The Statistics Teacher Network

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Feature Article...

American Statistical Association Center for Statistics Education

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One of the major goals of the American Statistical Association (ASA) is the shaping of statistical education. The Center for Statistics Education (CSE) was established to oversee and centralize different ongoing efforts to better statistical education and develop new directions and methods. More information about the extensive involvement of ASA in statistical education is available on the ASA's web site at *www.amstat.org.*

The CSE has developed several programs suitable for kindergarten through high school education and more are being planned. Statisticians have worked for years with legislators and education specialists to incorporate statistics in the K-12 curriculum. As a result of these efforts, in most states, statistical tools and methods have been incorporated in mathematics courses. Many high schools are offering courses in statistics, some at two levels, basic statistics and Advanced Placement (AP) statistics. Successful completion of the AP statistics exam earns students credit in many colleges and universities. The Advanced Placement program is a cooperative effort of secondary schools, colleges, and the College Board. Through this program college level courses and examinations in several subjects are available for high school students. About 845,000 students took 1.4 million AP exams last year in 35 different courses. From 1997 to 2001, the number of students taking AP Statistics exam increased from about 8,000 to about 42,000.

The K-12 school membership program invites schools to become members of the ASA. A one-year membership subscription entitles the subscribing school to *Chance Magazine*, *STATS: the magazine for Students of Statistics*, the *Statistics Teacher Network Newsletter* as well as the yearly directory of *Schools Offering Degrees in Statistics.* These schools also pay much reduced membership dues, lower than the institutional membership dues, even lower than the individual membership dues. The publications provide teachers of statistics in high schools with some teaching materials, information about professional development, and information useful to help students make decisions regarding future educational opportunities.

Another program developed by CSE is the Adopt-a-School program. The purpose of this program is to enable professional statisticians to help schools in their efforts to include statistics in the curriculum. Many teachers are enthusiastic about bringing quantitative literacy to their classrooms, but lack the background and formal training to do so with confidence. Statisticians make contact with teachers and administrators to arrange visits to the classroom. Key to the success of this program is the statistician's close work with the classroom teacher. Teachers welcome the assistance

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of professionals in the field. In 1992, twelve local ASA Chapters were chosen to test this program. Using sets of materials sent out from the ASA office, the Chapters began trying out the program. In 1993, twenty-three more volunteers received updated versions of the materials and began similar activities. Since then, statisticians have continued to work with teachers at many schools. The program was originally intended to be a Chapter-level activity. Some Chapters made wider use of the materials than others, involving several Chapter members and several schools. Others had effectively a one-person one-school experiment.

To promote the use of data analysis, statistics, and probability in the classroom a new series of programs called Quantitative Literacy (QL) was developed for serving elementary, middle, and secondary grade levels. These programs have prepared materials and a workshop format that are used to instruct teachers in these areas and present fun, hands-on ways for them to teach their students. The CSE helps those interested in bringing QL to teachers with the necessary arrangements. Information about the funding opportunities and other aspects are available on the ASA's web site. In the QL series, programs such as Bring QL to your teachers, QL publications, QL classroom projects, QL workshops for elementary, middle school, and high school teachers, AP statistics workshops, and more are available.

Several ASA publications promoting statistical concepts and education are available for teachers. *The Statistics Teacher Network* is a joint venture of ASA with NCTM (National Council of Teachers of Mathematics). The newsletter is published three times per year. Several publications such as *Guidelines for Teaching Statistics, Mathematics in a World of Data, Probability Through Data, Exploring Projects, Exploring Linear Relations, Advanced Modeling and Matrices* are available from Dale Seymour Publications. ASA also publishes two magazines that promote statistical concepts. *STATS: The Magazine for Students of Statistics*, provides practical educational and career information, often from students themselves, lively accounts of statisticians at work, and topical examples of statistically challenging problems in everyday life. *CHANCE*, a quarterly magazine published with Springer Verlag, New York Inc., is a general interest publication featuring the application of statistics to topical issues and problems—from political polling to toxic waste to sports statistics. In addition, ASA publishes a variety of brochures such as *Minorities and Statistics, Careers in Statistics, Women in Statistics*, and *Surveys and Privacy*, available free of charge in small quantities, and for a small charge for large quantities. *The Journal of Statistics Education* (JSE) is an online publication featuring teaching methods and methods for improvement of conceptual understanding of statistics.

