The Statistics Teacher Network

Number 40 ASA/NCTM Joint Committee on the Curriculum in Statistics and Probability Autumn 1995

Statistics in the Classroom

AP Statistics Course to Become a Reality in 1997

After years of planning, the College Board has approved the offering of an Advanced Placement (AP) course and examination in statistics. The first AP statistics examination will be given in May 1997.

Background

In 1987, the AP Calculus Development Committee conducted a study of possible new offerings in the mathematical sciences. A survey of high schools and colleges indicated that there was strong support for a course in statistics. It is noteworthy that this occurred at a time when there was great interest in changing the way in which introductory statistics is taught at the college level. It was also a time when a knowledge of statistics was becoming recognized as being important for people in all walks of life. The Committee recommended to the College Board that a Task Force be established to study the feasibility of offering an AP course in statistics.

Also In this Issue...

The Task Force began its work in 1992. To determine the feasibility of offering an AP statistics course, the Task Force sent a preliminary course outline to various high schools and colleges. The goal was to determine whether the high school teachers thought it would be possible to offer the course and whether the colleges would give placement and/or credit to students who had successfully completed the course. Responses from the high schools indicated strong support for the course, although concern was expressed about the use of technology and teacher training needs. The proposed course outline was also well received by college and university statistics and mathematics departments.

The client disciplines were not as supportive. Their departments wanted additional statistical techniques included before they would award either placement or credit. Given the variety and specificity of the client disciplines' needs, a course that could satisfy all or even most of the client disciplines seemed much less feasible than a course emphasizing a common core of concepts and techniques. The Task Force thus recommended that a concept-oriented AP statistics course and examination be created. This was approved by the College Board in late 1993.

The Course and Examination

In 1994 the AP Statistics Test Development Committee was formed and started its work to make AP statistics a reality. The committee has written a preliminary course description, developed test questions for the first exam in May 1997, and planned workshops for teacher training. The preliminary course description, published in April 1995, includes a course outline, a discussion of the AP statistics examination including sample questions, and statements on the use of technology and instructional emphasis.

The topics for the AP statistics course are divided into four major themes: exploratory analysis, planning a study, probability, and statistical inference. Within each theme the topics emphasize statistical thinking and minimize computational procedures. The instructional emphasis is toward a mode of teaching that engages students in constructing their own knowledge. Important components of the course should include the use of technology, projects and laboratories, cooperative group problem-solving, and writing as a part of concept-oriented instruction and assessment.

The AP Statistics examination consists of a 90-minute section of multiple-choice questions and a 90-minute section of free-response questions. The two sections are equally weighted. The free-response section asks the student to answer open-ended questions and to complete an investigative task involving more extended reasoning.

While it would be ideal for students to have access to the computer during the exam this is currently unrealistic. Thus, graphing calculators will be required and computer output will be provided as necessary. Students will be expected to be familiar with standard computer output and every school offering the AP Statistics course is encouraged to make available a computer with an appropriate software package for work both in and outside the classroom.

Teacher training is a major concern of the Committee. In the summer of 1994, members of the Committee led a teacher workshop at Clemson University. Last summer the College Board held a more far-reaching teacher training effort in San Antonio. It was attended by selected high school teachers and statisticians. It is anticipated that teams of these teachers and statisticians will subsequently conduct workshops across the country.

NOTE: A Preliminary Course Description (IN-201619) is available from: Advanced Placement Program, P.O. Box 6670, Princeton, NJ 08541-6670; phone (609) 771-7243.

Rosemary A. Roberts, Chair
AP Statistics Test
Development Committee

QL in the Football Stadium

Estimating the Attendance at a Football Game

Clemson Memorial Stadium and the warming sun welcomed thousands of worshiping fans. However for us, the South Carolina teachers who had attended the QL workshop at Clemson the previous summer, it was an opportunity to perform a mathematical experiment. We would this Saturday afternoon, apply the tag-and-recapture technique to estimate the attendance at the Clemson-Maryland football game.

