NEWSLETTER OF THE INTERNATIONAL STUDY GROUP FOR RESEARCH ON LEARNING PROBABILITY AND STATISTICS

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1. NOTES AND COMMENTS

In a few days some of us are meeting at the PME 21 Conference (Lahti, Finland), where our Stochastics Teaching and Learning Working Group is starting. Another important meeting point is the 51st Session of the International Statistical Institute (Istanbul, Turkey). You will find updated information concerning these conferences at the end of the newsletter.

I have received from John Truran complementary references concerning the statistical tests controversy in Australia and Marie Paul Lecoutre sent me a very complete bibliography on this controversy and some solutions offered by the bayesian approach. I am grateful to Marie Paul, John Truran, Cliff Konold, Susanne Lajoie, Iddo Gal, Eliseo Borras, Brian Phillips as well as to all the new members who have helped me to prepare this particular issue of the newsletter.

The specific "theme" I have chosen for this newsletter is the subjective perception of randomness. The bibliography concerning this issue is so wide that I am just including here those references

concerning people's understanding of randomness but, even so, it was difficult to select the references. Next October we are dealing with references related to the philosophical or epistemological analysis of randomness. Please let me know if there are other themes of interest to you, for the following newsletters.

The newsletters are now available from the Journal of Statistics Education Information Services (//www2.ncsu.edu/ncsu/pams/stat/info/infopage.html). This option could be useful for recovering past issues or for printing the newsletters more easily.

Please do not forget to keep me informed about your activities and publications. If there are any corrections or additions to the newsletter, please post them to all members on the list by using the e-mail address alias: stated_list@goliat.ugr.es

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2. NEW MEMBERS

Carmen Capilla
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Carmen is an associate professor of ptatistics at the polytechnic university of Valencia (Spain). Her research areas are statistical techniques for quality control and improvement (design of experiments, process control) and environmetrics. However, she is very interested in research on teaching/learning applied statistics, in particular to engineers and environmental scientists. He teaches statistics courses at engineering school undergraduate levels, and she is also involved in training in statistical techniques for quality improvement in industry. She has taught several masters degree courses in developing countries such as El Salvador.

Bruce Cooperstein
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Bruce has worked in incidence geometry, coding theory, and combinatorics. His interest in our group arises out of his leadership of several programs having to do with mathematics education, preparation and in service of teachers: The Monterey Bay Area Mathematics Project (MBAMP), directorship of the Santa Cruz site of the California Mathematics Diagnostic Testing Project (MDTP) and directorship of a internship program for prospective secondary mathematics teachers: the Community Teaching Fellowship Project (CTF). He has also created a course, "Abstract Algebra for Prospective Mathematics Teachers", which emphasises those aspects in the development of abstract algebra most relevant to secondary school mathematics - the developmental understanding of the real and complex numbers, non-solution of the classical Greek construction problems, Galois theory, etc.

Joachim Engel, PH Ludwigsburg
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Joachim teaches mathematics and mathematics education at a teacher's college (Paedagogische Hochschule Ludwigsburg), especially applied (or application oriented) mathematics. His special research interests are stochastics, especially stochastic modelling and exploratory methods in statistics, both from an educational as well as from a methodological point of view. After publishing several papers on nonparametric function estimation methods the focus of his current work includes more elementary methods of modelling scatter plot data, discovering structure in univariate data, and exploring new methods of teaching data analysis.

Sahib Esa
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Sahib Esa has been a lecturer in mathematics and statistics at Sulaimaniya University, Iraq and Sofia University, Bulgaria. He has also been a research fellow in computational statistics at the Bulgarian Academy of Sciences, lecturer in statistics at Lulea University and senior lecturer in statistics at Lulea University since July 1992. His academic background is in mathematics with a thesis within the field of multivariate statistical analysis. He has taught mathematics and statistics at Sulaimaniya University, Iraq and Sofia University, Bulgaria and Statistics at Lulea University since August 1991. His publications include papers in statistics and its applications in medicine, economy and industry.

Parul Deoki
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Ms Parul Deoki is a senior lecturer in mathematics specialising in the teaching of probability and statistics at the University of the South Pacific, which is a regional university serving 12 developing island nations in the S.W.Pacific. Her work involves the writing of the curriculum for the three statistics courses that are currently offered at the USP, and the teaching of these courses to both on campus as well as extension students by correspondence.

Andi Hakim Nasoetion
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He recently wrote a paper on the necessity to strengthen the teaching of statistics at the tertiary level if one would like to improve the research abilities and quantitative feelings of university graduates. He is pleading to five Ph.D.'s in statistics scattered all around from the northern tip to the southern tip of Sumatra to establish a joint short course for all universities in Sumatra in the sense they had been doing in the southern united states in the fifties and early sixties. Incidentally he is a graduate of NCSU of one third century ago. Upon his return home in early 1965 he remodelled the statistics and math curriculum of Bogor Agricultural University and in 1972 established its statistics department, the first in the country.

Bruno Lecoutre
UPRESA 6085 Analyse et Modeles Stochastiques,
C.N.R.S. et Universite de Rouen Mathematiques

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Bruno and Jacques work with Marie Paul Lecoutre and are very interested in hypotheses testing. For more than twenty years now, they have developed alternative procedures to significance tests, especially in the Bayesian framework. They are contributing to our session "Should we get rid of statistical testing ?" with a very valuable bibliography, as well as information concerning bayesian computer programs. Bruno and Jacques's teaching experience with Bayesian methods is now firmly established: they suggest that using the Bayesian interpretations of significance tests and confidence intervals comes quite naturally to students. In
turn the frequentist approach, and its methodological pitfalls when restricted to usual significance tests, appear to be more clearly understood.

John McColl
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John has read recently of the International Study Group for Research on Learning Probability and Statistics. This is an area in which he is becoming more and more involved.

Paul Morgan
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Paul is teaching mathematics at The London Oratory School in Fulham. He teaches A level statistics and is interested in non-formal teaching techniques. He is trying very hard to bring probability and statistics 'alive' in the classroom.

