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1. Notes and Comments

Happy New Year 2001!

We are glad to present the second volume of the *IASE Statistical Education Research Newsletter.* After a one-year trial, we were able to perceive the interest of our readers and their engagement in this collective project intended to promote and diffuse statistical education research. We were glad to receive messages of encouragement from many friends around the world who are reading our Newsletter and finding it to be useful. We want to thank all who contributed information along the past year, those who just sent us their suggestions and reactions and in particular those who decided to join the *IASE* and support in this way statistics education.

As it was remarked by the *ISI* president Jean Louis Bodin in the *ISI Newsletter* Volume 24, n. 3 (72) 2000, the *IASE* can contribute in the field of human development and human rights that now form one of the major components of the policies of international and national organisations. A major effort is needed to increase the statistical abilities of users, specially the NGOs and statistics educators can play a main role towards achieving this aim. We hope to see many more new members to consider how much we need their help and enter the association this year.

In this issue we are continuing the debate about research questions in statistics education, started in *SERN* 2(1) by publishing a series of reactions from statistics educators around the world who were willing to contribute to this special issue. We are preparing a note of response to these reactions for *SERN* 2(2), May 2000, and we plan to put the whole set of papers (original paper, reactions and final reply) at the *SERG* web site. Other similar debates are planned for future issues of the Newsletter and we encourage our readers to offer short papers of general interest for researchers in statistics education to be considered as starting points for new discussions.

An important content in this Newsletter is a brief note and a selection of statistical education works by Anne HAWKINS and David MOORE who were recently awarded as honorary members of the *IASE*. This small homage to these friends who contributed to the starting of the Association in a crucial period is well deserved.

We finally are informing about past and future statistics education events, which put in evidence the growing activity of our association and its contribution to development of statistics education at an international level.

Notes: Throughout the Newsletter, *IASE* members' names are highlighted in capital letters.

The whole Newsletter is located at the web site: http://www.ugr.es/local/batanero/sergroup.htm

2. What are priority areas of research in Statistics Education?

In vol. 2(1) of the *SERN Newsletter* we announced our plans to produce a special issue to debate what research questions were important in statistical education. As we stated in that issue, statistical education research is quickly increasing and we need to reflect on what we are doing and where we want to go.

We therefore included in *SERN* 2(1) a short paper by the editors Carmen BATANERO, Joan GARFIELD, M. Gabriella OTTAVIANI and John TRURAN entitled: *Research in Statistical Education: Some Priority Questions,* which can be recovered from http://www.ugr.es/local/batanero/sergroup.htm and were we tried to state the questions we felt deserved a special interest in our area. Along this Summer and Fall we asked some researchers from different countries with a varied type of training and experience to contribute to our Newsletter with a reaction to the paper. The response received was very satisfactory.

We are then glad to present in this issue this set of reactions and we are very grateful to all the authors who devoted their time and knowledge to contribute to this collective reflection about what research is important for the improvement of statistical education theory and practice. This is the type of work that the Statistical Education Group and Newsletter can convey and help to develop and we will including similar debates on other relevant themes in statistical education in the next newsletters.

2.1. On the paper "Research in Statistical Education: Some Priority Questions"

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As a mathematician-statistician who has worked for a long time both as a teacher and as a researcher in statistics and data analysis, I was step by step involved with interdisciplinary matters concerning teaching-learning statistics, applied research in statistics, and in some way statistical education research. My main workplaces were successively a traditional mathematics department, a traditional statistics department and presently a faculty of psychology and education.

Therefore being aware of recent developments on research in statistical education became in my professional life so relevant and urgent as being attentive to new developments in statistical research. The paper on "Research in Statistical Education: Some Priority Questions" by Carmen BATANERO, Joan B. GARFIELD, M. Gabriella OTTAVIANI, and John TRURAN thus represents a real challenge and I have discussed it with several colleagues trying to find clear and short answers to some of their questions. As a consequence we have now more questions to think about in the future. Meanwhile I will add in this note some of our present thoughts instead of answers or solutions, and a few comments and facts to analyse.

First of all, it turns out that from our experience from the applied statistical domain that "What is Research in *Statistical* Education" seems to have a lot in common with "What is Research in *Other Sciences* Education", where *Other Sciences* may be replaced by *Mathematical* as well as by *Medical* or even *Educational* (repetition looks here fairly appropriate!). Therefore describing and interpreting some cluster(s) of common features and finding and explaining a set of specific clusters, each associated to each *Other Science* Education, seems to be a good topic of research that may lead us to some suitable common methods of research and help us searching for other (new) specific and richer approaches.

We have no doubt that "researchers working within the field of statistical education (...) can find it difficult to have their work on statistics education recognised and valued by statisticians in mathematics and/or statistics departments", as it often happens with sciences where interdisciplinarity has a strong role. Actually it is clear for us that to be a good statistics teacher is not equivalent to be a good researcher in statistics education nor is it equivalent to be a good researcher in statistics, although it is quite possible to find a combination of two or three of these attributes concentrated in the same person.

Also we have no doubt that many works appearing in conferences and/or published in journals of statistics education certainly concern research in Statistical Education: they match quite well the idea that "scientific research can result in finding new facts about the way things behave in nature or new laws which govern their

behaviour" and furthermore "it can also be directed toward finding new ways of putting things together to make things behave in a new way...".

Our experience on the statistics domain, particularly on multivariate data analysis (m.d.a.) gave us an increasing interest to develop and to know more about suitable teaching and training strategies, and to solve students' difficulties in the m.d.a. topics. M.d.a. methodology is becoming more and more relevant, both in the theoretical point of view and in what concerns the applications in a large variety of domains. Teaching and/or training and learning m.d.a. methods, and techniques, and suitable software (that is, software for doing m.d.a. or software for learning m.d.a.), at different levels, to different people, is a very important and sometimes difficult matter, both for teachers and for students. Then debate and agreement / disagreement on this matter seem to be a major subject of research.

We believe that scientific societies are an excellent place to improve scientific research on developing areas, and scientific meetings an appropriate occasion to promote discussion on it. As a member of the International Statistical Institute, I have participated at the *ISI*99 conference in two *IASE* invited paper meetings (IPM), concerning "teaching and training multivariate data analysis" and "statistical education for life". In this IPM the central role of Statistical Education was shown in forensic sciences, in health sciences and in official statistical institutes ("dealing with the outside world"). In the first IPM speakers, discussants and participants were dealing with teaching / learning / training m.d.a. bringing to comparison their rich experience in such different fields as human sciences, business-management, mathematical statistics and environmental sciences, from such different places as France, Germany, USA and Japan. The papers included in the two IPM as well as the discussions presented in each one of the meetings, allow me to understand that the two subjects have really much in common and to realise that both have also much in common to become important subjects of research in statistical education.

Let me conclude the present note referring more in detail to two examples of experiments that were presented in those *ISI* papers. One paper explained a new way to teach multiple regression to business students by case studies: the author describes his own experience in teaching that topic in elementary business statistics courses at his university by emphasising case discussion; he points out that this approach is similar to standard discussion methods used in business curricula, but it is seldom used for statistics classes; he discusses the course and the students, the case discussion approach and its application to multiple regression classes in particular; and the results from applying it. The other example describes an experience accomplished with a small sample of students, which simply suggests that the common idea of randomness is often the one of a "robotic" non-random uniform distribution, without any clusters. The two examples clearly show the real need of a permanent, intuitive but rigorous, statistical education. Moreover both examples finally provide particular responses / paths on statistical education research to "*how is the teaching-learning of statistics unique and how is it related to the teaching-learning of (mathematics and of) other disciplines?" and "how learning procedures are aligned with different models of learning or cognitive development"* in the excellent paper by Carmen BATANERO, Joan B. GARFIELD, M. G. OTTAVIANI, and John TRURAN.

2.2. Research Questions in Statistics Education

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There are a variety of perspectives that can be used as a lens for viewing statistics education and statistical reasoning, but my lens here is "reasoning about data." Unlike many other problem solving situations in mathematics, reasoning about data is almost never complete; answers are rarely final. This is reflected by the models (e.g., Kader & PERRY, 1994) typically proposed as conceptualisations for reasoning about data. These models characterise this reasoning process as "circular," with the interpretation of data always leading back to re-examination of the appropriateness of the original questions that were posed. One implication of this for understanding reasoning about data is that a learner's explicit monitoring skills are an essential part of "doing statistics" and are perhaps a more critical part in success in this area than may be the case for most other areas of mathematics. Study of how understanding or reasoning about data develops, then, is confounded by the necessity to study metacognitive skills simultaneously.

The notion (shared with me by Paul Cobb and Kay McClain of Vanderbilt University) of "interrogating the

data" carries with it a very nice image of what is involved in reasoning about data. What can we learn from a set of data? What questions should be asked to reveal this information? Clearly, the context for a data set is absolutely essential in understanding the information contained in those data. For example, in comparing data about performance of air circulation systems, interpretations might be very different in the context of outfitting a space shuttle or designing an office building. Reliability is clearly a more important issue for a shuttle than for a building. When students explore and collect their own data, they probably become familiar with the context; but how can we provoke an understanding of the richness of possible questions to be explored? How does the learner's understanding of the context influence the interpretation of data represented in a graph? Is it possible to interpret data accurately without a significant level of understanding of the context?

Part of our understanding of reasoning about data comes from studying the components that might be part of that reasoning. These components (e.g., posing questions, analysing data) are suggested by the model of reasoning that forms the basis of such work, but deeper investigation of the chosen model may reveal components that are not immediately obvious. Detailed analyses of components can be greatly informed by knowledge that has evolved in other disciplines. For example, what we know about graph comprehension (e.g., Friel, Curcio, & BRIGHT, in press) is influenced by earlier study of visual decoding and more recent examination of the development of literacy. We need to build on, without being constrained by, such work. It is important to consider the theoretical perspectives and research techniques for any research base that we use. For reasoning about data, there are many questions that come to mind. How do students come to understand the perceptual demands of various kinds of graphs? Does listening to other's interpretations of graphs support understanding of those displays? How do we help children be inventors of displays that convey intended messages about the meanings of data? Are there explicit tasks that provoke such opportunities?

Reasoning about data has been difficult to study because curriculum materials and instructional strategies have historically been quite limited, so students have not had good opportunities to learn how to reason about data. It was not until the publication of NCTM's original Standards in 1989 that statistics became a highly v*ISI*ble strand of the mathematics curriculum in the US. Most teachers today were educated prior to the publication of those Standards, so they have limited backgrounds in statistics. Indeed, it is only the recent graduates of preservice education programs who have even completed a course in statistics; and most elementary school teachers still do not have explicit education about statistics as part of their preservice preparation. As researchers, we continue to face the difficulty of having to help teachers understand reasoning about data so that they are confident and effective when they teach this content. Professional development programs (e.g., Friel & BRIGHT, 1998) must continue to fill the gap at the same time that we are studying students' reasoning about data. This dilemma raises several critical questions. What is the influence of instruction on reasoning about data? How do different kinds of tasks influence what students learn? And, of course, it is also important to examine the courses that preservice teachers take in their teacher education programs. How do those courses affect both what teachers know and what they teach? How should other professional development experiences be structured so that teachers learn not only how to make better interpretations of data presented in graphs themselves but also how to help students develop similar skills?

Reasoning about data is an area within which we can study how both teachers and students learn content together (or at least at nearly the same time). As knowledge continues to explode, there will be other content that will be new areas of knowledge for teachers and students to explore together. We need to know how to support such common learning. Effective professional development in the 21st century will increasingly need to address content learning of teachers who are also teaching that content to students.

If we are going to improve the teaching of reasoning about data and make our study of the development of that reasoning more sophisticated, both researchers and teachers need frameworks for understanding the content and the strategies used to solve representative problems. What are benchmarks of understanding? Is reasoning about data developmental? It appears that sequencing of types of graphs during instruction can deepen understanding of data reduction and developing different aspects of graph sense. What are the most effective sequences?

References

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2.3. Reaction to the paper *"Research in Statistical Education: Some Priority Questions"*

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First of all, I want to say that I consider the paper to be interesting. Then, I contribute with some comments:

In paragraphs 1 & 2 the interdisciplinary aspects of the subject are well defined, although some references would probably better justify the authors' argument that *"Some academics strongly believe that education is not a discipline…"*

Foundations of research

The questions in the second section need to be re-orientated according to students' background and their interest in statistics itself or use of research methods for more interdisciplinary purposes. Additional principles could be added to that section, as I suggest below.

In trying to answer the general question "What is the meaning of research for Education in Statistics" one has to consider the fact that research and teaching differ depending on our academic environments. I would classify the academic environments in three categories:

(a) Students with a good background in Statistics-especially those enrolled in introductory courses in Probability Theory, Combinatorics, Computers - and who have difficulties in understanding "*Stochasticity*". That means that they find it difficult to understand that in Statistics there is not an absolute truth. While in Mathematics every logic proposition is proved to be true or false, in Statistics every logic conjecture (hypothesis) is accepted or rejected with a level of significance. They also find it difficult to understand that in Statistics data values (of the statistical variables) have a 'real meaning', they mean something (e.g. symbols M, F have a real meaning for gender), instead of just being symbolic abstract signs as those we use in abstract mathematical structures (e.g sets R, Z, N). At the same time, some people consider that Statistics is only relevant when the above principles- absolute truth, abstract structure- are satisfied that is, when it becomes a part of Mathematics.

(b) Students with a deeper background in Mathematics- particularly from introductory courses in Calculus, Number Theory, Mathematical Methods of Science (Physics)- and are interested in the use of specific Statistical Techniques in their own disciplines (e.g. Polytechnics, Economics or Sciences). Statistics is significant for them in that it is useful in applications, without being able to understand the importance of "modelling" (i.e., constructing abstract models from real situations), paying scarce attention to the models' assumptions, to the study of the context and the explanation of results.

(c) Students with a low background in Mathematics who consider that a simple familiarity with data analysis enables them to organise and conduct research surveys and to use advanced techniques. Our colleagues in other disciplines usually also know – mainly as users- advanced techniques they use in their own research or have used in their studies.

In each of these academic environments our didactic strategy has to be oriented towards clarifying the above misunderstandings so that the necessity to ask the "statistician" for help, as a necessary contributor at all the different research levels -design, conducting and explaining the results- is made clear.

A statistician (coming from environment A should have good communication skills, knowledge about the subject of research, ability to choose or construct statistical techniques. A researcher (who come from environments B and C should be able to formulate hypotheses, have good communication skills, and be able to understand the limitations and the requirements of the techniques.

In compulsory education Statistics should be oriented especially towards the presentation and analysis of data and information from real examples and mass media. The formation of a critically thinking citizen is possible

through statistical education.

Some more research questions

(a) Statisticians often use the same teaching method or/even the same textbook changing only different examples depending on the academic environment. This is generally wrong. Which is the best teaching method or the best combination of teaching methods for each academic environment?

(b) We have to evaluate (using statistical tools) the effectiveness of each teaching approach considering the place and the time. Should we develop general assessment tools and techniques?

(c) When using projects we very often teach how one can organise a project and present its results. Is it possible to teach Statistics using projects instead of teaching projects using Statistics? What are the requirements for this?

(d) Barriers between subjects in schools should be eliminated. Teachers must co-operate teaching the students, within the curriculum, in order to give them not only the specific subject essence but also the relations between subjects and their interaction. How should this be done?

(e) Computers and other tools must be used in daily educational activities. How can the statistician-teacher collaborate in this use at the school level? How should teachers be trained? How could we organise a Statistical Laboratory and who should do this? How can daily-life materials be used in teaching and research?

(f) Finally, our efforts should be oriented towards general standards and a unified curriculum. After all, in many cases we use the same materials and methods in teaching and research and we face the same reality and problems.

2.4. Comments about the article Research in Statistical Education: Some Priority Questions

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Some years ago I asked the director of an academic institution in mathematics and statistics why they did not develop a new area on mathematics and statistics educational research. The answer was strict and categorical:

> *"Only very experienced researchers might efficiently do research into learning and teaching– However, after being successful in a specific mathematical or statistical research topic, researchers do not usually are willing to change from that specific area to the broader and unknown area of education".*

Research on teaching and learning is almost non existent in statistics departments. Initiatives to start educational research in these departments were often isolated and had no institutional support. Moreover the institutions supporting research do not stimulate educational research projects, which fail to get funds under the argument that the candidates have not enough experience in the subject – and thus continue supporting a vicious circle.

