THEMATIC WORKING GROUP 5

STOCHASTIC THINKING

Theme:

PROBABILISTIC THINKING

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Since Piaget and Inhelder, a lot of works have shown how the idea of chance takes place in children's mind, and how children build a personal and naïve relationship with random situations. Fischbein, Kahneman, Shaughnessy, Lecoutre, Truran and others had studied misconceptions and biases.

However the questions that are predominant in the works of the 90' and in the papers of the recent years, focused on the stochastic thinking development. These works don't restrict themselves to study behaviour of children in random situations or how they understand probabilistic problems. These researches try to understand how children can go to a real and theoretical knowledge about probability, which is built through a stochastic thinking. These researches lead to some proposals for teachers and curriculum developers to adapt probability teaching to new aims, according to the stages of children's cognitive development and to new possibilities of tools for experimental teaching and learning.

The five papers, which contribute to our reflection, are written in this context and complement each other. They present typical didactical situations and provide extracts of children's interviews which enlighten the emergence of particular probabilistic knowledge.

Jenni Way (from Sydney, Australia, *The development of young children's notions of probability*) had studied the development of probabilistic notions on young children (from four to twelve years) in the framework of Piaget's theory of stages of cognitive development. Her work shows three stages and two transitional phases.

Jenni Way's works suggest the need to develop random situations with comparison problems in simple settings first, and then through various activities of doubling and halving, and to go progressively to a quantification of likelihood, using numerical and mathematical basic knowledge in situations of proportionality.

In this building process that I call "pré-probabilité", the concept of equiprobability based on the fairness idea plays a precursory role and allows the use of random games with familiar random generators as dice, spinners, coins, urns… according to Truran's observations. Thus, the concept of random fair games would be a forced way to a sense making quantification of likelihood.

That is the point of view of Maria Jesus Cañizares, Carmen Batanero, L. Seranno, and J.J. Ortiz (from Grenade, Spain, *Children's understanding of fair games*). They had worked with children from ten to fourteen. These authors suggest that children go beyond the primary apprehension of equal likelihood and of unfairness in games when the players have not the same probability to win.

Per Nilsson (from Vaxjö, Sweden, *Experimentation as a tool for discovering mathematical concepts of probability*), for seventh grade students, places children in competitive situations in which they have to overcome primary intuitions, especially equiprobability biases, in order to develop secondary intuitions. These intuitions come from learning and are linked to formal knowledge.

Risk perception is another way to reach basic probabilistic concepts. Jenny Pange (from Ioannina, Greece, *Literature survey and children's perception on risk*) and Mike Talbot (from Edinburgh, UK) have done a survey on risk that shows a large variety of approaches, depending on the researcher's status: psychologists, sociologists, economists, scientists or … probabilists

Dave Pratt (from Warwick, UK, *The emergence of probabilistic knowledge*) observes two such resources: the first is "the large number resource" which emerges out of the facility to generate many outcomes quickly in a computational environment, where children can perceive frequency fluctuations as well as its stabilisation with numerous trials.

The second resource, the "distribution resource", sets up a link between frequencies and the relative weights of the outcomes in a game which are shown by a working box. This second resource is a contextualized understanding of the link between frequencies and probabilities. This link is essential for a basic theoretical knowledge as the large numbers law.

With these five studies, we note the necessary increase from random situations with comparison problems in the settings, which include equiprobability somewhere, to a quantification of likelihood in situations of proportionality.

The concept of fairness games leads to some control of the probability in order to compare expectations in the case where equiprobability fails. The estimation of a probability to set a stake in competitive situations needs a real knowledge in a probabilistic point of view, which can go to a quantitative perception of risk.

The experimental environment in which the children can act on the parameters which structure the situations, promote a major place for computers in order to prepare the basic understanding of the probability historical duality, underlined in 1975 by Ian Hacking in his book: *The Emergence of Probability*.

From now, children can observe this duality through numerical experiences. This duality founds the essence of stochastic thinking and leads to the statistical applications. Then the children have to postulate that the stochastic aspect of common

reality can be interpreted in probabilistic terms, and that the theoretical probability is a good tool of decisions.

This presupposes that new researches on didactical situations without random games could be developed (for example, on geometrical random situations, or on statistical behaviour of populations…), by using computational simulations to study these situations. This supposes a real understanding of the difference between the stochastic part of reality phenomena and the probabilistic models more or less appropriate to control them. This leads to a strong learning of the modelling process.

Could this aim, focused on modelling as a tool for probabilistic thinking development, be assigned as one of the objectives for the secondary curricula?

List of contribution (related to this theme)

Introduction to Thematic Group 5