Julie Morrisett Clark
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Julie has got a Ph.D. in mathematics (coding theory), but she has been teaching statistics at a small liberal arts college in SW Virginia for the last six years. It has been her favourite course and something of a passion for her. During the summer of 1994, she was a participant in the MAA/NSF sponsored STATS workshop. About the same time she made a radical switch in her research - from pure mathematics to collegiate mathematics education. She now belong to an extended network of research collaborators calling themselves the Research in Undergraduate Mathematics Education Community (RUMEC). For the past two
years, RUMEC has been working to develop a framework (based on constructivism, and the theories of Piaget) for understanding and describing college students' mental constructions of mathematical concepts in such areas as calculus, discrete mathematics, and abstract algebra. Given

her interest in statistics, it was a natural progression for her to use this framework to begin an investigation of student understanding of some fundamental statistics concepts. With her colleague, David Mathews, she has recently finished the first paper in a series - it is entitled "Successful students' conceptions of mean, standard deviation, and the central limit theorem," and is currently under review. They are in the process of writing a follow-up paper which confirms and extends the findings of the first. Anyone interested in the paper, or RUMEC's paradigm can find out more by contacting Julie, or by visiting RUMEC's Web site: http://www.rumec.gsu.edu.

Simo Puntanen
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Simo is a Lecturer at the University of Tampere. His research interests cover linear models and related matrix theory. As regards teaching, his main interest lies in the use of computers in illustrating the concepts related with linear regression models. He is using Survo computer program: Survo is an integrated interactive environment for statistical analysis, computing, graphics and it also includes features related to spreadsheet computing, matrix operations, text processing, and report generating. The system has been developed by Professor Seppo Mustonen of the University of Helsinki.

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3. CHANGES IN E-MAIL ADDRESSES

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4. SUMMARIES OF PUBLICATIONS BY MEMBERS

ENGEL, J. (1997). Zur stochastischen modellierung funktionaler abhaengigkeiten: Konzepte, postulate, fundamentale Ideen (Stochastic Modelling of functional dependencies: assumptions, concepts, fundamental ideas). _Mathematische Semesterberichte_, 1997, 2.

Several methods for modelling scatter plot data are considered. Central is the idea to decompose the functional dependency between predictor and response into a sum of a from x dependable location parameter m(x) and a trend free stochastic term . For reconstructing m from the data two approaches are compared: a model with a priori specification of a parametric class of functions and nonparametric concepts which are based on the idea of a moving average. The results for the latter - curves - are intuitive, simple and usually easy to interpret.

FISCHBEIN, E. & Schnarch, D. (1997). The evolution with age of probabilistic, intuitively based misconceptions. _ Journal for Research in Mathematics Education_, 28(1), 97-105.
The purpose of this research was to investigate the evolution with age of probabilistic, intuitively based misconceptions. We hypothesised, on the basis of previous research with infinity concepts, that these misconceptions would stabilise during the convergence of the formal operation period. The responses to probability problems of students in Grades 5, 7, 9 and 11 and of prospective teachers indicated, contrary to our hypothesis, that some misconceptions grew stronger with age,

whereas other grew weaker. Only one misconception investigated was stable across ages. An attempt was made to find a theoretical explanation for this rather strange and complex situation.

JONES, G., THORNTON, C., Langrall, C. W., & Mogill, T. A. (1997). Assessing and using students' probabilistic thinking to inform instruction. Presented at the _Annual Meeting of the NCTM-SIG Research Presession_, Minneapolis, MN, April, 1997.

This paper reports on a program of four research studies on probability in the elementary and middle grades. In particular, it examines: a) a research-based framework for describing and predicting how elementary and middle grades' students think in probability; b) an instructional program in probability for the elementary level that was informed by the research-based framework on students' probabilistic thinking; and c) two instructional programs in the middle grades, one emphasising conditional probability and independence, the other focusing on probabilistic thinking and writing in the context of probability.

MCCLOSKEY, M., Blythe, S., & Robertson, C. (1997). _QUERCUS: Statistics for bioscientists. A student guidebook_. London: Arnold.

The QUERCUS package is a collection of courseware modules designed to tutor bioscience students in the basic concepts and techniques of statistics. Throughout QUERCUS the highly visual and interactive nature of statistics teaching is emphasised. Concepts are illustrated with diagrams, animations and simulations. This guidebook has been designed to provide the student with a framework for using the QUERCUS courseware so as to maximise its effectiveness as an aid to teaching and learning. Topics covered by QUERCUS include: classifying variables, using MINITAB, graphical representation, measurements of location and variability, sampling theory, confidence intervals, significance testing, regression, correlation, residuals and transformations, and ANOVA.

MORRIS, E. (1997). _An investigation of students' conceptions and procedural skills in the statistical topic correlation_ . CITE Report n. 230. Milton Keynes: The Open Universit.
This report describes a study that was conducted as part of the author's PhD. research that concerns the effective design of a computer assisted learning for the topic correlation.

ROA, R., BATANERO, C., GODINO, J. D., & CAÑIZARES, M. J. (1997). Estrategias en la resolucion de problemas combinatorios por estudiantes con preparacion matematica avanzada. (Strategies used by mathematics university students in solving combinatorial problems). _Epsilon_ 36, 433-446.

In this paper we analyse the processes followed by four students in the last year of their Bachelor in Mathematics when solving simple and compound combinatorial problems. These students, selected from a sample of 29, had the best and worst results when they were given 13 combinatorial problems to solve in a written questionnaire. An in-depth interview with each student explored his/her processes to solve the problems. The results show that these students, in spite of their high mathematical preparation, had a great difficulty with the problems. The use of the tree diagram was useless. The better problem solvers were characterised by their ability to identify the combinatorial configuration, their understanding of the relevancy of order and repetition in the statement of the problem; their systematic enumeration, their recursive and generalising capacity and their identification of either the adequate combinatorial operation, or the equivalent series of arithmetic operations. On the other hand, the main causes of failure were confusion about order and repetition, misunderstanding the type of element to be combined, lack of enumeration ability and changing the arithmetic or combinatorial operation needed to solve the

problem.

Romero, R., Ferrer, A., CAPILLA, C., Zunica, L., Balash, S., Serra, V., & Alcover, R. (1995). Teaching statistics to engineers (An innovative pedagogical experience) _Journal of Statistics Education_, 2(3).
In recent years, the growing consciousness of the importance of statistics in the training of engineers has been accompanied in the western world by an increasing dissatisfaction with the teaching of statistics in universities. Within the framework of the Educational Innovation Project (PIE) of the Polytechnic University of Valencia, a group of teachers in the Department of Statistics introduced an innovative project beginning in 1989. This project has entailed a complete restructuring of the syllabus, as well as the teaching methodology. In this paper we explain different aspects of this project, emphasising the important role of computer resources and the satisfactory results obtained.

TRURAN, K. (1997). Children's understanding of probability concepts. Some ideas for the classroom. _ Research Information for Teachers_ 1, 3, September.

