The Statistics Teacher Network

Number 39 — ASA/NCTM Joint Committee on the Curriculum in Statistics and Probability — Spring 1995

On Meeting A Statistician

Field Trips; Students Meet Statisticians

What is a statistician? Where do they work? What do they look like? Would I like to be one? Can our students answer these questions?

All of us remember early dreams of being doctors, firemen, cowboys or nurses. We were able to meet many of these heroes, yet students rarely meet statisticians and see what they really do or where they work. Beiersdorfer and Davis (1994) note that learning experiences bring certain teachers and projects to mind, while specific lectures pale in comparison to those memories retained from experiences outside of the classroom. Field trips have long been recognized as a teaching tool, particularly in the sciences. Likewise, the mathematical sciences and statistics can benefit from the "active learning" element of the education process with field trips used as effective tools for directly involving a student's visual receptors as well as cognitive abilities.

The Experience

Ring....ring...."Hello, am I speaking to the head of the household...?"

So started the idea for a field trip. A student of mine expressed interest in market research statistics. How was she chosen to be called? What exactly were they going to do with her answers? Why did different answers result in different lines of questioning? This recent mid-dinner phone call had her thinking!

I decided the best way to answer her questions, and provide the class with an example of statistics in action, would be to take a field trip. This would enable students to meet working statisticians as well as providing them with an insight into their future careers. Utilizing this approach, I not only introduced them to working statisticians, but opened their eyes to the values of field trips.

Step one–Prospecting.

First, I needed to find a prospect. I knew that one of our former students worked at some type of research company, and with the help of the alumni office I found the names of two alumni and their companies. Additionally, I looked in the phone book of a large city located nearby for other market research firms. I then selected three companies to contact.

Step two–The Proposal.

In my initial call, I explained my purpose and was given the name of the appropriate person to whom I could make my pitch. Armed with this information, I prepared my proposal. I called and introduced myself, explained that I was teaching a course and wished to have my students see market research stats in action. I continued that I wanted them to meet some of those "dinner interrupters" and to statistically follow through on the answers to the question... "Coke or Pepsi?"

Also In this Issue...

I suggested a two to three hour afternoon visit involving this person's department and specifically those persons who worked most closely with statistics and data analysis. I indicated that I would be bringing a group of six to ten students. I outlined our interests: the software and statistical methods used, personal experiences, their reasons for choosing statistics as a career, and market research in particular. I assured them that no confidential data need be disclosed! I told them what was in it for us: enhanced understanding of textbook knowledge; see first-hand applications of actual statistics; evaluation of statistical software; meeting real people... real statisticians ... applying and using real statistics.

I also reiterated what was in it for them! I included the following: developing a relationship with a University statistics department and professors; contributing to the knowledge and education of students; introducing their company to prospective clients and customers; as well as making favorable impressions on potential employment recruits.

Step three–Company Research.

Having obtained a favorable response from one of the companies, we prepared for our visit. The students split into small groups and obtained company brochures, magazine articles and other data. We reviewed applicable statistics they might be using and discussed how applications would be unique to this industry. To stimulate on-site discussions, questions were developed and assigned.

Step four–Preparation..."Ok Mom!"

I discussed etiquette, attire, where, when and how.

Step five.–Road Trip.

The day arrived. We hopped into the school van (seat belts appropriately buckled) and away we went. We were greeted by a company representative, given the nickel tour and a short presentation on the company's history. We were introduced to the department manager who was the company's chief statistician, a team mathematician and two staff researchers. We discussed their use of statistical software, how they apply it, and how surveys are designed around particular client requirements. We then visited the "operations center", the heart of data collection. Through the use of statistical-based software, each market researcher follows a different branch, or "script" depending on answers to earlier questions.

Several of the statisticians talked about why they had chosen statistics as a college major, what they liked about their jobs and what they liked about market research. We met a recent statistics graduate who was using the statistical package SAS to analyze data. We got some direct insight into many of the lectures and problems we had been discussing in class. The afternoon came to a close with the students getting to ask many of their questions. We were well received and the day was enjoyed by all.

Step six–Follow up.

