistics and probability. Throughout the Twentieth Century, there have been a number of important documents recommending change in the mathematics curriculum as taught in the schools. Each of these documents (e.g., *The Reorganization of Mathematics in Secondary Education*—MAA, 1923; *Mathematics in General Education*—Progressive Education Association, 1938; *The Place of Mathematics in Secondary Education* — NCTM /& MAA, 1940; *Program for College Preparatory Mathematics*—College Entrance Examination Board, 1959) recommended teaching graphs, methods of dealing with data, and elementary probability.

A number of people developed courses in statistics and/or probability for their school systems in the 1930s, 1940s, and 1950s. However, as the originators of these courses left teaching or retired, most of these courses ceased to exist. Successful courses in statistics and/or probability continued to be taught by people, largely isolated, with particular personal interest in these topics. In 1960-61, a television show on statistics and probability, offered on Continental Classroom early in the morning, served as a catalyst to renewed interest in offering these topics to pre-college students. This class was taught by Frederick Mosteller and Paul Clifford.

II. The Mosteller Presentation in Las Vegas

In 1967, the annual meeting of the National Council of Teachers of Mathematics was held in Las Vegas. Frederick Mosteller was invited to make a major presentation. He took this opportunity to investigate the status of the teaching of statistics and probability in New Jersey.

Based on the results of his sample, and stressing the importance and relevance of the topics, Professor Mosteller called for the establishment of a committee whose purpose would be to encourage the teaching of statistics and probability in the schools.

In 1968, the National Council of Teachers of Mathematics and the American Statistical Association established the Joint Committee on the Curriculum in Statistics and Probability.

III. Early Work of the ASA-NCTM Joint Committee

In 1968, the National Council of Teachers of Mathematics and the American Statistical Association established the Joint Committee on the Curriculum in Statistics and Probability. This committee was chaired by Professor Mosteller, and contained two representatives (in addition to the chair) from each organization.

(The Joint Committee has continued to function since that time, playing a leadership role in statistical education. The chair has alternated between the ASA and the NCTM.)

The first task of the Joint Committee was to oversee the development and publication of two works. These were: *Statistics by Example* (a

four-volume collection of examples ranging from middle school to grade twelve); *Statistics: A Guide to the Unknown* (a collection of essays showing uses of statistics in a variety of areas). These publications proved extremely popular.

In the mid-1970s, the Joint Committee received funding from the National Science Foundation to run a series of mini-courses at regional and annual meetings of the National Council of Teachers of Mathematics. These mini-courses usually followed the pattern of two or three talks on statistical topics, a demonstration class using high school students (often using an example from *Statistics by Example*), and a workshop involving teaching in active learning of statistical and/or probabilistic ideas.

IV. The 1981 NCTM Yearbook

To further emphasize the importance of statistics and probability, the 1981 Yearbook of the National Council of Teachers of Mathematics was devoted to these topics. It was titled *Teaching Statistics and Probability*. Included among its features were classroom activities at all grade levels, K-12, and suggested statistical projects. This yearbook has continued to be a popular seller.

V. The December 1981 Williamsburg Conference

As another attempt to highlight the importance of statistics and probability, the Joint Committee planned and conducted (under the direction of chair, Jim Swift) a conference for key mathematics educators in school systems across the United States and Canada. The conference was held in Williamsburg, VA, in early December 1981 and was five days in length.

The presenters at this conference included both statisticians and mathematics educators. Materials included papers written specifically for the conference, portions of the 1981 NCTM Yearbook, booklets from the Schools Council Project in Statistical Education (an English project), and featured active involvement of the participants.

An outgrowth of this conference was the Statistics Teacher Network and its associated newsletter, which is currently circulated to more than 4,200 mathematics educators, statisticians, and other interested parties.

VI. Development of the QL Units

Members of the Joint Committee continued to work on two fronts to make a greater impact in the schools.

One effort was the development of four units (on exploratory data analysis, probability, simulation, and sampling distributions) designed for use with middle school and/or high school students. These units, revised, ultimately became the Quantitative Literacy series.

The second effort was to seek funding for field-testing of the units and for teacher inservice training. This was eventually successfully accomplished as the Quantitative Literacy Project.

—Albert P. Shulte
Oakland Schools

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