The article summarises children's responses to a variety of random generators, and suggests a number of activities and questions which might form a basis for using all of these generators in primary classrooms.

VALLECILLOS, A, & BATANERO, C. (1997). Conceptos activados en el contraste de hipotesis estadisticas y su comprension por estudiantes universitarios. (Concepts involved in hypotheses testing and its understanding by university students). _Recherches en Didactique des Mathematiques_, 17(1), 29-48.

In this paper we present a study of university students' difficulties in understanding key concepts of hypotheses testing. Using in-deep interviews of seven students who had previously completed a questionnaire, we analyse their understanding of the following concepts: significance level, null and alternative hypotheses, parameter and statistics, and the overall logic of hypotheses testing. As a consequence, we indicate some points needing special attention in the teaching of statistical tests.

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5. RECENT DISSERTATIONS

BORRAS, E. (1996). _ Algunos modelos de simulacion aleatoria y su aplicacion a la ensenanza del azar_ (Some random simulation models and their application to teaching randomness). Ph. D. Universitat Politecnica de Catalunya. Supervisor: Dr. Claudi Alsina.

This research work intends to show the wide possibilities of some models and procedures, especially simulation and the probabilistic abacus, for the teaching of randomness in primary and secondary education. These models allow us to introduce non trivial problems of great interest to understand randomness at these levels.
In Chapter I we suggest that the concept of randomness is not so simple as it has been supposed. There is still a fight between determinism and undeterminism to explain all what happens in our world. Using random generators, we analyse in Chapter 2 physical and biological random processes as well as non random processes, such as building fractals and finding the zeros in an equation. Genetic algorithms, based on the idea of natural selection are simulation instruments frequently appropriate to estimate the solution of difficult mathematical problems.
In Chapter 3 the interest of Markov chains in the teaching of randomness is shown. Within these contexts, non trivial attractive problems concerning waiting times, transition probabilities,

recursion, etc; arise in a natural way. Four techniques are described, one of which is the probabilistic abacus suggested by Arthur Engel, that can serve to work on these type of process with primary students. The association of probability and flow in the graph that each Markov chain describes is interesting and fruitful.
In Chapter 4 some random models and games are analysed through the methods described in the previous chapter. Special attention is devoted to geometric games, where the difficulty of "random selection" is shown. In Chapter 5, using urns and checkerboards, we can discover that randomness produces some evolution and not others, because of retroaction mechanisms. Laws such as natural selection by Darwin, equilibrium or explosion of certain systems, are clearly modelled. A correspondence between functions and drawings is also established.
In Chapter 6, the complexity of stochastic concepts is shown through the analysis of daily language and some classroom experiences. Information concerning research on teaching and learning stochastics at primary and secondary level is provided. Ideas to introduce stochastics in the mathematics classroom are suggested in different places of the curriculum and at different levels. Finally a wide didactic and basic bibliography is included.

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6. THE ASSESSMENT CHALLENGE IN STATISTICS EDUCATION

The handbook, "The Assessment Challenge in Statistics Education", edited by Iddo GAL and Joan GARFIELD, is now ready for distribution.
Jointly published by the International Statistical Institute and IOS Press, the handbook contains 19 chapters (see listing below) written by leading educators and researchers from several countries, and has 4 main sections. Chapters address both conceptual and pragmatic issues in the assessment of statistical knowledge and reasoning skills among students at the college and precollege levels, and the use of assessment to improve instruction in diverse contexts.
The 19 chapters are organised as follows:

Part I: Curricular goals and assessment frameworks

1. Introduction: Curricular goals and assessment challenges in statistics education. Iddo GAL , & Joan GARFIELD. 2. What can we learn from emerging assessment practices in mathematics education. Andy BEGG.
3. Authentic assessment models for statistics education. Shirley Colvin, & Kenneth Vos.
4. Attitudes, beliefs, and the learning of statistics. Iddo GAL, Lynda Ginsburg, & Candace SCHAU.

Part II: Assessing conceptual understanding of statistical ideas

5. A framework for assessing teachers' knowledge and students' learning of Statistics.Susan FRIEL, George BRIGHT, Dargan FRIERSON, & Gary Kader.
6. Characteristics of "real life" problems which prompt students to construct conceptual models for statistical reasoning. Richard Lesh, Miriam Amit, & Roberta Schorr.
7. The danger of rushing to techniques: going beyond procedural knowledge. Finbarr Sloane, Anthony Kelly, & Andrea Whittaker.
8. Assessing understanding of relationships between statistical concepts. Candace SCHAU, & Nancy Mattern.

Part III: Innovative models for classroom assessment

9. Assessing statistical literacy through the use of media surveys. Jane WATSON.
10. Assessing graph comprehension in a small group setting. Frances CURCIO, & Alice Arzt .

11. Assessing Student Projects. Susan STARKINGS.
12. Assessing project work by external examiners. Peter HOLMES.
13. Portfolio assessment in a statistics class. Carolyn Keeler.
14. Computer technologies for assessing and extending statistical learning. Susanne LAJOIE.
15. Exemplars of written classrooms assessments. Flavia JOLLIFFE.
16. Assessment on a budget: using traditional methods imaginatively. Chris Wild, Chris Triggs, & Maxine PFANNKUCH.

Part IV: Assessing understanding of probability

17. Dimensions in the assessment of students' understanding and application of chance and probability. Kathleen METZ.
18. Combinatorial reasoning and its assessment. Carmen BATANERO, Juan D. GODINO, & V. Navarro-Pelayo.
19. Assessing students' understanding of probability through computer applications. Steve Cohen, & Richard Chechile.

For more information or for ordering instructions, check the IOS Press homepage at "http//www.iospress.nl," send
e-mail to: "market@iospress.nl", or contact the IOS Press main offices: IOS Press, van Diemenstraat 94, 1013 CN Amsterdam, The Netherlands, Tel: +31 20 638 2189, Fax: +31 20 620 3419.

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7. NEW BOOK ON STATISTICAL EDUCATION

LAJOIE, S. P. (Ed.) (1997)._ Reflections on Statistics: Learning, teaching, and assessment in grades K- 12_. Hillsdale, NJ: Erlbaum.

One call for reform in mathematics education is to address statistics at the precollege level. We created an interdisciplinary working group consisting of mathematics educators, cognitive scientists, teachers, and statisticians to address this call in a manner that could help teachers and researchers make informed decisions about how to introduce statistics in grades K-12. One of the outcomes of this multidisciplinary collaboration is this edited volume which represents a partial consolidation of some of our interactions and as such the book should appeal to both practitioners and researchers alike.