Normally it would be easy to estimate the number of Clemson fans filling the 80,000 plus seat stadium. Alas, as the gridiron goddess had not been smiling upon the Tigers, fans felt this ire and had not been worshiping at the stadium as often as usual.

The day began with a presentation by Dr. Joe Ryan of the Center of Excellence in the Assessment of Student Learning. He spoke on the myriad of ways to assess student performance in data analysis and quantitative literacy concepts. After that, we got down to business.

As we had in the summer QL workshop studied the tag-and-recapture method as it is used to estimate shark populations , most of us had used goldfish crackers to simulate a tag-and-recapture situation in our classes. However, that was a very controlled situation in which we already knew the number of goldfish in the population. We were about to embark on a completely unregulated situation.

We had a total of 3,000 bright green florescent 2" x 3" stickers with which we would tag the football fans watching the game. We chose to divide into groups of three and stand inside seven of the eight gates to the stadium. It was decided not to place a team at the gate which led to the private boxes, since it would be difficult to observe fans seated behind tinted glass panels. Afterwards, we were to meet in the stands, and sitting in seats provided by the Athletic Department, proceed to "recapture" the fans.

Thirty minutes before the start of the game, after having enjoyed a "tailgate" lunch, we moved to the stadium. Positioned strategically inside each of the gates to the stadium, we asked fans to place the green stickers on their shirt or blouse and leave them there until the end of the first half. Interestingly, we ran into a few unexpected snags.

Many fans refused to be tagged because they thought that it identified them as a supporter of some political candidate - even though we gave them a sheet of paper explaining that we were secondary teachers conducting a class experiment. We also noticed that fans that entered as groups of friends or family all wanted to be tagged if one member was tagged. The older fans often wanted not to be tagged while the student population thought that the tagging was a "neat idea". All but 147 tags were given out. A search of the bleachers found another ten tags which were thrown on the ground. We determined that 2848 people were tagged and remained tagged.

Having gathered in our seats, we relaxed and discussed our difficulties in tagging fans and how this might affect our experiment. We were concerned that our tagged fans might clump together in certain sections rather than be uniformly distributed throughout the stadium. Another concern was that some fans might remove their tags and so disturb our estimates.

Halfway through the first quarter, we split into six groups and each group was assigned a well-defined section of the stadium to count. Armed with a pair of binoculars, each team examined its section seat-by-seat to count the number of tagged spectators. Most groups had two members observe and count the number of tags in each section; their average was taken as the correct number. Using a map of the stadium with the number of seats listed in each section, each group estimated total attendance. These estimates ranged from 61,615 to 253,213 fans attending the game in a stadium holding only 80,000 seats. How could we be so far off in our estimates? Was the tag-and-recapture method inherently inaccurate?

The instructors of the summer workshop, themselves classroom teachers, huddled with the rest of the participants to discuss our difficulties. Brainstorming brought forth the following possible reasons for the bad estimates: the tags were not evenly distributed throughout the sections, the tags were not always visible to count, some people removed their tags, not all seats were filled so we used a poor estimate for the actual number of people captured, and 600 tags went to the upper deck and no section of the upper deck was sampled. Further examination resulted in a conclusion that to obtain a better estimate, the actual number of fans in each section should be counted, rather than the number of seats. A recount of three sections showed that the stands were filled to 60% of capacity. Using 60% of the actual number of seats available in each section as the number of fans captured, the estimate of the attendance ranged from 36,963 to 151,980. Again, we asked whether we were doing something wrong. These figures were better but still disturbing. Was getting a wide range a problem with the tag-and-recapture method?

