Topic Study Group No. 14: Teaching Learning of Probability

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The Programme

We contend that to adequately function in society citizens need to overcome their deterministic thinking and accept the existence of fundamental chance in nature. At the same time, they need to acquire strategies and ways of reasoning that help them in making adequate decisions in everyday and professional situations where chance is present.

By including probability in the curricula at different educational levels and in the education of teachers, educational authorities in many countries have recognized a need for probability literacy. However, including a topic in the curriculum does not automatically assure its correct teaching and learning; the specific characteristics of probability, such as a multifaceted view of probability or the lack of reversibility of random experiments, not usually found in other domains, creates special challenges for teachers, students and citizens.

Research in (what is becoming known as) probability education attempts to respond to the above challenges—as shown by the many papers on this topic presented at conferences such as the European Mathematics Education Conference (CERME), the International Conference on Teaching Statistics (ICOTS), as well as

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in regional or national conferences such as the Latin-America Mathematics Education Conference (RELME)—is now well established.

The general aim of the Topic Study Group on Teaching and Learning of Probability at the 13th International Congress of Mathematics Education (ICME-13) was to encourage new research in the domain. As such, the organisers welcomed diverse papers, including theoretical analyses and empirical research, in probability education whilst using a variety of research methods. The main topics of the papers were the following:

- *The nature of chance and probability*. This includes different views in the practice of statistics, and in the curricula, as well as philosophical problems and people's personal views throughout history.
- *Statistical versus probabilistic knowledge and reasoning*. Beyond being a tool for inferential statistics, probability is an approach to structure our world and both statistics and probability can connect to mathematical modelling with complementary views. There are also new paradigms in probabilistic reasoning research, once dominated by, for example, intuitions and the heuristics and biases program.
- *Components of probability reasoning and literacy in everyday or professional settings*. This includes dealing with risk and decision-making, and educational programmes to develop the related competences.
- *Probability in school curricula*. Since probability is increasingly being included in world-wide curricula, beginning in primary school in many countries, it is important to reflect on the main ideas that students should acquire at different ages, informal probabilistic reasoning, appropriate teaching methods, suitable teaching situations and successful teaching experiences. Further, the use of technology in teaching and learning probability and analyses of educational resources are also appropriate.
- *Education of teachers*. The field needs suitable models describing the components of teachers' knowledge to teach probability, especially those that take into account the specific features of teaching and learning probability. Research dealing with assessing and developing teacher's knowledge is also expected and encouraged.

The presentations included, as found in other Topic Study Groups, invited papers, contributed papers, and posters. The following invited papers were presented in the Topic Study Group sessions schedule:

Session 1. Theoretical analyses. Chair: Carmen Batanero. Speakers: Manfred Borovcnik and Ramesh Kapadia (Reasoning with risk: a survival guide); Cynthia Langrall (The rise and fall of probability in the k–8 mathematics curriculum in the United States); Hollylynne S. Lee (A framework of probability concepts needed for teaching repeated sampling approaches to inference).

Session 2: Students' reasoning and strategies. Chair: Hollylynne Lee. Speakers: Joachim Engel (Between fear and greed: the six looses); Ernesto Sanchez. (Theoretical dogmatism and empirical commitment in the informal probabilistic reasoning of high school students); Egan J Chernoff (Comparing the relative

probabilities of events); Peter Bryant (Teaching 9 and 10 year old children about randomness).

Session 3a. Attitudes and education of teachers. Chair: Joachim Engel. Speakers: Caterina Primi (Statistics anxiety: a mediator in learning probability); Assumpta Estrada (Exploring teachers' attitudes towards probability and its teaching); Emilse Gómez Torres (Prospective teachers' solutions to a probability problem in a sampling context); Robert Adam Molnar (High school mathematics teachers' understanding of independent events); Susanne Podworny (Design of a course for learning probability via simulations with Tinkerplots).

Session 3b. Teaching of probability. Chair: Ernesto Sánchez. Speakers. Pedro Rubén Landín and Jesús Salinas (Probabilistic reasoning in high school students on sample space and probability of compound events); Judah Makonye (Learners' use of probability models in answering probability tasks in South Africa); Roberto Oliveira (The teaching of probability in context through reading and writing strategies at secondary education); Carmen Batanero (Characterizing the probability problems proposed in the entrance to university tests in Andalucia); Haneet Gandhi (Understanding children's conception of ramdomness through explorations with symmetrical polyhedrons).

Session 4. Complementary issues. Chair: Egan J. Chernoff. Speakers: Rolf Biehler (Professional development for teaching probability and inference statistics with digital tools at upper secondary level); Per Nilsson (Interactive experimentation in probability—opportunities, challenges and needs of research); Rink Hoekstra (Risk as an explanatory factor for researchers' inferential interpretations).

In addition to the above, there were also four sessions of contributed short oral communications. The following papers were presented:

Session 1. Teaching resources and experiences. Chair: Egan Chernoff. Speakers: Vincent Martin and Laurent Theis (The teaching of probability to students judged or not with difficulties in mathematics in elementary classes in Quebec); Signe Holm Knudtzon (Pitfalls and surprises in the teaching of probability); Monica Giuliano, Silvia Pérez and Martín García (Teaching probability and statistics with e-status).

Session 2. Teacher education. Co-chairs: Carmen Batanero and Ernesto Sánchez. Speakers: Pedro M. Huerta (Preparing teachers for teaching probability through problem solving); Katharina Böcherer-Linder, Andreas Eichler and Markus Vogel (The impact of visualization on understanding conditional probabilities); Isaias Miranda and Beatriz Rodríguez (Understanding professors' decisions to assess students' learning of probability); Augusta Osorio (Strengthening of elementary teachers in the use of probability in everyday life events); J. Humberto Cuevas and Greivin Ramírez (Performance in stochastic between secondary teachers and teaching students: comparative study in Costa Rica and México); Annarosa Serpe (Mathematization of uncertainty with the aid of computers: a model of activity in high school).

Session 3. *Teaching resources and experiences*. Chair: Joachim Engel. Speakers: Jorge Soto-Andrade and Daniela Diaz-Rojas (Random walks as learning sprouts in the didactics of probability); Blanca Ruiz (Random variable and its relationship with statistical variable: an educational perspective from a concept analysis); María

Nascimento, Eva Morais and Alexandre Martins (Representations in probability problems).

Session 4. Students' and children's reasoning and strategies Chair: Hollyllynne Lee. Speakers: Ana Serrado-Bayes (Enhancing reasoning on risk management through a decision-making process on a game of chance task); Santiago Inzunsa (Connecting theoretical probability and experimental probability in a modeling environment); He Shengqing and Gong Zikun (Children's learning progressions on probability and suggestions for curriculum improvement); Gong Zikun and He Shengqing (Study on developmental stages and important periods of probability cognition for children aged 6–14).

We were extremely pleased that a number of posters were presented in our Topic Study Group. In particular, we had: Kemal Akoglu (A framework to guide task development for overcoming cognitive issues in learning conditional probability); Roos Blankespoor, Marja van den Heuvel-Panhuizen, Michiel Veldhuis and Anika Dreher (A pilot study on teaching probability in primary school); Melisa Castillo (Achievements and difficulties in learning probability); Eva Morais, María Bascimento and J. Alexander Martins (Representations in probability problems: some examples).

We would be remiss not to mention that the work by the group team, which started about one year before the conference, resulted in the publication of a Topical Survey on Research on Teaching and Learning Probability (Batanero, Chernoff, Engel, Lee, & Sánchez, 2016). Lastly, given that the group sessions were extremely productive, a monograph, with expanded versions of the main papers presented, is being developed and we all look forward to its publication.

Reference

Batanero, C., Chernoff, E., Engel, J., Lee, H., & Sánchez, E. (2016). R*esearch on teaching and learning probability.* ICME-13. Topical Survey series. Springer.

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