The Statistics Teacher Network

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Textbook Review

Introduction to Algebra and Statistics

The Ohio Math Project, Inc.
Green, Hubert, Kaiser, Martindale, Maynard, Schaefer, Silbaugh
EFA and Associates, 1992

Connections! If you believe that an introduction to statistics and algebra involves analysis of nondescript, irrelevant data sets, factoring, symbol manipulation, and meaningless equations, then this book is not for you. However, if you believe that data should be student generated or have real world connections and that algebraic concepts surface as students attempt to make sense of real world applications, then this book is for you.

Introduction to Algebra and Statistics, second in a two-course series, is written for students in grades 9-12. The Ohio Math Project, Inc., (Mathematical Activities that Help) was 100% federally funded through a Dwight D. Eisenhower grant. NCTM curriculum and evaluation standards are addressed. The NCTM's Addenda Series for grades 9-12 lists it as an innovative resource and comments that it ". . . is built primarily around statistics applications to graphing real-world data which eventually lead into algebraic ideas as ways to describe the relationships conveyed by graphing data" (148).

Real-world applications serve to motivate student involvement and interest as skills and concepts are mastered. Language used is readable, understandable, and not intimidating. An abundance of graphs, diagrams, tables, and charts are integrated into the text so as to captivate interest and promote understanding. Activities included are conducted in cooperative learning settings. Students are introduced to statistics as they organize, display, and analyze data collected from their responses to a questionnaire. Throughout the text, data are presented either from published sources or referenced to data-collecting activities for the students to perform. Given data sets draw from areas of student interest including sports, U. S. presidents, business, science, and school activities.

The book has 456 pages. Resources include worksheets available in student and teacher editions. The teacher's edition includes a test item bank. There are 10 units, each of which consists of 2 to 7 lessons. The first five emphasize statistics with the remaining stressing algebraic, trigonometric, and geometric concepts. Unit titles are: organizing and displaying data, collecting and reporting data, summarizing data sets, sampling, analyzing paired data, curves ahead, inverse variation, exponential curves, solving equations, geometry, and indirect measurement. Each begins with a unit overview. A listing of objectives, real-world applications, problem solving activities, student behaviors, and mathematical content follows. Lesson formats include: statement of objectives, a preview activity, introduction, discussion,

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practice activity, "try this," summary, and exercises. The preview activity can be completed quickly and promotes student interest and involvement. The introduction and discussion comprise instruction for topics covered. Practice problems provide input as to the level of students' mastery of required skills. Class work following practice serves as an opportunity for cooperative learning as students investigate activities relating to the mathematical content. "Try this" exercises provide guided practice. Topics are summarized and lessons conclude with independent practice exercises.

The first four units focus mainly on one-variable data sets. In the first, student responses to a questionnaire become the first data sets investigated. Data are organized and sorted by using tallies, Venn diagrams, matrices, and sequencing. Histograms, frequency polygons, stem-and-leaf plots are used to display data. Data collection and reporting become the focus for unit two. After collecting data from sources of authority and analyzing types of questions appropriate for inclusion in a questionnaire, students design a questionnaire. Data sets are summarized in unit three by finding the mean, median, and constructing box plots. Some of the box plots have outliers. Summary leads to analysis in unit four. Types of distributions and methods of sampling are addressed.

Two-variable data sets are investigated in unit five. Relationships between two variables are established as students examine contingency tables and scatter diagrams. Linear correlation and intuitive line fitting lead to median-median lines and residuals that require knowledge of addition of signed numbers. Algebraic concepts surface as students describe relationships between variables in words and find rules that fit data displayed in graphs or tables by writing linear equations. The linear family tree is introduced with the "granddaddy" being y = x. "Slide" and "stretch" branches lead to sketches of linear equations by transforming the "granddaddy." Students learn that members of the "family" have common characteristics. In unit six nonlinear rules are introduced. The "granddaddy" becomes y = x**2 as students fit data that produce curved graphs to rules that describe relationships among variables. Curves lead to inverse variation in unit seven. Exponential growth and decay lead to exponential and logarithmic family trees in unit eight. Linear equations are solved in unit nine and family trees become models used to describe data sets. Geometric concepts become important in unit ten with measurements of angles, similar and right triangles. The focus shifts to the right triangle trigonometry with tangent and sine ratios and the Pythagorean relationship. The sine function becomes a "granddaddy" for a new family tree.