Back in the classroom, we discussed what we had learned. The students got a chance to see statistics being used first-hand. They were able to put names and faces to people working in their career of choice. Perhaps most importantly, they saw that what the teacher had been talking about was applicable in actual situations. Because of this, the students could better see what practicing statisticians look like.

A few of the comments from students:

"I never realized how important being a statistician could be until Mr. Wilson told us about companies making decisions on product introductions based on the data analysis." "I liked the way she (a market researcher) used her speaking abilities to get her point across. It wasn't all formulas and theorems." "I hadn't thought about a career in statistics until I met someone who does it. The offices were really nice and I noted that they were well respected. I would like to get an internship after my Junior year."

In short, field trips enhance understanding of the material and provide an introduction to role models for future statisticians. Field trips provided my students with an experience unlike any classroom and gave them insight into selecting a career field that truly interests them. I believe including field trips as part of your course syllabus will allow students to be better prepared to make one of the most important decisions in their lives. For me it's really true - field trips aren't just for elementary students anymore!

Rebecca Pierce
Ball State University
Muncie, Indiana

Editor's Note: *ASA Chapters are excellent contact sources. Call the national office to locate the Chapter nearest to you.*

Book Review

Proceedings of the First Scientific Meeting
International Association for Statistical Education
University of Perugia, 23-24 August 1993
Edited by Lina Brunelli and Giuseppe Cicchitelli

This reviewer found that reading these proceedings cover to cover was an entirely new experience. (I suspect most people put such proceedings on their bookshelf, and then dig into appealing portions as interest or necessity dictate.)

By reading the entire book for this review, the reviewer received an entirely different view of the conference than he would have received had he been a participant. For people attending a conference, their view of the conference is what they experience: the sessions they attend, the particular individuals with whom they interact, the specific areas of interest they bring. Reading the proceedings book as a whole, one gets a picture of the conference as a whole. As the first scientific meeting of IASE, this conference sets the tone and the standard for future conferences. Papers are grouped into five major categories (the reviewer assumes the meeting program was divided along these lines): *Statistical Education at School Level*; *Teaching Probability and Statistics at University Level*; *Computers, Video and Other Tools in the Teaching of Probability and Statistics*; *Education Programmes and Training in Statistics*; *Issues in the Teaching of Probability and Statistics*. In addition, David Vere-Jones delivered an invited paper, "The IASE and Problems of Statistical Education in Developing Countries. A session on Updating Teaching."

Methods in Probability and Statistics was specifically designed for Italian school teachers. Abstracts of 13 poster sessions and a list of participants complete the book.

As a mathematics educator at the school level, with a strong interest in the teaching of statistics and probability in schools, this reviewer was particularly interested in the section *Statistical Education at School Level*. The seven papers in this category begin with an overview of what is happening in selected European Countries (Holmes). Three papers from the United States include: a description of the Teach-Stat professional development program for teachers, grades K-6 (Frierson, Friel, Berenson, Bright, and Tremblay); Stat-Maps, a curriculum development project for students, grades 9-12 (Perry);and a discussion of statistics as a motivator of topics in secondary school mathematics--e.g., the Data-Driven Curriculum (Scheaffer).

Three papers by Italians consider interdisciplinary issues (Lombardo, Rossi, and Zuliani), psychopedagogical implications of teaching statistics in primary school (D'Argenzio) and interplay between probability and fractions in primary school (Caredda and Puxeddu). The articles by Caredda and Puxeddu, Scheaffer, and Perry provide some concrete examples of classroom activities, while the remaining papers are more descriptive or formal.The section *Teaching Probability and Statistics at University Level* comprises ten papers. These include statistical topics for engineers (Box; Rade), business majors (McKenzie), and biostatistics for medical students (van Strik). Descriptions of programs include Hungary (Reiczigel), Bulgaria (Velev, Vuchkov, and Iontchev), Zimbabwe (Nikolov, Keogh, and Stielau), and South Africa (Stielau). Blumberg describes off-campus experiences for undergraduates, where students actually work as statistical consultants to businesses and industrial firms. Clark discusses the effect of context on the learning of statistical principles, looking particularly at different effects depending on gender. Each of these papers would be useful for a university statistics department looking for ideas. The reviewer has heard Clark speak on gender related to context (ICME 7; ICOTS 4); her findings have important implications for embedding statistical principles and topics in appropriate problem settings. He has also heard McKenzie deliver a similar paper (ICOTS 4), and found the presentation interesting and clear.

