The Statistics Teacher Network

Number 35 ASA/NCTM Joint Committee on the Curriculum in Statistics and Probability Winter 1994

Statistics in the Classroom

Now, It Is a Fair Game

In conducting a workshop for fifth grade teachers on data analysis, I looked into the activity, "Is This Game Fair?", contained in "Dealing with Data and Chance," one of the NCTM's middle school addenda to the curriculum and evaluation standards. The game is designed for two students, the "player" and the "opponent." Each student begins with 10 points (or to make it more interesting, $10). Only the player is allowed to roll a pair of dice. If the player rolls a sum of 7, the opponent loses $3 to the player; but if the player rolls a sum other than a 7, he or she must give $1 to the opponent. The game consists of 10 rolls of the dice, and the student with the most dollars after the 10 rolls wins the game. If a student loses all of his or her $10 (goes broke), then he or she automatically loses the game.

I had each pair of teachers play the game twice, acting once as the player and once as the opponent, so that each teacher had the opportunity to roll the dice. After completing all games, we recorded the number of times that the player won and the number of times that the opponent won as is suggested in "Dealing with Data and Chance." It was seen quickly that the opponent won the overwhelming number of games, and therefore it was concluded that the game was not fair to the player.

At this point, we discussed what constituted a "fair game," and the question of the probability of obtaining a sum of 7 on the two dice arose. It seemed reasonable at this point to also introduce the concept of "expectation." We determined the probability of a sum of 7 by constructing a table of the 36 ordered pairs, in which the first number indicated the outcome on the first die and the second on the second die. We saw that 6 of the 36 cases would produce a sum of 7, so the probability of a sum of 7 was 6/36. We then concluded that about 1/6 of the rolls of the dice would produce a sum of 7 and that 5/6 would produce something other than 7, so the player might expect to win (1/6)($3) + (5/6)(–$1) = –33 cents, or, in other words, lose on the average about 33 cents per roll of the dice. (The explanation of the calculation is that since the player wins $3 on 1/6 of the rolls, we weight that value with 1/6; and since he or she loses $1 on 5/6 of the rolls, we weight that value with 5/6.) Similarly, we showed that the opponent's expectation was (1/6)(–$3) + (5/6)($1) = 33 cents in which case the opponent wins about 33 cents per roll of the dice.

In light of these observations, it seemed reasonable to conclude that a fair game was one in which the expectations for both the player and the opponent were 0. With this in mind, it was decided to change the game so that it was fair to both the player and the opponent. This could be done in two ways: (a) by changing the stakes, or (b) by changing the probabilities of winning. Changing the stakes required finding

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a solution to (1/6)(__) + (5/6)(__) = 0. By trial and error, it was seen that $5 and -$1 would do the job; that is, the player would win $5 on the roll of a 7 and would lose $1, otherwise.

Changing the probabilities was slightly more difficult. It was necessary to find a solution to (__)($3) + (__)(-$1) = 0 and such that the two probabilities would sum to 1. Again, by trial and error, it was found that 1/4 and 3/4 would work. The problem now was to find which outcomes of the dice toss would produce probabilities of 1/4 and 3/4. By consulting the 36 ordered pair chart that we had constructed earlier for the two dice toss, we discovered that a sum of 7, 11, or 12 produces a total probability of 9/36 or 1/4. Consequently, the game was changed so that the player would win $3 from the opponent if a sum of 7, 11, or 12 appeared; otherwise, the player would lose $1.

The teachers played both of the new games a large number of times to convince themselves that both changes would produce nearly equal winnings for the player and the opponent. The result of the activity was that the teachers had a good time and learned some fascinating ideas of elementary fair game theory.

—Donald J. Dessart
The University of Tennessee
Knoxville, Tennessee

Learning Opportunity

Woodrow Wilson Summer Institutes in Statistics and Probability

The Woodrow Wilson National Fellowship Foundation (WWNFF) administers one-week summer institutes in statistics and probability for middle and secondary school mathematics teachers. To participate in an institute, you need not have any statistics background. All participants receive a notebook of materials that provide immediate use in the classroom as well as a wealth of ideas, experiments and approaches to involve students in their own learning.