Although the text fails to address the use of technology, this is a minor criticism. The reviewer had no difficulty in integrating the use of graphing calculators into the curriculum. In fact, use of these tools enhanced activities and conceptual understanding. It is the reviewer's understanding that products, including software applications, designed to enhance this text are being developed.

Introduction to Algebra and Statistics is an excellent introductory statistics and algebra text. Hands on and cooperative learning activities, real-world applications and problem solving promote student involvement, interaction and understanding. The text promotes "a positive classroom atmosphere which facilitates learning comprehension rather than applying rote memorization teaching methodologies." It is an excellent tool that should be used by educators who are "rethinking mathematics for today's student."

—Reviewed by Shirley Glover
T. C. Roberson High School
Asheville, North Carolina

Letter to the Editor

QL a Hit in Kansas

As a participant in a 1989 Quantitative Literacy (QL) workshop held at Washburn University in Topeka, Kansas, I became excited about the material available that made mathematics real. That year, I introduced a new one-semester probability and statistics course at Wichita High School West. Although a textbook had been adopted for the course, I was able to incorporate quite a number of units from the QL materials. The following year, I transferred to Derby High School where there was no class and very little statistics being taught.

As a newcomer to the district, I inquired about the possibility of adding a probability and statistics class. In early 1991, I was given the responsibility of designing the course and making a presentation to the district Curriculum Council. The course using QL materials was subsequently approved by the Council and the

Board of Education. My sincere appreciation to Gail Burrill for her assistance in the design and outcomes of the course.

The first offering of this semester course was last year. During the first semester, 26 students completed the course with 27 completing it in the second semester. Still designed as a one- semester course, all four QL books are used as the primary curriculum. In addition to this material, the district purchased the new set of statistics videos "Statistics—Decisions Through Data" and "Data Insights" software. Both of these packages are used to make statistics come alive and to teach units such as the correlation coefficient that QL does not introduce.

The results of the first two semesters have been gratifying, with students scoring very high. As practiced in the QL workshops, students complete their semester with two to three weeks of small group projects. During this time, there are three group evaluations that are incorporated into the individual student grade for the project. The project constitutes 18% of their final exam grade plus 2% coming from a multiple choice exam over course objectives.

Interest is increasing in the course. With an Algebra I prerequisite, there are some students who enroll who "need another math course"; however, increasingly the students coming from the upper level courses are choosing to take this practical mathematics class. There is sufficient enrollment for a class both semesters of the 1993-1994 school year. There will be continual modification of content and time-line as students come to the class more knowledgeable from prior course work. Since the Kansas Mathematics Outcomes and Assessment stress a working knowledge of probability and statistics, topics will be introduced at lower grades. As this becomes the standard, there will be less time devoted to the QL *Exploring Data* book and more time given to measures of central tendency and correlation.

Student responses have been extremely positive. They have learned that since these books have no answers in the back, daily application is necessary as is regular and consistent attendance and participation. The group project has introduced students to learning how to work with people they do not know or who come from different backgrounds. They are learning how to compromise and agree on the subject, method for gathering and analyzing data, and writing and presenting their report to the class. This learning experience has consistently been shared by students as a highlight of their experience.

Again, as students begin to study introductory topics in the elementary and middle schools, the high school course can evolve into a junior/senior class for the noncalculus student. This would give more students the opportunity to study more mathematics during their high school years.

Without the QL materials and workshop, this course would have been more challenging to create, and the selection of materials much more difficult to choose.

—Robert D. Keefer
Derby High School
Wichita, Kansas

Statistics in the Classroom

Coin Tossing and the Normal Distribution

Since 1987, the Nuclear Regulatory Commission has been supplying volunteers to Montgomery County schools in Maryland for classroom lectures, judging science fairs, mentoring, and other activities. In conjunction with this program, at the beginning of every school year I have been visiting Mrs. Greene's third-grade classroom in Flower Valley Elementary School where I talk about coin tossing and the normal distribution. Mrs. Greene likes to have me come in just before back-to-school night so that she can impress the parents with the histograms and normal curves that she leaves up on the blackboard!

I start my visit by asking the children to think of events that cannot be predicted, and they usually come up with the weather and sporting events. I then bring out a spinner with a horse's head on one side and a tail on the other and let the kids play with it. This leads directly to the idea of coin tossing, and we discuss what equal chance or 50-50 for heads or tails means. I write "probability" on the board and point out that while individual coin tosses cannot be predicted, we will see what happens when we perform a series of tosses.