I only agree partially with the authors in the necessity of collaborating with mathematicians at the different educational levels. In my opinion we also need the collaboration with teachers of other different areas that are dealing with quantification, such as physics, biology, sociology, etc. Firstly, since statistics is obviously interdisciplinary, statistics as well as the other subjects would greatly benefit from this collaboration. Secondly although statistics and mathematics are related through quantitative tools, they have their own specific ways of reasoning and thus need to be separate. For instance, a brilliant mathematics students might not be interested in statistics, and, at the same time it is possible to find a student with no interest in mathematics to be successful in statistics.

Those who teach statistics know that every question asked by the authors are also their questions. Many of these questions are related and all of them are very important indeed. I will discuss about the teaching of inference at undergraduate level, and about the use of projects to make the student's learning more meaningful

In accordance with the current paradigm, every undergraduate students takes a basic course in statistics. The program for such courses follows an Anglo-Saxon tradition, coming from the sixties, where the search for a scientific basis to knowledge was very valued.

The students (mainly from biological and human sciences) do not understand why statistics is included in their curriculum, since there is no reference to statistics in other disciplines, which describe a deterministic world. As they have no scientific concerns, they do not see how statistics can help them. It is even worse when statistics teachers only use dice, coins or urns as examples of random phenomena, which are easy to understand, but lack any appeal for the students. Starting teaching from the easiest examples can be the quicker way to understand the technique, but the teacher should facilitate the transferring of concepts and/or techniques from one scenario to another. Students need the teachers' orientation: neither abstract knowledge nor instrumental knowledge alone are adequate. They need to see some connections to a meaning in their specific subject.

The introductory probability and statistics course at undergraduate level begins with some probability concepts and some descriptive data analyses. It is common to present inference ideas in the second part of the program, most of the time from a classical point of view (a fusion between Fisher and Neyman- Pearson methodology). The students, who are beginners at the university, have no idea about scientific processes, hypotheses, experiments, observational studies, etc. In addition they find conditional logic difficult. These and many other problems make inference difficult for the student. As a consequence, they develop a negative attitude towards statistics, and use inference in an instrumental way, without epistemological considerations. Lack of tradition in performing interdisciplinary activities contributes to this situation.

From my point of view, inference should be approached from a more philosophical than instrumental point of view, giving students some time to discuss scientific research procedures, as well as some different research approaches, indicating their advantages and disadvantages: for example, we could present a comparison between the classical and Bayesian approaches.

The Bayesian school, reborn in the middle of the XXth century, has not reached in education the same relevance that the classical school, due to philosophical and technological reasons. Students learn the Bayesian probabilistic approach, but it is very difficult to find a program presenting the Bayesian statistical approach. Sometimes it is argued that students are not as strong as needed in conditional probability concepts. Sometimes other reasons are presented.

In every introductory inferential course the student should be exposed to both classical and Bayesian reasoning: I consider this one of our main duties as teachers, being Bayesians or not! The state of art of inference should be considered and part of the history of statistics should not be hidden. I also feel it is easier to introduce these fundaments to the students than trying to make them understand a classical hypothesis test for a difference between two means with unknown but equal variances!

With respect to the teacher-student relationship, it is worthwhile to remember that it is not enough to have a good teacher – it is also necessary that the student learns! This only happens when the object of learning has a meaning for the student, and this does not depend on the inferential school you present. It strongly depends on a balanced involvement of teacher and students, which is easier to get if the design of projects is included in the activities. Such projects would help the student to learn statistics, and at the same time would increase the student's innovation capacity, creativity, and critical attitude.

In my opinion, a very good text about projects is the book *Anthropologie du Projet,* by *J.P. Boutinet* (1990), where the author proposes some points for understanding the project proposal: a) pedagogical negotiation; b) articulation of different projects; c) specifications of objectives and d) conclusion and assessment of the project. Each of these topics deserves many comments which but I will not focus on them. What is important to the success of a project is stripping teachers and student of their current paradigms – the road's uncertainties will continuously calibrate the course. Time for execution needs to be well defined and assessment is a very important element too,, which need to be done throughout the process, An interdisciplinary pedagogical project, with real data, seems to be an adequate solution that will benefit teaching and learning inference statistics, from both classical and Bayesian point of view.

Reference

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2.5. A Reaction To "Research In Statistical Education: Some Priority Questions"

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This is an interesting and thought-provoking article, through which the authors have invited reflection and reaction. I am pleased to have been sufficiently provoked to offer a personal response.

The first point I should like to raise is the fundamental issue of defining what constitutes research in statistics education. The authors introduce the need to clarify the nature of research in the field of statistics education and refer to the much-quoted publication of Sierpinska and Kilpatrick (1998). In that watershed work, mathematics education as a research discipline is examined at length, with a number of researchers contributing to the debate by offering their perspectives on the nature of research in mathematics education. To my knowledge nothing like this has occurred in statistics education. Although BATANERO et al. do not meet this issue head-on, they do pose questions that point us in the right direction. For example, they make it clear that there is a need "to clarify what should be considered as research in statistical education" and ask "what are the features of a good research study in statistical education?" and "how might we develop criteria for evaluating what is good research?"

To my way of thinking, there are no simple answers to any of these questions at present, largely because there is no consensus among us as to just what statistics education *per se* is. The parallels with mathematics education are inescapable, but some statistics educators muddy the water by arguing that just as statistics is a part of mathematics, so is statistics education a part of mathematics education. I agree with the authors [and VERE-JONES (1997)] that statistics education has come of age. However, I would go further and argue that it is recognised internationally as an identifiable and important field of knowledge in its own right, one which is not simply a subset of either statistics or education (GLENCROSS, 1998; GLENCROSS & Binyavanga, 1997). For me, statistics education is made up of the multiplicity of activities related to the teaching and learning of statistics, so that research in statistics education is research about the teaching and learning of statistics. I realise that this is itself simplistic, but perhaps in the spirit of the BATANERO et al. article, the idea may be viewed as part of an on-going debate in which we confront each other's ideas and approaches. This should enable us to work towards a better mutual understanding of what we think we mean when we talk about research in statistics education. Whatever we decide, we should recognise that there is a built-in ambiguity because research is both a *process* and a *product.* It is a *process* in the sense that we are searching for truth and trying to build knowledge. It is also a *product* in the sense that the outcome of the research process is knowledge itself (Ernest, 1998). This is clearly a matter for further debate.

An important issue tucked away in the article is that of what theoretical frameworks and research methods might be recommended for research in statistics education. The authors do not elaborate on what they mean by 'theoretical frameworks', but it is common knowledge that any research takes place within an explicit (acknowledged) or implicit (assumed) theoretical research perspective, or *research paradigm* (Kuhn, 1970). Kuhn's coined phrase referred to established research traditions in a particular discipline and included their accepted theories, models, body of research and methodologies (Mouton, 1996). As noted by Ernest (1998), educational researchers tend to distinguish three dominant research paradigms among the many possible paradigms. First is the *scientific* research paradigm, exemplified by rationalism and the scientific method and used, for example, in the physical sciences. Next is the *interpretative* (or naturalistic) research paradigm, arising from methods used in the social sciences and which is largely qualitative. Third is the *critical-theoretic* research paradigm, with an emphasis on social critique, which is often associated with action research in the classroom. Each research paradigm is determined by its assumptions about epistemology (what constitutes knowledge and learning), ontology (existence and the nature of the social world) and methodology (how knowledge is obtained). So where does research in statistics education fit in? It is not a matter of choosing one paradigm and ignoring the others. The multifaceted nature of both statistics education and its academic partner, statistics education research, means that we cannot simply acknowledge the existence of many areas for investigation, many research approaches, theories, practices, interests, and so on, but that we must accept and tolerate this diversity. Clearly this is another area for further debate, but one which must be tempered by the realisation that ultimately, research is carried out by individual human beings with their own personalities, cognitive styles, preferences and interests.

Among the many questions posed by BATANERO et al., one in particular stands out: "What are the features of a good research study in statistics education?" There is a related question, "How might we develop

criteria for evaluating what is good research?", but I believe that if we are able to answer the first question, we will have gone a long way towards answering the second. In one sense, asking the question 'what is good research in statistics education' is akin to asking 'how long is a piece of string'. My answer: it depends. It depends on a number of things: what question(s) does the researcher want to answer, for what purpose, in what context, under what conditions, and so on. These are issues about research in general, not just research in statistics education. As far as research in statistics education is concerned, I would like to stimulate the discussion by suggesting, following Hatch and Shiu (1998), that unless it affects classroom practice and experience it is of limited value. Logically this implies that research that has a pay-off in the classroom in some way is 'good' and that which does not is 'not good', or perhaps 'less good'. In any event, in these days of accountability, cost-effectiveness and limited budgets, I do not believe that we can judge the quality of statistics education research in any absolute way, in isolation from the world of teaching and learning. Thus, one of the features of good research should surely be whether its results could be implemented in the teaching-learning arena.

The authors have raised many pertinent questions, each one the source of numerous others. They are described as 'priority questions' and grouped under two broad headings: 'foundations of research' and 'specific research questions'. I would like the authors to clarify their rationale for deciding that these are in fact *priority* questions. Presumably there were other questions under consideration that were not regarded as having priority. Under the 'foundations' banner, the issue of culture has been raised. This is something we should take much further. For example, educational research is not particularly noted for replicating research in different cultural conditions. Do we, as members of SERG, have an opportunity for a global, multicultural research project?

With regard to the specific research questions raised, grouped under the sub-headings *statistical thinking, technology, inferential reasoning* and *training teachers*, there is much scope here for many research activities. These four areas could be developed in more detail as themes for research, while SERG members could usefully collaborate on research projects within these themes.

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2.6. Reaction to “Research in Statistical Education: Some Priority Questions"

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I shall limit my discussion only to the question of the differences between statistical literacy, statistical reasoning, and statistical thinking. When we talk about statistical education, and research therein, we must be careful about what levels of students and what aims of teaching we have in mind.

The problems of statistical education may be classified into the following five categories:

(a) Statistical literacy education for the future citizens who are to become "consumers" of statistics, are expected to read newspapers intelligently and learn by their experience. This type of education is carried out at elementary and secondary schools, and also in introductory statistics course for non-statistics majors at colleges and universities;

(b) Training elementary and secondary schools' teachers of statistics. Most elementary school teachers are trained to teach all subjects, but some elements of mathematics together with statistics should be included in their training program at colleges and universities. As regards statistics, a statistical literacy education similar to that described in category a. may suffice if it is good. At secondary schools statistics is taught by teachers of mathematics, and therefore colleges and universities are expected to provide future teachers of mathematics with good mathematics programs at the undergraduate and master's levels which include at least one introductory statistics course for non-statistics majors.

(c) Teaching statistics and statistical methods for the future "users" of statistical methods in their respective fields of application: sciences, technology, industry, medicine, business, government and others. This training is given at colleges and universities for non- statistics majors at undergraduate as well as graduate levels.

(d) Teaching statistics and statistical methods for future "producers" and “analysers” of official and non-official statistical data. This training is for statistics or non-statistics majors at colleges and universities at undergraduate as well as graduate levels. Also government and non-government offices provide such teaching for their employees;

(e) Teaching theoretical and applied statistics for future "producers" of statistical methods, i.e., professional theoretical and applied statisticians, and teachers of statistics at colleges and universities at undergraduate and graduate levels. There are bachelor's, master's and doctoral programs at colleges, universities and research institutes of statistics for this purpose.

I am of the opinion that the term “statistical literacy” should be used only in the statistical education of category a, just as the term “literacy” is originally understood. Computer literacy in the information age seems to be used similarly.

I think, however, that statistical thinking should permeate all categories of statistical education, from a to d, even though the levels of students and the aims of teaching are different. Statistical thinking in Dransfield, Fisher and Vogel(1999), and WILD and Pfannkuch(1999) are at the level of professional statisticians and statistics educators. In the discussion of the former paper, Hoerl quotes the definition of statistical thinking by AQL(1996), which states that statistical thinking is a philosophy, better than the use of certain tools. I fully agree with his view that statisticians must be competent in both formal methods and statistical thinking to play a significant role in the modern world.

Even when teaching statistics at elementary and secondary schools level we must try to give students a sense of statistical thinking by means of elements of exploratory data analysis, descriptive statistics, and calculus of probability. In his discussion of the latter paper, Moore gave an example of a suitable structured framework to teach the elements of statistical thinking in a college introductory course. I add that Moore(1998) states that the liberal arts view (of statistical thinking) emphasises the fact that statistics involves thinking, and that statistics involves distinctive and powerful ways of thinking that should not be swallowed up by information technology. He says that the computing/communication revolution presents everyone with very large masses of very disordered information, and that statistical thinking offers simple but non-intuitive mental tools for trimming the mass data, ordering the disorder, separating sense from nonsense, selecting the relevant few patterns from the irrelevant many facts.

Although some people seem to suggest that statistical thinking and statistical reasoning are almost synonymous, I think that statistical reasoning underlies the interface between the "science" of statistics and the "art" of statistics. The former is a mathematics-oriented deductive system, whether Fisherian, frequentist, or Bayesian. The latter is concerned with an inductive logic whereby an informed application of statistical methods based on a deductive system is carried out in a field of application. Statistical reasoning is present explicitly or implicitly in any statistical education level, but it should be taken up formally in statistics-major courses at undergraduate as well as graduate levels.

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2.7. Reactions to "Research in statistical education: some priority questions"

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It is pleasing that the first two issues of the Statistical Education Research Newsletter have contained papers on the nature of the activity of such research, its future direction, and the desire by researchers that this research should be given academic recognition (OTTAVIANI 2000, BATANERO et al 2000). Both papers take forward themes discussed in JOLLIFFE (1998) and the ICOTS-5 session at which that was presented. An expanded version of that paper is in the final stages of preparation. The more that these issues are discussed, the more visible our research will become, and increased academic recognition of our activities might follow. In addition to its aim of promoting research related to teaching and learning statistics the SERG needs to keep in mind the underlying aim of promoting the results of this research.

BATANERO et al (2000) suggest that not only is statistical education research not always fully recognised as being valuable by (mathematical) statisticians but that some academics in other areas think that research in education in their own field does not contribute to knowledge. The implication is that the profile of all research in education needs to be strengthened. As most research benefits if there is a statistical input, if statisticians are involved in educational research in other disciplines as well as in statistical education research, the quality of educational research in general is likely to be higher. In consequence all educational research, including that in statistics, will begin to be seen as worthwhile.

However, as is pointed out in JOLLIFFE (1998) little is known about, or has been published on, the methodology of statistical education research. It is not always possible to experiment in educational research and is often not ethical to do so. This is the case in social and medical research also, but social and medical statisticians are widely recognised for their contributions to statistics, and many of the methods they use are immediately applicable to research in education. By developing and discussing appropriate statistical methodology, researchers in statistical education have an opportunity to advance the discipline of statistics itself and to be recognised as *educational* statisticians. OTTAVIANI (2000) suggests some techniques of statistical analysis which might be used in educational research and remarks on the need to deal with quasi-experimental designs. According to BLUMBERG (2000) the proper analysis of quasi-experimental designs is still a matter of some debate. Statisticians involved in educational research are in an ideal position to take part in this debate.

OTTAVIANI (2000) suggests that two segments of research and analysis in statistical education should be considered – the teaching of young people, and society. She gives five examples of broad topics of study under the first heading, but says very little about the second. Yet many of the topics suggested as relevant to the teaching of young people apply also, with a slight change of emphasis and wording, to society as a whole. For

example, “forms and processes of awareness and learning of statistical concepts by students” could be a research topic under society if the word “students” were replaced by “adults”. In fact in today’s world where continuing education and continuing professional development are encouraged, teaching takes place to persons of any age, not just to the young. We could use the subheadings suggested by OTTAVIANI (2000) under the teaching of young people as a basic framework for statistical education research under the heading of society. I am suggesting that there is less difference between the two than might seem apparent at first.

