NEWSLETTER FOR THE INTERNATIONAL STUDY GROUP ON
LEARNING PROBABILITY AND STATISTICS CONCEPTS

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Notes and Comments

As our membership keeps growing and more people send me their e-mail addresses, it seems time to print out an updated list of members, addresses, and e-mail addresses. Please note that there are some changes in some of the addresses, so disregard previous lists.

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New Members

I'd like to welcome the following new members to our group. Their addresses are included in the attached membership list.

- Claude Gaulin, who is on the Faculty of Education at Laval University in Quebec City.
- Janice R. Mokros and Lynn T. Goldsmith, who both work at Technical Education Research Centers (TERC) in Massachusetts, USA.
- Georg Schrage, University of Dartmund, West Germany. Georg is especially interested in educational uses of microcomputers and determining how simulation and visualization help teach ideas in statistics.
- Juan Diaz and Carmen Batanero, who are at the Department de Didactica de la Matematica, Escuela Universitaria del Professores, in Spain. They have written a book on psychological misconceptions of chance and related teaching activities.
- Carol Joyce Blumberg, and several colleagues of hers in the mathematics and statistics department at the University of Minnesota. They are: Joyce Quella, George Gross, Martyn Smith, Cheryl Quinn, Frederick Olson, Sandra Olson, and Duane Wolfe, Winona State.

Information from Members

Mary Rouncefield wrote that she is now a lecturer in statistics at Chester College. She is also working with primary and secondary students, as there is quite a demand for help in probability and statistics. She writes that there is now a National Curriculum for Mathematics in all the schools, which includes a large section on statistics and probability starting at age 5 or 6. For those who are interested, the full Mathematics National Curriculum document can be obtained from HMSO Publications, P.O. Box 276, London SW85DT England. More information is given in the "Curriculum Matters" section in the summer 1989 issue of Teaching Statistics.

Andrei Matuszewski has sent me two items of information for this newsletter.

1. I have written an article entitled: "Reasoning on percent rates for small samples." The other article: "Two approaches in projecting statistical expert systems" will be ready soon. Unfortunately they are written in Polish and it is not very easy to translate them into English (at least for me) since they are partly philosophical in nature. The articles address the controversy between classical and Bayesian points of view. We look for the practical solutions to that controversy to be employed in the statistical expert system (SES).

   There is a chance that I will present a compilation of those articles at the congress of Bernoulli Society to be held at Uppsala, Sweden August 13-18, 1990 or at the Conference of Scientific Computing and Automation (Maastricht, Netherlands, 12-15 June 1990).

It should be stressed that in contrast to the typical statistical software, SES can influence very strongly our area of study. The reason is that the existing software is basically oriented for professional or at least semi-professional statisticans. In contrast, expert system helps in solving statistical problems formulated in a common sense language.

Dr. Mieczyslaw Klopotek and I have developed an expert system called Statrelations. We can send a description of that system on request.

It seems that the most difficult and controversial part of SES is the "common sense language." We have validated that language of Statrelations through different types of application. We allowed non-statisticians to use our sytem. Statrelations was included as a module to extended application sytems too. We will appreciate any comments.

2. Our group should formulate a certain program to become more effective. It is not sufficient for us to inform ourselves about recent publications. Even such an aim is not fulfilled by some members in a satisfactory way. Maybe they feel that our group lacks something.

Let me assess the area we (the group) are studying. An aim or one of the basic aspects of our activity could be the following. We look for an approach to the diagnosis of what are the probability and statistics concepts which we believe are the most important for non-statisticians (while helping the future statisticians too). We feel that actual curriculas have very important disadvantages.

Those concepts will form the substance to be taught to various types of students. We should compile and evaluate the list of such concepts as our primary task. In education research, however, the form of the information transmitted to the students is also very important. Psychological aspects must be taken into account, therefore. We will not discuss those aspects in the present proposal, however, since they are quite covered in the papers of our members.