K-12 teachers are encouraged to participate in ASA's annual Poster and Project Competitions. Teachers encourage and direct students, either solo or in groups to prepare entries for these competitions. Local statisticians also help in the process. A committee of distinguished statisticians and dedicated teachers of statistics meet in May each year to evaluate entries. The deadline for both contests is April 15, annually. Winners receive cash awards and ASA certificates for their efforts. These posters are also displayed at the annual Joint Statistical Meetings (JSM) in August every year and at the ASA/NCTM booth at the NCTM annual meeting. A statistical project is the process of answering a research question using statistical techniques and presenting the work in a written report. A statistical poster is viewed as a display containing two or more related graphics that summarize a set of data, look at the data from different points of view, and answer some specific questions about the data. The number of entries in these competitions has grown to almost 2000 in a short period of time.

To provide teachers of statistics with exemplary practices and materials to enhance their understanding of content of the AP course, to enable to cover content of AP syllabus more effectively, and encourage them to try innovative forms of teaching to meet the needs of their students, AP statistics workshops have been developed. The AP syllabus covers most of the topics taught in a college level introductory statistics course based on modern data analysis. The course also emphasizes the use of appropriate technology for graphical displays and computation, and use of hands-on activities to teach concepts. The CSE also offers Beyond AP Statistics, a course for experienced teachers. It covers statistical topics that extend beyond the AP syllabus thus enriching teachers' understanding of statistics enabling them to better instruct their students and preparing them for further studies in the discipline.

The Curtis Jacobs Memorial Prize was established in 1991 by the ASA Washington Statistical Society chapter to honor the memory of a former statistician of the U.S. Bureau of Labor Statistics. Mr. Jacobs served as the chief statistician on many major federal economic statistics programs, including the Consumer Price Index, which measures the rate of infla-

tion in the American economy. The Jacobs Award program provides encouragement for students to gain an understanding and appreciation of surveys and their uses, appreciate strengths and weaknesses of statistics reported in the press and elsewhere, gain understanding of how surveys are taken and how results are reported. High school or middle school students in the Washington, DC area participate in the competition. Their projects may focus on the role of sample surveys as a way of gathering information for making decisions, as a way to make comparisons among groups, or as a way of collecting data for analyzing trends over time. All entries are judged based on the creativity in the choice of objectives and topics, understanding of the steps needed to conduct a survey and proper execution of steps, selection of appropriate sample selection methodology, thoughtfulness and ease of questionnaire design, and analysis. The winning team is awarded $200 in U.S. savings bonds, and is invited to the Washington Statistical Society's annual dinner where the prize is awarded. The supervising teacher is awarded a plaque and a dinner invitation. The school is awarded a one-year free school membership to ASA.

Information about example programs in statistics, schools offering degrees in statistics, internships available, scholarships, and awards, etc is compiled and made available. Such information, available in one place, is useful for teachers in advising students in career opportunities, and for students in developing their careers in statistics. Information on career opportunities, professional opportunities, and job availability made available on the ASA's Web site as well as through publication of *Amstat News* is also useful in student advising.

In September 2000, the first career issue of *Amstat News*, the membership magazine of the American Statistical Association was published. This issue contains *Statisticians in History, A Day in the Life of a Statistician* (described by several statisticians working in diverse areas), *The Future of Statistics, Career Corner: What we do with degrees in statistics, Preparing Curriculum Vitae, Finding Jobs in Statistics*, etc. Again in September 2001, a career issue was published, and judging from the response received, ASA will continue to publish career issues of *Amstat News* in future.