In an attempt to identify the important key ideas that need to be considered for children and adolescents learning statistics, the book is organized into four interdependent themes: content, teaching, learning, and assessment. By focusing chapters on particular themes, we intend to cultivate a better understanding of how each area relates to improvements in statistics education by (a) clarifying the important mathematical ideas in statistics; (b) investigating student learning from a cognitive perspective describing how students formulate, represent, reason about, and solve statistics problems, examining the construction of ideas via the social interaction that occurs in and out of school; (c) investigating the beliefs, pedagogy, and content knowledge of teachers; and (d) ensuring that teachers have a deep understanding of statistics so that they
can provide a classroom environment that stimulates deep thinking by their students.

LAJOIE and Romberg introduce the volume by describing the main issues that have arisen in our working group as they pertain to statistical content, teaching, learning and assessment. Statistical content is addressed by two chapters. SCHEAFFER, WATKINS, and LANDWEHR's chapter provides a detailed account of what a high school graduate should know about statistics and at

what grade levels certain statistical content should be introduced. BURRILL and Romberg focus on statistical content for middle school and suggest ways in which this critical period can serve to bridge the gap between informal knowledge about making conjectures from collections of data and the formal ways users of statistics analyze
data. The teaching statistics section presents one chapter on teaching statistics to upper elementary students (BRIGHT and FRIEL) and one chapter on teaching statistics to teachers through a professional development workshop (FRIEL and BRIGHT).

The three chapters in the learning section cover students' learning statistics and probability from primary school to adulthood. The chapters by Horvath and LEHRER (2nd graders, 4th and 5th graders, adults) and METZ (primary grades) carefully examine the dimensions of students' intuitions and the transitions in this knowledge that reflect emerging statistical competence. Derry, LEVIN, OSANA and JONES focus their discussion of statistical learning in terms of statistical gaming situations where students engage in simulations of professional activities such as conducting research, preparing presentations, and participating in hearings and conferences in which students are required to develop statistical arguments centering on their own statistical evidence.

Assessing statistics is covered in three chapters that explicitly address how to integrate assessment with instruction. LAJOIE, Lavigne, Munsie and Wilkie and Schwartz, Goldman, Vye, Barron, and the Cognition and Technology Group describe ways in which technology can be used to enhance the assessment process through modeling student performance so that students can internalize the assessment goals of instruction. LAJOIE et al. describe new assessment methods for monitoring student progress in statistics in a grade eight classroom. Schwartz et al. discuss ways of stimulating learning through the direct confrontation of competing prototheories. GAL describes a multi-layered approach to the assessment of the
reasonableness of student opinions about statistics. Finally, LAJOIE provides an epilogue that presents her reflections on what can be learned from this volume and presents some suggestions for future work in this area.

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8. SHOULD WE GET RID OF STATISTICAL TESTING?

1. John TRURAN reports that the Statistical Testing Issue has also occurred in Australia. The volume 5, n. 1 of the _Mathematics Education Research Journal_ contained an important article by R. Menon which challenged the theoretical bases of statistical significance tests and argued that the use of it should be discontinued in mathematics education research:

   Menon, R. (1997). Statistical significance testing should be discontinued in mathematics education research. _Mathematics Education Research Journal_, 5(1), 4-18.

   The following list include the responses to Menon's paper in _Mathematics Education Research Journal_, 5(1), and Menon's final reply to them:

   Bourke, S. (1997). Babies, bathwater and straw persons: a response to Menon. _Mathematics Education Research Journal_, 5(1), 19-22.

   Clements, M. A. (1997). Statistical significance testing: providing historical perspective for Menon's paper. _Mathematics Education Research Journal_, 5(1), 23-27.

   Rowley, G. (1997). Response to Menon. _Mathematics Education Research Journal_, 5(1), 28-29.

Menon, R. (1997). Take off those blinkers mate! Response to Bourke, Clements, and Rowley. _Mathematics Education Research Journal_, 5(1), 30-33.

In the editorial of vol. 8, n. 2 of the same journal, Nerida F. Ellerton summarised the following recent developments related to this controversy:

Haig, B. D. (1996 a). Statistical methods in education and psychology: A critical perspective. _Australian Journal of Education_, 40 (2), 190-209.

Haig, B. D. (1996 b). Rejoinder to Barry Mc Gaw. _Australian Journal of Education_, 40 (2), 190-209.

McGaw, B. (1996). Response to Brian D. Haig. _Australian Journal of Education_, 40 (2), 209-213.

Shea, C. (1996). Are stats skewing psychology? _The Australian Higher Education Supplement_, September, 1996, 26.

Schmidt, F. L. (1996). Statistical significance testing and cumulative knowledge in psychology: Implications for training of researchers. _Psychological Methods_, 1(2), 115-129.

2. Bruno LECOUTRE, Jacques POITEVINEAU, and Marie-Paul LECOUTRE are very interested in hypotheses testing. For more than twenty years now, they have developed alternative procedures to significance tests, especially in the Bayesian framework. They sent me a very complete set of references about hypotheses testing misuses and abuses, theoretical criticisms and alternative solutions(methodological and some more technical papers). These references are the bibliography of a doctoral thesis (in French), by Jacques POITEVINEAU (1997):

Méthodologie de l'analyse des données expérimentales - Etude des pratiques relatives à l'usage des procédures d'inférence statistique (Methodology of experimental data analysis - Study of pratices related to the use of statistical inference procedures) and of a paper submitted for publication:

LECOUTRE, M. P., POITEVINEAU, J., & LECOUTRE, B. (1997). Uses, abuses and misuses of significance tests in the scientific community : Won't the Bayesian choice be unavoidable ? _American Psychologist_.

Bruno, Jacques and Marie-Paul will be glad to provide this bibliography to other colleagues (Bruno's e-mail address is bruno.lecoutre@univ-rouen.fr)

In addition to the bibliography Bruno and Jacques have developped some window computer programs for alternative solutions to classical inference.These programs are available on the Internet at the following address: http://epeire.univ-rouen.fr/labos/eris/pac.html
If you are interested in these programs, Brubi, Jacques and Maie Paul would greatly appreciate your comments and suggestions. Below I include a description of these programs as well as some references:

*** PAC (LECOUTRE and POITEVINEAU, 1992 - Limited evaluation version) is a general

univariate and multivariate analysis of variance software. It includes the traditional analysis of variance significance tests, but offers additional capabilities, including Bayesian (and frequentist) procedures for assessing the magnitude of effects and investigating assumptions about variances and covariances. Special attention has been accorded to the analysis of complex and realistic designs. In return only relatively simple prior distributions have been considered (rather than general prior distributions for simple problems).