All this is by way of introduction to the main activity. The teacher divides the class into teams of two and passes out a penny and a small paper cup to each team. I explain that each team member will toss the penny 10 times while the other records using tally marks, and then they will switch roles. I have found that shaking a penny in a paper cup is better than

having the kids flip or spin it, which is more difficult to do and often leads to the penny rolling on the floor. Before starting the penny tossing, we discuss the possible outcomes but I recommend against asking the class to predict the results. Once when I did this, the number of series with 5 heads and 5 tails was way out of line. After each team has performed two series of 10 tosses, I ask each child to tell me the number of heads he or she got, tally the results on the board, and construct a histogram. We discuss the pattern. If time permits, we repeat the exercise, plot a second histogram, and compare it with the first. Finally, I combine the two histograms.

Whether we do one or two series of coin tosses, I superimpose a line graph over the histogram and discuss what would happen if the sample size would increase. I then fit a normal curve to the line graph. I ask the class to suggest names for the shape (e.g., mountain, hat, bell) and I then tell them why it is called a normal curve. I use height, weight, and battery life (they are familiar with the Evercady commercial) as illustrations. Finally, I discuss exceptions to the normal distribution, such as income.

This lesson takes between 45 and 60 minutes (if two series are carried out). I have done it about a dozen times and I feel that I can get the ideas across reasonably well, even to third-graders. The lesson reinforces basic math skills such as recording counts with tallies and constructing bar graphs, as well as introducing basic notions of probability and data variability.

—Lee R. Abramson
U. S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research

Statistics in the Classroom

Sunday Morning "Moth" Selection—An Exploratory Data Analysis Activity

Natural selection is a driving force behind evolution. Selection for the individual organism may be either a positive or a negative factor. When acting on an organism in a positive manner, the organism survives and leaves more offspring in the next generation. When acting in a negative manner, the organism fails to thrive and leaves few or no offspring in the next generation. Natural selection, therefore, causes changes in the population by influencing the genetic composition of future generations.

I have my students use a model to demonstrate this principle. The model will be based on the idea that insects are sometimes protected from predators by camouflage. Insects protected like this either use shape or coloration or both to blend in with the background. If the camouflage is not very good, the insect is easier to find and will fall prey to the predators more frequently.

The exercise involves using a population of "moths" as the prey species. The predators are a species of "moth-eating birds." The "moths" are represented by shapes cut from the Sunday edition of the local newspaper. The role of the "bird" is played by a young person selected by the student.

The materials that are needed are: a copy of the Sunday paper, scissors, a long pointer, a 4-8 year old subject ("bird"), graph paper, a pencil, and a watch or stopwatch.

Students are given the following procedure to do over a weekend:

1. Cut out 20 moth models from the comic section of the paper. Cut them so that they have a wing span of about two to four centimeters. Try to make them look as much like real moths as possible.
2. Cut out 20 moth models from the classified or financial section. It is not important which one you use. Just make sure that there is lots of small print and no pictures or graphs.
3. In a clear space on the floor, spread out a full sheet of either the classified or the comic section. Distribute all 40 of the moth models over the surface of the page of newspaper. Make sure that none are on top of each other and that none are touching each other.
4. Bring your young subject into the room. Try not to let him or her see the newspaper on the floor. Have him or her stand with his or her back to the newspaper. Explain that he or she is going to pretend to be a bird. **Do not mention** anything about camouflage or selection. To do so would be to influence your subject's choice and bias the outcomes of the experiment. The kind of bird the "bird" is pretending to be eats moths. Show him or her a sample of each kind of moth. Tell your subject that like most birds he or she must feed quickly. It is dangerous for a bird to be on the ground too long! Each feeding session will last only 15 seconds. Demonstrate how the "bird" is to feed by using the pointer to tap the moth he or she wants to eat. After each moth is tapped, it must be removed from the newspaper before your "bird" can eat another one. Do this as quickly and effi-

ciently as possible without distracting your subject from his or her "feeding." After the 15-second feeding is over, record the number and kind of moths eaten and the background newspaper used on your data chart.