Teachers are always looking for the latest teaching methodologies, projects, hands-on-activities, etc. Considering how fast the technology is changing and its deep impact on how we do statistics, statisticians are on the lookout for the latest technological developments geared to do statistics. Many professional development activities such as courses, workshops, on-job-training, videos, and professional conferences are made available for teachers.

Conferences provide an excellent opportunity to share ideas, experiences and knowledge with others. ASA organizes one big annual meeting known as the Joint Statistical Meetings (JSM) every August with help from five other sister societies/organizations. The Institute of Mathematical Statistics (IMS), International Biometric Society's Eastern North American region (ENAR) and Western North American region (WNAR), and Statistical Society of Canada (SSC) are partners of ASA in this joint venture. This is a big event with approximately 4,000 attendees converging at the conference venue from all over the world to share their knowledge with others. The conference venue changes from one part of U.S. to another every year. Since ASA partners with SSC, about once a decade the joint meeting is held at some location in Canada. The JSM offers over 25 parallel sessions for four days. Invited and contributed presentations, poster presentations, round-table meetings provide multitudes of opportunities for professional development. ASA also sponsors regional special topics meetings. ASA also works with other organizations such as NCTM in developing programs at their meetings. Many sessions related to statistics education are organized in these meetings. Many high school teachers are invited to share their ideas and experiences with attendees.

ASA offers Continuing Education (CE) activities at JSM and outside. Although a major thrust of CE is at JSM, the CSE also takes the show on the road under the umbrella program called LearnSTAT. The CSE identifies locations around the country with the need for education in specific topics and matches them with leading statisticians. The CSE is certified through the International Association of Continuing Education and Training (IACET). IACET is an internationally recognized organization for standards and certification for continuing education and training. This organization ensures quality in continuing education through its programs, publications, and research, and aids ASA in meeting its criteria and keeping in compliance. The CE program offers 1-day and 2-day courses and workshops at JSM and around the country. CSE also offers workshops in statistics in conjunction with conferences of other organizations such NCTM or Mathematical Association of America (MAA).

Most of the education related information is available at *www.amstat.org/education.*

Pretzel Patterns

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Students were able to make predictions, identify shapes and patterns, and record and display data. This lesson can be modified to meet the needs of a wide range of learners. Vocabulary and concept knowledge of congruent, adjoining and contiguous was a prerequisite.

The problem presented was "How many pretzel sticks are needed to make a congruent, an adjoining and a contiguous square? How many squares can you make with 27 pretzels?" Twenty-seven pretzel sticks per student and recording sheet for squares and triangles were distributed.

Students were asked to predict how many pretzels are needed to make a congruent, an adjoining, and a contiguous square, and to predict how many squares you can make with 27 pretzels. They recorded predictions in the data sheet.

With a partner, students were to arrange four pretzels into a square. Next they used three more pretzels to make a congruent, an adjoining and a contiguous square. They now had two connected squares. Students continued manipulating the pretzels to determine how many squares they could make with 27 pretzels.

Next, students arranged three pretzels into the shape of a triangle. They used two or more pretzels to form a congruent, an adjoining, and a contiguous triangle, creating two connected triangles.

Then the students added more triangles, one at a time and each time, recorded the total number of pretzel sticks and the total number of triangles made. They continued creating triangles, looking for a pattern.

Students compared findings including predictions and discovered patterns and shapes. (There is more than one way to form the shapes so patterns and predictions may vary.) We graphed the class outcomes including number results, patterns and shapes. A scoring rubric was utilized assessing graph accuracy to include: labeling, alignment, title, accuracy and neatness. Individual handouts were assessed for completion.

As an extension, contact the National Pretzel Bakers Institute for data and figures related to popcorn. Challenge students to use the data to calculate the approximate amount of revenue that producers earn per pound of pretzels, based on the average price that consumers pay.

A reference is *Munchable Math: Appetizing Adventures in Math Investigations* by Lisa Crooks

NASCAR Slope

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This lesson can be used after any scatter plot lesson, graphing of linear equations and best fit lines. It can supplement any linear equation section to reinforce the meaning and interpretation of slope. The benefit of this lesson is that students will understand linear and non-linear data. They will use slope in a real-world application of a line and write an explanation.

Lesson objectives are to interpret data using a scatter plot, to show data as a linear model, and to represent the slope of a line using data. Statistical topics addressed are construct and interpret scatter plots and create linear model using data. Other topics addressed are to find mathematical associations from data as well as from a graph and to write linear equations.

Students should be able to make scatter plots, calculate lines of best fit, and have some understanding of slope as prerequisite skills.

Students entered race 19 of 36 in the 2001 season. The information was collected from the *www.nascar.com* and given as a handout.

Using graph paper and the graphing calculator students made a table of values for points and winnings of the first 30 drivers. A scatter plot was made from the lists (points x-axis, winnings y-axis). Students were asked to iden-

tify an association of the data if any.

Next they drew an "eye-ball" fit line using the calculator or a piece of transparency on the window of the calculator. Students drew and wrote the equation of the line of best fit for the scatter plot.

Then they compared and contrasted the student drawn line and the best-fit line. Using the equation, students determined the slope and wrote a statement that represented the rate of change.

Outliers of the data were identified. Students discussed and wrote an explanation of real-world conditions that could affect a driver's winnings.

Finally the students compared the drivers in first and second place. They wrote a paragraph to explain their reasons for the amounts earned by each driver using all the information from the chart.

Investigating Apples...

Investigating Apples

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Investigating Apples is one of the several MESA Series modules that I have explored. The MESA Series is a cross curriculum that connects pre algebra topics and science investigations through hands-on experiences that excite students. This module connects students and statistics with real-world mathematics and science. Students collect, organize, represent, and interpret data. The module utilizes the statistics used in the apple-growing industry and includes: Career Links to Food Scientists, Apple Growers, and Statisticians; History Links to Rachel Carson and Gertrude Mary Cox; Writing Link to Taste Tests; Interest Links to The Harvest, Pomology, and Apple Facts; and Technology Links to Controlled-Atmosphere Storage and Apple in a Can.

The first of five activities introduces students to pomology, the science of growing fruit. Students discuss how apples displayed in a store appear to be the same size, but are different sizes when growing on a tree, to how apple size is determined. When the approximate masses for a size of apples is shared, students are asked if every size–80 apple is the same. Three dozen of three varieties of size–80 apples are given to small groups who collect data on the masses of the apples, then display the data using a line plot. After writing a one paragraph summary of the statistical data and their interpretations, groups discuss the center and spread of distribution: extremes, range, outliers, clusters, gaps and the median mass of each variety.

The next activity introduces students to statistics and the wide range of career opportunities for a statistician. Working in small groups, students create and explore the stem plot using the data collected previously on the mass of their size-80 apples. Sharing data, back-to-back stem plots are created to compare the mass values of two varieties of apples. Students discuss the advantages of the line and stem plot, which they prefer, and situations where one type might be preferred.

The following activity introduces students to a new measure relating to spread, the quartile. Students begin by listing the mass values in order from least to greatest dividing the data into four equivalent groups. The lower extreme, lower quartile, median, and upper quartile, and upper extreme are determined and the box plot is drawn for the variety of size-80 apple. This five number summary is shared with the other groups and the box plots are created using the same number line. The varieties of apples we used were New Zealand, Grannysmith and Red Delicious. My students found the box plot gave the most pronounced visual effect of the difference in size-80 data for the three varieties. Though we were using the same data as used in the construction of the line plot and stem plot, the discussion was lively concerning the advantages and disadvantages of each type of plot. Conclusions were drawn about the sizing of apples based on their data.

During the fourth activity students investigate further questions that relate to an apple's size by collecting data on the height and diameter of the size–80 apples. Students decide how the height and diameter will be consistently measured. Line plots, stem plots, and box plots are created and examined. With this additional information students are asked to consider how the size of the apple is determined. Is height or diameter the best fit with the mass of the apple? My students were surprised to find the dimensions and masses were proportional. During each activity the three small groups created plots first with the data collected and then a plot with the data from all three groups. Students explore the advantage of creating a spread-out stem plot to determine the shape of the data.

