THE INTERPLAY OF PROBABILITY AND STATISTICS IN TEACHING AND IN THE TRAINING OF THE TEACHERS

M. Gabriella Ottaviani
"Sapienza" University of Rome, Italy
mariagabriella.ottaviani@uniroma1.it

The Discussion Document of this ICMI/IASE Conference justifies the teaching of statistics at the school level as part of the mathematical curriculum because of the usefulness of statistics and probability for daily life, its instrumental role in other disciplines, the need for a basic stochastic knowledge in many professions, and the important role of statistics in developing critical reasoning.

All of these are positive, relevant points of view, but it is also interesting to remember "the efforts of mathematics educators and mathematicians to revitalize the mathematics curriculum" (Scheaffer, 2006, p. 312). These arguments are similar to those taken into account by Manfred Borovcnik (this panel) in his presentation where he enlightens how data handling answers at least two demands of modern mathematical curriculum: to come closer to a kind of mathematics for all and to fulfil the request for applications.

Even if we are aware that statistics and statistical reasoning are different from mathematics and mathematical reasoning and that this may create distance among mathematicians and statisticians, our difficult task is to find ways to present mathematics and statistical concepts and tools to the learners so that the two disciplines may evolve together in an harmonious way (North & Ottaviani, 2002). Statisticians know that number, algebra, geometry, and measurement are all necessary to organize and analyse data. It is fundamental that also mathematicians are aware of this. As Scheaffer says: "One of the benefits of teaching statistics and mathematics together is that statistics can enliven a class through real examples that promote and illustrate virtually any topic in school mathematics. Done well, this approach can increase interest in, and the learning of, both mathematics and statistics" (Scheaffer 2006, p. 313).

If it is clear that mathematics and statistics are different; in fact differences exist also among probability and statistics. As Jean Claude Girard (this panel) says: "If probabilities have always been seen as a part of mathematics, the same thing cannot be said, even nowadays, about statistics", and many statistics educators probably agree with him. However, following Efraim Fischbein's line of thought it is possible to bring the two disciplines closer. He says: "Probability and statistics belong to a line of thought which is essentially different from deterministic reasoning. The fundamental characteristic of the statistic-probabilistic approach is that it uses models adapted to manipulating uncertain data in a reasonable predictive manner" (Fischbein, 1990, p. 48). Fischbein continues explaining: "It is not enough to show random phenomena. To enrich the child's probabilistic experience, it is necessary to draw the distinction between what is random and what is chaos. Playing probability games helps to the extent that they permit the child to move towards ways of predicting in a random context" (Fischbein, 1990, p.55). It is in this sense that Manfred Borovcnik (this panel) seems to ask for a stronger role for probability within the stochastic curriculum, as, he writes, probability is "a tool to investigate and or structure reality" and it "is indispensable for understanding the methods of inferential statistics". In this context the "connection to inferential statistics cannot be understood without probability – even if a lot of mathematical considerations may be replaced by the simulation methods". But Jean Claude Girard (this panel) concludes his writing by putting in evidence that: "teaching probability by modelling and simulation is not so easy. (…) The link between statistics and probability is still to be clarified" and he admits that, "instead of opening up to other fields, simulation keeps mathematics inside themselves".

This same point was raised by Anne Hawkins at the ISI Round Table Conference in Budapest, 1988, when during the discussion of Fischbein's paper she said: "We like to train our teachers with working with real data, EDA, and so on forth. Then on the other hand, we have the discussion of probability, tossing dice, playing games. What we do not seem to know how to

 In C. Batanero, G. Burrill, C. Reading & A. Rossman (Eds.), *Joint ICMI/IASE Study: Teaching Statistics in School Mathematics. Challenges for Teaching and Teacher Education. Proceedings of the ICMI Study 18 and 2008 IASE Round Table Conference.*

do is to bridge the gap between these two aspects; to bring in the modelling aspect, which can link the dice and the probabilities to the real world, which generated our real data set" (question raised by Hawkins in Fischbein 1990, p. 55).

Maybe some replies to this come from the considerations of Delia North and Helen MacGillivray (this panel). These two authors observe that in relation to chance, critical key landmarks for teachers

> tend to be associated with use of language and comparisons of likeliness leading to the seeding concepts of modelling of, and with, probability through equally-likely situations. However, too much or too long a focus on the traditional and basic equally-likely scenarios of coins, dice and "balls in boxes", stultifies growth and, for students and teachers, eventually turns chance into a backwater of boredom and unreality. An advanced landmark that may be introduced in senior school and that combines chance and data, is the concept of chance of obtaining our observed data under assumptions – the concept that underpins statistical testing no matter what philosophy is followed.

At the end: "Through data, teachers can gradually and coherently develop understanding of essential foundations for probability models."

There is a recent volume, *Exploring Probability in Schools* (Jones, 2005), which, according to the Editor, presents a coherent body of research-based knowledge on probability teaching and learning. We hope that very soon there will be a volume on "Exploring statistics in schools" edited from the materials of this ICMI/IASE conference. Perhaps we need another one on "Exploring statistics & probability in school", as the risk could be that the two disciplines continue not to converge in school and, worse still, in our learners' minds.

REFERENCES

Fischbein, E. (1990). Training teachers for teaching statistics. In Hawkins, A. (Ed.), *Training teachers to teach statistics*, Proceedings of the International Statistical Institute, Round Table Conference, Budapest, 1988. Voorburg, The Netherlands: International Statistical Institute.

Jones, J. (Ed.) (2005). *Exploring probability in schools: Challenges for teaching and learning.* New York: Springer

North, D., & Ottaviani, M. G. (2002). Statistics at foundation school level in South Africa. The way forward. In B. Phillips (Ed.), *ICOTS 6 Papers for school teachers*, IASE, Voorburg. The Netherlands: International Statistical Institute.

Scheaffer, R. L. (2006). Statistics and mathematics: On making a happy marriage. In G. Burrill (Ed.), *NCTM 2006 Yearbook: Thinking and reasoning with data and chance*. Reston, VA: NTCM.