Computers, Video and Other Tools in the Teaching of Probability and Statistics includes 14 papers. Naturally, most of these papers address the use of computers and/or computer software. The exception is Moore, who writes about the uses of video, based on the series *Against All Odds*. Arnold's orientation is directed toward the use of computers as aids in electronic communication. Biehler and Blejec provide thoughtful articles discussing potential and actual uses of computers in furthering the learning process. Konold presents information about the use of resampling techniques. Morin discusses a project teaching statistics to technicians and factory workers. Jones, Lipson and Phillips discuss the use of computers in teaching statistical inference. Topics specifically addressed in the remaining articles include: hypertext (Camillo and Pedroni), an expert system (Capiluppi and Fabbris), an intelligent tutoring system (Griffin and Rouncefield), use of specific software, including statistical packages (Cohen, Smith, Chechile, and Cook; Janvier, Saporta, and Verdoire; Militky, Meloun, and Kupka; Puranen).

Section 4 is *Education Programmes and Training in Statistics*. Eight papers are included in this category. They examine the role of statistical consultancy (Barnett), training government staff in Africa (Ntozi and Kibirige), the Eurostat project (Teekens), teaching biostatistics to medical professionals (Bangdiwala), and teaching production personnel (Garcia). The important role of ISEC, Calcutta, in providing training to the third world countries in Asia and the Far East is discussed by Raha. Rozga examines the statistical education situation in Croatia, and Starkings looks at statistical education in Pakistan.

The final major section, *Issues in the Teaching of Probability and Statistics*, contains nine papers. These papers range widely, some reporting on controlled experiments, some taking a theoretical look at teaching, and some providing concrete examples used in teaching particular topics. Belli discusses student views about effective and ineffective learning (including self-criticism at times); Taffe presents a variety of investigations which he wants students to consider and work on prior to formal instruction; Borovcnik examines the role of intuition; Rouncefield discusses simulations and shows sample student materials. Sowey looks at how to make statistics topics memorable. Jolliffe examines proportion, while Nuesch discusses the mean of the hypergeometric distribution. Cakiroglu and Nemetz see a role for secret codes in teaching statistics. Shvyrkov raises the question "What is the main goal of statistical education?", which to him is how representative a sample is with respect to a homogeneous population. Vere-Jones' invited paper places the IASE meeting in historical context, growing out of work of the ISI. A major portion of the paper is devoted to discussion of improving statistical education in developing countries and countries in transition. Twenty-two teachers, mostly secondary, attended the session for precollege teachers of statistics in Italy.

Naturally, the abstracts of poster sessions included in the proceedings serve as accent points alongside the papers. As one would expect, these range over a variety of topics. My personal favorite is "Sprint--Analysis of a Game" (Mascelloni). This describes a game where a hare, a squirrel, a tortoise, and a snail are competing, running courses that are, respectively, 32, 24, 16, and 8 squares long. The dice used provide different speeds (the sides of the hare's die are 4-3-3-2-2-2, that of the squirrel 3-3-2-2-1-1, that of the tortoise 2-2-2-1-1-0, and that of the snail 1-1-1-1-0-0). The reviewer leaves it to the reader to determine which animal, if any, has the best chance of winning.

This volume is well worth having on your shelf, whether your interest is in what statistics topics are appropriate for precollege students, how collegiate instruction may be brought closer to the "real world", what progress is being made in developing countries, or what students think about statistics courses.

Reviewed by Albert P. Shulte
Oakland Schools
Waterford, Michigan

Editor's Note: *IASE is a new section of the International Statistical Institute, the primary organization devoted to international cooperation and integration in statistics. IASE has statistical education as its primary focus. A copy of the proceedings is available for US$5 from ISI, 428 Prinses Beatrixlaan, 2270 AZ Voorburg, The Netherlands.*

Conceptions of Probability

Is Seeing Believing? A Problem to Improve Middle Schools' Students' Stochastic Vision

What are middle school students' conceptions of probability? Are there activities that confront inconsistencies in students' thought processes? What problems can assist students in expanding their view of probability from an experiential one to a more theoretical one? The purpose of this article is to propose a learning task that will enable children's vision of probability to broaden.