PAC includes standard Bayesian procedures (using noninformative prior distributions). For one degree of freedom comparisons, conjugate priors for the parameters of interest can be used to incorporate outside information. A "Bayesian module" displays and prints Bayesian probability distributions and calculates the corresponding probability statements, in interaction with the user. Furthermore procedures involving no assumptions about variances and covariances are provided for most usual situations. These procedures are direct extensions of the Behrens-Fisher solution to the basic problem of comparing two means with variances not assumed to be equal.

All of the procedures are applicable to general experimental designs (in particular, repeated measures designs), balanced or not balanced, with univariate or multivariate data, and covariables. A powerful request language allows the user to easily perform specific analyses for all comparisons of interest: main effects, partial effects, interaction effects, conditional effects, component effects in polynomial regression, etc.

Recent relevant references are:

LECOUTRE, B. (1996)._Traitement statistique des donnees experimentales: Des pratiques traditionnelles aux pratiques bayesiennes_ (Statistical analysis of experimental data: From traditionel practices to bayesian practices). Saint-Mande France: C.I.S.I.A

LECOUTRE, B. (1997). Teaching analysis of variance and procedures for assessing the magnitude of effects to non statisticians: The specific analysis approach. Submitted for publication.

Rouanet, H. (1996). Bayesian procedures for assessing importance of effects. _Psychological Bulletin_, 119, 149-158.

Rouanet, H., LECOUTRE, M. P., Bert, M. C., LECOUTRE, B., Bernard, J. M., & Le Roux, B. (1997) _Statistical Inference in the Strategy of the Researcher_ (first edition in french entitled L'Inférence Statistique dans la Démarche du Chercheur, 1991). Berne: Peter Lang, in press.

*** LeBayesien is a simplified didactic version of PAC, very easy to use.

*** LesDistributions gives both the density curves and the probability statements for the main univariate distributions involved in the frequentist and Bayesian analysis of normal models, including the non-central khi-square, F and t distributions, the psi-square, or alternate F distribution, the lambda-square or alternate khi-square distribution, and the K-prime and K-square distributions.

References:

LECOUTRE, B. (1997). Two useful distributions for Bayesian predictive procedures under normal models. Submitted for publication.

LECOUTRE, B., Guigues, J. L., POITEVINEAU, J. (1992). Distribution of quadratic forms of multivariate Student variables. _Applied Statistics_, 4, 3.

Rouanet, H., & LECOUTRE, B. (1983). Specific inference in ANOVA: From significance tests to Bayesian procedures. _British Journal of Mathematical and Statistical Psychology_, 36, 252-268.

Schervish, M. J. (1995). _Theory of Statistics_. New York: Springer Verlag.

*** LesEchantillons draws samples, and simulates the sampling distributions for descriptive statistics (mean, difference of two means from independent groups, standard deviation) and for inferential statistics (t test statistic and credibility limits for one mean and for the difference of two means). The parent distributions can be Normal, Gamma (or Chi-square), exponential, or Uniform.

*** LesEffectifs computes the predictive Bayesian probabilities (which includes the traditional frequentist power as a particular case), to obtain, with a specified sample size, a given conclusion, for all the situations considered in LeBayesien. Conversely it computes the necessary sample size to obtain, with a specified predictive probability (with a specified power as a particular case), a given conclusion.

*** LesProportions displays and prints Bayesian probability distributions and calculates the corresponding probability statements, for inferences about proportions in the case of one and two independent samples (binomial model with a Beta prior). For two proportions, inferences can be obtained for the difference, the relative risk and the odds ratio. For one proportion, predictive distributions are available.

Reference:

LECOUTRE, B., Derzko, G., & Grouin, J. M. (1995). Bayesian predictive approach for inference about proportions. _Statistics in Medicine_, 14, 1057-1063.

*** LesImplications computes Bayesian probabilities to investigate the degrees of implications between binary attributes (with a multinomial model and a Dirichlet prior).

Reference:

Charron, C., & Lecoutre, B. (1997). Bayesian analysis of the degrees of implications between binary attributes. Submitted for publication.

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9. SUBJECTIVE PERCEPTION OF RANDOMNESS

Subjective perception of randomness has been extensively researched by psychologists and statistical educators using a variety of production and judgement tasks involving randomness, and, consequently, different biases characterising people's performances have been described. These results, especially as far as children and adolescents' understanding of randomness are concerned, are highly relevant for educational research, as new mathematics curricula for compulsory teaching levels propose broadening the study of random phenomena. Below I include some references on this question.

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Kahneman, D., Slovic, P., & Tversky, A. (1982). _Judgement under uncertainty: Heuristics and biases_. Cambridge: Cambridge University Press.

KONOLD, C. (1995). Confessions of a coin flipper and would-be instructor. _The American Statistician_, 49, 203-209.

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KONOLD, C., Lohmeier, J., Pollatsek, A., & Well, A. (1991). Novices' views on randomness. In R. G. Underhill (Ed.), _Proceedings of the Thirteenth Annual Meeting of the International Group for the Psychology of Mathematics Education . North American Chapter_ (v.1, pp.167-173). Blacksburg: Virginia Polytechnic Institute and State University.

LECOUTRE, M. P., & Durand (1988). Jugements probabilistes et modeles cognitifs: etude d'une situation aleatoire. _Educational Studies in Mathematics_, 19, 357-368.

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METZ, K. (1994). Development of the concept of randomness. In D. Kirshner (Ed.), _Proceedings of the XVI Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education_ (v1., pp. 307-313). Baton Rouge: Luisiana State University.

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Pollatsek, A., & KONOLD, C. (1991). Randomness is well enough understood to be misunderstood. _Journal of Behavioral Decision Making_, 4, 218-220.

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10. OTHER PUBLICATIONS OF INTEREST

Bonsangue, M. V. (1994). Symbiotic effects of collaboration, verbalization, and cognition in elementary statistics. In J.J. Kaput, & E. Dubinsky (Eds.), _Research issues in undergraduate mathematics learning_ (pp. 109-117). MAA Notes Number 33. The Mathematical Association of America.