Any important concept to be taught to non-statisticians should be the compromise among the following three criteria:

1. The topic must be empirical which basically means that certain frequentist interpretation can be applied to convince the students about reality of the topic.

2. The concept should be useful in the real life. In our area it means that either it is necessary for description of an important real mechanism or it eases performing the data analysis.

3. The concept to be taught should be deep, which basically means that a non-trivial mathematical theorem is included in it.

A group of topics of such kind belongs to the area of correlation (so the notion of correlation is sort of a super concept). That area should include not only the models usually taught in the chapter called "Correlations," however. The student test e.g. can be treated as a way of evaluation of correlation between binary variable and the other which is of the interval type. ANOVA can be included to the such extended meaning of correlation too. Correlation can also be evaluated for data consisted of non-independent, identically distributed observations.

We must insist on correlation topics since it is vital for the prestige of statistics to not allow the data analysts to finish their analysis after the marginal (i.e. one-dimensional) calculations.

Ann Rosebery sent information about a project she is directing at BBN, entitled "The Mathematics Computer Curriculum" that is being funded by the National Science Foundation. The project is developing two graduate level, in-service mathematics courses for middle school teachers. One of the courses, in probability and statistics, is called "Reasoning About Data." The goal of both courses is to enhance middle school teachers' knowledge of and enjoyment in teaching mathematics through the use of computers and inquiry-based pedagogy. The "Reasoning About Data" course consists of three modules: Exploring Data (single variable explorations), Samples (exploring how probability is the basis of statistical inference), and Relationships and Data (exploring association among two or more variables). The courses have been pilot-tested at Wesley College and will be offerered this summer at University of Massachusetts - Boston.

Papers and Presentations

Several members of our study group presented papers in a symposium at the American Educational Research Associations, which met in Boston last April. The title was "Statistical Reasoning: Students, Teachers and Data." The papers given were:

1. "What's Typical? Children's Ideas About Average." Janice Mokros, Amy Weinberg, Lynn Goldsmith and Susan Jo Russell.

2. "Statistical Concepts and Statistical Reasoning in Elementary School Children: Convergence or Divergence?" Iddo Gal, Karen Rothschild and Daniel Wagner.

3. "Learning About Sampling: Trouble at the Core of Statistics." Andee Rubin and Bertram Bruce.

4. "What's Typical? Teachers' Descriptions of Data." Susan Jo Russell and Janice Mokros.

I've received copies of two of the papers. In the paper by Mokros et. al., the difficulty in understanding the concept of average is analyzed. Two major sets of questions about children's understanding of average are addressed:

1. When they are working with data sets, how do children construct and interpret indicators of center?

2. How do children develop their thinking about the mean as a mathematical relationship? How do they develop this mathematical abstraction and map (or fail to map) it onto their informal understanding of the concept?

In this study 21 children from grades 4, 6, and 8 were interviewed using a series of open-ended questions that examined the notion of average. Four predominant approaches used to solve averaging problems were identified. In addition, childrens' misconceptions were analyzed and related to the four strategies.

The paper by Rubin and Bruce, which is based on the work of the NSF-funded ELASTIC project, explored some of the underlying conceptions and heuristics students bring to the study of statistics, and makes some initial hypotheses as to how these approaches might complicate students' learning the foundations of statistical inference. The research was organized around a set of concepts about sampling that are central to understanding statistical inference. In order to investigate students' naive conceptions of sampling representativeness and variability, 12 senior high school students who had never taken a statistics course were interviewed. The analysis of their responses indicates that students have inconsistent models of the relationship between samples and populations.