Both OTTAVIANI (2000) and BATANERO et al (2000) comment on the importance of interaction with specialists in other disciplines, particularly psychologists and those active in mathematics education, two groups who have and still do contribute to research in statistical education, and who provide an outlet for reports of statistical education research. To some extent statistical education research has grown out of research done by psychologists on stochastic reasoning and research in mathematical education and can build on this foundation. In searching for an identity for research in statistics education much can be learned from the tome edited by Sierpinska and Kilpatrick (1997) which is concerned with mathematics education.

Interaction between researchers in statistical education and education specialists should mean that statistical education research is based on educational theory. This is essential if researchers in statistical education wish to be accepted as part of the wider community of education specialists. The questions posed by BATANERO et al (2000) as relevant to an understanding of statistics education (in the section on foundations of research) might be considered to be part of a more general framework of research questions in education. Learning about how similar questions have been studied when applied to other areas could be useful.

There is no shortage of statistical education research topics, and researchers in statistical education are fairly well agreed as to where more research is needed and on areas for future research. BATANERO et al (2000) give several suggestions. Some other research questions are *“What is an appropriate balance between the use of information and communications technology and traditional methods in teaching statistics?”, “How can careers skills be taught effectively in statistics courses?”* and *“How can we measure whether a method of teaching statistics has been successful?”.*

Readers of this newsletter are likely to be well informed as to the conferences and journals where statistical education research is reported and to know of some of the research in progress. However, few readers will have complete knowledge of all the research activities. Those who are new to the field or those who are more interested in using the products of the research, for example teaching methods or computer software, than in doing research, might have even more limited knowledge. There is a need for a data base of statistical education research activities. I shall be taking the lead on an international survey of research into pedagogic issues in statistics and operational research, working closely with Susan STARKINGS and Mike FULLER. This is funded by bursaries from the Learning and Teaching Support Network Centre for Mathematics, Statistics in the UK. It is intended that a data base of researchers and their research will be one of the outcomes of the survey. Readers of this newsletter are invited to contact me with suggestions regarding the survey and a data base.

I should like to finish with three questions important to research in statistical education – *Who should research in statistical education? Where should the research be carried out? How should the research be funded?* These need to be considered in parallel with the priority questions asked by BATANERO et al (2000).

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2.8. Reaction to "Research in Statistical Education: Some Priority Questions"

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BATANERO, GARFIELD, OTTAVIANI, and TRURAN invite us to consider how we might improve research in statistics education, how we can sharpen its impact and raise its status as an academic enterprise. While they address the research community as a whole, the questions they raise are precisely the ones that each of us as researchers ought to always be asking ourselves. And because I believe that the regard granted our work ultimately will depend on its quality and usefulness, I offer a few questions we should be asking ourselves about our own research.

Where is my research headed?

A single study is unlikely to have much of an impact. We ought to be striving to develop programs of research. We should not wait until one study is completed to consider where to go from there but rather have some idea as we begin one study what "the handoff" will be. How will you or someone else use your research to take the next step?

What kind of theory do I need?

I have a bias of sorts against capital T Theories. Too often I get the sense that researchers' theories and distinctions are what is most important to them, that they perceive theory as the goal rather than a means. I believe we should be working to develop and build from smaller theories, theories that are probably specific to statistical thinking as it develops in classrooms. These would explain how students at various ages view phenomena such as causality, probability, variability, group tendencies, distributions, how their views differ from those of the expert, and how we might help students build on their current understandings to make them more expert-like.

What are others doing?

One of the most consistent problems I encounter in reviewing manuscripts for publication is that the authors have done a poor job of reviewing the existing research. Many times, critical studies are not mentioned at all, which suggests that the researchers have undertaken a costly enterprise without first checking what others have already done. And the research that is cited is too frequently simply mentioned in passing to support simple claims rather than discussed and critiqued. Here's a warning sign: You are about to submit your article for publication and as a last step you rifle through your files to find references you can cite in all the places in your manuscript that you hastily wrote "insert reference." We will not make much progress as a research community until we become more familiar with what one another is doing. The best way to do this is to read and discuss research in a small group and to get and stay in touch with people doing research in your area.

What could teachers take from my research?

During the last few years, I've had several opportunities to write about research in statistics education for teachers. This exercise has convinced me that we can no longer afford to see the task of "translating" our research for teachers as someone else's job. We ought to be doing it ourselves. Indeed, I think our primary audience for research ought to be teachers. The best way to judge whether what you are doing will have any impact in the classroom is to ask teachers to read and comment on write-ups of your research. Does it help them better understand what their students are saying, illuminate why their students are having difficulty with particular concepts, give them ideas about what they might do to help students thinking develop? We should not need a final section in our research article entitled "educational implications." Those implications ought to be what the whole article is about.

2.9. Validating Statistical Education: A Response to BATANERO, GARFIELD, OTTAVIANI, & TRURAN

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BATANERO et al.'s article, *Research in Statistical Education: Some Priority Questions*, provides us with a detailed look at a research community in transition. It might even be safe to say that statistical education has moved from infancy (GARFIELD & AHLGREN, 1988) to adolescence. It is apparent from BATANERO et al.'s paper that statistical education is "growing up." This growth is reflected by the increased number of publications appearing in reputed journals and edited volumes and by the existence of several statistical education forums (i.e., conferences such as ICOTS, *IASE*, PME), and there has been an.

I suggest that statistical education may be in an adolescent phase because there seems to be a search for identity or even an identity crisis. This search is revealed in BATANERO et al.'s discussion about the need for academic recognition in the different disciplines in which we work, and in the difficulties the community is having in locating an academic home. The multi-disciplinary nature of statistical education makes it is difficult to situate this research field in a single academic home. -. In 1993, a working group on the learning and teaching of statistics was formed at the National Center for Research in Mathematics Education, in Madison, WI. Educators, statisticians, mathematics educators, and educational, cognitive and developmental psychologists, were all brought together to formulate a research agenda for statistics education in K-12. The strength of this group was the multi-disciplinary context that it provided. We put together our own agenda for K-12 statistics education and described the outcome of our work in a book that spoke to issues of the statistical content, learner needs, instructional methods and assessment goals (Lajoie, 1998). However, the differences in disciplinary voices were quite strong in this small working group even though we were working toward a common goal. BATANERO et al.'s paper discusses how difficult it is to describe our research to other disciplines when we do not share common goals. They suggest that the validity of statistical education must become more obvious to the academic community at-large. The research questions identified in BATANERO et al.'s paper indicate ways in which the validity of our work can become clearer. More importantly, the questions push us to consider moving our research forward to more carefully consider the guiding theoretical paradigms that should guide our research and to determine which issues should be considered immediately to help improve learning and instruction in statistics.

BATANERO and her colleagues have provided us with excellent questions that could be pursued in our future research endeavours. Due to page limitations I will only comment on a few of these issues.

- *Statistics education needs to work with all educators across all disciplines especially mathematics educators*.

To a large extent, this goal seems the most realised, at least from a K-12 perspective. In part, this goal has been facilitated by the National Council of Teachers of Mathematics, which provided guidelines for curriculum, teaching and assessment in the area of statistics as it is covered in mathematics classrooms. As mentioned earlier, evidence of this implementation can be seen in *JRME, PME, ICOTS*. On a personal note, I have served as an external evaluator on quite a few dissertations in this area. One question that is still important here is whether statistics education should be considered part of the mathematics curriculum or whether it should be considered throughout the curriculum. I see the next research issue building on that question.

- *Statistics education should build on related work in other disciplines and make use of cross-discipline linkages that have already been established.*

As statistical education evolves as a discipline I anticipate more research involving the examination of statistical reasoning across disciplines. For example, statistical investigations can cross into areas of scientific reasoning quite easily. In both situations, research questions are posed, data are collected, analysed, graphed and interpreted. Perhaps such relationships should be made more explicit. Perhaps this type of cross-disciplinary linkage should be attempted in history and the social sciences. GRAHAM (1987) and MOORE (1992) argue that statistics is important in areas, such as ecology, biology, engineering, and economics. It is quite possible that instruction that crosses the curriculum may tie the concepts of statistical reasoning and statistical literacy more tightly. Lehrer and Schauble (2000) have looked at the relationship between mathematical concepts and science, as has Cobb (in press). However, these cross-disciplinary relationships need to be further examined.

The next few issues might be considered jointly:

- *What psycho-pedagogical models can help understand the development of statistical reasoning and how can*

these models be used to facilitate development?

- *What teaching-learning theories can help us understand and explain the teaching-learning of statistics?*

Learning theories, developmental differences, theories of pedagogical competence and instructional design may be considered jointly or in separate research agendas. Examining the learning context, be it with or without technology, needs to be planned in relation to the type of statistical understanding that is being promoted. Evidence of readiness to learn, learning trajectories, and transfer of learning are interesting concepts that should be explored in statistics (Schwartz, 1998, 2000). Learning environments that are set up to provide activities that assess readiness to learn statistics might be considered along with developmental differences in statistical understanding. It is quite possible that properly designed learning environments can build on students' naïve statistical intuitions.

- *How do different cultures affect the transferability of our research results?*

Multicultural perspectives in learning and instruction need to be considered in all fields of instruction. In terms of statistical education, we need to have some knowledge of how statistics is being taught in order to build on existing prior knowledge and instructional methods. As demonstrated in the international conferences in statistics education, statistics instruction is a global concern. However, when working towards transferability of research it is necessary to consider both local and global issues of education. Benilde Garcia and I are collaborating on a project that extends the design principles of the authentic statistics project that I developed for grade 8 students in Canada (Lajoie, Lavigne, Munsie & Wilkie, 1998), to the development of an undergraduate statistics curriculum for psychology students in Mexico (Garcia et al., in prep.). The transfer has been quite seamless in that both countries value project-based work with small groups and principles of modelling have been incorporated rather easily. However, such collaborations must include travel between countries to help establish shared understandings of the instructional settings.

- *What are the differences between statistical literacy, statistical reasoning and statistical thinking? What are the important goals for students in developing these different types of cognitive processes and how are they best taught and assessed?*

This question can take researchers down many avenues. My personal belief is that statistical literacy could be considered more generally, whereas statistical reasoning should be considered in the context of specific statistical content. Lavigne (2000) demonstrated that different levels of statistical reasoning could be attributed to the type of statistical design attempted. Developmental transitions in statistical reasoning should be identified by statistical content.

- *What are the effects of technological tools on student learning?*

This question needs to be further refined to include the type of learning paradigm guiding the technological tools and the types of statistical problems considered.

In summary, I found BATANERO et al.'s paper quite stimulating. I look forward to reading the responses to their paper because together this collection of papers will help develop some valuable research directions in the area of statistical education.

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2.10. Comment on "Research in statistical education: Some priority questions"

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A quality research study in statistical education should incorporate three complementary aspects: normative, descriptive and prescriptive. We shall more specifically comment on the necessity of a cognitive experimental approach and our interest in two concepts: active learning and analogical processing.

Descriptive aspects

A common approach to research is to list errors and deviations from *a priori* normative models. A lot of misconceptions have been successfully investigated (for instance, in probabilistic situations: representativeness bias, availability bias, equiprobability bias, and so on). Such an approach is useful but clearly insufficient. Indeed, most of the surveys that aim to study these misconceptions induced stereotypical answers and reflected subjects' theoretical knowledge in probability and statistics more than their own opinions and reasoning. Consequently the origin of these misconceptions should also be studied: Are they fundamental erroneous intuitions, resulting from various everyday-life experiences, erroneous interpretations of what is taught, etc.? Furthermore, when experimental treatments are used to remedy these misconceptions and result in correct answers, is such an acquisition stable? Experiments should be designed to answer these questions.

Furthermore, and concerning more specifically the descriptive aspects, a deeper approach is *necessary* in order to provide evidence of a number of fundamental statistical intuitions. It is essential to study both spontaneous representations, and their evolution. A primary objective of any research in statistical education should be to provide an analytic description of the underlying cognitive processes, with the aim of revealing some *internal coherence* in spontaneous judgement and reasoning. Of course normative models have a role to play in defining and constructing situations of interest. It is also important to link experimental findings to relevant normative concepts and to build models that contribute to elaborate formal descriptive models of cognitive reasoning.

Active learning

In this perspective, the best situations are those where subjects are led to construct themselves the adequate representations. Such an active construction appears to be a determining factor in the stabilisation of these representations. This conclusion is quite in accordance with a comment by Fischbein and Schnarch (1997): "If students can learn to analyse the causes of the conflicts and mistakes, they may be able to overcome them and attain a genuine probabilistic way of thinking". Furthermore, it is in agreement with the framework of many recent research programs in statistical education, in which it is emphasised that it is important for students to construct their own knowledge and develop probabilistic and statistical concepts through the use of active learning. In particular, we may attempt to act upon the cognitive representations used by students by determining the best conditions under which the appropriate representations are activated. Such an approach appears indeed to have significant didactic implications concerning the teaching of statistical (and more generally mathematical)

concepts.

Transfer and analogical processing

It is also of interest to experimentally investigate the conditions of transfer to various isomorphic situations. Results could be interpreted within the framework of analogical processing, a general mechanism which is playing a more and more important role in explaining cognitive activity. A lot of experimental evidence in psychology has shown that the frequency of the use of analogy is due to its heuristic and economical nature, which allows people to make "mental leaps" (Holyoak & Thagard, 1995) between different domains, and to interpret a new situation by transforming the newness into a well-known situation. Usually, analogical processing is studied in an experimental paradigm in which a "base" analogue (solutions in problem solving or a set of knowledge in a domain) is taught to participants before testing their behaviour within a "target" situation (the new problem or new domain). It is commonly accepted that one may describe this process by a comparison mechanism which allows people to recognise and infer similarities between situations, and which can be decomposed into steps. Researchers in the field agree that the first two steps in analogy are (i) the access to a source situation - the base analogue when a target situation is given - and (ii) the mapping between the source and the target. The crucial question of access has been relatively recently studied by cognitive psychologists (see e.g. Forbus, Gentner & Law, 1995; Hummel & Holyak, 1997).

The study of different contexts of various isomorphism of a same problem solving situation can serve to demonstrate how the general and familiar knowledge activated in these isomorphism can explain the differences in the difficulties encountered in solving this type of problem (see e.g. Clément & Richard, 1997). A way to interpret these findings is to consider that this knowledge of domain effect is an expression of a general analogical mechanism. Indeed, when the student has to solve a new situation in which no base analogue is given, he/she uses his/her own base analogue evoked or activated by the (semantic) context of the new situation.

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2.11. Statistical Thinking and Research

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The authors BATANERO, GARFIELD, OTTAVIANI and TRURAN have raised many issues in their SERN article regarding research in statistics education. The fact that statistics and statistics education are both new disciplines contribute, I think, to a sense that research in the education area is not valued by either statisticians, schools or the immense number of other fields that use statistics. Perhaps we are asking too much of other people to accept the educational side when they are grappling with a new discipline and a new way of thinking within their field. Statistics has only recently been introduced into school curricula and is also a relatively new discipline in academic programmes. However what could be seen as a barrier to the acceptance of statistics education research could be also seen as an opportunity. Since both statistics and statistics education are new disciplines they could develop together. This would require statistics education researchers working in

collaboration with statisticians.

According to Snee (1999) the development of statistical thinking is the next step in the evolution of the discipline of statistics. If this is so then statistics education researchers should regard research into developing students' statistical thinking as a priority. I believe that statistical thinking operates in three distinct areas: empirical enquiry; evaluating enquiries; and everyday life. If my analysis is correct then research on the development of statistical thinking is required in these three particular areas.

Empirical Enquiry

In empirical enquiry statistical thought processes are operationalised when questions are posed, during problem definition and study design, and when data are collected and analysed to make an informed judgement about a situation. This area is already being researched (e.g., Hancock et al., 1992; Konold et al., 1997, BEN-ZVI & Friedlander, 1997) perhaps because projects using statistics are now relatively commonplace in school curricula. However much more research is needed on (1) how to enculturate students into a statistical way of thinking during empirical enquiry, (2) the particular ways of thinking that students' attention should be drawn to while they are conducting an investigation and (3) the types of questions that students should be investigating to promote the development of statistical thinking.