5. At the end of the 15 seconds, turn your subject around with his or her back to the newspaper again. Switch the background newspaper you just used. Turn the subject around and ask him or her to feed for another 15 seconds. Again record the number and kind of moths eaten and the background newspaper used. Also record the age and gender of your subject. Thank your subject for being such a good "bird" and give him or her a treat!
6. Now set up a graph but do not enter any data. Label the vertical axis "Classified Moths Eaten" and the horizontal axis "Comic Moths Eaten." Make sure that each scale goes from 0 to 20. The graph should be nice and big to show the results well. Do not enter your data yet. We will do that together in class by entering all of your results.
7. Before coming to class on Monday, draw a line on your graph that would represent the results you would expect to get if no selection occurred. Draw the line in pencil just in case your "guess" is a little off.
8. Bring your graph, a sample of your "moths," and your data chart with you to class on Monday.

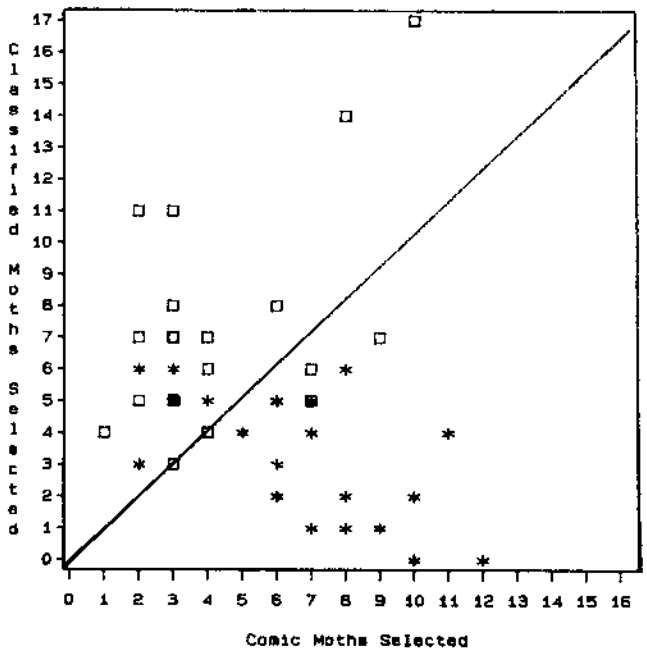

Figure 1. Sunday Morning "Moth" Selection.
Symbols: Comic background data are in squares. Classified background data are in asterisks.

The data chart is one sheet of paper that each student must complete with the following information: student's name, class, and period; date; subject's age and gender; results of each feeding—background type, number of comic moths eaten, number of classified moths eaten; and any observations or comments that the student had regarding the carrying out of his or her experiment.

From the graph, students easily see the effect of camouflaging. If there is no camouflage effect, all data would lie close to the 45 degree line. The comic background data are entered as asterisks and the classified as squares. Note that a "bird" easily found "comic" moths on the classified background while having difficulty finding classified ones there—camouflage effect!

—Michael Kimmel, Biology Teacher
Conneaut High School
Conneaut, Ohio

National Involvement

The Fourth Annual American Statistics Poster Competition Results

The American Statistics Poster Competition is a joint project of the Section on Statistical Graphics and the Center for Statistical Education. The basic purpose of the competition is to encourage our school children from kindergarten through the twelfth grade to use their creative skills to analyze data graphically. The contest is open to all public or private schools in the United States and Canada.

There are four categories: grades K-3, 4-6, 7-9, and 10-12. Prizes totaling $200 are given in each category. Plaques are given to the schools of the winning entrants. Honorable Mention certificates are awarded as well. The first contest in 1990 had 91 entries from across the country. The number increased to 152 and 530 but fell off to 287 last year. The quality of entries has increased each year. Dale Seymour Publications is producing a booklet of the winners from the 1991 and 1992 competitions with comments from the teachers of the students on ways to motivate and involve students in statistics activities.

1993 POSTER COMPETITION WINNERS

Grades K-3:

■ "The Seeds of Life: Comparisons of Plant Growth"
Raymond Guido, III
Saint Lawrence School, Huntington, Connecticut
Advisor: Naomi Macari

Grades 4-6:
■ "Hot, Cold—Drip, Drop"
Erin Black and Aaron Wolk
Schuyler Colfax School, Wayne, New Jersey
Advisor: Jill Gunderman

Grades 7-9:
■ "Clean Up Time"
Jeffrey Green and M. Thomas Marks
Rancho San Joaquin Middle School
Irvine, California
Advisor: Pauline Embree

Grades 10-12:
■ "Is There Association Between the Length of the Foot and Forearm?
Diane Marrapese
Magnificat High School, Rocky River, Ohio
Advisor: Lois Andressakis