This summer, there are five sites for middle school and three for secondary level institutes. You may obtain a brochure and registration form from one of the contact people or by calling Jacquie Pillsbury, WWNFF, (609) 452-7007.

Middle School Sites and Times:

- June 20-24 Dr. Jane Schielack, Texas A & M Univ., (409) 845-3150
- June 27-July 1 Dr. Don Cambell, Middle Tennessee State Univ., (615) 895-5130
- July 11-15 Mr. John Haubner SUNY Plattsburgh, NY (518) 564-5000
- July 18-22 Ms. Hope FLorence, College of Charleston (803) 953-5635
- August 1-5 Mr. Bryson Edmonds, The Alabama School of Fine Arts (205) 250-2591

Secondary Level:

- June 27-July 1 Ms. Helen Purks, Columbus College, GA (706) 568-2480
- July 11-15 Dr. Thomas Butts, Univ. of Texas at Dallas (214) 690-2496
- July 18-22 Ms. Mary Ann Luciano SUNY Oneonta, NY (607) 436-3920

—Bill Sloane
WWNFF Program Coordinator

Text Review

Nontraditional Textbook Leads to Student Projects

Functions, Statistics, and Trigonometry is the fifth text in the Scott Foresman, UCSMP (University of Chicago School Mathematics Project) series. For those of you not familiar with the UCSMP Series, please note that Scott Foresman takes a nontraditional approach toward the math curriculum. The entire UCSMP series moves the traditional algebra, geometry, and advanced algebra courses ahead one year. Although the algebra, geometry, and advanced algebra texts are not as stringent as other traditional texts, the UCSMP series does offer the significant advantage of introducing the students to key topics at an earlier age. While the UCSMP texts may not be as rigorous as other texts, the series adjusts for this by providing an extra course to be taken between advanced algebra and precalculus, namely *Functions, Statistics and Trigonometry*.

This course (FST) is designed to provide closure for the advanced algebra course, and indeed, many of the topics and chapters mirror those found in a traditional algebra II text. However, the additional year afforded by the UCSMP series allows more time for applications

involving nontraditional material, including an introduction to statistics, probability, and data analysis. Both authors of this article have enjoyed working with this series. The series provides a wide range of supplementary materials that help the teacher adjust the course to best meet the needs of his or her students. The series also provides a lot of concept repetition which helps reinforce important topics.

Reading Encouraged, Drills De-emphasized

The UCSMP series homework assignments differ from the traditional mathematics text in two major approaches. First, the series encourages the introduction of new material through student reading. Second, there is limited drill and practice. Each homework problem applies a slightly different approach. Repetitive exercises are de-emphasized in the text, although supplementary materials that are more drill-oriented are available. For the most part, the reading sections are well written and explain the concepts thoroughly, and the different problems provide variety for the students.

The entire FST text relies on the use of technology, both computer and calculator. The statistics portion of the text requires a standard statistical calculator that handles mean, variance, standard deviation, combinations, permutations, a random number generator, etc. Computer software is also recommended that will graph boxplots and scatterplots, and handle linear regression, power regression, exponential and logarithmic regression, correlation coefficients, etc. The Scott Foresman StatExplorer software is now available and is recommended, as it uses a spreadsheet format, which most students easily grasp. The remainder of the text relies heavily on graphing and the use of graphing calculators and/or access to computer graphing software for homework assignments.

The text divides its coverage between functions, statistics, and trigonometry. Only four chapters in the text are devoted solely to statistics, although statistics and probability do arise occasionally throughout the other chapters. The remainder of this review will focus on the statistical content of the text.

The first chapter of the text introduces the measures of central tendency. Mean, median, and mode are all introduced as well as minimum, maximum, quartiles, percentiles, outliers, boxplots, and histograms. The section that covers reading and interpreting tables is handled well. Variance and standard deviation are introduced and explained. The formulas are given and a few of the problems have the students use the formulas, but after the introductory section on standard deviation and variance, the remainder of the book allows for the use of a statistical calculator.