We re-examined our earlier possible reasons for bad estimates. Comparing our situation with the shark example discussed in our workshop, we decided that the tendency that family groups wanting to be tagged together (the tags were not uniformly distributed) was no better or worse that the fact that sharks and fish school and when fishing to tag sharks, members of a school would tend to be caught together. The fact that some people removed their tags was the same as some tagged sharks either losing their tags or leaving the area. The only situation in which we

Figure 1

Sections	Tagged	Seating	N	Attendance	N
UAL, UB, UCR, AL, B, CR	111	4,444	114,023	2,666	68,403
UER, UFL, ER, FL	93	2,012	61,615	1,207	36,963
UHL, UI, UJR, HL, I, JR	102	4,326	120,789	2,596	72,484
WL, V	22	1,956	253,213	1,174	151,980
K, LL, UK, ULL	103	3,627	100,288	2,176	60,167
SR, T, USR, UT	50	2,377	135,394	1,426	81,225
Average			130,887		78,537
Total	481	18,742	110,971	11,245	66,582
Actual Attendance			67,819		67,819

seemed to be lax was our use of the number of seats in an area rather than the actual number of fans and this was corrected in the later estimates. Thus our corrected estimates should be as good and/or poor as actual tag-and-recapture estimates in the field. Then we remembered that the shark estimator flew above the sharks in his ultralight aircraft to obtain a count of the sharks to compare with his estimates.

So, as a last estimate, we pooled our counts into one large recapture and obtained an estimate of 66,582 for the attendance at the game. A telephone call to the athletic department yielded an official paid attendance of 67,819. Our pooled estimate was only 1.5% below the actual attendance.

What did we learn from our grand experiment besides the fact that statistics and tailgating make for an enjoyable Saturday afternoon? We learned that tag-and-recapture estimates in an uncontrolled situation can vary widely. We also learned that we need to count the actual number of items recaptured rather that use some inaccurate estimate. Finally we learned that when we recapture a relatively large number of items, that the estimate becomes better. All in all, a very (statistically) productive afternoon was enjoyed by all. Who says that learning statistics can't be fun!

For those with a bent for the actual data, *figure 1* lists the six observations of recaptured fans at the football game. Column 3 lists the number of seats in the observed sections, column 4 lists the (incorrect) estimates resulting from this count, column 5 represents the actual number of fans in each section, and column 6 represents the estimates based on the actual number of fans captured.

By the way, Clemson won!

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Book Review

A Handbook of Small Data Sets

by D.J. Hand, F. Daly, A.D. Lunn, K. McConway, and E. Ostrowski, (1994)
ISBN 0-412-39920-2, Chapman Hall (800) 842-3636 $64.95 U.S.

Real statisticians do not analyze fake data, so the data our students work with should usually be real. Having students collect data of interest to them is a way to increase their motivation. It is also important for students to do some data-gathering because otherwise they will not learn about the first half of a statistical investigation: formulating a question, designing a study, and gathering data. However, student-gathered data may not illustrate the varied and important uses of statistics in society, and it may not always illustrate the points we want to make in class. It also takes a lot of time to gather data. For that reason, it is often desirable to use real data that have already been gathered by someone else. However, not many of us have a mass of appropriate data of our own to share with our students. There have been a number of attempts to provide statistics teachers with data sets, as part of a textbook, in a supplement to a textbook, or in separate collections. The book under review is my own favorite collection. Unfortunately, it does have some problems, and I feel a need to dwell on those in order to make them less of a problem for you.

One of the things that often discourages people from using technology is the vast collection of difficulties that crop up during your first attempt. This collection is a bit clumsy to use, it has an error-prone index, and the data disk is so badly scrambled that it would take weeks to straighten it out. Still, my hope is that you will buy this book, because it really is a wonderful collection of data sets. Just be forewarned that there may be some glitches, especially with the data disk. I'll spend some time on the problems with the disk, so you can check for and correct any problems in data sets you might use with your students. With those caveats in mind, let's turn to the book's virtues.