A paper entitled "Which Group is Better? The Development of Statistical Reasoning in Elementary School Children" by Iddo Gal, Karen Rothschild, and Daniel Wager; appeared in the January-February 1990 issue of Teaching Thinking and Problem-Solving. This paper describes research designed to answer two types of questions. First, do children engage in "descriptive statistics" by organizing observations and summarizing data and what stratagies do they use. Second, what characterized the development of statistical reasoning in the absence of direct instruction? What kinds of "naive" or "everyday" concepts do children bring with them to their formal study of statistics at school? Subjects in the research study were 31 children each in grades 3 and 6. The third graders had received no formal instruction in statistics, while the 6th graders had learned how to calculate a mean in their math class. Children were interviewed individually and asked to compare group distributions involving different contexts. The authors found a variety of reasoning strategies used and were able to identify several factors that affect children's ability to correctly draw conclusions from data. They also raised several important questions for further research.

I received several papers from Andee Rubin which describe different aspects of her work with colleagues at BBN on the ELASTIC project. These papers are:

1. "Getting an Early Start: Using Interactive Graphics to Teach Statistical Concepts in High School," published in the proceedings of the Statistical Education Section, American Statistical Association, 1988.

2. "A Computer-Enhanced Approach to Developing Statistical Reasoning," which will soon be published in Teaching Statistics.

3. "Reasoning Under Uncertainty: Developing Statistical Reasoning," published in the Journal of Mathematical Behavior, 1989, Volume 8.

I also received from her the Annual Report for the ELASTIC project, which discusses their current research on sampling and statistical inference, and the development of a computer-based data collection environment in which students take measurements on videotapes which they themselves have filmed

Cliff Konold sent me two of his recent papers:

1. "Understanding Students' Beliefs About Probability" will appear in E. Von Glasersfeld's forthcoming book Constructivism in Mathematics Education. This paper describes different interpretations of probability, heuristics used by individuals to reason about chance events, and implications for teaching students.

2. "An Outbreak of Belief in Independence?" is a newer version of the paper he presented at PME-NA last fall, which was described in a previous newsletter.

Cliff has been directing the NSF-funded Chance-Plus project at University of Massachusetts at Amherst this year. He has been running a discussion group that meets regularly to read and critique research-related to learning and understanding probability and statistics. I hadn't seen some of the papers on their reading list, so he sent me copies. They are:

"The Impact of Probability Judgments on Reasoning About Multiple Possibilities," by Karen Horobin and Curt Acredolo, published in Child Development, 1989, Volume 60.

"Suppressing Natural Heuristics by Formal Instruction: The Case of the Conjunction Fallacy," by Franca Agnoli and David Krantz, published in Cognitive Psychology, 1989, Volume 21.

"Similarity and Decision-Making" by Edward Smith and Daniel Osherson, in the book Similarity and Analogical Reasoning, by Vosniadov and Ortony, 1989.

Bob delMas recently had a paper published in Focus on Learning Problems in Mathematics, summer 1989. This paper, co-authored with William Bart, reports on the differential effects of two variants of an activity-based instructional unit on students' misconceptions of probability.

Rolf Biehler sent me a copy of his chapter "Computers in Probability Education" which is part of a forthcoming book, edited by Ramesh Kapadia, entitled Chance Encounters: Probability in Education. This comprehensive chapter describes every aspect of using computers to assist in probability instruction, and has an extensive reference and software list.

Miscellaneous

I have taken over the task of chair of the Statistics and Data Modeling Working Group, which is a group that has been formulating a position on the future role of technology in learning statistics. A draft of a paper summarizing this position along with information on the work of some current technology-enhanced curriculum development projects, was shared at a pre-NCTM meeting. If anyone would like to read and react to this paper, let me know. I welcome your input.

The Third International Conference on Teaching Statistics: ICOTS3

It's hard to believe that four years have passed since ICOTS2 in Victoria, B.C. I am very much looking forward to meeting many of you in New Zealand this August and also renewing acquaintances made four years ago. I plan to hold at least one meeting of the study group for those who attend the conference. I'd like to explore the formation of subgroups of people who have similar research interests. Group topics might indicate: research on statistical understanding of elementary school children, research on the impact of technology in learning statistics, and development of measures to assess statistical understanding. Bring your ideas!

Have a good summer! The next newsletter will be in September, 1990.

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