Technology Instead of Formula

The second chapter introduces bivariate data and the concept of line of best fit. Some linear models are examined, and correlation is discussed. All the sections in the text that involve lines of best fit rely exclusively on technology. The formula for the line of best fit is not even presented to the students. The readings discuss an intuitive interpretation of line of best fit, and then ask the students to accept the computers calculations. This sets a precedent for the remainder of the regression models, all of which rely solely on computer or calculator calculations, with no discussion of formulas. Quadratic models are introduced almost immediately after linear regression, and most students have little trouble adapting the technology to analyze quadratic models.

After the second chapter, FST moves into the function and trigonometry sections and doesn't return to any statistics until chapter 7, when it tackles probability, independent, dependent, and mutually exclusive events. Combinations and permutations are covered as well as a short introduction to simulating events using Monte Carlo techniques and how these techniques are mirrored in calculus.

The text does a nice job in chapter 8 of developing the binomial theorem through the use of the students previous knowledge of combinations and Pascal's Triangle. This topic is extended and enhanced in chapter 10, when the text introduces the normal distribution and the normal approximation of a binomial distribution. The chapter culminates with a discussion of the Central Limit Theorem and leads the students through some hypothesis testing given a specific significance level. The whole introduction, implementation and discussion of the normal distribution, hypothesis testing and confidence intervals is excellent.

Student Projects a Major Focus

We believe that one of the best features of this text is the implementation of student projects. Each chapter provides the class with five to eight mini-projects that can be used to supplement the material covered in the text. We chose to use a small group approach to the projects and were extremely pleased with the

results. The projects allowed the students to do more "real-world" applications, and also encouraged them to be more creative and original with their mathematics. The statistics projects in particular involved many different types of sampling and analysis of data.

We were so pleased with the work the students were doing for their projects that we decided to "show off" their results with a student project fair. Designed much the same as a science fair, we had more than 100 students involved with 35 projects, each with a table or booth in our gymnasium. We invited parents, administration, faculty, other math classes and even the press. The result was an overwhelming success. The students were more than happy to share what they had learned, and did so in a very impressive, professional manner.

Administration and faculty members were invited as judges, and we gave awards for the most creative, and most informative projects. Even the other members of the faculty took time during their preps to visit the gymnasium to see what all the excitement was about. The public relations aspect of the fair was so outstanding that the School Board even gave us Certificates of Appreciation. It was a fantastic culmination for the year, and we would highly recommend this activity to any school that decides to use this text.

For more information about putting on your own project fair, look for our session at the OCTM conference next fall in Toledo.

—Pam Garrett and Greg Koltas
Kenston High School Mathematics Dept.
Bainbridge Twp., Ohio

Book Review

The Art of Science Writing

by Dale Worsley and Bernadette Mayer, New York: Teachers & Writers Collaborative, 1989, xiv + 206 p., paperback. ISBN: 0-915924-20-X.

Although this is not a statistics book, I found it so intriguing that I thought teachers may also. As a statistician, I work with scientists and engineers on interdisciplinary projects. An important component of statistical work is the writing of design and analysis so that those who are working on a project, as well as those who must make decisions based on the report of the study, understand the problem, analysis, conclusions, and recommendations thoroughly. Writing across the curriculum is a topic that is helping to reshape K-12 education today. I believe that this book will aid all teachers in this regard, and particularly those who are having their students write statistical studies and projects.

The best place to begin reading this book is the preface. It begins by stating that the book "is addressed to secondary school teachers who are interested in developing good student writing in the areas of science and math." It mentions further that teachers of other subjects may likewise benefit, and that the ideas can also be useful to elementary and college level teachers. I would add that professionals outside of education can also benefit greatly from this book.

Advice from the preface: "It is not necessary to read this book from cover to cover.... We advise that readers simply start with whatever section interests them most, go only as far as they like, and try out ideas only as long as they are engaging." (It may be a few more weeks or even months before I have read every page at least once, but my growing interest frequently draws me to sections still new to me.)