Too often textbooks present the sample space for the sum of two dice in the form of an addition table. Unfortunately, the highly symbolic nature of such a chart does not help students understand the origin of the sums. Students passively accept the fact that 7 is the most frequent sum and that the sum of 1 can never be achieved. The challenge then is to create for middle school students an environment in which they can not only model and simulate the sum of two dice, but also form conjectures and confront misconceptions. Such a problem was presented in the 8th Grade Mathematics Monograph (Ohio Department of Education, 1984). An extension of that task, presented in this article, is based upon Jerome Bruner's (1966) theory of representation. According to Bruner, three modes of representation are necessary to meaningfully understand a concept--the enactive (concrete), the iconic (pictorial), and the symbolic (abstract). Bruner felt that multiple ways of representing material assist teachers in helping students see relationships, internalize concepts, and transfer learning so that they are able to solve problems at the symbolic level.

At the enactive level, it is necessary for the child to manipulate objects in order to internalize the concept. The iconic level is characterized by thought processes occurring without objects, but with some pictorial representation. At the symbolic level, the child becomes capable of manipulating symbols and translating experience into language (Heddens & Speer, 1992).

Description of the Game:

Each student is given 36 unifix cubes and a number-line from 1 to 12. They are to place the 36 counters in stacks above one or more of the 12 numbers in a manner that will enable them to win the following game.

(1) A pair of dice will be tossed repeatedly by the teacher;
(2) After each toss, the total for the dice will be announced;
(3) The student is to remove one counter from the stack on the number that is called;
(4) The winner is the first person to remove all 36 counters.

Enactive Mode of Representation: Playing the Game

A few students will place a unifix cube on the number "1." They soon realize that this is an impossible sum during the course of the game and their interest often wanes. A helpful strategy may be to encourage students to observe and note the results in the hope of influencing future decisions.

The idea of course is that as they play the game a few times, they see that some numbers don't appear too often whereas others are much more frequent.

Iconic Mode of Representation: Recording the Results

As the numbers are called and students remove unifix cube markers, one student records the sums in the format of a histogram.

						x					
				x		x	x		x		
				x	x	x	x	x	x		
			x	x	x	x	x	x	x		x
		x	x	x	x	x	x	x	x	x	x
	x	x	x	x	x	x	x	x	x	x	x
1	2	3	4	5	6	7	8	9	10	11	12

A class discussion focussing on the winning strategy and analysis of the histogram is appropriate at this time. Histograms are an important source for students to "see" the usefulness of mathematics.They should provide information to help the student decide what numbers to select for the next game. However, basing the decisions on a "one-case" event is not always a reliable choice, rather students should examine "infinitely" many occurrences which can be generated through the following computer program:

BASIC Program to Simulate the Sum of Tossing Dice (IBM Computer)

```
10 RANDOMIZE TIMER
20 DIM C(15)
30 REM INITIALIZE COUNTERS
40 FOR J = 1 TO 12
50 LET C(J) = 0
60 NEXT J
70 REM SIMULATION OF TOSSING DICE
80 REM D1, D2 = DICE
82 REM S = SUM OF TOSSED DICE
84 REM C(I) = COUNTER
90 INPUT "HOW MANY TIMES WOULD YOU LIKE TO
   TOSS THE DICE"; N
100 PRINT" DO NOT EXCEED 10,000 TIMES"
110 FOR I=1 TO N
120 LET D1 = INT (RND(1) * 6 + 1)
130 LET D2 = INT (RND(1) * 6 + 1)
140 LET S = D1 + D2
150 LET C(S) = C(S) + 1
160 NEXT I
170 PRINT
180 PRINT "HISTOGRAM OF RESULTS: SUMS OF
   TOSSING DICE"
190 PRINT
```

```
200 REM HISTOGRAM
210 IF N>400 AND N<1000 THEN PRINT "EACH *
  REPRESENTS 5 TOSSES"
220 IF N>=1000 THEN PRINT "EACH * REPRESENTS
  10 TOSSES"
230 FOR J = 1 TO 12
240 IF N>400 AND N<1000 THEN C(J)=INT(C(J)/5)
250 IF N>=1000 THEN LET C(J)=INT(C(J)/10)
260 PRINT J; TAB(5); " ";
270 FOR K = 1 TO C(J)
280 PRINT "*";
290 NEXT K
300 PRINT
310 NEXT J
320 END
```