1993 HONORABLE MENTION AWARDS

Grades K-3:
■ "What is the Favorite Planet of Boys and Girls?"
Kira Greco, Chris Gronkowski, and Gina Sobotka

■ "What is the Favorite Holiday?"
Eric Barber, Lyndsay Hall, Gina Sobotka, Lyndsay Trosterud

■ "What is the Most Popular Pet?"
Eric Barber, Adam Durfee, Kira Greco, Gina Sobotka
Heim Elementary, Williamsville, New York
Advisor: Eleanor Yuhasz

Grades 4-6:
■ "These States Generated 27,650,000 tons of Trash in 1991"
Tyler Tracy and Chad Parli
Cascade Brook School, Farmington, Maine
Advisor: Cynthia Herrick

■ "How is the Weather in Israel and Virginia the Same?"
Yael Or and Katie Hayes
Jack Jouett Middle School, Charlottesville, Virginia
Advisor: Sheila Porter

Grades 7-9:
■ "The Cost of Raising a Child"
Sara Alonso and Amy Looney
Churchill High School
San Antonio, Texas
Advisor: Roland Rios

■ "How Do Average 7th Grade Students Spend Their Allowance?"
Ryan Winters
Jefferson Middle School, Albuquerque, New Mexico
Advisor: Paul Mitschler

Grades 10-12:
■ "Birds of a Feather"
Sheila Ross, Dave Russell, Rachael Davida
Whitnall High School, Greenfield, Wisconsin
Advisor: Gail Burrill

The Seventh Annual American Statistics Project Competition Results

The American Statistics Project Competition is sponsored by the Center for Statistical Education. It offers an opportunity for students to work together as a team to discover the scope and applicability of techniques in statistics; to apply these techniques in what might be unfamiliar context; and to develop a critical appreciation of the logical progression from research questions to research conclusions, the scientific method in practice. Cash prizes are given in each of the grades categories 4-6, 7-9, and 10-12. Also, a special prize is awarded to the team submitting the statistics project making the best use of a computer. The winners for 1993 are as follows.

1993 PROJECT COMPETITION WINNERS:

Grades 4-6:
■ "Pilot's Plot"
Sarah Courtney, Brad Davis, Chip Sparrow, Katie Spurrier
Harbison West Elementary School
Columbia, South Carolina
Advisor: Pamela Spurrier

Grades 7-9:
■ "Conservation of Momentum: Kinetic Energy vs. Friction"
Darryl Langshaw, Brad Lodge, Ryan McCarlhan, Mike McLaughlin,
Solon Middle School, Solon, Ohio
Advisor: Karen Lenox

The Solon entry was also awarded the prize for best use of a computer.

Grades 10-12:
■ "Do Employment and School Work Mix?"
Sara Groff, Howie Thai, Ann Wilk, Jason Yellin
Henry Sibley High School, West St. Paul, Minnesota
Advisor: Gerry Brown

1993 HONORABLE MENTION AWARDS:

Grades 4-6: None

Grades 7-9:
■ "Does the Sex of a Person Affect Ones Reaction Time?"
Scott Barnhill, Shannon Knight, Britt Tucker
Tifton County Junior High School, Tifton, Georgia
Advisor: Renee Bridges

Grades 10-12:
■ "Is There a Preferred Choice?
The Quest to Discover What Doctors and Dentists Truly Recommend"
Kelly Adels, Tarryl Churchwell, Amy Kantor, Miriam White
Bellaire High School, Bellaire, Texas
Advisor: Diann Resnick

The brochures for the 1994 poster and project competitions should be available in November and can be obtained from Kathryn Rowe, Center for Statistical Education, American Statistical Association, 1429 Duke Street, Alexandria, Virginia 22314-3402.

Congratulations to all students who entered the competitions. Their interest in the practical use of statistics will go far in helping this country become quantitatively literate. By the way, I know that there are competitions elsewhere in the world started well before ours, England and Japan to name two. The poster competition in Japan has been held since 1955; the number of entries they receive in their total competition that includes categories beyond K-12 is around 80,000!