Among the things I like about it are: 1) there are over 500 data sets; 2) all data sets are provided on a disk with the book; 3) the context of the data is usually clearly explained, and meaningful to a layperson; 4) many of the studies are ones that could easily be replicated in class or as student projects; 5) there are references to the source (and sometimes to published analyses) of the data; 6) some (too few) have suggestions on how the data might be used in teaching; and, 7) a wide range of application areas are included.

Let me mention just one data set by way of an example. At about the time Australia converted to the metric system, a college instructor asked two classes meeting in the same room to estimate the dimensions of the room. One class was asked to do estimates in feet, and the other in meters. The results illustrate the concepts of bias and variability in data: the estimates in meters vary much more than those in feet, and they are not "correct on the average."

On the down side, for too many of the data sets you are left to guess what it is you are supposed to find out from the data. Even when there is some clear purpose to the study, it is often not one of much real importance. The data sets can be used to illustrate statistics, but not always to show its importance. Finally, few of the data sets are random samples from a well-defined population, and so are not suitable for illustrating inference techniques. They are more useful for exploratory data analysis.

All the rest of the things I don't like have to do with the mechanics of locating and using the data sets you might want. They are listed in random order in the book. You will need to turn to a table in the back of the book to discover the name of the computer file containing the data. (There is no systematic naming system.) When you try to read one of those files into your software, you may be in for a surprise. One good use for fake data is to create a very simple illustration. Here is an illustration of the kinds of problems you will find on the data disk. (The problems are not made up, and, yes, all these problems did occur in a single file, and similar problems can be found in most of the other files!) Made-up data on pianists might appear in the book in a table like this.

*Bachauer	23	51	Richter	32	52
*Haskil	12	33	Rubinstein	23	44
Lipatti	43	45			

For each pianist, we have measurements on two variables. In addition, the asterisks denote female pianists. On the disk, the data might look like this:

23	51	32	52
23	44	12	33
43	45		

The names and sexes of the pianists have been lost. A less obvious problem is that most statistical packages will interpret this data file as having four measurements on each of three subjects—except that two measurements appear to be missing for the last subject. This may cause an error message or it may cause the package to refuse the data. Even if it does not, and you ask for the mean of the first variable, you will get the mean of three numbers, not five. If you give data files like this to your students, you will need to drastically increase your life insurance coverage.

To add the missing information, you could try typing in 0's and 1's to represent male and female respectively, but when you do, you may discover (or worse, you may not!) that Haskil and Rubinstein have been switched on the disk. Assuming you are content to keep the order on the disk, the data file would look like this after you finish editing it.

1	23	51
0	23	44
0	43	45
0	32	52
1	12	33

This is a lot of work! Perhaps those of us who use the book can share cleaned up versions of the data files, and/or convince the publisher to do some cleaning. Still, the book is great for browsing, and it's great to have the data on disk in any form!

I could not find any clue on the disk or the book's cover what kind of computer might be able to read the disk, but it looked like a 720k DOS disk to my PC clone. I doubt you could read this with an 800k Mac drive; I'm not sure about the higher density Mac drives. The files take up about 500 times the smallest chunk of disk space you can allocate—about 0.5Mb on the floppy provided, about 4Mb on my 340 Mb hard disk. That's a lot of space. I have heard tales of some systems going off to never-never land when asked to convert the more than 500 DOS files to Mac files. Since most of the files are unusable in their current state anyway, it is probably best to work with just one at a time, converting, editing, moving to your hard disk, and importing to your stats package as needed.

Despite the problems, I still think it is a great book. The publishers could rectify the problems by cleaning up the data sets on the disk and adding to the disk a proofread (I found too many errors) and corrected version of the data index in an electronic form that one could sort and search. (I wrote them about this at the time I agreed to write this review, and have not heard from them when the deadline arrived ten weeks later.) Even if you threw out the disk and index and only used 20 of the given data sets (typing them in yourself), the book would be worthwhile.