The five sections plus appendix are organized as follows:

- Section 1: Essay Development Workshop
- Section 2: Writing Experiments
- Section 3: Questions and Answers
- Section 4: Samples
- Section 5: An Annotated Science Writing
- Bibliography
- Appendix: Using Writing in Mathematics, by Russel W. Kenyon

The Essay Development Workshop (Section 1) covers 10 steps. Incidentally, "exercises" and "inspiration" are steps 1 and 2, respectively, while "rough draft" is down at the step 6 level. A small sampling from Writing Experiments (Section 2) includes "being scientific as a writer," "dream writing for problem solving," and "interdisciplinary investigations." (As a statistician working with scientists and engineers, this section is especially valuable to me.) Questions and Answers (Section 3) "is a forum in which issues and ideas are discussed as if the authors were answering questions at a conference of science and math teachers." Samples (Section 4) contains selected writings of Lewis Carroll, Charles Darwin, Albert Einstein, Jane Goodall, William Wordsworth, and others, plus student and teacher samples. The annotated bibliography (Section 5) has more than 150 entries.

My experience has been that the ideas presented in this book are very engaging, and, while reading, I often pause to reflect on the wealth of ideas and information provided in the excellent writings. Of course, the real benefit comes from practicing and applying selected ideas or methods in everyday work and activities. During some of my busiest workdays, I find it helpful to read from *The Art of Science Writing* for just a couple of minutes. It helps spawn creativity and can serve as a refreshing reminder to take time to think.

The authors conclude the preface with these words: "We hope our book will stimulate the desire among students and teachers to write, to love to write, and to publish writing that is beautiful, speculative, and new." That hope should be realized in the case of each thoughtful, motivated reader.

It is possible that the book may be found elsewhere as well, but I discovered it in the Dale Seymour Publications 1994 Secondary Mathematics catalog (p. 91), $13.95.

—Reviewed by Mark Martin, Statistician
Ciba Corning Diagnostics Corp.
Oberlin, Ohio

Statistics in the Curriculum

A K-12 Quantitative Literacy Program for Pennsylvania

To help both elementary and secondary teachers in Pennsylvania implement the probability and statistics goals of the K-12 NCTM Standards into their classrooms, Project SEQuaL (Statistics Education through Quantitative Literacy) has been established at Indiana University of Pennsylvania (IUP). Funding was obtained through an Eisenhower grant. To date, workshops using the Quantitative Literacy (QL) Series as the primary materials have been given during the summers of 1992 and 1993, to serve a total of 40 elementary and 42 secondary teachers.

SEQuaL is a QL training program for K-12 teachers that consists of a pre-workshop orientation, an intensive one-week training workshop and two follow-up sessions. The follow-ups are used for teachers to describe how they planned, taught and assessed their own QL class units and to present examples of their students' QL projects.

The workshop included five daily sessions for the participants, including a "Statistician's Day" and a "School Administrator's Day." During the Statistician's Day, ASA chapter statisticians from government, academia and industry were present to participate in the workshop. Administrators from the school districts represented were invited to attend the School Administrator's Day to give the administrator a comprehensive overview of the workshop, its statistical content, the teaching techniques employed and suggested materials needed for implementation of quantitative literacy into their curriculum. It is very important that administrators appreciate the content of the material and what is required to implement it.

Participants worked in teams to carry out a project involving a statistical investigation. The projects began with the formation of a question, moved to collecting data and analyzing the data and ended with conclusions related to the original question. Teams presented their findings to the entire group as a concluding activity.

The unique aspect of the SEQuaL workshop is the comprehensive training provided for elementary school teachers. This workshop used the texts of the QL Series, the *Used Numbers* Series, the NCTM *Addendum* Series plus other commercial texts, Data Insights software, and original materials that were developed by the workshop leaders.

There are advantages and disadvantages with conducting a comprehensive K-12 workshop. Among the advantages are:

- Elementary and secondary teachers interact with teachers within the same district. Ideally a school district team should consist of 4 teachers, one each from grades K-3, 4-6, 7-9 and 10-12. The team can then form a QL committee to train other teachers in their district.
- Teachers can see the K-12 curriculum and their part in the overall picture.
- Elementary teachers serve as great models for creative activity-based lessons, thus challenging secondary teachers not to rely on the traditional lecture/formula teaching approach. It seems that elementary teachers tend to have more interesting project presentations as they use skits, costumes, props, etc., very naturally.
- Secondary teachers provide elementary teachers with an even better understanding of the scope of probability and statistics with projects that typically require more advanced analysis.