Evaluating Enquiries

The second area where statistical thinking operates is when an empirical enquiry is reported upon either in a research article, in the media, in a recommendation report to a company and so forth. This area requires different types of statistical thought processes not only on how to read the report, but also on how to react to what is present and not present in the report. The interpretation and judgement of statistically-based reports should be regarded as a priority for research. Limited research has been done in this area (e.g., WATSON, 1997, Gal, 1997). In New Zealand the school curriculum states students should be "evaluating statistics presented in the news media, and in technical and financial reports, and confidently expressing reasoned opinions on them" (Ministry of Education, 1992, p. 199) yet this aspect is still not being implemented to any great degree in the classroom or in examinations. Thus research should be focussed upon (1) finding effective teaching methods for the reading and judging of statistically-based reports and (2) defining criteria or "worry questions" for the judging and evaluation of a report. This area of research is not confined to teaching and education. For example, Breslow (1999) considers that the interpretation of information in statistical reports is an area of research that could improve medical literature. The SERN article also considers defining good quality research in statistics education as an issue to be addressed. Therefore evaluating reports or enquiries is an area of statistical thinking where research should be focussed.

.**Everyday Life**

The third area where statistical thinking is required is in everyday life when information that is not formally collected as data is used to operate in and to understand one's environment, and to understand one's reactions to and rationalisations of events. According to Snee (1999, p. 257): "we can use statistical thinking without data". Understanding variation is central to this way of thinking. Developing a statistical way of thinking for everyday life is not addressed by school curricula although it is the area that the statisticians, particularly in quality management, see as an important area for development. They believe that their way of thinking about variation will alter the way people view reality. Thus some base-line research questions may be appropriate. Some questions that could be researched are: How do people come to conclusions with everyday data? How can we characterise this everyday statistical reasoning that students enter the classroom with? How do people differ in their everyday statistical thinking? How do teachers implement such a culture of argumentation or thinking into their teaching? Alternatively statistics education researchers could collaborate with the quality management field to learn more about this way of thinking before determining research questions for teaching.

Statistics and statistics education are new disciplines. I believe that new ways of conceptualising the intellectual method and reasoning of the statistical discipline are needed and must evolve with statistics education research that seeks to understand statistical thinking, learning and teaching. Addressing the three research areas of empirical enquiry, evaluating enquiries, and everyday life, should promote the development of statistical thinking.

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2.12. Towards a Theoretical Model for Conceptual Change in Probabilistic Thinking

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BATANERO, GARFIELD, OTTAVANI and TRURAN have proposed a catalogue of questions and issues, regarding the future direction of research in statistical education. It would be easy to respond by raising yet more questions, or by seeking to refine the questions posed. However, in the face of complexity, my personal strategy is always to focus and to specialise. For me, the alternative is to flounder. With this strategy in mind, I wish to focus on just two related (but fundamental) questions out of their catalogue: (i) What psycho-pedagogical models can help us understand the development of statistical reasoning, and how can these models be used to facilitate development? and (ii) what teaching-learning theories can help us understand and explain the teaching-learning of statistics? These two questions are still too broad, so, whilst acknowledging the crucial role that external factors, such as the teacher, play on how learning develops, I wish to focus on the learner . In the end, it is what the learner learns that matters; we can gain few insights about teaching without researching learning. Furthermore, I wish to specialise on elementary ideas of probability, though perhaps some of the ideas will have broader relevance – that will be for you to decide.

The dominant research effort of the 70's and 80's was to identify, mostly through paper and pencil tests, ways in which people made judgements of chance. Many researchers (for example, Kahneman, Slovic, & Tversky, 1982) identified widespread fallibility in the sense that respondents to their questions appeared frequently to use non-statistical heuristics to make judgements of chance. By the end of the 1980's, it was clear that many adults were unable to deal competently with a whole range of questions that might have involved probabilistic thinking. During this period, researchers, looking for regularity amongst the findings, identified a series of underlying intuitive heuristics that, through in-built systematic bias, led to error. Now, in hindsight, this research effort seems to mirror that in mathematics education a decade or so earlier, where similar methodologies identified catalogues of misconceptions. The implications of such research are (i) such misconceptions are "hard-wired" into our brains and there is little teachers can do about it, or (ii) there are in fact some little used potentially effective pedagogic approaches, waiting to be discovered or popularised. The limitation of such research is that it offers few insights into what such a pedagogy might look like The misconceptions research is essentially theory-free. Indeed Kahneman and Tversky claim that the cataloguing of such heuristics is itself a theory. Well, if so, it is not so much a theory of conceptual change (which teachers need) as a theory of conceptual state. Suppose we search for a model of conceptual change by characterising findings from research on probabilistic thinking and then by assessing models of conceptual change as predictors of that characterisation . Whereas models of conceptual *state* were devised by matching snapshots of thinking, models of conceptual *change* must be related to the findings from methodologies that have sought a deep analysis of how thinking changes, either over an extensive period of time (as in longitudinal studies) or during

periods of significant transition (as in some clinical interviewing).

When I examine the research findings emerging from methodologies of this type, the single most obvious fact is that there is no pattern – that thinking about probability is vicarious, perhaps dependent critically on the context or the tools being used (see, for example, Konold, 1989). Is the inability to find commonality a reason for desperation? In my view, absolutely not. On the contrary, it is a reason for searching for a framework that encapsulates such variety – that predicts the sort of varied responses that we see in so much of the recent research.

I invite you to consider diSessa's model of conceptual change (diSessa, 1993). I do not claim that there are no other models that might also help to make sense of research findings on probability, but diSessa offers a level of detail that I have not found in any other model of conceptual change. He argues that primitive knowledge is piecemeal. We have many fragments of knowledge, some of which diSessa has identified. These pieces of knowledge are abstracted from our experiences and so are referred to as p-prims, short for phenomenological primitives. It is not appropriate here to detail how his theory can be adapted to probabilistic thinking (for more details, see Pratt, 1998, 2000). Suffice it to say that diSessa offers us a world in which, when a child is confronted with new data, s/he will attempt to make sense of this situation through these small pieces of knowledge. Which p-prims are cued will depend on surface features of the situation. Gradually as some p-prims are found to be more reliable, they will be more likely to be used in future sense-making situations. Gradually p-prims may become more structured through "tuning towards expertise", so that groups of mutually consistent p-prims are fired simultaneously.

It seems that everyday experience does not usually lead to much re-structuring of randomness-related p-prims, perhaps because the nature of feedback in such contexts is so elusive. Even conventional teaching seems to provide little tuning towards expertise, if we are to believe the earlier research on misconceptions. The implication is that we need to identify the primitive roots of probabilistic thinking and find non-conventional pedagogies that support tuning towards expertise. In this sense, perhaps the most important role for the computer in statistical education is not as a tool for carrying out statistical techniques efficiently, but as a laboratory in which children can test out their conjectures about randomness and probability, learning from feedback that the everyday world can not provide, and thus tuning their knowledge towards a higher level of expertise. Some such laboratories already exist ([1] [2] [3]) but much research is needed to improve their effectiveness, and this research needs to be based on a model for conceptual change that encompasses what we already know about research on probabilistic thinking.

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Notes

[1] "Chance-Maker" is one such laboratory and can be downloaded free of charge from: http://fcis1.wie.warwick.ac.uk/~dave_pratt/ .You will first need Boxer, a programming language in the style of Logo. At present it is only available for the Macintosh computer but will soon be available for the PC. You can find out more about Boxer, including free download, from: http://www.soe.berkeley.edu/~boxer/

[2] A second such laboratory is "Probability Simulator". You can order or find out more about "Probability Simulator" (for the Macintosh computer only) from: http://www.umass.edu/srri/serg/probsim.html

[3] A third such laboratory is "Probability Explorer". You can find out more about "Probability Explorer" on: http://www4.ncsu.edu/~hsdrier/dissertation.html

3. *IASE* Members

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Paulo is a Professor at the Military Institute of Engineering, where he is teaching mathematical statistics and statistical quality control. He is also teaching probability, statistics and stochastic processes and doing some consultancy work at Santa Ursula University. In 1999 he publishes a book "Probabilidades & Estatística" (Reichmann, &Affonso Editors, ISBN 85-87148-07-9), which has now being translated to Spanish by Prentice-Hall, Addison Wesley and Pearson Education ("Probabilidad & Estadística", 2000, ISBN 958-699-012-5). This book is based on his revolutionary philosophy of teaching, and is based on the use of calculators, Excel and Statistica. He invites *IASE* members to visit his web site: http://www.estatistica.eng.br , where he plans to include a Spanish page.

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Bryan MANLY has left academic life after 27 years at the University of Otago in New Zealand, most recently as the Professor of Statistics. He is now working as a consultant for Western EcoSystems Technology Inc. (www.west-inc.com), in Cheyenne, Wyoming, specialising in applications of statistics in ecological and environmental areas, and the move coincides with the publication of his new book Statistics for Environmental Science and Management (Chapman and Hall/CRC).Bryan remains as the Editor of the Journal of Agricultural, Biological and Environmental Statistics and his e-mail address remains unchanged at bmanly@compuserve.com.

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Roberto is currently teaching Social Statistics, Psychometrics, Statistics and Survey Statistics at the University of Turin, Italy. He is doing research about direct and indirect ways in the study of public opinion. Direct way is based on questionnaire analysis, while indirect way are based on content analysis. A paper on the latter subject "Newspapers, geographical zone and culture" is available from his web site. Another recent work is "Concepts and colours. An experimental research in the psychocromatics field", Guerini, Milano, 2000 ("Concetti e colori. Una ricerca sperimentale in ambito psicocromatico"). In Italian.

In 1995 Roberto published "Valutazione della didattica nella Facoltà di Economia di Torino. Indagine pilota", Giappichelli, Torino (Didactical assessment at the Faculty of Economics, Turin. A Pilot test), where he was searching a good questionnaire by which the students could evaluate their lecturers teaching capacity. This questionnaire is currently used at the end of each course.

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Banjade has been working as an assistant lecturer in the University and he is teaching inferential statistics to students in their third year of Batchelor in Education. He is also a part-time secondary school teacher. He is currently working as the President of the Youth Forum of Statistical Education in Nepal. He is interested in following Ph.D. studies in statistics and in playing an active role in statistics education at an international level.

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Peter graduated in cognitive educational psychology at the University of Maastrich this summer. As a final project he conducted research about the knowledge restructuring in medical experts, under the supervision of Prof. Dr. Henk Schmidt and Dr. Margje van de Wiel. He is starting his Phd-project on collaborative learning in statistics at the department of Methodology and Statistics, University of Maastricht, the Netherlands. The goal of his project is to improve the statistical education at the University of Maastricht in general and at the Faculty of Health Sciences in particular. At this moment the statistical education at the University of Maastricht is mostly expository. In the present Phd-project Peter would like to experiment with a different learning environment (i. e. collaborative learning), and he will try to provide a detailed analysis of the factors that determine the strength of this particular learning environment. Furthermore, he would like to examine the cognitive psychological effects that a collaborative learning environment has on learners, the nature of statistical knowledge and the statistical reasoning process more thoroughly. Eventually, the Phd-project should accumulate in a didactical blueprint, which can be used to efficiently monitor the learning processes in a collaborative learning environment.

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4. Brief News

IASE National Correspondents

As the main scientific and professional association devoted to promoting and extending statistical education world-wide at all levels, the *IASE* offers its membership the opportunity both to learn from, and contribute to, innovations and progress in statistical education. To achieve this aim, the *IASE* Executive Committee has always recognised the importance of having good channels of communication between statistical educators who sometimes find themselves relatively isolated in professional terms. When the *IASE* was first set up a system of National Correspondents was established to help the *IASE* strengthen its links with statistical educators in each country. The Executive is now updating these positions.

These correspondents can help the organisation in a number of ways. These include passing on information about *IASE* activities to local statistical educators and letting us know about important activities concerning teaching/learning statistics and probability in their country so we can let others know what is happening around the world. An important activity which Correspondents can help is the in planning for ICOTS-6. This not only includes helping disseminate information of this event to those interested in statistical education, but also to nominate authors, projects and researchers who could make a worthwhile contribution to the Conference. Furthermore, the Correspondents may also like to facilitate statistical educators groups in their own country.

We would like to thank those who have already agreed to take on, or continue, in this important role and encourage others to help expand and improve the work of statistics educators. You can check the list on: http://www.swin.edu.au/maths/*IASE*/correspondents.html and if you see a vacancy you would like to fill please contact us.

One-day meeting on teaching statistics

Elda GALLESE is reporting that the Statistical Commission at the Professional Council and Graduate College in Economical Sciences, Maipu. Argentina, organised a one-day meeting on "Teaching Statistics to Undergraduates on August, 25, 2000. The main goal was to start and maintain a discussion forum on the teaching of statistics to professionals. Main topics were: Pedagogy and computation; the influence of statistics in accounting theory. There was also a round table on the teaching of statistics at different educational levels.

International Education Project

Juarez-Lincoln-Marti International Education Project is dedicated to providing faculty development to Mexican and Ibero American universities, especially public and provincial institutions, as well as to strengthening mutual understanding between American and Ibero American faculty. The Juarez-Lincoln-Marti was founded in 1994, as the SUNY-Mexico exchange project. Under this name it functioned between 1994 and 1998 when its Director, Dr. Jorge ROMEU, took early retirement from SUNY. Since its inception in 1994, the Juarez Lincoln

Marti Project established contacts with multiple Mexican universities and research centres, donated several boxes with dozens of mathematics and science textbooks and other teaching materials to several universities, maintained two email information lists (for Academics and researchers) and found scholarships that allowed Mexican faculty to attend the SUNY CIT Conferences for Instructional Technology (CIT). Recently, the project director has obtained a grant to deliver a series of technology in education workshops in Mexico. With the proceeds of this grant, the Juarez-Lincoln-Marti Project has launched a new program to provide additional workshops to other Mexican public and provincial institutions. More information is available from Jorge Luis ROMEU <jromeu@cat.syr.edu> or from the web site http://snycorva.cortland.edu/~matresearch/

Statistics in Transition on the Web

Jan KORDOS <J.Kordos@stat.gov.pl> informs that the last two issues of the journal Statistics in Transition (English Journal of the Polish Statistical Association) are on Web site: http://www.stat.gov.pl/english/transition.htm. The journal editors decided to introduce in our journal a new section entitled "*Statistical Education*" which will be devoted to different aspects of statistical education in different countries and in the last issue Jan is including a report on the tasks and activities of *IASE*.

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5. *IASE* new Honorary Members
A deserved tribute to Anne HAWKINS and David MOORE

The *IASE* by-laws were recently modified to include the possibility of nominating Honorary Members as a way to recognise the work and dedication of some of our members. We are glad to announce that the *IASE* Executive Committee approved the nomination of Anne HAWKINS and David MOORE, who were President of the Association in a crucial period for the establishing of the same and whose work on behalf the *IASE* has contributed to the flourishing and extension of our Association. As a modest homage, we are including below a brief sketch of their C.Vs and a list of their main publications in statistical education.

5.1. Anne HAWKINS

Anne was member of the *IASE* Interim committee 1991 - 1993, President-Elect (1993-95) and President of *IASE* (1995-97). For many years she tried to promote the improvement of statistical education and thinking at all levels, within education (primary to tertiary), within employment (including the continuing professional development of statisticians, and all who use statistics as part of their professional lives or who work with statisticians), and within society at large. She was secondary school seacher, mathematics/statistics & psychology, careers advisor (1970-73), lecturer in psychology at S E Northumberland Technical College (1974), lecturer at Sunderland Polytechnic (1975-1977) in research design and analysis, and information processing, lecturer in statistics and statistical education at the Institute of Education, University of London (1977-90), visiting lecturer at the Jos University, Nigeria (1979), research fellow/lecturer in statistics, at the University College, London School of Medicine (1990-93)

As the director of the Royal Statistical Society Centre for Statistical Education, University of Nottingham, she made this centre a focus for national and international collaboration, which actively engaged in statistical education research as well as stimulated and provided support for initiatives elsewhere. She has always supported existing statistical education projects; stimulated research projects and conferences on teaching, understanding and learning statistics; established links between institutions; and developed *IASE*'s publications programme on behalf of the International Statistical Institute. She was a member of the Advisory Board for the World Numeracy Programme and CTI Statistics. Other qualifications include: Member of the International Statistical Institute Council Member, and a number of committees of *ISI*, member of the Task Force on Statistical Education Centres Throughout the World and council member and council representative - RSS Education Committee at the Royal Statistical Society; PhD, Hull University, Faculty of Life Sciences, MSc Psychology, Hull

University, FSS, fellow of the Royal Statistical Society, by election, MIS, membership of the Institute of Statisticians, by examination, PGCE (Distinction), Hull University and BSc Hons II(i) Psychology, Hull University.