Bibliography

I list but two titles. Singer and Willett give an extensive bibliography of data sources. The other papers in the collection are worth reading as well. The book by Chatterjee et al. is listed because it is too recent to have been included in Singer and Willett. It is at a considerably higher level than the book reviewed above, but has the virtues of including extended analyses of many of the data sets and more examples suited to inferential techniques.

Chatterjee, S., Handcock, M.S., Simonoff, J.S. (1995), A Casebook for a First Course in Statistics and Data Analysis, John Wiley and Sons, New York, ISBN 0-471-11030-2.

Singer, J.D., and Willett, J.B. (1992), "Annotated Bibliography of Sources of Real-World Datasets Useful for Teaching Applied Statistics", in Gordon, F., and Gordon, S., Eds., (1992), Statistics for the Twenty-First Century, Mathematical Association of America, 1529 18th St., NW, Washington, DC 20036, ISBN 0-88385-078-8.

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Statistics in the Classroom

Chance Course...

A Chance course is a quantitative literacy course being developed under an NSF grant. It deals with current events in the news that involve probability or statistical concepts such as results of clinical trials, the use of DNA fingerprinting in the courts, reliability of AIDS tests, the margin of error of a poll, and the use of IQ tests.

A Chance discussion group has been established to permit those teaching a Chance course or any course that uses current events in the news, to exchange ideas and experiences. To join this group send a note to jlsnell@dartmouth.edu.

An additional service provided by the Chance project is the e-mail Chance newsletter that provides abstracts of current news articles appropriate for such a course. Previous issues of the Chance newsletter as well as other resources for teaching a Chance course, such as a teacher's guide, are kept on the Web at the address:

http://www.geom.umn.edu/locate/chance

To receive this newsletter by e-mail send a note to jlsnell@dartmouth.edu. If you would like to receive a printed version of the Chance teachers guide or a 12 minute video of scenes from a Chance course, just mention this in your request or by a separate note. There is no charge for any of these materials.

Laurie Snell
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Letters to the Editor

Teacher Takes Probability Activity One Step Further

I am the K-6 math and computer specialist at Munsey Park School in Manhasset, New York. I read with interest Joanne Caniglia's article (STN spring 1995) on the use of dice to improve middle schools students' conceptions of probability. I too do the probability activity described, but I carry it a step further and put the results of the computer toss into a spreadsheet and create a graph. I use a Logo procedure instead of Basic. It is a nice extension of that lesson and is appropriate as early as the fourth grade.

More specifically, the first thing I do is a homework assignment to toss two dice 10 times and chart the results. The homework results are discussed as to the frequency of each outcome. Then I make a chart on the board of all the ways each sum can occur. This is the way I build the 36 possibilities and stress the idea that the more times you carry out the experiment, the more likely it is to achieve your predicted results. That is why we use the computer (to get more tosses). Each student runs the Logo procedure which tosses two dice 100 times and tabulates the results. Then I have Clarisworks available on another computer and they enter their results in a column under their name. I use this as an introductory spreadsheet activity and show how you add columns and rows. When everyone has entered their results, we have between 2,000 and 2,500 tosses, and I show them how to make a chart from Clarisworks which I print out and give them to take home.

Marilyn Tahl
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"Best College" Data Analyzed

Long lists of numbers in newspapers and magazines, even those organized in charts, can scare off many readers. The valuable information obtainable from that data is often lost unless the authors present verbal summaries. However, for some readers looking for a quick overview, these summaries may not be very satisfying. Some sort of pictorial representation might be more informative.

Annually, U. S. News and World Report publishes a guide to America's best colleges. What makes those "best" colleges in the various categories so good? I challenge my students to convince me that these "best" schools really are that good with a graphic display of box and whisker plots and some written and oral arguments to support their claims.

Since so much data are involved, we limit our investigations to several key areas such as percentage of faculty with Ph.D.'s, student/faculty ratio and graduation rate. Box and whisker plots are then created either manually or using a graphing calculator to represent the data in each of these categories for the schools within the highest ranking group taken as a whole, then for the tier below that taken as a whole, etc. By displaying all of the box and whisker plots together for graduation rates, say, students can clearly see how the very best schools compare with the schools in the other groupings. Conclusions can be drawn easily by observing the spread of the boxes and the length of the whiskers.