Among the disadvantages are:

- There is increased complexity with regard to materials coordination and class scheduling.
- More facilities are needed to put on the workshops.

To continue the project, IUP has joined with the school districts in the surrounding two-county region to form "academic alliances" in a variety of areas such as the arts, library science, social studies and home economics.

The purpose of these alliances is to create and maintain conversation among basic and higher education faculty regarding knowledge development in a discipline. The SEQuaL team is in the process of establishing the Mathematics Academic Alliance for Quantitative Literacy (MAAQL). This alliance will meet regularly (bimonthly or quarterly) for a dinner andpresentations on quantitative literacy. Its activities will be open to all teachers in the districts, thus to encourage past workshop participants to keep abreast of QL and to interest other teachers in attending a workshop.

Having created a model workshop and having trained teachers in the IUP area, the SEQuaL team also plans to present workshops at regional sites around the state of Pennsylvania. IUP will serve as a focal point for offering these workshops by establishing the Center for Statistical Education in Pennsylvania (CSEPA). CSEPA will exist at IUP for the purpose of doing research in probability and statistics education, reviewing and gathering related information and instructional material and disseminating information and materials to enchance the instruction of quantitative literacy throughout Pennsylvania. Through the creation of CSEPA, teachers in the state can access a data base of instructional QL materials, QL lessons used by past participant-teachers in their classes and research articles in the area of probability and statistics education. CSEPA, in conjunction with the MAAQL alliance, is to publish a QL newsletter for distribution to SEQuaL participants, intermediate units and other interested educators in Pennsylvania.

—Fred Morgan and Jack Shepler
Indiana University of Pennsylvania
Indiana, Pennsylvania

Editor's Note: The Editor thanks Fred and Jack for allowing him to extract this article from material they presented at the American Statistical Association meeting in San Francisco last August. To be in a position to cover the quantitative literacy needs of a whole state is very exciting.

Book Review

Fifty Things to Do with Databases and Spreadsheets

by Michael Hammond, Centre for Statistical Education, University of Sheffield, Sheffield S3 7RH, UK.

(The price is equivalent to $35 and includes permission to make copies of the materials to use in classes with students.)

This book was written as part of a project funded by the Nuffield Foundation entitled *Using Databases and Spreadsheets to Teach Data-Handling.* The project developed curriculum materials for secondary school students (ages 11 to 16) and in-service materials for teachers. In this book 50 activities are provided that either offer existing data sets or instructions for collecting data in the context of solving problems from different subject areas. The book's introduction states that these materials are to be used either by "Information Technology coordinators" or individual subject teachers, although many activities seem like they would be used most appropriately by teachers of statistics.

For those unfamiliar with the British school curriculum this book may seem confusing, because it refers by number to different stages in the curriculum and provides specific information for "Information Technology (IT) coordinators." Peter Holmes explained to me that there has been a big push for Information Technology in the British schools, so most schools or regions now have an IT coordinator to encourage the use of information technology in classrooms and IT tools such as databases and spreadsheets are to be used across the curriculum. Therefore, the school IT coordinator is responsible for ensuring the appropriate use of IT materials in different subjects. While this book is addressed initially to the IT coordinator, it will be the subject matter teacher that uses the particular material.

Fifty Things to Do with Databases and Spreadsheets is definitely not a statistics text, and it does not offer statistical strategies for analyzing data. Instead, it offers interesting sets of data or suggestions for gathering data for different subject areas, along with questions for teachers to use in stimulating discussions and

explorations with students. It is assumed that these teachers are already familiar with statistical techniques.

Another confusing aspect of the book is that although activities are grouped by subject area, it is not until the end of each section that notes for teachers are provided. These notes are very brief and contain references to stages in the British curriculum that can be ignored by teachers in the United States.

Examples of some of the data sets or spread sheets and their subject areas are:

English: " A Good Read," a spread sheet to be created based on books read by students in a class, including information on title, author, themes, location, and which students in the class have read each book.

Foreign Languages: "Going on a Holiday" where data are to be gathered by students from travel advertisements on holiday locations, accommodations, price per person, and descriptions of the vacation.

Geography: "Global Statistics", a spreadsheet of data on a sample of countries and some of their statistics, such as population, birth rate, life expectancy, infant mortality, and GNP.