The effect of a collaborative learning model on student achievement was examined for two groups of students enrolled in introductory statistics. One group used a collaborative model as part of the instruction, and the other used a traditional lecture format. External factors such as course instructor, time of class, and evaluation of student performance were controlled for both groups. Moreover, the control and treatment groups were selected at random before the course commenced. No differences were found between groups in attendance, homework completion, or course completion rates. Comparison of control and treatment groups showed no difference in achievement on the first exam; however, significant differences favouring the treatment group were observed at all measurement point thereafter. Time series residual analysis was performed to illustrate the widening gap of achievement effects throughout the semester once preintervention effects were removed. Students' understanding of statistical concepts and applications are discussed, together with an example of a student conversation. Implications for alternative classroom structures in college mathematics courses are considered together with the need for replication and further

study.

Hauff, H. M., & G. J. Fogarty (1996). Analysing problem solving behaviour of successful and unsuccessful statistics students. _ Instructional Science_, 24(6), 397-409.

This study investigated problem solving behaviour in statistics by documenting differences between successful and unsuccessful students. Two methodological approaches were used. The first required students to identify key structural features of common problems. The second used verbal protocol procedures to examine the processes employed when "good" and "poor" statistics students solve an ANOVA problem. It was expected that findings obtained by these earlier researchers in the domain of physics would also apply in statistics. Two groups of students in undergraduate psychology course were selected for the study.

Hubbard, R. (1997). Assessment and the process of learning statistics. _Journal of Statistical Education_ , 5(1).

Because assessment drives student learning, it can be used as a powerful tool to encourage students to adopt deep rather than surface learning strategies. Many standard assessment questions tend to reinforce the memorisation of procedures rather than the understanding of concepts. To counteract this trend, some techniques for constructing questions that test understanding of concepts and that address specific goals of statistical education are described and illustrated withexamples.

McFarlane, A. E., Friedler, Y., Warwick, P., & Chaplain, R. (1995). Developing an understanding of the meaning of line graphs in primary science investigations, using portable computers and data logging software. _Journal of Computers in Mathematics and Science Teaching_, 14(4), 461-480.

The project reported here introduced dynamic line graphs to children as young as eight, using probes and software in the context of a science investigation. The results suggest that this approach facilitates effective use of a line graph as a model of the relationship between variables. The experience of introducing this new technology in the classroom, as well as comparison with a control group is described.

Monchoux, M. F. (1996). Difficultes dans l'enseignement des probabilites (seconde annee d'universite) (Difficulties in learning probability theory (second year of university). In C. Keitel, U. Gellert, E. Jablonka, & M. Muller (Eds.), _The challenge of social change and technological development_ (pp. 334-340). Berlin: Karlsruhe.

Examinations questions concerning probability in second year of scientifically university are classified according to their percentage of success.The comparison of experimental and theoretical classifications point out notions (independence and disjunction) and intellectual activities that defy classifications. Some false assertions (for example events related to an experience are of equal probability") were found in student's responses. Some of these assertions are resisting to teaching and have often an historical or didactic origin.

Oxman, V, (1996). Original intuition of symmetry and misconception of probability of young children. In C. Keitel, U. Gellert, E. Jablonka, & M. Muller (Eds.), _The challenge of social change and technological development_ (pp. 178-184). Berlin: Karlsruhe.

This research shows that in their probability statements 6-12 year-old children are often guided of principles which are perfectly different from generally accepted and conventional. The child's

personal experience that is attained, for example, in games, doesn't always lead to correct probability intuition formation.

Schwarz, C. J., & Sutherland, J. (1997). An on-line workshop using a simple capture-recapture experiment to illustrate the concepts of a sampling distribution. _Journal of Statistical Education_ , 5(1).

We describe a world wide web-accessible workshop designed for students in an introductory statistics course that uses a capture-recapture experiment to illustrate the concept of a sampling distribution. In addition to the usual "sampling bowl" experiment, the workshop contains a computer simulation program written in XLISP-STAT that will allow students to further investigate the properties of the estimator.

Simonoff, J. S. (1997). The `Unusual Episode' and a Second Statistics Course. _Journal of Statistical Education_ , 5(1).

Dawson (1995) described a data set giving population at risk and fatalities for an unusual mortality episode (the sinking of the ocean liner Titanic), and discussed experiences in using the data set in an introductory statistics course. In this paper the same data set is analysed from the point of view of the second statistics course. A combination of exploratory analysis using tables of observed survival percentages, model building using logistic regression, and careful thought allows the statistician (and student) to get to the essence of the random process described by the data. The well-known nature of the episode gives the students a chance at determining its character, and the data are complex enough to require sophisticated modelling methods to get at the truth.

Zetterqvist, L. (1997). Statistics for chemistry students: How to make a statistics course useful by focusing on applications. _Journal of Statistical Education_ , 5(1).

By putting emphasis on applications in two basic statistics courses for chemistry students and chemical engineering students we have enhanced student motivation and increased student activity. In addition to a traditional in-class exam, the students complete a take-home project where statistical problems relevant to chemists are discussed. We give several examples of the course and project material. The main difference between the two courses is that the first is optional, attracting approximately 15 students, while the second is compulsory with approximately 100 students. We discuss how the different requirements affect the learning situation and how separate strategies of teaching have to be developed for the small class and large class situations, respectively.

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11. COMPLEMENTARY SHORT REFERENCES:

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Derry, S., Levin, J. R., & Schauble, L. (1995). Stimulating statistical thinking through situated simulations. _ Teaching of Psychology_, 22(1), 51-56.

Fecso, R. S., Kalsbeek, W. D., Lohr, S. L., SCHEAFFER, R. L., Scheuren, F. J., & Stasny, E. A. (1996). Teaching survey sampling. _The American Statistician_, 50(4), 328-340.

Fletcher. M. (1997). Strike it lucky _Teaching Statistics_, 19(1), 26-27.

Graham, A (1997). Hey - What's the big idea? _Teaching Statistics_, 19(1), 8-11.

GREEN, D. R. (1997). Recognising randomness. _Teaching Statistics_, 19 (2), 36-38.

Hillmer, S. C. (1996). A Problem-solving spproach to teaching business statistics. _The American Statistician_, 50(3), 249-256.

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Marasinghe, M. G., Meeker, W. Q., Cook, D., & Shin, T. S. (1996). Using graphics and simulation to teach statistical concepts. _The American Statistician_, 50(4), 342-351.

Meyer, J. (1997). Simple paradoxes in descriptive statistics. _Teaching Mathematics and its Applications_, 14(2), 51-60.