Students prepare a booklet and an oral report based on their observations to simulate what it might be like in the business community to make an oral presentation at a meeting. Since the topic is so relevant to high school students faced with making college choices, both the organizational part of the project as well as the oral presentations are well received

When the project has been completed, students have had the experience of working with real world data and of seeing how even some elementary statistical concepts can take an imposing group of numbers and get it under control. They have the added benefit of learning about many colleges as they begin their own college searches.

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Quantitative Literacy

QL Programs, A Review

Quantitative Literacy (QL) efforts started when the Joint Committee on Curriculum in Statistics and Probability was formed by NCTM and ASA in the early 1970's. ASA's Center for Statistical Education has collaborated with this committee and others to create five QL projects, all sponsored by grants from NSF.

QL I led to the development and publishing of hands-on units, introducing basic statistics and probability at the secondary level. The materials, currently in five volumes, were written by teachers, mathematics educators, and statisticians.

QL II focused on training teachers to become workshop instructors. These instructors and others have taught QL to over 3,000 teachers since 1989.

QL III, "A Data Driven (DD) Curriculum Strand for High School Mathematics," uses data analysis to motivate essential topics in algebra, geometry, and advanced mathematics and teaches skills in data analysis so that students will be skilled participants in society. DD workshops have begun; a week-long one was held in Cleveland last summer.

Grades K-6 are the targets of QL IV. The project focuses on concepts in data analysis and in teaching skills to enable teachers to weave a statistics and probability strand into an elementary school curriculum. Training workshops were held the previous two summers.

Materials for QL III and IV are being prepared for publication by Dale Seymour.

QL V, Science Education and Quantitative Literacy (SEAQL) was approved and funded by NSF in 1994. The first workshop was held last summer at Johns Hopkins. Forty science teachers from grades 6-12 learned how data analysis can used in their laboratory lessons for chemistry, biology, earth science, physics and general science. Two more workshops will be held in 1996.

QL continues to grow and develop. The newest project is QL VI, Data-Centered Studies, which will use interdisciplinary, problem-centered projects, emphasizing hands-on activities that encourage collaborative learning.

ASA has a list of QL-trained teachers available to conduct teacher workshops. For information, contact me at the ASA Office of Education, 1429 Duke Street, Alexandria, Virginia 22314-3402, 703-684-1221 x146, cathyc@asa.mhs.compuserve.com.

Cathy Crocker
ASA Director of Education

From the Editor

If your students want to know which universities in the United States and Canada offer major programs in statistics, the ASA has a free publication listing them. Contact ASA at 1429 Duke St. Alexandria VA 22314-3402 or call 703-684-1221.

"America's Lifeline" is a chart of health and population trends in the US (see review, STN Fall 1994). Mike Adams of Health Data Inc. informed me that they now have an electronic version called "America's Lifeline Online" that appears on the World Wide Web. Check it out by addressing http://web.syr.edu/~cakincai/lifeline.html

I hope that you were able to attend an interesting workshop last summer, especially if the topic was probability and statistics. Teachers in the Cleveland, Ohio area who had previously attended a QL workshop were invited to a weeklong workshop on data driven mathematics. (See Fall 1994 STN issue for details on DD.) DD is a very exciting approach to motivating topics in algebra, geometry and advanced mathematics from a data collection and analysis point of view. There will be more on DD in future issues, as materials are published in 1996.

Let me know what statistics projects and presentations you and your students are doing. This year, I hope to include more articles for teachers at the elementary level. For example, in addition to other publications, I will be sure to relay information on the Elementary Quantitative Literacy materials, as soon as they are published.

Hope you are having a great year! Plan on contributing to STN. 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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