The use of the the computer program, once students have experimented with dice, is an essential linkage between empirical and formal approaches to probability. The NCTM Standards (1989, p. 111) recommends the use of technology precisely for this purpose.

Symbolic Mode: Developing Winning Strategies

At this point in the discussion, you should direct your students to see the differences among the various types of probability and to recognize the difficulties that they may have in each of them. Hawkins and Kapedia's (1984, p. 349) definitions of the different types of probability (Apriori, frequentist, subjective , and formal) are helpful to the teacher in understanding students (mis)conceptions of probability.

Students are eager to "play" again. Filled with their new knowledge of winning strategies from both their experience and the formal probability chart, students' strategies change. Most students will move the majority of their chips to the numbers that were announced most frequently in the previous game. Few will use the symmetry and logic of a theoretical table of results.

None will place their markers on the "1" space. Despite these changes, students will position many of their markers in the same place, as in the previous game. This reasoning is consistent with research by Shaughnessy (1992) that probabilistic beliefs and conceptions are difficult to change.

Implications for Teaching

The significance of the dice problem described in this article is not only to enable the students to move or progress toward a more powerful definition of probability, but the task also assists the teacher in understanding and valuing the informal/intuitive knowledge children bring to the classroom. In many respects, the problem provides a rich opportunity for the classroom teacher to see how children think about probability, what strategies they use in making decisions, and what (mis)conceptions they may have.

References

Bruner, J. (1966). *Toward a Theory of Instruction.* New York: W.W. Norton & Company, Inc.

Hawkins, A., & Kapedia, R. (1984). *Children's' Conceptions of Probability: A Psychological and Pedagogical Review.* Educational Studies in Mathematics, 15, 349-377.

Heddens, J. & Speer, W. (1992). *Today's Mathematics.* New York: Macmillan.

Shaugnessy, J.M. (1992). "Research in Probability and Statistics: Reflections and Directions". In D. A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning.* New York, NY: MacMillen Press.

Sister Joanne Caniglia
Eastern Michigan University
Ypsilanti, Michigan

Statistics in the Classroom

Using the Calculator Based Laboratory in the Algebra Classroom

Recently, while teaching at a local high school, I introduced my algebra students to the application of graphs in real life situations. Students had been asking me, "Where am I going to use this in real life?" I did my best to answer them while teaching a unit on the graphing of linear equations. My involvement with the SEQuaL project (Statistics Education through Quantitative Literacy) had put me in touch with the wonderful capabilities of the TI-82 graphing calculator and the calculator based laboratory (CBL), and I was able to use the knowledge to good advantage. (The TI-82 calculators and the CBLs may be borrowed through the Texas Instruments calculator Loan program. They may be reached at 214-917-1550.)

I began with simple activities that involved predicting future track records, the life expectancy of males and females, natural gas demand, the cost of long distance taxi cab rides, and car rental rates (Keedy, Mervin and Bittinger, Intermediate Algebra, Addison Wesley, 1991). Students used given sets of data to calculate the traditional point-slope equation of a line. After mastering this technique, they learned how to enter data on the calculator and calculate the linear regression equation.

The students then learned how to gather and use their own data. They blew up balloons while measuring the circumference and diameter of each balloon after one breath, two breaths, then more until they reached the maximum capacity of the balloon without breaking it. Students plotted the data on graph paper predicting the patterns of diameter and circumference, flight time (indicated by the period from when the balloon was released to when it was fully deflated) and diameter, diameter and number of breaths, and flight time and number of breaths. (See Coes, "The Functions of a Toy Balloon," The Mathematics Teacher, November 1994.) As there were more than two points to graph in this activity, and they clearly did not all lie on a single straight line, we talked about the line of best fit. The TI-82 graphing calculator was used to plot the data and calculate the equation of the best-fitting line. Part of our discussion involved the correlation coefficient "r" to give us some indication of how accurate a line fit the data. Most of the r values found were above .95.