Moran, C. (1997). Dice simulation with year 8. _Micromath_, 13(1), 14.

Navez, J. (1997). La variable aleatoire exponentielle: un outil remarquable. (The exponential random variable: a remarkable tool) _Mathematique & Pedagogie_, 111 (1), 33-42.

Nicholson, J. (1997). The relative effects of sample size and proportion. _Teaching Statistics_, 19(2), 47-48.

Perelli d'Argenzio, M. P. (1996). Statistical nella scuolla elementare: analisi di proposte didattiche (Statistics in primary schools: An analysis of curriculum guides)._L'Insegnamento della Matematica e delle Scienze Integrate_, 19A (5), 451-464.

Perry, P. I., Maza, V. M., FERNANDEZ, F., & Gomez, P. (1996). _Matematicas, azar y sociedad. _ (Mathematics, chance, and society). Bogota: Una empresa docente.

RANGECROFT, M., (1990). In-service training for teachers of statistics by distance learning. _Proceedings of ISI Conference_.

RANGECROFT, M., (1997). Designing a service template for distance learning. Teaching and learning: Sharing experience . _LTI Summer Conference_.

RANGECROFT, M., & du Feu, C. (1997). _Using statistics in your project_. The Royal Statistical Society.

RANGECROFT, M., & McDonald, M. (1996). _Handling data 4_. Nuffield National Curriculum Mathematics. Heinemann.

Romero, R., Ferrer, A., CAPILLA, C., Zunica, L., Balash, S., Serra, V., & Alcover, R. (1993). Teaching statistics to engineers. Presented at the _First Scientific Meeting of the International Association for Statistical Education_ Perugia (Italy).

Romero, R, Alcover, R., Ferrer, A., & CAPILLA, C. (1995). Reforma de la asignatura de Estadistica en la E.T.S.I.Agronomos, Facultad de Informatica y E.U. Informatica. Presented at the _Symposium of University Innovation_, September 1995, Barcelona (Spain).

Ruttkay, S. (1997). Composing Mozart variations with dice _Teaching Statistics_, 19(1), 18-19.

Shute, V, J., Gawlick-Grendell, L. A., Young, R. K., & Burnham, C. A. (1996). An experiencial system for learning probability: Stat Lady description and evaluation. _ Instructional Science, 24 (1), 25-46.

Smith, P. T. (1987). Levels of understanding and psychology students' acquisition of statistics. In J. A. Sloboda & D. Rogers (Eds.), _ Cognitive processes in mathematics_ (pp. 157-168). Oxford: Claredon Press.

Stromberg, A. J., & Ramanathan, S. (1996). Easy implementation of writing in introductory statistics courses _The American Statistician_, 50(2), 159-163.

Tomlinson, S., & Quinn, R. (1997). Understanding conditional probability. _Teaching Statistics_, 19(1), 2-7.

Tyrrell, S. (1996). Statistics using spreadsheets. _Micromath_, 12(2), 32-36.

Vastola, D. A., & Walker, E. L. (1995). The design and implementation of an interactive learning tool for statistical reasoning with uncertainty. _ Computers & Education_, 25(4), 193-213.

Velleman, P. S., & MOORE, D. S. (1996). Multimedia for teaching statistics: Promises and pitfalls. _The American Statistician_, 50(3), 217-225.

WATSON, J. A., & Callingham, R. A. (1997). Data handling: An introduction to higher order processes. _Teaching Statistics_, 19(1), 12-16.

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12. INTERNET RESOURCES OF INTEREST

1. The Journal of Statistical Software: http://www.stat.u*cla.edu/journals/jss/*

The Journal of Statistical Software publishes software and descriptions of software useful for statisticians.
The Journal is managed by UCLA Statistics. It is peer-reviewed, electronic, and free.

Journal Contents for Volume 01 - 1996:

1.Ronald Barry: A diagnostic to assess the fit of a variogram model to spatial data.
2.Jason Bond, & George Michailides: Homogeneity analysis in Xlisp-Stat.
3.Thomas Lumley: Xlisp-Stat Tools for building generalised estimating equation models.
4.Anja Struyf, Mia Hubert, & Peter Rousseeuw: Clustering in an object-oriented environment

2. CTI Statistics: http://www.stats.gla.ac.uk/cti/

The CTI is funded by the Higher Education Funding Council for England, the Scottish Higher Education Funding Council, the Higher Education Funding Council for Wales and the Department of Education for Northern Ireland. Here you will find software reviews and articles, a searchable guide to software for teaching, a diary of forthcoming statistical events worldwide, a CBL software developers' forum, mailing list information, contact addresses, and links to a wealth of

statistical resources worldwide.

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13. INFORMATION ON PAST CONFERENCES

1. Annual Meeting of the American Educational Research Association, Chicago, IL, March, 1997

Three papers on statistical education were given by members of the study group:

FAST, G. Using analogies to produce long term conceptual change.

JACOBS, V. Children's understanding of sampling in surveys.

JONES, G., THORNTON, C., Langrall, C. W., & Mogill, T. A. Using students' probabilistic thinking to inform instruction .

Responding to world wide recommendations that recognize the importance of having younger students develop a greater understanding of probability, this study designed and evaluated a third grade instructional program in probability. The instructional program was informed by a cognitive framework that describes students' probabilistic thinking and also adopted a socio-constructivist orientation. Two classes participated in the instructional program, one in the fall (early) and the other in the spring (delayed).
Following instruction, both groups displayed significant growth in probabilistic thinking that was not simply due to maturation. There was also evidence, based on four target students, that children's readiness to list the outcomes of the sample space, their ability to connect sample space and probability, and their predisposition to use valid number representations in describing probabilities, were key factors in fostering learning.

2. ICME 8 Papers on Statistical Education

The ICME8 papers, edited by Brian PHILLIPS, has been published by Swinburne Press, Hawthorn Australia, April 1997, with the title:

Papers on Statistical Education presented at ICME-8, ISBN 0 85590 753 3. They can be obtained through:

Brian PHILLIPS, Swinburne University of Technology
E-Mail: bphillips@swin.edu.au
PO Box 218 Hawthorn 3122
Victoria, Australia

Brian is asking for postage and basic administrative costs, but he is providing the book free. This is the list of contents:

PHILLIPS, B. New pedagogy and new content: The case of statistics.

STARKINGS, S. An international overview of data analysis within the mathematics curriculum.

BURRILL, G. Curriculum issues in United Sates schools.

Shen, S.M. Data analysis in secondary education in Hong Kong -curriculum, examination and

project.