Anne has helped to organise a number of *IASE* conferences such as the 1st Scientific Meeting of *IASE*, 1994, Perugia, Italy, ICOTS IV, Morrocco, 1994, ICOTS V, Singapore, 1998, as well as other RSS conferences and she was the Chair of the International Statistical Institute's Round-table conference "Training Teachers to Teach Statistics", Budapest, Hungary, 1986. She edited *IASE* matters in 1992, was *ISI* national correspondent in 1987-94, Member of Editorial Board, "Teaching Statistics" and responsible for the sections 'Statistics in Practice' and "Research Reports' in 1996. Her research projects include MEANS (Matching Education, Assessment and Employment Needs in Statistics), statistical and probabilistic understanding by those involved in the legal process (in collaboration with colleagues at the College of Law); The methodology for studying statistical concepts and understanding among teachers of statistics; The use of computer hardware and software in the teaching of statistics (in collaboration with Rolf BIEHLER, Universität Bielefeld, Germany); Cross-cultural study of the evolution with age of probabilistic, intuitively-based, misconceptions (with Professor Efraim Fischbein, Tel Aviv University, and Marie-Paule LECOUTRE, France); The development of statistical education in developing and transition countries (in collaboration with Lionel PEREIRA-MENDOZA, Memorial University, Newfoundland, Canada); She was also statistician, grant-holder and co-director/ consultant for a number of other projects, including research and development of software and teaching materials in collaboration with sociology and geography teachers and advisers; evaluation of American educational software for possible conversion and adoption in UK schools; and evaluation of educational materials. She was frequently invited speaker at statistics education, statistics and mathematics education conferences.

As a modern woman, Anne has been able to deal with her professional work as well as with taking care of her family and raining her son. Her kindness, intelligence and her interest in other people's work made her gain many friends among statistical educators all around the world. Last ICOTS we were upset when she announced her decision to gave up her work in statistical education and dedicate herself to help her son in developing his career. We respect and understand her decision, since she is, most of all a mother. In awarding her our honorary membership we want to recognise how much are we indebted to her ideas and her impulse.

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5.2. David MOORE

David was president of *IASE* in 1991-93. He studied bachelor of arts ad the Princeton University, 1962 and Ph.D. at Cornell University 1967. He was assistant professor of statistics at Purdue University 1967-76, professor of statistics at Purdue University since 1977, where he was assistant dean of the Graduate School (1977-80), director of statistics and national science (1980-81) and he was awarded Shanti S. Gupta Distinguished Professor of Statistics (1996). His is fellow of the American Statistical Association, where he was associate editor of the Journal of the American Statistical Association (1973-77), chairman of the Section on Statistical Education (1979), council member (1980-82), associate editor, of *Technometrics* (1989-92), member of the ASA-MAA Joint Curriculum Committee (1991-1997), president in 1998 and participated in a number of different committees. He was also member of different committees of the Institute of Mathematical Statistics. David is elected member of the International Statistical Institute, council nember (1993-1995), associate editor of *International Statistical Review* (1992-95), member of the program committee for the Fourth International Conference on the Teaching of Statistics and associate editor of *Journal of Statistics Education* (1993-96). He has been visiting professor in a number of universities in the USA, Malaysia, New Zealand and South Africa.

His research interest include statistics education, large sample theory, tests of fit, and categorical data. He has taught applied statistics, quality control, statistical theory, statistics for non-technical students, AT &T Technologies, and has participated at the Purdue continuing engineering education TV network. He took part in the project , "On the Shoulders of Giants"' (1988-1989) and was member of the advisory boards for the following NSF education projects: Quantitative Literacy Project (American Statistical Association), 1987-1990; Reasoning Under Uncertainty (BBN Laboratories), 1988-1990; Connected Mathematics (Michigan State University), 1991-1996; Investigations in Number, Data, and Space (TERC), 1991-93; Principles and Practice of Mathematics (COMAP), 1991-93; Statistics Curriculum Development (Ohio State University), 1993-1996; ARISE (secondary curriculum) (COMAP), 1993-1997 and Multimedia Statistics (Data Description), 1994-1996. He developed the statistics content for the TV and video series For All Practical Purposes (1987), Against All Odds: Inside Statistics, (1989); and Statistics: Decisions Through Data (1992).

David has published many papers in statistics, in prestigious books and journals such as *Annals of Mathematical Statistics, American Mathematical Monthly, Annals of the Institute of Statistical Mathematics, Biometrika, IEEE Transactions in Information Theory, Journal of the American Statistical Association,* and *Journal of the Royal Statistical Society.* He was chair of the University Senate (1973-74), and chair of a number of committees ant the statistics department and the Purdue University. Other activities include member of the National Research Council, committee on applied and theoretical statistics (1982-1985), mathematical sciences education board (1996-1999), U.S. national commission on mathematics instruction (1999-2001), National Science Foundation; member of different external review committees and supervising doctoral dissertations in sampling properties of the Chi-Square test.

David is a brilliant and popular speaker and, as such, is invited to many conferences in statistics and statistics

education, including ICOTS III, ICOTS IV, ICME VII, ICME VIII, Regional and Joint Statistical Meetings of the American Statistical Association, Mathematical Association of America meetings, National Council of Teachers of Mathematics meetings, International Association for Statistical Education, Perugia, Italy, Statistical Society of Canada, Royal Statistical Society, South African Statistical Association, Nordic Conference on Mathematical Statistics (Lahiti, Finland) and Statistics Society of Australia. His books, which have been translated to different languages, reflect his didactical ideas and make statistics understandable and interesting to students all around the world. As an active statistics and statistics educator, he continues diffusing the message that statistics education is essential and possible for the educated citizen and is, therefore one of the *IASE* best ambassadors.

David MOORE selected publications in statistics education

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6. Summaries of Publications by *IASE* Members

LAMPRECHT, T. (1998). Using computers as an aid in lecturing statistics and mathematics to disadvantaged students in South Africa. *VITAL,* 12(1), 56-62. Many problems are experienced by disadvantaged students who have not passed Grade 12 (final year of high school) mathematics in learning and understanding statistics and mathematics at university. As most of these students are studying in a second or third language, language difficulties abound. Different ways in which these students can be helped are discussed — videos, ordinary (traditional) class tutorials and the use of the computer. How the computer can be used in tutorials (drills-and-practice), simulations, and exploratory tools in the teaching of Mathematics and Statistics are described.

MARVULLI, R. (2000). *Introduzione alla statistica* (Introdution to Statistics). Torino: Utet. In this book I try to train in Statistics persons coming not only from scientific but also from humanistic studies. Table of contents: 1 Premises; 2. First elaboration; 3. Averages; 4. Variability; 5. Time series; 6. Bivariate distributions; 7. Probability; 8. Probability Calculus; 9 Random Variables; 10. The Normal distribution; 11. Statistical sampling; 12. Sampling random variables; 13. Sampling random attributes); 14 Selecting a sample; 15. Introduction to tests.

WELDON, L. K. (2000). A simplified introduction to correlation and regression. *Journal of Statistics Education,* 8(3).The simplest forms of regression and correlation involve formulas that are incomprehensible to many beginning students. The application of these techniques is also often misunderstood. The simplest and most useful description of the techniques involves the use of standardised variables, the root mean square operation, and certain distance measures between points and lines. On the standardised scale, the simple linear regression coefficient equals the correlation coefficient, and the distinction between fitting a line to points and choosing a line for prediction is made transparent. The typical size of prediction errors is estimated in a natural way by summarising the actual prediction errors incurred in the data set by use of the regression line for prediction. The connection between correlation and distance is simplified. Despite their intuitive appeal, few textbooks make use of these simplifications in introducing correlation and regression.

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7. Recent Dissertations

Beckett, T. M. (1999). *Development of conceptual understanding of statistics for concrete thinkers in a constructivist learning environment.* ED.D. University of Lowell Supervisor; Regina Panasuk. UMI 9942531.

Today, college students are being prepared for a much different workplace than has ever existed before. Students who are trained only to memorise facts and do computations will be at a disadvantage because the computer has proven to be a more cost effective way to store information and perform calculations. The contemporary college mathematics curriculum should emphasise thinking, communication, and understanding. The literature suggests that students whose level of cognitive reasoning is not at the stage of formal operations, as defined by Piaget, will not be successful in a college level statistics course.

The purpose of this study was to identify the students who have not reached the level of formal operations and explore a strategy that will enable them to achieve conceptual understanding of probability and statistics. It was hypothesised that teaching practices consistent with constructivist epistemology will be conducive to students whose thinking remains at the concrete level. The study explored a constructivist learning environment which focused on students interacting in groups to discuss, share, and communicate their ideas, thought processes, and misconceptions as they work on interesting problems using real life data.

The study involved 101 college students enrolled in four separate sections of an Introductory Probability and Statistics course. An initial paper and pencil test, called the Formal Operational Reasoning Test (FORT), determined if each student's ability to reason was at the pre-formal or formal operational level. Four existing classes were involved in this study through an entire semester. Two classes were identified as an experiential group where students worked in groups to discuss and collaboratively find solutions to problems. In these classes

the constructivist learning environment was built. The other two classes were identified as a control group.

At the end of the semester, all of the students responded to the Constructivist Learning Environment Survey (CLES). This questionnaire evaluated the students' perceptions of teaching strategies that create a constructivist learning environment. To enhance the validity of the study, to minimise the researcher's b*IASE*s, and to increase agreement on the description of the presence or absence of specific teaching strategies, an independent observer surveyed all of the classes. All of the students took the same final exam, which assessed their conceptual understanding of probability and statistics.

An analysis of variance (ANOVA) test determined that the results from the control and experimental groups were significant and supported the hypothesis that a constructivist learning environment is conducive to students' conceptual understanding. Information obtained from this study could be used to either support or alter the recommendation that certain teaching methods promote conceptual understanding of probability and statistics. Specifically, the findings in the study determined that a student who has not achieved the formal operational level of cognitive development and who is involved in the constructivist learning environment can acquire an acceptable level of conceptual understanding. The findings of the study will inform both theory and practice of the phenomena surrounding the constructivist learning environment.

HOWIE, D. J. H. (1999). *Interpretations of probability, 1919-1939: Harold Jeffreys, R. A. Fisher, and the Bayesian controversy.* Ph.D. University of Pennsylvania. Supervisor Roberte Kohler. UMI. AAT 9937734

A probability can be interpreted in one of two distinct ways. On a frequentist definition, it is a limiting ratio of samples from some physical ensemble; on a Bayesian definition, it is a degree of rational belief in a proposition or hypothesis. This dissertation is a historical study of the two interpretations of probability during the 1920s and 1930s. It focuses on two British scientists, Sir Harold Jeffreys (1891-1989) and Sir Ronald Aylmer Fisher (1890-1962).

Jeffreys was a theoretical physicist who used sophisticated mathematical models to study the Earth and solar system. Since his hypotheses were always uncertain, needing revision or even abandonment in the face of incoming results, Jeffreys tried to construct a formal theory of scientific reasoning based on Bayesian probability. Fisher was a biological and agricultural statistician specialising in problems of genetic inheritance.

Chiefly concerned with the reduction of experimental data, he regarded Bayesian methods as unfounded in principle and misleading in practice, and worked to replace them with a theory of statistical inference based on frequencies. A direct confrontation between the two men during the early 1930s proved inconclusive: though the two theories were incompatible, each was coherent and defensible. Yet they were not generally regarded as equally persuasive.

The Bayesian interpretation, though implicitly adopted by many scientists and statisticians during the eighteenth and nineteenth centuries, was gradually abandoned during the 1920s and largely discredited by 1939. This was not solely due to conceptual difficulties with Bayesianism. I argue instead that not even a mathematical theory of probabilistic reasoning is a disembodied product of logical deduction. The specific meaning given to Bayesian methods, their evaluation as tools for scientific research, and ultimately the reasons why they lost out to the frequentist school; at least until their post-war revival; depended on local contexts of disciplinary practice.

LIPSON, K. The Role of the sampling distribution in developing understanding of statistical inference. PhD. D. Swinburne University of Technology. Supervisors: Peter JONES and Brian PHILLIPS.

There has been widespread concern expressed by members of the statistics education community in the past few years about the lack of any real understanding demonstrated by many students completing courses in introductory statistics. This deficiency in understanding has been particularly noted in the area of inferential statistics, where students, particularly those studying statistics as a service course, have been inclined to view statistical inference as a set of unrelated recipes. As such, these students have developed skills that have little practical application and are easily forgotten.

This thesis is concerned with the development of understanding in statistical inference for beginning students of statistics at the post-secondary level. This involves consideration of the nature of understanding in introductory statistical inference, and how understanding can be measured in the context of statistical inference. In particular, the study has examined the role of the sampling distribution in the students' schemas for statistical inference, and its relationship to both conceptual

and procedural understanding. The results of the study have shown that, as anticipated, students will construct highly individual schemas for statistical inference and that the degree of integration of the concept of sampling distribution within this schema is indicative of the level of development of conceptual understanding in that student. The results of the study have practical implications for the teaching of courses in introductory statistics, in terms of content, delivery and assessment.

MELETIOU, M. M. (2000) Developing students' conceptions of variation: an untapped well in statistical reasoning. PhD Thesis, University of Texas at Austin. Supervisor: Jere Confrey

The conjecture driving this study is that if statistics were to put more emphasis on helping students improve their intuitions about variation and its relevance to statistics, we would be able to witness improved comprehension of statistical concepts (Ballman, 1997). Both the research literature and previously conducted research by the author indicate that variation is often neglected, and its critical role in statistical reasoning is under-recognised. A non-traditional approach to statistics instruction that has variation as its central tenet, and perceives learning as a dynamic process subject to development for a long period of time and through a variety of contexts and tools, is laid out in this thesis. The experience and insights gained from adopting such an approach in a college level, introductory statistics classroom are reported.

The prevailing methodology employed by researchers examining concepts of data and chance of taking snapshots of students' thought processes by posing cognitive tasks to them in order to catalogue their misconceptions provides little guidance as to how one might systematically research conceptual change. The conjecture-driven research design (Confrey & Lachance, 1999) employed in this study, which sees research and practice as interwoven, and advocates curriculum construction based on an on-going process of development and feedback offered an alternative path. It allowed finding similarities and differences between students' informal intuitions and formal statistical reasoning, and working with students' intuitive notions to help them develop ways to map new and richer concepts onto the ones they already possessed.

The results of this study point to a number of critical junctures and obstacles to the conceptual evolution of variation and its role, including the following:

1. Understanding of histograms and other graphs;
2. Familiarity with abstract notation and with statistics language;
3. Development of a critical attitude towards new ideas and information;
4. Distinguishing between population distribution, distribution of a single sample, and sampling distribution; and
5. Understanding of the reason behind finding confidence intervals when producing an estimate of some parameter based on a sample.

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8. Internet resources

TIMSS (**T**hird **I**nternational **M**athematics and **S**cience **S**tudy) is the largest international study about student achievement: http://timss.bc.edu

The International Study Center at Boston College is dedicated to conducting comparative studies in educational achievement. Principally, it serves as the International Study Center for IEA's studies in mathematics, science, and reading – the Trends in Mathematics and Science Study (TIMSS) and the Progress in International Reading Literacy Study (PIRLS).

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9. Other Publications of Interest

Ainley, J., Nardi, E., & Pratt, D. (1999). Constructing meaning for formal notation in active graphing. In I. Schwank

(Ed.), *Proceedings of the European research in mathematics education conference* (Vol. 1., pp. 193-204). Osnabrueck, Germany: Forschungsinstitut fuer Mathematikdidaktik .Active Graphing has been proposed as a spreadsheet-based pedagogic approach to support young children's construction of meaning for graphs, particularly as a tool for interpreting experiments. This paper discusses aspects of a detailed study, illustrating how Active Graphing emerges as a facilitator of the children's passage from a vague realisation of relationships to the articulation of rules and finally the construction.