Another topic of discussion involved reasons why the points did not all fall exactly on a line. One group of students had a football player who was quite athletic and who was one of the blowers. Students thought that his lung capacity must be higher than others who were blowing balloons and thus his point was not on the line. Other groups kept one consistent blower, and concluded that was the reason they had the highest r values. Another measure of relationship was seeing which group came closest to the value of pi in the circumference/diameter ratio for the slope.

The next activity was to have students gather their own data using the CBL which links to the TI-82 and TI-85 calculators. A motion detector probe was attached to the CBL, and a student was directed to move in front of the detector. The calculator graphs a line based on the data gathered from the motion detector.

Questions that I asked the class were: What motion should you make in order to produce a horizontal line? How can you move to make a "steep" line? How is the slope related to how you move? In groups of four or five students, they were to produce a written answer to each of the questions. One group even asked to move from the classroom to the front lobby so that they could have more space to run as fast as they could. This group produced the "steepest" line, which they of course proudly shared with their peers. Some students who were stopped because of space limitations, naturally discovered how to make a horizontal line. Through this activity, students very naturally related slope to rate of change.

In another class period, we investigated a different program using the motion detector. It was a line matching program suggested by Christopher Brueningsen in his "CBL Activities," from a Center for Statistical Education Workshop he presented at IUP. In this activity, the calculator randomly produced a line, and then students needed to walk or run to match that line. Those groups of students who had answered the questions in the previous day's activity were able to match lines without difficulty.

The groups who concluded their activity early were able to experiment with the heat detector which is another probe that also connects to the CBL. Using boiling water, they were able to see the graph of the temperature against the time it took the probe once removed from the boiling water to cool to room temperature. We then discussed why that line went in a different direction than the previous graphs produced using the motion detector. This led to a discussion of positive verses negative slopes. The groups had to answer why the lines had negative slopes. Gathering their own data and seeing the graphs immediately on the calculator provided prompt positive reinforcement and a good review of the unit on graphing straight lines. I believe that the prior activities made the students ready to use and appreciate the capabilities of the CBLs and the graphing calculators. I plan to use these activities again, and hope that my experiences encourage you to try them also.

Elaine Carbone
Center for Statistics Education
Indiana University of Pennsylvania
Indiana, Pennsylvania

From the Editor

As a member of the ASA/NCTM Joint Committee on the Curriculum in statistics and Probability, I will be meeting in early May with a College Board committee to discuss matters regarding AP Statistics. I will provide details of the project in the fall issue of STN.

As summer homework, I encourage you to attend a workshop on probability and statistics. For example, we are holding two workshops in the Cleveland area: our seventh annual one on the Quantitative Literacy materials and our first annual on a new curriculum called Data Driven Mathematics. The latter is designed to motivate mathematics topics in algebra, geometry and advanced mathematics from a data collection point of view. If no courses or workshops exist near you, contact a local university or ASA chapter and encourage them to organize one. I would be pleased to help you in your efforts.

Also, if you have used any software, materials, or text that you have found to be beneficial, write a review and send it to me. Articles on sucessful classroom statistical activities are always welcomed. Have a relaxing, intellectually stimulating summer!

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:

Jerry Moreno, Dept. of Mathematics, John Carroll University, University Heights, OH 44118

or moreno@jcvaxa.jcu.edu

or fax: (216) 397-3033

Production Editor: *Kristen Fernekes, American Statistical Association*

To be added to the mailing list or make an address change, please send your name and address to: Statistics Teacher Network, c/o American Statistical Association, 1429 Duke St., Alexandria, VA 22314-3402; (703) 684-1221; fax: (703) 684-2036; e-mail: wayne@asa.mhs.compuserve.com

Printed in the U.S.A

Statistics Teacher Network
c/o American Statistical Association
1429 Duke Street
Alexandria, VA 22314-3402
USA

Non-Profit
Organization
U.S. Postage
PAID
Permit No. 361
Alexandria, VA

Let us know your Zip +4!