LEARNING PROBABILITY CONCEPTS THROUGH GAMES

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Probability and statistics play a central role in decision-making processes in everyday life. They are also effective means of reinforcing mathematical methods. Therefore, teaching of probability and statistics is generally included in many k-12 school curricula, e.g., in Curriculum and Evaluation standards, NCTM, 1989; Curriculum for Middle and High School, Israel, 1993; A National Statement on Mathematics for Australian Schools, 1990; National Curriculum Mathematics, UK, 1990.

Mathematics of probability permits us to make predictions for random events and for cases lacking sufficient information. The concepts of probability and statistics may be developed through experiments in simple situations such as throwing a pair of dice or tossing a coin, as well as by solving real life problems (Lesh, R., Amit, M. and Schorr, R., 1997).

Concepts such as chance and independent and mutually exclusive events may be best acquired by children intuitively through games. For example, upon rolling dice, children collect real data, ask questions such as “What are the chances that...”, make predictions, and create their own rules for the games.

Below we describe research conducted in Israel, aimed at studying how children (and teachers) think, develop and use probability concepts to make decisions about fairness and chances to win.

The experiment was conducted with 62 students of two classes, 5th and 6th grade respectively, of public elementary schools in the southern region of Israel. The students had no previous formal education of probability, but had studied some in statistics, including data collection and calculating means. The two teachers, who volunteered to participate with their classes in our experiment, became co-partners in the research. The students were glad to hear that they were going to play games during the mathematics lesson and participated willingly. The students were asked to do the tasks in pairs, to document their solutions and try to convince the other pair who shared their desk of the soundness and validity of their solution. Then the class teacher led a discussion.

The sessions were documented by videotape, collection of the students’ products, and interviewing several students.

Two tasks, developed by Carolyn Maher of Rutgers University, were given to the students.

A GAME WITH ONE DIE FOR TWO PLAYERS

Directions

Assign a player's number (first or second) to the participant.

Toss one die.

If the die falls on the numbers 1, 1, 3, or 4, the first player scores one point (the second player scores 0 points).

If the die falls on the numbers 5 or 6, the second player scores one point (the first player scores 0 points)

The player who first gains 10 points is the winner.

A GAME WITH TWO DICE FOR TWO PLAYERS

Directions

Assign a player's number (first or second) to the participant.

Toss two dice.

If the sum of the two dice is 2, 3, 4, 10, 11, or 12, the first player scores one point (the second player scores 0 points).

If the sum of the dice is 5, 6, 7, 8, or 9, the second player scores one point (the first player scores 0 points)

The player who first gains 10 points is the winner.

After fulfilling each task, the student had to answer the following questions:

1. Is this game fair?
2. Do the results confirm your answer to question no. 1?
3. If you think the game is unfair, how will you change it so that it will be fair?

As the full discussion and analysis of the results will be presented in the session, here are some anecdotes.

1. The students started playing the games, collected data and documented the results. Some students debated - who will be the first to throw the dice, believing the first to throw has an advantage and better chances to win and that the player who

throws the dice may affect the result in his favor. Hence, some pairs decided to take turns for fairness.

2. Students who were familiar with the various possible results (from previous experience with Backgammon) made distinctions between “good results” (3,3 or 6,6) and “bad results” like (1,5 or 2,3) because of the benefit of double in Backgammon, not realizing that doubles have a smaller chance. Some mentioned that it is much harder to get a 6,6 result than a 3,3 result and therefore 6,6 in Backgammon gives you more benefits. They confused the chance to get a specific number on the dice and the value itself.
3. In cases in which the winner was the one with the lowest chances from a probability point of view, one of the teachers was worried that the result would spoil the whole theory of probability, not grasping the concept of probability. The students, on the other hand, understood the principle of uncertainty of prediction and accepted the results with no doubt.

Rules for fair games and sophisticated strategies to prove their justice were developed by students and will be presented in the session.

Notes

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