Teran, T. An Argentinian experience of statistics teaching for masters of high school.

SHAUGHNESSY, J. M. Emerging issues for research on teaching and learning probability and statistics.

GAL, I. Assessing students' interpretations of data: Conceptual and pragmatic issues.

HAWKINS, A. Teachers of statistics: Needs and impediments.

LIPSON, K. Technology and the teaching of statistics.

NEMETZ, T. An overview of the teaching of probability in secondary schools.

TRURAN, J. & TRURAN, K. Statistical independence: One concept or two?

PEARD, R. A summary of chance and data research activities from PME 20

HOLMES, P. Forum: How statistics and probability can best be incorporated into the overall shool program?

GORDON, S. Teaching statistics to reluctant learners.

FORBES, S. Bringing the real world into statistics?

WATSON, J. & Moritz, J. Student analysis of variables in a media context.

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14. FORTHCOMING CONFERENCES

PME 21 - Psychology of Mathematics Education

The 21st Conference of the International Group for the Psychology of Mathematics Education (PME 21) will be held on July, 14-19, 1997 in Lahti, Finland. For more information about PME 21 please contact the Conference Secretary Ms. Marja-Liisa Neuvonen-Rauhala (Marja-Liisa.Neuvonen@Helsinki.fi).

Papers related to Stochastics:

1. Research reports

Bueno, G., & Cuevas, C. A. A new approach for intelligent tutoring systems: an example for statistical activities.

CAÑIZARES, M. J., BATANERO, C., SERRANO, L., & ORTIZ, J. J. Subjective elements in children's comparison of probabilities.

FISCHBEIN, E., & Grossmann . Tacit mechanism of combinatorial intuitions.

HAWKINS, A., & Hawkins P. Are lawyers prey to probability misconceptions irrespective of mathematical education?

Spinillo, A. G. Chance estimates by young children: Strategies used in an ordering chance task.

TRURAN, K, & Ritson, R. Perceptions of unfamiliar random generators. Links between research and teaching.

2. Short oral communications

Dupuis, C., & Rousset-Bert , S. Tree diagrams in probability: a real register of representation.

FERNÁNDEZ, F, & Monroy , O. L., & Rodríguez L. Understanding of the notions of p-value and significance level in the solution of hypothesis tests problems.

HARTMAN, A. On the knowledge of high school mathematics teachers for teaching probability.

Nasser, L., & Acselrad, M.V.: The comprehension of graphs and second school mathematics.

Tarmizi , R. A. Correlates of students' performance in statistics.

3. Posters

BATANERO , C., GODINO J. D. & Navas, F. J.: Some misconceptions about averages in prospective primary school teachers.

4. Working group

The Stochastics Teaching and Learning Group will be meeting at the PME Conference in Finland in July. Its major project will be preparing an annotated bibliography of key works in the topic, with a view to publishing in about 2 years time. It will also be working with the Advanced Mathematical Thinking Working Group to look at advanced mathematical thinking in Stochastics. More information available from batanero@goliat.ugr.es

51st Session of the International Statistical Institute, 18-26 August 1997, Istambul

Invited paper sessions related to statistical education:

36. Research on teaching and learning statistics. (Organizer: J. M. SHAUGHNESSY, USA)
37. Research and teaching of probability and statistics in the physical sciences. Organizer: D.Vere-Jones, New Zealand and Ed. Waymire, USA).
38. Teaching and training in statistics with sampling and sample surveys. (Organizer G. Cichitelli. Italy).
39. The role of Bayesian methods in statistical education.(Organizer: Jeff Witmar, USA).
40. Data centered versus mathematics centered training in statistics. (Organizer: ShirMing Shen, Hong Kong).
41. Assessment and measurement in education. (Organizer: A. Bazarghan, Iran).
51. Computational statistics, electronic publishing and access to research data. (Organizer: T. ARNOLD, USA).
52. Technology in teaching statistics ("teachware"). (Organizer: E.M. Tiit, Estonia)..

88. Rountable on "What is Statistical Literacy" - International Literacy Institute (Organizer: D. Wagner).

Information avaible from ISI97@die.gov.tr
Internet: http://www.die.gov.tr/ISI/isi ~i.html

ICTMT-3. The Third International Conference on Technology in Mathematics Teaching. September, 29- October, 2, 1997. University of Koblenz, Germany.

This conference is about the role of technology in mathematics education at school, college anduniversity. It seeks to continue at a European venue the tradition established by the InternationalConference on Technology in Collegiate Mathematics (ICTCM), founded by Professors BertWaits and Franklin Demana of the Ohio State University, and held annually in the United Statesof America since 1988. That tradition has been widely influential in the effective use oftechnology in mathematics teaching. ICTMT-3 continues as the third European conference (thefirst in Birmingham, England, 1993 and the second in Edinburgh, Scotland, 1995). More information from http://euler.uni-koblenz.de/ictmt3/index_e.html

The Fifth International Conference on Teaching of Statistics

Place: Nanyang Technological University, Singapore,
Dates: June 21 - 26, 1998.
Web Site: http://www.nie.ac.sg:8000/~wwwmath/icots.html

Theme: Statistical Education - Expanding the Network

Contacts:
Chair IPC: Brian PHILLIPS, bphillips@swin.edu.au Fax + 61 3 9819 0821
Chair LOC: Teck-Wong Soon, twsoon@singstat.gov.sg
Singapore contact : Lionel PEREIRA-MENDOZA, pereiraml@am.nie.ac.sg

The second announcement for ICOTS5, which will be held in Singapore, from June 21 to 26, 1998 will be soon available. It contains, among other things, some details of the scientific program including a list of the invited talks (as known at the end of May, 1997) fees, information on accommodation, tours and registration forms. As further information on the scientific program becomes available, it will be placed on the Web page :http://www.swin.edu.au/maths/icots5 /intro.html

The annoucement will also be made available on the WWW at: http://www.nie.ac.sig:8000 /~wwwmath/icots.html

If you would like to receive a hardcopy of the announcement please contact the ICOTS-5 Secretariat:
Conference & Travel Associates Pty Ltd, 425A Race Course Rd, Singapore, 218671 (Tel: (65) 299 8992
Fax: (65) 299 8983, email:ctmapl@singnet.com.sg

PME 22, will be held from July 12-17, 1998 at the University of Stellenbosch, South Africa. More information from Alwyn Olivier, aio@akad.sun.ac.za
htt://www.sun.ac.za/local/education/pme22