—Jerry Moreno, Chair
American Statistics Poster Competition

Software Review

Statistics Workshop

Statistics Workshop is an easy to use software program for the Macintosh that provides students in grades 6 through college with interactive environments in which to explore data and learn statistics. The program provides a simple data base for students to use to enter and explore data using histograms, bar graphs, box plots and scatterplots. It will calculate basic descriptive statistics, correlations and regression lines. Some data sets are included and used in sample activities. The package is available from WINGS for Learning/Sunburst, for $129.00. An accompanying teacher's guide includes teaching ideas and sample activities as well as information on the role of statistics in the mathematics curriculum, the processes involved in analyzing data, and an overview of basic concepts in statistics that would be useful for teachers with a limited statistical background.

A reference guide explains all aspects of the software program, provides details on each type of plot, and explains special commands that allow you to further analyze the data, such as subdividing the data set into different groups. Some unique features of this software are described below.

"Stretchy histograms" allows the user to construct and manipulate histograms using the mouse to raise and lower bars, and which prints on the screen (below the histogram) the mean, median, and mode. This program allows students to explore the relationships among the measures of center as different shaped histograms are created and modified.

"Exploding Boxplots" allows multiple box plots to be shown on a single screen. This feature allows students to compare multiple groups on a single variable, or to subdivide one group into subgroups and compare them on the same scale.

"Shifty Lines" allows students to experiment with fitting a line to data on a scatterplot. This feature allows students to observe the change in slope and y intercept for different lines fitted to the same scatterplot, and to read a "fit meter" indicating how well a particular line fits the data.

The Statistics Workshop software is easy to learn and use, the materials are well-written, and the suggested teaching activities are excellent. Although some data sets are provided, teachers are encouraged to have students generate or gather their own data to input on the data base and then analyze.

I have used some of the software programs in my introductory statistics class for college students. I have found that "Stretchy histograms" is a wonderful way for students to create different shaped graphs, and to use these to develop an understanding of where the mean and median are located in these graphs. In one activity I use, students are guided to create uniform, bimodal, skewed, and bell-shaped distributions, each time recording the mean and median. After they hypothesize the relative locations of these measures for each type of graph, they are instructed to generate another set of graphs for each shape, and to determine if their hypotheses were confirmed.

I have found that the "Shifty lines" program works well if you have a set of bivariate data that you know is linear. (The program includes a set of cricket chirps and temperature data that does have a strong, linear relationship.) I instruct students to experiment with the line until the "fit meter" shows that it is the best one, and then compare it to the actual regression line (which is provided by the computer when requested). It is also useful to try this with nonlinear data, to show how a regression line can be constructed that best fits the data and to illustrate how much error results in fitting this line.

Statistics Workshop software may also be used by students in an introductory course to enter and analyze data as part of individual or group projects, without requiring students to learn details of a more complicated software package.

—Reviewed by Joan Garfield
University of Minnesota
Minneapolis, Minnesota

Moreno's Memo . . .

I trust that you all had an interesting and educationally productive summer. I'm still checking my mailbox hoping to find it filled with "Statistics in the Classroom" articles I requested (begged?) in the last issue of STN that you write to share with your colleagues! The assignment is still out, so feel free to receive your automatic "A" grade by getting an article to me. Thanks.

A couple notes: The May 11, 1993, Volume 12, Number 9 issue of *PC Magazine* reviewed 13 powerful statistics packages: BMDP/386 Dynamic, Genstat, Minitab, NCSS, P-Stat, SPSS for OS/2, SPSS for Windows, SPSS/PC+, Stata, Statgraphics, Statistica/DOS, Systat for DOS, and Systat for Windows. Prices begin at $395 for complete versions.

Teaching Statistics is an excellent publication from England that contains regular features and articles for teachers of students aged 9 through 19. It is designed to help teachers of mathematics and statistics teach in exciting and creative ways as described in the NCTM Standards. It is published three times a year in February, May, and September. Reduced rates for NCTM members are available. Contact Teaching Statistics, Dept. of Probability and Statistics, University of Sheffield, Sheffield S3 7RH, England.

For those of you who have access to internet, you may be interested in the new electronic *Journal of Statistics Education* that aims to publish high-quality articles on a variety of topics related to the teaching of statistics. It is for postsecondary teachers of statistics. Specific information may be obtained from E. Jacquelin Dietz, Dept. of Statistics, Box 8203, North Carolina State University, Raleigh, NC 27695-8203. (919) 515-2585, dietz@stat.ncsu.edu. Also see the December issue of *Amstat News*, pages 31-32. The JSE is supported by the Department of Statistics at North Carolina State University.

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 **fax: (216) 397-3033**

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