Introduction to: Research and development in the teaching and learning of probability – Topic Study Group 13 at ICME 11 Monterrey, México 2008

Manfred Borovcnik, University of Klagenfurt, Austria

This Topic Study Group at ICME 11 was organized by Manfred Borovcnik (Austria) and Dave Pratt (United Kingdom) with the assistance of Yingkang Wu (China) and Carmen Batanero (Spain).

Aims and focus of the topic study group

Probability and statistics education are relatively new disciplines. Both have only recently been introduced into main stream school curricula in many countries. While application-oriented statistics is undisputed in its relevance, discussion about probability is more ambivalent. When probability is reduced to its classical conception, mainly based on combinatorics or its formal treatment in higher mathematics, it can be seen as irrelevant, and may be abandoned to leave only the statistical element of the stochastics discipline. However, we believe that there are some powerful arguments in favour of a strong role for probability within stochastics curricula:

i. Sound probabilistic judgements support people's rational decision-making in important situations, such as medical tests, jury verdicts, investments, assessment, etc.
ii. Equally, reasoning about uncertainty is an important everyday skill. For example, the concepts of risk (not only in financial markets) and reliability impact on our everyday decision-making. Clearly, these concepts are closely related to and dependent upon probability.
iii. Probability is essential in understanding any inferential procedures in statistics.
iv. Probability offers a tool for modelling and "creating" reality. For example, modern physics cannot be formulated without reference to probability concepts.

Thus, the challenge is to teach probability through designing materials and tools that encourage understanding. The focus has to be on creating approaches to probability that are more accessible and motivating, utilising practical applications as appropriate. Pedagogy should embrace schools of thought such as the frequentist and subjective views of probability.

We see the emergence of approaches that promote the visualisation of abstract concepts. Simulation is one such strategy but there are many others. The use of technology also enables a change in emphasis from the technicalities of calculation to conceptual underpinning. At the same time, we recognise the fundamental importance that pedagogy addresses personal attitudes and intuitions in its approach.

With these challenges in mind, we have encouraged papers and presentations at ICME 11 that will help us to share the diversity of endeavours in research on understanding and teaching of randomness, chance and probability. May future teaching take advantage of this exchange, which we expect will initiate new research projects on the teaching and learning of probability.

The Call for Papers focussed on the following topics

Individuals' corner

- Ideas of probability in young children
- Students' understanding and misunderstanding of fundamental probabilistic concepts

Impact of technology

- The use of technology for students' learning of probability
- Using software (Fathom, probability explorer, etc.) to study probability and sampling distributions
- Special issues in e-learning

Teacher's corner

- Teacher education on the topic of probability
- Teachers' conceptions about teaching probability

Fundamental ideas

- The probabilistic idea of random variable – distribution – expectation
- The central limit theorem – convergence
- Bayes theorem and conditional probability – independence – exchangeability
- Probabilistic modelling – a probabilistic look at distributions

The final programme

The final programme covered three sessions on specific topics and a panel discussion on fundamental ideas.

Issues in Probability Teaching and Learning

Chance Encounters – 20 years later. Fundamental ideas in teaching probability at school level
Ramesh Kapadia

Teaching the Mathematics of Gambling to Reinforce Responsible Attitudes towards Gambling
Robert Peard

Concrete to Abstract in a Grade 5/6 Class
Seth Ireland & Jane Watson

Probability Calculus and Connections between Empirical and Theoretical Distributions through Computer Simulation
Santiago Inzunsa

The Role of Representations in the Understanding of Probabilities in Tertiary Education
Sofia Anastasiadou & Theodore Chadjipantelis

Informal Conceptions

Bridging Theory: Activities Designed to Support the Grounding of Outcome-Based Combinatorial Analysis in Event-Based Intuitive Judgment – A Case Study
Dor Abrahamson

Primary School Children's and College Students' Recency Effects in a Gaming Situation
Francesca Chiesi & Caterina Primi

Strengths and Limitations of Informal Conceptions in Introductory Probability Courses for Future Lower Secondary Teachers
Knut Ole Lysoe

Shaping the Experience of Young and Naïve Probabilists
Dave Pratt

Betting As a Pathway to the Law of Large Numbers – Self-Construction of Strategies for Initiating Conceptual Change
Susanne Prediger & Katrin Rolka

How Do Teachers Deal with the Heuristic of Representativeness?
Lucia Zapata Cardona

Conditional probability and Bayes' theorem

Students' Biases in Conditional Probability Reasoning
Carmen Díaz & Carmen Batanero

On Conditional Probability Problem Solving Research – Structures and Contexts
M. Pedro Huerta

Probability Teaching in Basic Education in Brazil: Assessment and Intervention
Veronica Y. Kataoka, e.a.

A Practical Approach to Probability in the Context of a Science Fair
Hugo M. Hernández Trevethan, e.a.

Hands-on Modelling with Wason Cards and Tinker Cubes: First Steps in Logical and Bayesian Reasoning in Fourth Grade
Laura Martignon & Stefan Krauss

A Parallel Discussion of Classical and Bayesian Ways as Introduction to Statistical Inference
Ödön Vancsó

Panel discussion: "Fundamental ideas in probability teaching at school level?"

As a starter for the panel discussion, the following questions and topics were put to the fore: More recent trends in school curricula have removed probability at early stages in favour of data analysis techniques. This brings with it a loss of possibilities to prepare a qualitative understanding of probability and related concepts, the possibility to confront children with guided situations with random ingredients where they could get more directed experience necessary to develop their own intuitive strategies for randomness. The panel discussion could focus on the following topics:

- Relative merits and the potential of probabilistic and data analysis approaches
- What are fundamental ideas in probability? Which are relevant for teaching?
- How to extend intuitive strategies of the young students?
- Approaches to probability (subjectivist, classical, frequentist)
- Learning environments to engage students actively in the learning

The discussants focussed on the following topics in their contributions:

Manfred Borovcnik: Some Fundamental Ideas in Probability

Ramesh Kapadia: Ten Statements on Probabilistic Behaviour

Jane Watson: Development of Probabilistic Intuitions and Interpretation of Risks

Yingkang Wu: Probability Teaching at School Level in China

Other activities linked to probability education at and around ICME

Research and development in the teaching and learning of statistics

Topic Study Group 14 at ICME-11

Joint ICMI/IASE Study

Statistics Education in School Mathematics: Challenges for Teaching and Teacher Education

ELEE: Latin American Statistics Education Meeting

This meeting was specifically directed to Latin American Statistics Educators

Further developments related to ICME

Report on the Topic Study group on probability
Manfred Borovcnik

The future of interactive, electronic publishing research
Manfred Borovcnik & Ramesh Kapadia

Special issue of the *International Electronic Journal of Mathematics Education* on
Research and Developments in Probability Education
Manfred Borovcnik & Ramesh Kapadia