Reasoning about Probabilistic Phenomena: Lessons Learned and Applied in Software Design

1. TECHNOLOGY ADVANCES IN PROBABILITY TEACHING AND LEARNING

The 21st century is a complex, data-driven technological world. Public literacy and preparation for the workforce demand that students be able to make data-based decisions, risk analysis, inferences, and predictions. All of these statistical pursuits have probabilistic phenomena at their heart. By probabilistic phenomena we mean situations where data is produced via a random experiment repeatedly conducted on a population or space of possibilities. Probability and statistics is now a common curricular strand in K-12 school curricula and there is a rapid increase in students taking the Advanced Placement Statistics exam in high school (e.g., College Board, 2007; Franklin et al, 2005; National Council of Teachers of Mathematics [NCTM], 2000). With access to more advanced technologies, teachers are encouraged to use tools for graphical and numerical data analysis and use an empirical introduction to probability through computer simulations (Batanero, Henry, & Parzysz, 2005; Biehler, 1991; Ben-Zvi, 2000; College Board, 2006; NCTM, 2000; Parzysz, 2003). There is a growing body of literature on students' understanding of probability and statistics concepts (e.g., Jones, 2005; Jones, Langrall, & Mooney, 2007; Shaughnessy, 1992, 2003, 2007), and general agreement that research has been lacking sufficient study of how learners make connections between empirical data generated by repeated random experiments and a theoretical model of probability (e.g., Jones, 2005; Jones et al, 2007; Parzysz, 2003).

In describing the various ways technology tools can support students' learning in statistics and probability, Chance, Ben-Zvi, Garfield, and Medina (2007) promote the use of simulations as pedagogical tools. In particular, they emphasize the role of technology in allowing students to study random processes and to observe what happens when a process is repeated a large number of times. The pseudorandom number generators in technology tools use a function dependent on a defined distribution as the basis for its input to generate subsequent "random" outputs. Thus, in a technology environment, students can model probabilistic situations based on assumptions about a theoretical distribution, simulate an experiment to generate a large amount of data, and manipulate and represent the data in various ways that would be nearly impossible to do within the time constraints of school curriculum and instruction. In this regard, technology offers a rich medium for designing tools and studying students' reasoning about probabilistic phenomena.

As Biehler (1991) noted almost 20 years ago, "It would be valuable to have more experiences with software where students can design random devices on the screen" (p. 189). Since that time, many researchers have designed probability software based on different perspectives and with sometimes different goals for students' learning (e.g., *ProbSim,* Konold, 1992; *Chance World*, Jiang 1992; *Probability Inquiry Environment*, Vahey, 1998; *ChanceMaker*, Pratt, 1998; *Probability Explorer*, Drier, 2000a; *ProbLab,* Abrahamson &Wilensky, 2002; *Model Chance*, Konold & Kazak, 2008). Jones et al (2007), in their review of recent advances on the study of computer software in probability instruction, state: