THE STATISTICS TEACHER NETWORK

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THE ROLE OF STATISTICS AND PROBABILITY IN THE NCTM STANDARDS

The National Council of Teachers of Mathematics has released a draft version of the Curriculum and Evaluation Standards for School Mathematics which represents a vision of the mathematics that should be a part of every child's education. Statistics and probability have prominent places in this working draft which was prepared by teachers, teacher educators, supervisors, mathematicians, and researchers for the NCTM Commission on Standards. "...in various classrooms, one could expect to see students recording measurements of real objects, collecting information, and describing their properties using statistics,..." The document has been divided into four parts: standards for grade levels K-4, 5-8, 9-12, and an evaluation component. The following article gives a general overview of the standards as they relate to the areas of statistics and probability. At the end of the article, several questions are posed as "food for thought". The Joint Committee would appreciate any input from Network readers regarding these issues as well as any other pertinent comments. This input will be included in our response as a part of the reviewing process established by the Commission.

Standard 10, statistics and probability for grades K-4, states that students should be able to collect, organize, and display data; make and verify predictions from data; be familiar with experimental concepts of probability; and use statistics to solve problems. Activities at this level should be experimental and exploratory with students posing questions, deciding what data to collect, and determing how to organize and interpret that data to obtain an answer to those questions. Students are encouraged to construct their own graphs using their own data and to compare several different ways of graphing the same information. The discussion stresses many different methods of displaying data in increasing levels of complexity beginning with creating bar graphs from actual physical objects to using graphs with different scales. Probability should be presented in terms of simple experiments where students generate results and use them to explore the ideas of chance and of likely outcomes. The essential aspect of both statistics and probability in these early grades is that of investigation and actual involvement by the students to establish a firm foundation for work in the upper grades.

Standard 9, statistics for grades 5-8, extends this view of statistical investigations by having students systematically collect, organize, and interpret real world data. An added dimension is the expectation that students will also describe data, construct reasonable arguments, and evaluate arguments based on data analysis. Students should understand their role as consumers of statistics in society and be able to use their knowledge to make intelligent decisions. Again the emphasis is on active involvement of the students in

collecting their own data from areas of interest to them. Graphical displays, extended to include stem-and-leaf plots and box plots, should be presented in conjunction with descriptive statistics such as measures of central tendency. Computer software with data base and graphing programs can be used to allow the students to focus on data interpretation and to construct and evaluate arguments based on their analysis.

At this level, Standard 10 (probability) concentrates on modeling situations. Included are the use of simulation to provide answers to probability problems and the study of both empirical and mathematical probabilities. Probability should be studied as it occurs in the real world where predictions and decisions are made about events in areas such as business or science. Students should continue to be actively involved in experimentation as their development in understanding grows to include numerical measures as descriptors of the data. Here the notion of variation and degree of certainty can be explored comparing several different experiments or using a computer generated simulation. Predictions can be made from graphed data, thus relating the statistics standard to the measure of the likelihood of an event. Students should begin to explore the notion of sampling, of bias, and of their significance in making valid predictions.

Standard 9, statistics for grades 9-12, continues the study of data analysis and statistics to enable students to make inferences from summarized data describing real world situations. It incorporates experimental design as a way to study problems so that the students recognize the significance of sampling and logical reasoning in their conclusions. Measures of central tendency, variation, and correlation become statistical tools, and the process of fitting a curve to real data is used to make predictions. For college bound students, additional objectives include data transformation and its effect on measures of central tendency and variability, selection of appropriate sampling methods, and hypothesis testing. The essential spirit of this standard is to use the knowledge gained from the students' K-8 experiences to solve problems, to answer questions, and to evaluate statistical arguments they encounter in their environment. Communication is a major component in understanding data and extracting pertinent information from it. As much as is possible, the data should be chosen from other disciplines and related to other mathematical topics. College bound students should be able to derive certain algebraic results (like the simplified variance calculation), and their curriculum should include a study of normal and chi square distributions.

Standard 10, the probability standard for grades 9-12, indicates that students should be able to represent and solve problems with experimental probability, theoretical probability, or simulation using whichever method is most appropriate for the situation. All students should be familiar with the common probability distributions. College intending students should also be able to generate and interpret probabilities using the standard models and should understand the concept of randomness. The use of simulation and actual experiments should help students develop an intuitive sense of probability needed to evaluate and interpret the validity of statistical claims and to solve probability problems. Simulation techniques are stressed as a way to model complex real problems and as a mechanism to explore the variability in a situation. "Formal definitions and properties should be developed only after a firm conceptual base is established so that students do not indiscriminately apply formulas when solving probability problems." Simulation should also be used to generate approximations of distributions. Not only should college intending students explore the relationship between the distributions, but they also should investigate probability and random variables as function concepts.

-Gail Burrill
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FOOD FOR THOUGHT
CONCERNING THE STANDARDS

At several different places throughout the 5-12 standards, the suggestion is made that students simulate a probability problem and then work the problem theoretically. What relation should exist between the theoretical and the simulated approach to a problem? Should students be encouraged to check theoretical results by simulation, simulated results by theory, or neither? At what level, if any, should this be explored? How do we address the problem of the "real" answer?

Should hypothesis testing be a part of the recommendations for all students or only for college bound students? Is the concept of confidence intervals sufficient?

When and how should students experience the concept of the normal distribution? When should they distinguish between discrete and continuous distributions? Which of the distributions are significant and for what level of student?

Should the concept of variation become a part of the data handling in grades 5-8? When should the concepts of variance and standard deviation be introduced?

Should the traditional counting procedures, permutations, and combinations be a part of the probability strands? When and why?

Should there be a separate statistics strand or course at the high school level or should the concepts be integrated into the rest of the mathematical content?

Should any students be expected to derive formulas? If so, which ones and at what level?

Please send your responses to these questions, your recommendations on the issues raised, or any comments you may have about the Standards to the chair of the Joint Committee, Gail Burrill, at the address given at the end of her article on the previous page. -Ed.

HELP!

THIS SECTION OF THE NEWSLETTER IS FOR YOUR QUESTIONS. SEND YOUR REQUESTS TO THE EDITOR. IF YOU HELP ANYONE SOLVE A PROBLEM, PLEASE MAIL A COPY OF YOUR LETTER TO THE EDITOR SO THAT OTHERS MAY BENEFIT FROM YOUR REPLY.

The ASA/NCTM Joint Committee is preparing a teacher resource book for the Quantitative Literacy Project. This book will support the QL materials, especially Exploring Data. If you have used Exploring Data or any of the other QL materials, we would like to hear from you. Please tell us what would be helpful to you, e.g. additional data tables, more tests and quizzes, additional sources of data, or suggestions for student projects.

We are particularly interested in activities you have built around the tables in Exploring Data. We would also appreciate your sharing interesting data sets which you have located, teaching tips, and examples of student projects. Any material used in the final version of the book will be credited. Please send all suggestions and examples to:

-Ken Sherrick
Berlin High School
139 Patterson Way
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I am Development Manager for High School Mathematics at Sunburst Communications, Inc. We are currently planning computer software in the area of statistics and data analysis. Since our planning is at the most beginning stage, I am searching for teachers who are currently instructing high school statistics and are already using computer software in their courses to help review and suggest modifications to any statistics products we develop. I would also like to obtain resource lists of recommended statistics materials appropriate for high school use. If you are interested or can offer suggestions, please respond to me at the address below:

-Lois Edwards
Sunburst Communications Inc.
Pleasantville, NY 10570

LETTERS

PLEASE WRITE TO THE EDITOR IF YOU WOULD LIKE TO SHARE ANNOUNCEMENTS, BOOKS, ARTICLES, IDEAS, OR LESSONS THAT HAVE BEEN SUCCESSFUL IN YOUR CLASSROOM.

Business and industry use statistics everyday and are eager to share their experiences with our students. For the past few years, I've been inviting business and industry practitioners to share some everyday statistics applications with my classes. W. Edward Deming's admonitions to improve statistical process control or go out of business are more relevant to teenagers if they relate to clothes, food, and other daily concerns.

A textile (denim) manufacturing executive explained the "JUST IN TIME" concept now widely used in many industries. It eliminates the costs of inventory storage but demands a high degree of reliability. To a teenager, significant difference, margin of error, and quality control are more important when you are talking about blue jeans.

A doctor presented the problems of AIDS testing and the ramifications of type I and type II errors. The classic question of drug effectiveness generated a discussion on the the use of generic drugs as a cost containment strategy. The students now realize that the medical profession views statistics as an indispensible diagnostic and treatment aid.

Since product appeal is integral to consumer purchasing decisions, surveys are used by snack food manufacturers to test their products. One illustration outlined by a statistician involved a situation where a product was not selling well in one area of the country. Careful analysis of the data yielded a machine failure at one manufacturing plant which had the potential for destroying the popularity of an entire product line. On another visit we learned about testing different attributes of a particular cookie.

"Statistical Process Control" (SPC) has three components: controlling the process, improving the quality, and increasing productivity. A manufacturer of jet engine parts explained that, in order to achieve a high level of SPC, his company requires all employees to participate in a 15 hour statistics class. They learn basic concepts such as variation and ways to measure it, significant difference, the normal distribution, and how to present data in order to improve SPC. Sampling techniques enable machine operators to get reliable measures even when they test only a few products.

Statistics books are filled with examples and problems, but the best illustrations are the ones you provide by inviting representatives from local businesses into your classrooms. Students see mathematics in action and are introduced to career opportunities. Best of all, business and industry leaders can assume a supportive role in the task of mathematics education.

-Helen Purks
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While on study leave, I am examining high school statistics course syllabi and visiting high school statistics teachers to learn about their texts, workbooks, use of computer assisted instruction, use of computers in data analysis, examinations, selection of students for courses, reponse of students after taking the course, follow-up of such students, and recommendations for course improvement. For your information, I have a report of a preliminary survey of state boards of education revealing which states have guidelines for teaching statistics.

If you are interested in providing me with copies of your syllabus and/or being interviewed about these topics by telephone or in person, please contact me at the address below. All participants will receive a content analysis of the syllabi and all materials developed during the study.

-Norman M. Chansky
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Philadelphia, PA 19122

NEW PUBLICATIONS AND PRODUCTS

Stigler, Stephen M.
THE HISTORY OF STATISTICS: THE MEASUREMENT OF UNCERTAINTY BEFORE 1900
Harvard University Press
79 Garden Street
Cambridge, MA 02138
1987, Cloth Text, $27.00

This superb book is the first comprehensive study of the history of statistics from its beginnings around 1700 to its emergence as a distinct discipline around 1900. Stigler illustrates how statistics arose from the interplay of mathematical concepts and the needs of the applied sciences. His emphasis is upon how, when, and where the methods of probability theory were developed for measuring uncertainty. The work includes engrossing details about the scientific context in which the logic of measurement emerged; there are witty historical asides; and many original data sets are used as illustrations.

According to Fred Mosteller, "After hundreds of years, our field has a much longed-for masterwork by a scholar who combines his skills as a historian of science and a researcher in statistical inference with a gentle sense of humor." Stigler's work provides a deeper understanding of the use of statistical methods and reveals the promise and limitations of such techniques. It is well worth an investment of your time to examine it. -Ed.

Moser, James M. (Editor)
TEACHING QUANTITATIVE LITERACY
A MANUAL FOR WORKSHOP LEADERS
Wisconsin Dept. of Public Instruction
Madison, WI 53707-7841
1987

The materials in this handbook and the set of masters which accompany it were assembled and developed at a EESA Leadership Conference in Madison, WI, last year. The purpose of the book is to provide workshop leaders with materials and suggestions for carrying out professional development and awareness activities with teachers, administrators, and parents. The overall intent is to allow as much flexibility and latitude as possible.

The major portion of the materials are oriented towards and derived from the QL materials developed by the Joint Committee. However, a number of the ideas are drawn from other sources or are creations of the talented teachers who helped to develop this handbook. It is strongly recommended that any workshop which is conducted using this book as a guide should make the QL materials available for the workshop participants.

The book is divided into six sections. The first section is devoted to materials and suggestions for a general workshop which is intended to be of a motivational nature and is not designed to impart specific skills or knowledge. The next four sections are devoted to the four books which make up the QL Series. The final section presents graphical display of data and is designed to contain material that can either stand alone or be used in conjunction with the other sections.

The handbook is accompanied by a set of blackline masters that can be used to produce overhead transparencies and/or handouts for participants. All masters except those taken from copyrighted materials can be used to produce student worksheets. Almost all of the masters have been reduced and copied in the handbook so that the reader may refer to the master while reading the suggestions for its use.

Contact the editor, Jim Moser, for details about purchasing the handbook. It is excellent. -Ed.

BOOTSTRAP STATS
Scholar Tech
P. O. Box 83371
Lincoln, NE 68501

In the last issue of the newsletter, the BOOTSTRAP STATS package was reviewed by Pam Coffield. Scholar Tech has since lowered the price. The base price is $59.95. Lab packs including 2 user's manuals, 6 quick cards, and 6 program diskettes sell for $129.95. Class packs include 15 diskettes, 15 quick cards, and 2 user's manuals and sell for $179.95. The Apple version is $10.00 less. -Ed.

THE AMERICAN STATISTICAL PRIZE CONTEST

The Joint Committee and the Center for Statistics Education is sponsoring the American Statistical Prize Competition for the second time this year. The procedure for submitting entries and the contest guidelines have not changed since last year's announcement in the Network. The first contest attracted widespread interest and drew entries from all parts of the country. Sponsors are expecting an even greater level of participation this year since publicity efforts have increased public awareness of the event. In last year's competition, two of the prizes awarded went to Kim Meyer and Betsy Barnum, students advised by Diann Resnick of Bellaire High School in Bellaire, Texas.

Kim, who won last year's computer prize, conducted a statistical analysis comparing the grade point averages of students who routinely used a computer to those who did not. Her null hypothesis was that the mean gpa of computer users <= the mean gpa of non-users. Kim chose a random sample of over 400 students. She then used a computer program to help calculate test statistics and to draw histograms, box-and-whisker and stem-and-leaf plots. Her final conclusion was that students spending at least 3 hours a week using a computer did significantly better in school than those students who did not.

Betsy was the winner in the grades 10-12 category. Her project investigated the effect of divorce on elementary students' grades, attendance, and conduct. She conducted a random survey of third, fourth, and fifth graders in four elementary schools. A two part questionnaire (one part for the student and one for the teacher) was completed for each student in the sample. As a result of her research and analysis of the data, Betsy concluded that children of divorced parents had lower grades and poorer conduct than children of married parents, but there was no significant difference in the attendance of the two groups.

As is obvious from the descriptions of these two winning projects, excellent work is being done by many of our students under the direction of skilled and dedicated teachers like Diann. Participating in a contest of this type not only motivates the students, it also provides an opportunity for them to learn how statistics can be used to help answer questions about their daily lives. Dwayne Cameron, Old Rochester Regional High School, Mattapoisett, MA 02739, is again serving as contest director. Winners will be announced by June 1, 1988. -Ed.

GTE GRANTS

General Telephone and Electronic Corporation has been offering grants to teams of mathematics and science teachers for the past several years and is continuing to do so in selected states across the country. Their goal is to integrate these two disciplines and promote cooperative ventures between mathematics and science teachers. The inter-disciplinary efforts of these teams provide an ideal vehicle for data analysis and statistical testing.

Teachers at Bellaire High School in Bellaire, Texas, have been awarded two grants by GTE. Alice Johnson and Karen Hall won a grant with a proposal which incorporated statistics into their chemistry and calculus classes, and Diann Resnick and Ida Medlen were awarded a grant for their proposal to integrate biology and mathematics. Gretchen Davis of Santa Monica High School, CA, also won a grant. Her project involves using statistics to solve problems in a marine biology class. These programs were all designed to help the science student see the quantitative nature of the data which was collected in laboratory experiments and then to implement data analysis and statistical testing from this data.

WHERE TO WRITE

Address all letters, announcements, questions, articles being submitted for publication, and requests to get on or off of the mailing list to the editor:

-Beth Bryan
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