The fifth activity has students create scatter plots to investigate the association between height and mass and between diameter and mass. Student understanding of cause–effect relation was an interesting discussion.

My students loved handling food and were careful not to bruise the apples. The apples were stored at the end of each class period in the kitchen's cooler to extend shelf life. The students suggested adhering their plots to giant-sized apples representative of the particular variety and display them in the hallway. Teachers and students alike were seen stopping to examine the plots.

The final activity is an apple taste-testing survey and opinion poll conducted with the student's family. Using five or more varieties of apples students collected data on the flavor and texture of each variety. This is an excellent time to discuss random sampling and bias as the students discuss how they might set up the family taste-testing survey. We did not include the apples used in the previous data collecting activities after discussing the wisdom of not ingesting food that had been used around scientific equipment.

Investigating Apples
The MESA Series
University of Washington MESA
(Mathematics, Engineering, Science Achievement)
Nancy Cook and Christine Johnson

Catapults and Candy...

Catapults and Candy

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9th and 10th grade mathematics

Judy Buckler
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8th-12th grade mathematics

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9th and 10th grade mathematics

Students perform an experiment and form an equation of an eyeball fit line to make predictions. This lesson was used with Algebra I students when working on graphing and coming up with the equation of a line. It was taught in conjunction with the Data-Driven Mathematics Exploring Linear Relations pages 130–132 of the Data–Driven Mathematics series.

The materials needed for each group included: Gummy Bears, two ice cream sticks, two rubber bands, pencil, calculator, graph paper and ten small blocks. The statistical topics addressed include eyeball line of best fit, scatter plots, and data gathering. The mathematical topics addressed include calculations, graphing using x and y coordinates, and slope of a line. Students should have some previous experience in graphing.

Given instructions for constructing the catapult, students built catapults. After we modeled how to conduct the experiment, the student catapulted a piece of candy and measured the distance it flew when catapulted at different heights. The students recorded the data on a scatter plot and answered questions related to the experiment.

Students gathered data in a very exciting lab. This hands-on activity was of interest to the students. They were able to catapult candy around the room, but at the same time, the students are recording data to eventually make a scatter plot and answer questions associated with the graph.

World Vision...

World Vision

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Do students realize how many people living in North America, compared with the population of the world, how much surface area the United States has compared to the world, and the food consumption of the United States compared to that of the world?

The objective of this lesson was to allow students to create different visual representations of percentage problems and use those representations to make comparisons. Students should be able to form percents from data and understand organization of thoughts as prerequisites for this lesson.

Introducing the lesson, students were told that they would simulate population, land surface area, and food consumption of the worlds continents. A review was held on how to find percents of data (for example, 8 of 30 students are girls which is approximately 26.7%).

Discussion was held with students on how the population of the world has increased dramatically in the last 150 years. Students were asked if the world is the same size and as the population keeps increasing, what is happen-

ing in and around us (Possible answers include: overpopulation, pollution, and food shortages). A worksheet was distributed in which pairs of students calculated percentages for population, land surface area, and food consumption of the worlds continents.

After 15-20 minutes of work, each question was discussed. Students were then told they would simulate what this looks like. Students clustered desks to approximate the percentage of population (for example, North America has 16% of the land, then 16% of the classroom desks is equal to North America).

Now students were assigned to a continent as percentage of population (for example, North America is 6% of the world population, then find 6% of your class to sit at those desks).

Candy was distributed to each of the continents as percentages of food consumption that was determined (for example, North America has 28% of the world food consumption, so they were given 28% of all the food).

As an extension, use the percent data for area and for population of the continents to make a scatter plot with the percent of Earth's land area on the horizontal axis and the percent of Earth's population on the vertical axis. Then ask students to write a short paragraph describing what the plot shows about the relationship between area and population. In addition, use the percent data for population of the continents and food consumption to make a scatter plot with the population on the horizontal axis and food consumption on the vertical axis. Ask students to write a short paragraph describing what the plot shows about the relationship between population and food consumption.