Ainley, J., Nardi, E. & Pratt, D. (2000). The construction of meanings for trend in active graphing. *Journal of Computers for Mathematical Learning,* 5 (2), 85-114. The development of increased and accessible computing power has been a major agent in the current emphasis placed upon the presentation of data in graphical form as a means of informing or persuading. However research in Science and Mathematics Education has shown that skills in the interpretation and production of graphs are relatively difficult for Secondary school pupils. Exploratory studies have suggested that the use of spreadsheets might have the potential to change fundamentally how children learn graphing skills. We describe research using a pedagogic strategy developed during this exploratory work, which we call Active Graphing, in which access to spreadsheets allows graphs to be used as analytic tools within practical experiments. Through a study of pairs of 8 and 9 year old pupils working on such tasks, we have been able to identify aspects of their interaction with the experiment itself, the data collected and the graphs, and so trace the emergence of meanings for trend.

Bingham, N. H. (2000). Studies in the history of probability and statistics XLVI. Measure into probability: from Lebesgue to Kolmogorov. *Biometrica,* 87(1), 145-156. Both probability and statistics had developed into major fields by the end of the nineteenth century, with a sizeable body of theory and extensive application, but both disciplines achieved their existing form only this century, by making use of modern ideas. This study traces this evolution, with particular reference to the role of measure theory, from its introduction in definitive form by Lebesgue in 1902 to its successful use in the axiomatisation of probability by Kolmogorov in 1933.

Bruinede B. W., Fischhoff, B., Millstein, S. G., & Halpern-Felsher, B..L. (2000). Verbal and numerical expressions of probability: "It's a fifty-fifty chance." *Organizational Behavior and Human Decision Processes*, 81(1), 115-131. When estimating risks, people may use "50" as an expression of the verbal phrase "fifty-fifty chance," without intending the associated number of 50%. The result is an excess of 50s in the response distribution. The present study examined factors determining the magnitude of such a "50 blip," using a large sample of 433 adolescents (5th, 7th, and 9th graders) and 144 adults.

Cahan, S. (2000). Statistical significance is not a "kosher certificate" for observed effects: A critical analysis of the two-step approach to the evaluation of empirical results. *Educational Researcher,* 29(1), 31-34. In order to prevent misleading conclusions based on spurious observed effects -- especially seductively large ones--Robinson and Levin (1997) suggested a two-step approach to the reporting and evaluation of empirical results. According to the two-step model, the evaluation of the magnitude and substantive significance of obtained effects should be conditional upon their statistical significance: Authors should first indicate whether the observed effect is statistically improbable, and only if it is should they then indicate how large or important it is. The purpose of this paper is (a) to show that even though the underlying intention--to prevent unwarranted evaluation of spurious observed effects -- is a laudable one, the two-step approach is inappropriate for this purpose, and (b) to reiterate the preferred approach, namely increased sample size and computation of confidence intervals.

Croucher, J. S. (2000). Using probability intervals to evaluate long-term gambling success. *Teaching Statistics*, 22(2), 42-44. Simple probability calculations show some of the dangers of gambling. The technique outlined in this paper can be applied to any game where a discrete probability distribution for the rewards can be constructed. This includes many of the popular casino games such as Keno, Roulette and Craps. It is an interesting student exercise to find both the mean and the standard deviation of the rewards for playing and serves to demonstrate that the longer you gamble the chance that you will wind up ahead is just about zero.

Flusser, P., & Francia, G. A. (2000). Derivation and visualization of the binomial theorem*. International Journal of Computers for Mathematical Learning*, 5 (1). The binomial theorem presents us with the opportunity to weave many different mathematical strands into one lesson. It has a fascinating history – the study of which leads to a better understanding of how mathematics evolved. In this paper, we have involved computer graphics, geometry, algebra and combinatorics in the derivation of the binomial theorem. The study of functions with finite domains and ranges helps students understand some of the more subtle

properties of functions which have the set of real numbers for their domain and range. These are the functions which they study to the exclusion of all others in high school and in their first two years in college. We believe that the lesson presented in this paper encourages students to express mathematical ideas in the vernacular, one of the major standards recommended by the National Council of Teachers of Mathematics.

Hald, A. (2000). Studies in the history of probability and statistics XLVII. Pizzetti's contributions to the statistical analysis of normally distributed observations, 1891. *Biometrika,* 87(1), 213-217. Pizzetti's work is considered as bridging the gap between Helmert and Fisher. By means of an orthonormal transformation Pizzetti decomposed the total sum of squares in the linear normal model into its constituent and independent parts, thus providing the theoretical basis for the analysis of variance in the fixed effects model. He calculated a table of the [khgr]^2 distribution, which he used for finding probability limits for *s*/[sgr]. He derived the estimates of the components of variance in the random effects model for the one-way classification.

Mittag, K. C., & Thompson, B. (2000). National survey of AERA members' perception of statistical significance tests and other statistical issues. *Educational Researcher*, 29(4), 14-20. Almost as soon as statistical significance tests were popularised near the turn of this century, critics emerged. Of course, statistical tests also have support from some, though even most advocates concur that the tests are sometimes misused or misunderstood. A balanced and comprehensive treatment of the controversies is provided by Harlow, Mulaik, and Steiger (1997). However the fact that statistical experts and investigators publishing in the best journals cannot consistently interpret the results of these analyses is extremely disturbing. Seventy-two years of education have resulted in minuscule, if any, progress toward correcting this situation. It is difficult to estimate the handicap that widespread, incorrect, and intractable use of a primary data analytic method has on a scientific discipline, but the deleterious effects are doubtless substantial. Indeed, several empirical studies have shown that many researchers do not fully understand the statistical tests that they employ. The present report was written to address two objectives. First, we wanted to explore current perceptions of AERA members regarding statistical significance tests and other statistical issues, about which there has also been some controversy. Second, we also wanted our report to serve as a vehicle promoting further discussion of controversial statistical issues. Although we have arrived at reasoned positions regarding the merits of some research practices, reasonable people disagree over such issues. We hope our presentation will provide a framework prompting further discussion.

Dugdale, S. (1999). Establishing computers as an optional problem solving tool in a nontechnological mathematics context. *International Journal of Computers for Mathematical Learning*, *4(2/3),* 51-167 Learners' choices of problem solving tools and techniques are influenced by the context in which a problem is encountered, and methods utilised in one context may not be recognised as natural ways to proceed in other contexts. In professional development institutes for teachers of grades K through 12, participants readily applied computer investigation and solution methods to situations that arose in the context of a technology-intensive mathematics class. However, the methods used in that class were slower to find their way into the repertoire of tools participants applied in more general problem solving contexts. This paper explores the process of fostering learner-initiated applications of technology to address a wide range of problems outside of the technology-intensive environment.

Pratt, D. (2000). Making sense of the total of two dice. *Journal for Research in Mathematics Education*, 31(5), 602-625. Many studies have shown that the strategies used in making judgements of chance are subject to systematic bias. Concerning chance and randomness, little is known about the relationship between the external structuring resources, made available for example in a pedagogic environment, and the construction of new internal resources. In this study I used a novel approach in which young children articulated their meanings for *chance* through their attempts to "mend" possibly broken computer-based stochastic gadgets. I describe the interplay between informal intuitions and computer-based resources as the children constructed new internal resources for making sense of the total of 2 spinners and 2 dice.

Preston, S. (2000). Teaching prediction intervals, *Journal of Statistics Educatio*n, 8(3). Teaching prediction intervals to introductory audiences presents unique opportunities. In this article I present a strategy for involving students in the development of a nonparametric prediction interval. Properties of the resulting procedure, as well as related concepts and similar procedures that appear throughout statistics, may be illustrated and investigated within the concrete context of the data. I suggest a generalisation of the usual normal theory prediction interval. This generalisation, in tandem with the nonparametric method, results in an approach to prediction that may be systematically deployed throughout a course in introductory

statistics.

Schwartz, J. L. (1999). Can technology help us make the mathematics curriculum intellectually stimulating and socially responsible? *International Journal of Computers for Mathematical Learning*, *4(2/3).* In order to answer the question posed in the title of this paper, we must take a wide perspective and explore the goal societies have for maintaining educational systems, how curriculum contributes to the attainment of these goals, how mathematics in the curriculum contributes to effectiveness in attaining these goals and finally some of the ways in which appropriately crafted technology can help to make mathematics a more effective part of the curriculum.

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10. Complementary Short References

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11. Information on Past Conferences

11.1. 9TH DIDACTIC CONFERENCE ON MODERN METHODOLOGY OF TEACHING QUANTITATIVE METHODS, *Poland, 5-6 June 2000*

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The 9th annual didactic conference on *Modern Methodology of Teaching Quantitative Methods* was held in £ódŸ (by the Institute of Econometrics and Statistics, University of £ódŸ), 5-6 June 2000, and dedicated to *Professor Wladys³aw Welfe* to celebrate his fifty years of scientific and didactic activity. Representatives of the Polish academic centres, among others, from Czestochowa, Katowice, Kraków, £ódŸ, Poznañ, Rzeszów, Szczecin, Warszawa and Wroc³aw took part in the conference, as well as those of non-public universities.

The following papers, were presented at the conference.

M. Kolupa: "*What should determine the content of the econometrics course",* pays special attention to the importance of profound mathematical education for constructive work in the field of econometrics. He states that the explanation of mathematical principles in econometrics theorems is as important in lectures as the interpretation of the obtained results. He also observes the necessity to maintain the correlation among all disciplines taught at economic universities.

M. WoŸniak, K. Zaj¹c and A. Zeliaœ in their paper "*Teaching statistics based on example*" underlines the importance of looking for coherence between the Arts and branches representing all quantitative subjects. It requires the application of relevant methods into teaching the latter and, first of all, good examples, also

in didactic aids. Appropriately prepared lectures or manuals should, apart from classes, indicate the usefulness of quantitative methods in exploring different phenomena of our life.

W. Wagner in his paper "*Proposal of objective teaching of selected methods of representative statistics*" suggests the way of teaching one of the subjects involving statistical inference. The author pays special attention to the symbolic representation of relation to the and signs, called symbolism of objects. Its application should greatly simplify the "notation" of formulae in quantitative subjects used at lectures.

£. Tomaszewicz in her paper "*Quantitative subjects in minimum programs for BA studies*" presents the analysis of programs for BA and complementary MA economic studies stressing the importance of cohesion between these two as well as correlation of examples of quantitative methods with the theme of course subjects for particular economic studies.

H. Klepacz in her paper: *"Classes on mathematics for economics BA studies*" characterises students admitted to economic colleges (BA studies) at the University of £ódŸ and points out some problems with running classes on mathematics resulting from different level of mathematical background presented by them.

I. Nykowski in his paper "*Elements of decision optimisation for economic colleges (BA studies)*"underlines the importance of introducing a lecture on elements of decision optimisation in the form of separate subjects into economic BA studies.

J. Wiêcek characterises the programs and methods of teaching quantitative subjects at University of Trade in Zgierz (Wy¿sza Szko³a Kupiecka).

E. ¯ó³towska presents some programs of quantitative methods and their implementation at Academy of Management in £ódŸ (Wy¿sza Spo³eczna Szko³a Przedsiêbiorczoœci i Zarz¹dzania).

J. Skrzypek in his paper: "*The idea of virtual laboratory "Kombiz 2k"*" introduces his own method of enriching the process of teaching various academic courses – the virtual laboratory "*Kombiz 2k*". The author presents the principles of team-work in the laboratory, its model structure, advantages for students and academic teachers, as well as conditions for its setting. He describes such a laboratory in great detail.

M. Plich in his paper: *"the use of computers in teaching econometrics. program G – Version for Windows*" stresses the advantages resulting from the widespread use of .personal computers in making teaching quantitative subjects more interesting and shortening the time of solving numerical problems. One of the programs used for econometric calculations is discussed. The author proves its great educational value as well as its importance for research work, he also reports its practical application into the teaching process.

M. Melaniuk in his paper *"Methodology of obtaining decision information. didactic aspect."* deals with the problem of teaching rational decision taking, but particularly the methodology of obtaining information. Due to the determination of decision and information needs, and the confrontation of these two factors, it is possible to get a map of information flows and decision centres of a given organisation.

E. Nowak in his presentation *"Quantitative methods in the syllabus of management accountancy"* very clearly introduces the possibility of application of various quantitative methods into management accountancy problems. The author stresses the need to enrich the accountancy programs by taking advantage of students knowledge acquired at quantitative methods courses which is vital, first of all due to the fact that accountancy aims at analysis of information system of business entities.

M. Król and M. Sobolewski in their paper: *"Quantitative changes in teaching quantitative subjects at the management and marketing department of technical University in Rzeszów*" present their experiences concerning the syllabus and methods of teaching some quantitative subjects. The authors point out the ongoing changes, possibilities of their implementation and the observed results. They give some findings of the poll conducted among the course graduates concerning number of hours, interest in statistics and advantages of the course.

M. KaŸmierska-Zatoñ and W. Zatoñ in the paper *"A few remarks and ideas on teaching econometrics for non-econometric studies"* introduce some ideas aiming at enhancing the popularity of econometric methods among students. They point out the necessity to correlate classes on this particular subject with the syllabus of the curricular subjects, to enlarge the practical material at the expense of theoretical matters and intensive application of urgent need for the preparation of a textbook on econometrics for non-econometric studies.

11.2. PME Discussion Group for Stochastics Teaching and Learning, Hiroshima, July, 2000

John and Kath TRURAN

Numbers at this years Discussion Group meetings were smaller than in previous years: only 12 participants, but we had several new members, and good discussions on our theme - *The Relationship between Stochastical and Mathematical Thinking, Learning and Teaching*. The following summary was prepared by Jenni WAY and James NICHOLSON. John TRURAN made a general introduction to the Discussion Group, its aims, activities and association with other groups.

Short Presentation by Mario Barra: *The Relationship between Probability and Geometry: a Didactic Use.* Mario looked at connections between probability, which is very abstract for many students, and geometry, which is practical and concrete and allows students to visualise relationships. He gave a number of very interesting examples of such situations. *Key Points from the Discussion were:*

- Some of the examples given related to 'equally likely' events, so a 'next step' would perhaps be to examine other types of events.
- The linking of probability to geometry is more than the use of 'metaphor' (a topic of general conversation at PME meetings) because the linking does not just provide a meaning, but in making the connection, provides a way to think.
- A difficulty in the learning and teaching of probability is that it is mostly disconnected from other fields of maths.

Short presentation by Jenni WAY and Paul Ayres: *The Relationship between Pattern and Randomness.* A series of studies into various aspects of the probabilistic thinking of Australian primary and secondary students, has revealed a range of decision-making strategies. One particular outcome of note is the insistence of many children to look for patterns in a series of random outcomes. This is perhaps because current teaching of mathematics emphasises the patterns within mathematics. This highlights the conflict between some aspects of probabilistic thinking and other types of mathematical thinking. *Key Points from the Discussion were:*

- Other strategies that have been identified by other researchers in tasks that involve the listing of outcomes include choosing sequences that appear to be representative of the sample space, that don't appear too random nor too ordered.
- The nature of independence is multi-faceted and children's perceptions of different aspects are hard to distinguish and categorise.
- Children's strategies are not always internally consistent when provided with a range of scenarios, and this poses problems for researchers trying to map out this area.
- The fact that children's intuitions do not seem to develop in this area between ages 11 and 14 is used by curriculum managers as an argument that children are not ready to study such material, where it could be argued that instruction and exploration of the underlying concepts would help provide a frame of reference for the students to use when approaching such situations.

Short presentation by James NICHOLSON: *Perspectives from Students and Teachers on the Differences in Thinking in Mathematics and Statistics* (Co-author Gerry Mulhern). The presentation elaborated on the following key point: In school mathematics, outcomes are almost always unique, though there may be multiple approaches possible which arrive at the same 'solution'. In statistics, students have to do some things which are 'purely mathematical' in the above sense, but there are also situations where the answer in a particular case requires judgement to be exercised, and therefore it is possible to have different answers, each of which has some merit. *Key Points from the Discussion:*

- A lot of Statistics courses are taught by mathematicians, therefore the calculations are done well, but not the interpretation. There is a need to start early with the expectation of simple interpretation to provide the basis for more complex interpretations. This links with the concern that there is not enough statistics included in teacher education.
- It is not generally accepted in mathematics that 'answers' are given in words, as is needed in interpreting statistics. This gives added difficulty for students whose native language is different to the language of instruction.