History: "Roman Emperors," data on 56 Roman Emperors, including where they were born, how long they ruled, and how they died.

Mathematics: "Queues," where instructions are given for gathering data on the number of people in a queues at a local supermarket , in order to make predictions about the number of people in a queue after given amounts of time.

Science: "Planets" provides data on each planet in the solar system, including diameter, distance from the sun, length of day in hours, number of moons, and surface temperature.

Technology: "Breakfast," where students enter data on their breakfasts, including the types of food eaten, the portions of food, and the calories.

Other categories of activities include "Religious Education," "Home Economics," and "Administration."

Although the instructions for some of the activities seemed confusing to me, and I couldn't understand the references to the British curriculum, I nonetheless enjoyed reading about the different activities and data sets and could think of several ways to use them in my own statistics classes.

—Joan B. Garfield
General College, University of Minnesota
Minneapolis, Minnesota

From the Editor

Camouflage, Posters . . . and You

I received several inquiries regarding where to obtain copies of *Introduction to Algebra and Statistics*, which Shirley Glover reviewed in the fall 1993 issue. The marketing representative at EFA & Associates to contact is William McDougall, 160 Woodbury Drive, Dayton, Ohio 45415-2840; (800) 878-9754.

Regarding Mike Kimmel's fall 1993 article on an exploratory data analysis classroom experiment, the scatterplot and description below the plot are correct as written, but the corresponding information in the last paragraph is backwards. It should read "The comic background data are entered as squares and the classified as asterisks." The error is the editor's.

I recently read an article "The Colors of Camouflage" by Joanne Curran that does for grades 2-4 what Mike Kimmel provided at a higher level. This article appears in the fall 1993 issue of *The Elementary Mathematician*, a COMAP publication. If you are not familiar with COMAP, it is a nonprofit organization that has many excellent publications in K-16 mathematics. For information concerning membership to COMAP, you may call 1-800-77-comap, or write to COMAP, Suite 210, 57 Bedford Street, Lexington, MA 02173.

Poster and Project Reminder

Don't forget that application forms for the poster and project competitions for all grades are available from Kathryn Rowe, American Statistical Association, 1429 Duke Street, Alexandria, VA 22314-3402. Please note that in the poster competition, one rule has been changed. In the K-3 category, there is no limit on the number of students who can work on a single poster. This is in response to a request that indicated that often at the elementary level, activities are done as an entire class with all students participating in collecting data and, in this case, constructing a poster.

Speaking of the poster competition, Dale Seymour has recently published a soft-bound book entitled *Student Poster Projects—Winners of the American Statistics Poster Competition, 1991 and 1992*. It includes hints from the teachers who sponsored the winning students on how they got their students involved in the contest and motivated to learn and apply statis-

tics. It also contains four 17" x 22" color copies of winning posters.

A Reader's Request

I received a letter from Carol Blumberg, who has a request. She is doing a synthesis of the research on the learning and teaching of data analysis concepts and skills (not probability) in secondary and post-secondary schools, to be presented at the ICOTS IV conference. Topics of studies of interest include: descriptive statistics; exploratory data analysis; graphics (both creating and interpreting); inferential statistics; sampling/polling; survey questionnaire design; design of experiments; modeling (including using regression); and uses of computers and computer packages. If you have done such work or know others who have, please contact Professor Blumberg, who is on sabbatical, at C.J.BLUMBERG@SHU.AC.UK or 129B Greystones Rd., Sheffield S11 7BS, England.

Hello Out There!

I send another gentle reminder to encourage you to share your successful statistics activities with your colleagues through STN. We are all very interested in what is and is not working in your classroom. So, please share your expertise. To those of you who have contributed to date, a hearty thanks.

Keep Us Informed...

The Statistics Teacher Network is a newsletter published three times a year by the American Statistical Association—National Council of Teachers of Mathematics Joint Committee on the Curriculum in Statistics and Probability.

We need your letters, announcements, articles, and information about what is happening in statistics education! Please send hard copy, and, if possible, a disk written in standard ASCII text to the editor:

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or **moreno@jcvaxa.jcu.edu**

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