- There is learning value in exploring the relationship between theoretical probability with probability experiments, as one can support the understanding of the other.
- Data sets that support several different arguments and conclusions should be used with students
- A 'consultancy' approach (i.e. students take on a real task for an external agency) can be very useful for emphasising the skills needed in communicating conclusions drawn from statistical analysis to 'non-statistics' people.
- Cultural differences (e.g. superstitions) need to be considered when dealing with uncertain events.

11.3. Working Group on Statistics, Probability and Combinatorics at the SEIEM

Antonio ESTEPA, <aestepa@ujaen.es>

The Spanish Society for Research in Mathematics Education met at the University of Huelva in September, 2000. The following papers were presented in the stochastics working group:

Luis SERRANO (lserrano@goliat.ugr.es) and Juan Jesús Ortiz (jortiz@desierto.ugr.es), University of Granada, Spain. *Reasoning strategies and solving stochastic problems. A proposal of educational intervention.* In this project, which is included in our research line on the teaching of probability and statistics we propose a didactical action at two different educational levels; 11 year-old primary school students and 14 year-old secondary school students. We gave these students a pretest to get some data on the students' conceptions in random situations and their probabilistic reasoning. On the base of these data a didactical proposal was applied and later its adequacy for the students was assessed.

María Candelaria ESPINEL (mespinel@ull.es, Universidad de La Laguna*, A proposal for the teaching and learning of Combinatorics at secondary school level.* We are designing curricular materials to introduce discrete mathematics (graphs, arrays, game theory) at school levels. Here, we present a proposal to study Combinatorics from its applications, starting from the idea of power index in co-operative games. Weighted voting systems and related terms such as player, weight, quote, dictator, coalition, are a good vehicle to show and improve the perception of mathematics in society.

Celi Aparecida ESPASANDIN (celilopes@terra.es), Faculdade de Educação – UNICAMP - Brasil*. Probability and Statistics in Pre-School levels. A study on the teachers' training an practice.* Our project is intended to answer the question of what changes might provoke a reflective process on the teaching of statistics and probability in the teacher's training and practice. To answer this question we are developing a qualitative research, and defining the analysis categories, in a reflective process on the empirical data, which include interview, video- recording and written reports of participant teachers.

Liliana Mabel TAUBER (liliana@cica.es), Universidad Nacional del Litoral. Santa Fe. Argentina*. Building the meaning of normal distribution from data analysis activities.* Our research analyse the students' understanding of normal distribution in an introductory data analysis course at University level. We report here previous research on this theme, the main goals of our research, the stages of the same, instruments used to collect data and techniques of data analysis.

Rafael Roa Guzmán (rroa@platon.ugr.es), Universidad de Granada. *An empirical study of combinatorial reasoning in University students.* We analyse the difficulty of simple and compound combinatorial problems for students in the 4th and 5th year of University, who are majoring in Mathematics. We study the effect of implicit combinatorial model, combinatorial operation and size of solution on the problem difficulty and compare our results with research carried out with secondary school students.

11.4. XXVII Jornadas Nacionales de Estadistica, Valdivia, Chile, 9-11 Octubre 2000

Pilar Loreto Iglesias Zuazola, Departamento de Estadistica, Facultad de Matematicas, Universidad Catolica de Chile, <pliz@mat.puc.cl> and Irma MOLINA, *Universidad Austral,* <imolina@uach.cl>

The Chile Statistical Society (SOCHE) in collaboration with The Institute of Statistics at the Faculty of Economics and Administrative Sciences, Universidad Austral, Chile organised the 27th National Statistics Conference, which was held in Valdivia, October, 9-11. The activities, aimed to exchanging knowledge and experience were mainly oriented towards the role of Statistics in Science, Education, Business and Economy.

At the Opening session, the Dean of the Faculty of Economics and Administrative Sciences (Eng. Edmundo Borel), and the President of the Chile Statistical Society (Dr. Pilar Iglesias) welcomed the participants. Dr. Carmen BATANERO *IASE* President-Elect emphasised in her plenary lecture the role of national and international associations -in particular *IASE*- in improving statistics education, to thus benefit research, science and technique and offer promising perspectives to future generations.

Three short courses were offered to participants:

- Teaching statistics and probability at secondary school level (Dr. Carmen BATANERO, University of Granada, Spain
- Reliability methods in the analysis of product life-time data (Dr. Luis Escobar, Lousiana State University, USA)
- Statistical methods forest monitoring and research (Dr. Sylvia Mori, Forest Service, California, USA)

Plenary lectures by were given by experts in the following different fields:

- Education: Interactive Statistics by Dr. Martha ALIAGA (University of Michigan, USA),
- Science: An application of generalised estimating equations in the analysis of longitudinal data by Dr. Antonio Sanhueza (Universidad de la Frontera, Chile) and Bayesian model for spatial data by Dr Renato Assunçao, Universidad de Minas Gerais, Brazil,
- Economy and Business: New methodological and technological frontiers of official statistics by Eng, Maximo Aguilera, Director of National Statistical Institute, Chile)
- Statistical theory "Distance Tests Under Non regular Conditions: Applications to the Comparative Calibration Model" Dr. Heleno Bolfarine (Universidad de Sao Paulo, Brazil),
- International activities: Aims and activities of the Inter American Statistical Institute by Dr Evelio Fabbrioni (Technical secretary of the IASI)

There was a practical presentation of new developments in the package Statgraphics by Rigg Technology and around 52 short papers and 6 posters were presented, 3 of them dealing with statistical education. There were 188 attendees to the conference, including members of SOCHE, university lecturers, professional of forest services and the national statistical institute. Students majoring in statistics, statistical engineering, and doctoral students in statistics contribute with their presence (about 50% of the attendees) to a more lively and enjoyable meeting.

A Round Table co-ordinated by Victor Figueroa (Director of the Instituto de Estadistica, Universidad Austral, Chile, with participation of Martha ALIAGA, Carmen BATANERO, Luis Escobar, Evelio Fabbrioni, Pilar Iglesias and Sylvia Mori debated the main challenges for Statistics in Science, Education, Business and Economy. There was agreed that time is ripe for statisticians to take the leadership in changing the statistical activity, which should follow technological advances. Otherwise, other professionals would mark the future direction of statistics developments, methods, tools and applications from their own specific fields. A compromise was stated to continue the exchange of experiences and thus to collaborate in the advancement of statistics from the current situation, as in maintaining an open communication and increasing collective work efficiency is fostered.

The conference was sponsored by the *IASE*, *IASE*, INE, Forest Service, RIGG, Banco de Chile, Universidad Austral de Chile, Chile Statistical Society and received a wide diffusion through regional television and newspapers. The SOCHE is very grateful to all these institutions and to the following people who spent a lot of

time and effort to prepare the meeting and contribute with their warm welcome to make participants enjoy the conference.

- Scientific Committee: Héctor Allende, Universidad Técnica Federico Santa María; Luis Cid, Universidad de Concepción; Gloria Icaza, Universidad de Talca, Pilar Iglesias, Pontificia Universidad Católica de Chile, Juan Moncada, Universidad Católica de Temuco, Sergio Muñoz, Universidad de La Frontera, Eliana Scheihing, Universidad Austral de Chile, Claudio Silva, Universidad de Santiago de Chile and Héctor Varela, Universidad de Antofagasta;
- Local organising committee: Irma MOLINA, Victor Figueroa, Andrea Báez, Juan Moncada y Osvaldo Rojas; Universidad Austral;
- Introduction to research: Ricardo Aravena, P. Universidad Católica de Chile and Manuel Galea, Universidad de Valparaíso.

11.5. Association of Statistics Lecturers in Universities Annual Conference: Statistical Education at the Beginning of the Millennium (20 September, 2000)

Report by Erica MORRIS

In September, I attended the Association of Statistics Lecturers in Universities Annual Conference, which was held in conjunction with the *Royal Statistical Society Education Section*, and was entitled *Statistical Education at the Beginning of the Millennium*. This interesting one-day conference involved a variety of presentations relating to areas in statistics education. These talks raised a range of concerns, such as the use of ICT in the teaching of statistics, assessment in undergraduate statistics teaching and factors that might influence the effective transfer of statistical training from the university to the workplace. For example, Peter Holmes's (Nottingham Trent University) talk looked at current issues in undergraduate statistics teaching, and emphasised the need to use innovative methods of assessment in teaching which should be tied to teaching strategies that encourage a deep approach to learning. Along this line of thinking, assessment methods should be both formative and summative, and include student projects, presentations and portfolios of work. This talk also raised issues relating to challenges in undergraduate teaching which have arisen from an increase in student numbers and the diverse mathematical backgrounds of students who need to study statistics. Here, student motivation was also considered: Many students now take statistics as a component part of another degree, which can mean that they really want to be studying management or business or psychology and therefore lack the incentive to study the statistics component of their major degree course.

Interestingly, Professor Deborah Ashby (Queen Mary and Westfield College) presented work on developments in evidence-based medicine and provided an overview of The Cochrane collaborative, and looked at how parts of the Cochrane Library could be used as a resource in the teaching of statistics. The Cochrane Collaborative is an international organisation that prepares, maintains and promotes the accessibility of systematic reviews of the effects of healthcare interventions, and thus aims to help people make informed decision about healthcare (http://www.cochrane.org/). The main output of this collaboration is the Cochrane Library that provides several different databases, such as The Cochrane Review Methodology Database which contains references to articles and books on the science of reviewing research.

Flavia JOLLIFFE (University of Greenwich) provided an interesting report on the *IASE* (International Association for Statistical Education) Round Table (August, 2000) which focused on *Training Researchers in the Use of Statistics*. The Association of Statistics Lecturers in Universities recent conference therefore provided a valuable opportunity for those involved with the teaching of statistics in higher education to attend to and discuss pertinent issues in statistical education.

11.6. International Statistical Education Centre Jubilee Celebrations, October 2000

Professor Manoranjan Pal, ISEC, Calcutta

The *International Statistical Education Centre, Calcutta*, was founded in 1950 and is operated jointly by the International Statistical Institute and the Indian Statistical Institute, under the auspices of the *UNESCO* and the Government of India. The Centre provides training in theoretical and applied statistics at various levels to selected participants from countries in the Middle-East, South and South-East Asia, the Far East and from the Commonwealth countries in Africa.

The Centre offers a ten-month (June to March) regular course of training every year. The course is divided into two parts. The first eight months are devoted to training on general statistical methods including six-week training in official statistical systems conducted by the Central Statistical Organisation (CSO), Government of India, New Delhi. During the remaining two months, each trainee specialises in one selected branch of applied statistics, like large scale sample surveys, data processing, statistical quality control and operations research, vital statistics and demography. The course is offered through lectures, practical work and assignments, field visits and guided reading. In addition to the regular course, a few persons are admitted from time to time, on an individual basis, for special courses of varying duration (usually less than 6 months) and in different fields. Facilities are also available for research work and advanced study by senior visiting statisticians from abroad.

Some of the trainees at this Centre are financially supported by their respective national governments and a few are supported by their employers. The United Nations and its specialised agencies award fellowships to a few others. Majority of the candidates are supported by Fellowships awarded by the Government of India, mainly under the technical co-operation scheme of the Colombo Plan, the Special Commonwealth African Assistance Plan (SCAAP), Indian Technical and Economic Co-operation (ITEC), Aid to Sri Lanka and Aid to Maldives. In recent years, a number of fellowships have been awarded by the Commonwealth Fund for Technical Co-operation (CFTC), Commonwealth Secretariat, London.

The teachers of this Centre are mostly drawn from the various units of the Headquarters at Calcutta of the Indian Statistical Institute. Many statistical officers of the Goverment of India participate in the teaching of the six-week course in official statistics organised by the Department of Statistics, Government of India, New Delhi, for Regular Course trainees.

I. Delhi Conference. Theme "*Policy Issues in Demography, Health & Education, and Economics*" at India International Centre, New Delhi on Friday, 13 October 2000 and Saturday, 14 October 2000.

In the Inaugural session Brian PHILLIPS remarked that the *IASE* and the ISEC are closely linked by their histories. David VERE-JONES when speaking at ICOTS5 about the struggle to promote statistical education internationally, said how he was struck by the remarkable differences in the character of this struggle in different countries when working on the isi Education Committee, in the 1970's and 80's.

Brian spoke of the remarkable influence of Prasanta Chandra Mahalanobis (29 June 1893 - 28 June 1972) who possibly had the greatest influence on the progress of statistics, and statistics education, both in India and in the wider world. Mahalanobis founded the Indian Statistics Institute in Calcutta on 17th December, 1931, and it gained the status of an institution of national importance by an act of the Indian Parliament in 1959. VERE-JONES claimed that all statistical paths in India lead back to Mahalanobis. This point was also made by Ghosh et al in their 1999 IS Review paper. In their closing comments, they say the developments in Statistics in India which took place between, 1930 and 1960 were quite remarkable and unique. They felt the single most important reason was the appearance of the right man at the right place, Mahalanobis, who had almost by accident switched from physics to statistics, he recognised statistics as one of the key technologies of the time.

After independence he was invited by Nehru to become statistics advisor to cabinet and held many important posts during this critical period of India's history. The importance of statistical methods, especially sampling, became more recognised to societies and governments from the 1930's and during the war, then took off in the post war years, This was greatly helped by the work of Mahalanobis and a number of other great Indian statisticians.

Among Mahalanobis's lifetime of remarkable achievements was the importance he placed on education, the greatest example was his involvement of establishment of the International Statistical Education Centre.

When ISEC was established in Calcutta in 1950 we experienced what was probably the best example of international collaboration in statistics education ever. It combined the forces of The Indian Statistics Institute, the International Statistical Institute, UNESCO and the Indian Government. With the apparent change in focus of organisations such as UNESCO such cases of international collaboration in statistics education are now too rare. Mahalanobis' was not alone in the great advances made by Indians in the field of statistics. As pointed our by JK Ghosh et al they include CR Rao, RC Bose, SN Roy, SS Bose, KR Nair, D B Lahiri and many others.

During its 50 years of service the Institute has trained almost 1300 trainees from about 60 countries mostly Government officials engaged in statistical work in developing countries. The students have come mainly from Asia, Africa and the Far East, but also from as far afield as Fiji and Syria. The courses provide a wide variety of skills from general statistical methods to advanced training in statistical methodology. In particular it specialises in training in survey sampling, demography, data processing, economic planning. It also offers various short-term courses in statistics.

This work is even more important today with the need to provide accurate, up to date information to the society to feed the information explosion occurring around the world. It is now not only governments and large organisations that are looking to use such data for their planning purposes, as was usually the case in the past, but also by individuals who have ready access to it using technologies such as CD's and the internet. Furthermore, with statistical techniques being regularly under review and the technology available to carry out the analyses being constantly updated, the need for both initial and further training to keep abreast with the latest developments is more crucial than ever.

Brian suggested that the birth of the *IASE* was the end of a long process which began in 1949, and owes a lot to these events in India some 50 years ago. It was about this time that the Committee on Statistical Education within the *ISI* was founded which was also heavily influenced by Mahalanobis. His passion for helping to improve statistical education world wide was shown by the fact that he was Chair of the *ISI* Education Committee from 1954-1960, an even more remarkable achievement when we think of all the events at home had had to deal with. In closing he congratulated ISEC, its administration, teaching staff, students and all involved in its organisation for a wonderful achievement over the past 50 years and wish it all the best for its ventures in the future.

Statistics Education Papers

Brian PHILLIPS. *Aspects of statistical education: The IASE and new challenges*.

Peter HOLMES. *40 years of statistics in English schools: Some milestones*.

II. Calcutta Conference. Theme "*Contemporary Issues in Statistical Education*" at Indian Statistical Institute, Calcutta on Tuesday, 17 October 2000 and Wednesday, 18 October 2000.

Papers presented

Jean-Louis Bodin. *Contemporary training needs for official statisticians.*

David VERE-JONES. *Official statistics and the University statistics programme*.

Derek Bond and Moira Cullen. *Flexible education and training of official statisticians*.

R. Teekens. *Lifelong Training of official statisticians: a European perspective*.

B. PHILLIPS. *Teaching and learning statistics in the 2000's*

Peter HOLMES. *Matching university education, assessment and employment needs*.

Luigi Biggeri. *Main issues in disseminating statistical literacy and applied statistical educatio*n.

D.Berze. *Fifty years of cooperation between ISEC and the International Statistical Institute*.

A.B. Raha. *ISEC: The pioneer centre for statistical training of government sponsored statisticians from developing countries of the third world, mainly from the Commonwealth Africa, Asia and the far east*

Marcel Van den Broecke. *The future of statistical education.*

J. Roy. *Teaching of statistics at various levels.*

T.J. Rao. *Issues in statistical education with special reference to training in sample surveys*.

A.M. Goon. *On the writing of statistical reports*.

Shibdas Bandyopadhyay: *Data that require little more care*.

The summaries of the papers are available from the *IASE* Web page.

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12. Forthcoming Conferences

Seattle April 10-14, 2001 *What We Know and How We Know.* 82nd Annual Meeting of the American Educational Research Association

Everyone seems to have an opinion about what educational research should and shouldn't do, how it should and shouldn't be done, what counts as 'data' and what doesn't, what is and what is not 'scientific,' and what educational research does and does not say about key topics and issues. For the most part, these discussions, these opinions, these pronouncements are being conducted by non researchers and others outside of the arena of educational research. It is time to take back the ball, to weigh in on what we know best, to assume control again of this enterprise within which we work and live.

Within our different research traditions, we have built real bodies of knowledge that inform the educational issues of today. As last year's theme made clear, educational research is being conducted within a range of epistemological perspectives, using diverse methodologies, and addressing different questions. Furthermore, all of this work is viewed, within the different methodological sub communities that carry it out, as significant to policy and to practice. We do have something to say based on past research results. We need to say it.

Inevitably, as our epistemological presuppositions and methodologies differ, so do our standards for rigor, our perspectives on constructs such as validity and reliability, and the ways in which our results can be generalised and used. What counts as rigor, what counts as evidence, and what is viewed as valid depends on the research tradition and methodology being used. But it is not true that 'anything goes.' Within each tradition there is good, solid research that can be differentiated from poor research. We know this, though we may forget it when thinking of research traditions remote from our own; we suspect that others do not know it and that misinformation is being spread based on this lack of knowledge. Thus, it is time for us to make this clear, to remind ourselves as well as to inform others. We call for penetrating and weighty discussions around issues of research methodologies, rigor, standards -- within every research paradigm.

More information from http://www.aera.net/meeting/am2001/call01/index.htm

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Mathematical Literacy in the Digital Era. Research and Classroom Practice Towards a New Conception of Mathematics for all, 4-10 July 2001, International Commission For The Study And Improvement Of Mathematics Education

Our society that is more and more formatted by mathematics set up more and stronger demands for mathematical competencies. In the community of mathematics education there are conflicting debates about the consequences of the obvious fact that the mathematical knowledge and skills taught in schools are no longer compatible with those of the mathematised society. A big number of pupils and adults risk missing the opportunity for autonomously and competently acting in the digital era. The goal of CIEAEM 53 conference in Rhodes is to engaged all participants, the teachers as well as the researchers, in mutually "revisiting" their common references and their different practices with a perspective for the needed innovation to be undertaken for the years to come.

Themes:

1. The relationship between the research on mathematical literacy and the improvement of teaching and learning mathematics;
2. The transformation of the new competencies into curricula and learning materials, in the context of the new social demands;
3. The challenge of the research on the professional education of teachers and on the possible innovations of classroom practice on national and international levels;
4. The possibilities, limits and risks of the information and communication technologies in supporting mathematical literacy;
5. Mathematical literacy and differential education: the question of cultural diversity and social equity.

More information is available from F. Kalavassis, University of the Aegean, Department of Pre-school Education, Dimokratias 1, 85100 Rhodes, Greece, http://www.rhodes.aegean.gr/cieaem53, <cieaem53@rhodes.aegean.gr>.

25th PME conference, 12 - 17 July, 2001, Utrecht, The Netherlands

The PME conference will be held at Utrecht University, the Netherlands. The conference dates are 12-17 July 2001. Following the PME25 Conference, a Summer School will be organised by the Freudenthal Institute. The dates of the summer school are 18-20 July 2001.

Further information: http://www.fi.uu.nl/pme25 or contact Marja van den Heuvel-Panhuizen University of Utrecht, Freudenthal Institute Utrecht, The Netherlands. Email: <m.vandenheuvel@fi.uu.nl>

PME Stochastics working group

Our discussions will be *on the relationship between stochastical and mathematical thinking, learning, and teaching*. We consider that there is more on this theme which can usefully be discussed. It is our intention to approach this theme from multiple perspectives, including:

- Philosophical, in terms of the perceived boundaries of the disciplines.
- Historical, in terms of the developments of the disciplines.
- Educational, in terms of the positioning and implementation of the teaching and learning of stochastics within school and tertiary curricula, including such fundamental issues as teacher development, assessment, and technology.
- Psychological, in terms of the specific cognitive and socio cultural processes involved in the teaching and learning of stochastics.
- Research, in terms of cross-fertilisation of theoretical frameworks and methodologies.

All members who intend to be at PME25 are invited to make a short presentation (10 minutes) on some aspect of the theme. This would be followed by 20-30 minutes discussion. Please make submissions to Kath at <Kath.truran@unisa.edu.au>. It would be good if we could have advance notice before the next Newsletter at the end of November.

Group Coordinators

Antonio ESTEPA <aestepa@ujaen.es>
John TRURAN, <truranjk@camtech.net.au>
Kath TRURAN, <Kath.truran@unisa.edu.au>

PME STL DG Website: http://www.ujaen.es/huesped/stochastics/

The Fifth International Conference on Technology in Mathematics Teaching August 6 - 9, 2001, University of Klagenfurt, Austria

Working groups

- Visualisation and computer animation, Gert Kadunz, <gert.kadunz@uni-klu.ac.at>;
- Systems dynamics and systems thinking, Günther Ossimitz, <guenther.ossimitz@uni-klu.ac.at>;
- Continued professional development, Ed Laughbaum, <elaughba@math.ohio-state.edu>;
- Probability simulators and data analysis programmes, Manfred Borovcnik, <manfred.borovcnik@uni-klu.ac.at>;
- Dangers and limitations of the use of technology.

website http://www2.ifi.uni-klu.ac.at/ictmt5/

SRTL-2 The Second International Research Forum on Statistical Reasoning, Thinking, and Literacy, Armidale, Australia, August 15-20, 2001

The second in a series of International Research Forums, being offered under the umbrella of the Statistical Education Research Group of the International Association for Statistical Education, is to be held in Australia in August 2001. This Forum is sponsored by the Centre for Cognition Research in Learning and Teaching and the School of Curriculum Studies at the University of New England; the International Association for Statistical Education and the University of Minnesota. This gathering offers an opportunity for a small, interdisciplinary group of researchers from around the world to meet for a few days to share their work, discuss important issues, and initiate collaborative projects. The topic of the Forum will be Statistical Reasoning, Thinking and Literacy. One outcome of the Forum will be the publication of a book summarising the work presented, discussions conducted, and issues emerging from this gathering. Presentations at the SRTL-2 Forum should focus on:

- What does research on SRTL tell us about learning and teaching of statistics? What are the cognitive, socio-cognitive, or developmental aspects of learning SRTL in different age/grade levels?
- What theoretical frameworks and methodologies are appropriate for researching SRTL? What types of qualitative and quantitative research studies are needed to help us better understand these ways of processing information and to help promote them in educational settings? Particularly, how do we collect, use and analyse video material for research on SRTL?
- What are the implications of research into SRTL for learning goals, curriculum design, and assessment?

SRTL-2 Advisory Committee: Dani BEN-ZVI (Weizmann Institute of Science, Israel), Joan GARFIELD (University of Minnesota, USA) and Chris READING (University of New England, Australia) are co-chairs of this International Research Forum. They will be assisted by Janet Ainley (University of Warwick, UK), Iddo Gal (University of Haifa, Israel), John Pegg (Director of the CRiLT Centre, UNE, Australia), and Brian PHILLIPS (President of *IASE*, Swinburne University of Technology, Australia).

IASE Satellite Conference on Statistical Literacy

IASE Satellite Conference on Statistical Literacy
Seoul, Korea, 21-22 August, 2000
http://www.swin.edu.au/maths/*IASE*/statlit.html

This satellite conference on statistical literacy is jointly organised by the *IASE* and the Korean Statistical Society and will immediately precede the *ISI* session in Seoul. It will give the opportunity for people to enjoy presentations given by people who have a special interest in statistical literacy. There will be a number of invited speakers, as well as the opportunity for others to give contributed presentations. The presentations are planned to include discussions of the main components in statistical literacy and the relevance of statistical literacy in the general education of citizens.

The approach will be non-technical, suitable for a non-specialist audience who would like to learn how to make better use of probability and statistical ideas in their everyday and working lives in areas in which chance and risk is involved. This meeting is intended to be of interest to a wide cross section of society including teachers, educational administrators, researchers in statistical education and in probabilistic reasoning and others who want to gain a better grasp of statistics in general and who would like to broaden their knowledge of statistics applications. It should also be of interest to people wishing to understand more about risk in making investments and gambling, by those concerned with interpreting sociological, economical, political, scientific or educational reports, predicting sports results, by policy makers, journalists, health professionals and others from the general population.

Location: Convention and Exhibition Centre (COEX), Seoul, Korea

Program times:

- Tuesday August 21: 9.00 am - 5.30 pm, Conference Dinner: 7.30 pm
- Wednesday August 22: 9.00 am - 12.30 pm

Programme committee:

Brian PHILLIPS (Australia) (Chair), Professor Yong Goo Lee, (Korea) (Local organiser),

Tae Rim LEE (Korea), Carmen BATANERO (Spain), Larry WELDON (Canada)

More information: See web page: http://www.swin.edu.au/maths/*IASE*/statlit.html

Contacts:

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International Statistical Institute, 53rd Biennial Session Seoul, Korea, 22–29 August, 2001

It is a great pleasure for Korean statisticians to host the 53rd Session of the International Statistical Institute(*ISI*) which will be held in Seoul from 22 to 29 August 2001 under the auspices of the Korean Government and the National Statistical Office (NSO), the Korean Statistical Society and Korean Statistical Association.

The Session will provide a forum for the international exchange of knowledge among participants, and also aims to encourage the international integration of statistics by establishing world-wide relations between the statistical societies and other official and non-official organisations concerned. In addition to being a dynamic forum for scientific and academic exchanges in various fields of statistics, the Session will provide a rare opportunity for all participants to experience the unique Korean culture, history and lifestyle.

The National Organising Committee has the pleasure and honour to invite all members of *ISI* and its Sections as well as non-members to attend this 53rd Session. In preparation for this conference, arrangements for convenient and comfortable facilities are being made for all participants as well as for a wide variety of social events and cultural tours that will hopefully leave everyone with fond and lasting memories of their visit to Korea.

Again, we are confident that Korea is ready to welcome all visitors from around the world who wish to participate in this first *ISI* Session of the 21st century. **Information**: *ISI* Permanent Office, Prinses Beatrixlaan 428, P.O. Box 950, 2270 AZ Voorburg, The Netherlands. Tel.: +31–70–337–5737; Fax: +31–70–386–0025; E-mail: *ISI*@cbs.nl *or* visit the Session website at http://www.nso.go.kr/*ISI*2001

IASE Invited Paper Meetings, Seoul, Korea, August 2001

The *IASE* is very pleased to see that the increasing interest in our discipline has lead to an even larger number of statistical education sessions at the 53rd *ISI* session to be held in Seoul, Korea in August, 2001. There are seven sessions to be organised by the *IASE* alone, with another four being jointly organised with other sections. Lionel PEREIRA-MENDOZA is co-ordinating our section of the programme. Planning has started and anyone interested in more information should contact Lionel, email: lpereira@nie.edu.sg.

IASE Sessions

1. *Forum: IASE and statistics education in developing countries.* Organiser: Maria-Gabriella OTTAVIANI <ottavian@pow2.sta.uniroma1.it>.
2. *Undergraduate level statistics programmes.* Shen Shir MING <HRNTSSM@hkucc.hku.hk>.
3. *The Future of Statistics Education Research.* Joan GARFIELD <jbg@maroon.tc.umn.edu>.
4. *Research on teaching statistics at School and University levels.* Susan STARKINGS <starkisa@vax.sbu.ac.uk>.

5. *Undergraduate statistics education in non-statistics degree programmes.* Elisabeth SVENSSON <eliss@math.chalmers.se>.
6. *Continuing Statistics Education in the Workplace.* Carol BLUMBERG <wncarolj@vax2.winona.msus.edu>.
7. *Postgraduate training of statisticians.* Gilberte SCHUYTEN <Gilberte.schuyten@rug.ac.be>.

Proposed Joint *IASE* Sessions

1. *Women's Contributions to Leadership in Statistical Education*, Joint with CWS. Martha Bilotti-ALIAGA <aliaga@umich.edu>.
2. *The role of official statistics in the university curriculum*, Joint with IAOS. Organiser: Reiner Staeglin, Germany <rstaeglin@diw.de>.
3. *Education and the Internet: Effective Structures*, Joint with IAOS Brian PHILLIPS <bphillips@swin.edu.au>

EARCOME 2002 - SEACME 9, June 2002

The second ICMI-EARCOME (East Asia Regional Conference on Mathematics Education) is to be held in Singapore in June 2002. This conference, also designated as the Ninth Southeast Asian Conference on Mathematics Education or SEACME 9, has been officially recognised as an ICMI Regional Conference. It will be hosted by the National Institute of Education, Nanyang Technological University, Singapore and the Association of Mathematics Educators, Singapore. Information can be obtained from EARCOME 2002, Division of Mathematics, National Institute of Education,469 Bukit Timah Road,Singapore 259756, Republic of Singapore <earcome2@nie.edu.sg>.

The Sixth International Conference on Teaching Statistics

Durban, South Africa,7 - 12 July 2002

IPC Website: http://www.beeri.org.il/icots6

LOC Website: http://icots.itikzn.co.za/

ICOTS 6

2000 has been a very important year for ICOTS-6: The year of planning. The Topics and Convenors were already in place by November 1999, but since then the Topic Convenors have been selected for the Sessions and addressed their ideas with the ways they could actually implement them. The exact record of all the work already done is on the ICOTS-6 Website (http://www.beeri.org.il/icots6). At this point, proposed Session Organisers have been contacted by the Topic Convenors. From August 2000 the IPC Website comprises the full programme: the Topics and their Sessions, with the Topic Convenor's and Session Organiser's names and addresses. Also the keynotes speakers of the Conference will soon be decided. The preparation process is accelerating now. IPC members and Session Organisers are receiving expressions of interest of researchers from all around the world. The Website is being enriched by the abstracts of each Session. In the New Year period the IPC will approve the Invited Speaker's list and the Session Organisers will send them an official invitation letter. At that point, it will be the Invited Speaker's responsibility to prepare their most interesting, updated and exciting paper for ICOTS-6. The harmonious and dedicated work of the membership of the International Programme Committee, the Session Organisers and the Local Organising Committee is the best omen for the success of ICOTS-6 in South Africa.

IMPORTANT DEADLINES

Invited Papers

Expressions of interest for invited sessions should have been sent to the relevant Session Organiser, or the IPC Chair. Anyone still wishing to express interest please do so ASAP.

Invitations - Session Organisers will formally invite the speakers by Jan 31, 2001.

Abstracts - each invited speaker has to present a (provisional) title and an abstract (no more than 500 words) of his/her presentation to their Session Organiser by April 1, 2001.

Final manuscript - the authors of invited papers are to submit the final manuscript of their paper to their Session Organiser by December 1, 2001.

Contributed Papers

Expression of interest for contributed paper sessions are to be submitted to Susan Starkings (starkisa@sbu.ac.uk) by December 1, 2001. Papers not accepted for an invited speaker session will also be considered for these sessions.

Other Contributions

Abstracts of posters, software demonstration and other special sessions should be submitted to the IPC Executive by February 1, 2002. Details of the final submission arrangements of papers and other presentations will be announced later. The Committee is convinced that the ICOTS-6 academic and social program will provide a most rewarding experience. For more information please contact the Conference Chair or the IPC Scientific Secretary.

For further details please contact:

IPC Chair	**International Organiser**	**IPC Scientific Secretary**
Maria-Gabriella OTTAVIANI	Brian PHILLIPS	Dani BEN-ZVI
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