

How to Always Win!

Activity Summary:

Probability and chance are vital concepts not just within statistics, but in real life.

This activity will investigate what we mean by bias, how we can identify whether something such as a die is biased, and how we can use it to our advantage!



Activity Learning Outcomes:

- Understand what the word “biased” means
- Be able to identify a biased die
- Determine whether the bias is favourable

Suggested Resources:

- Ludo board with counters (the bigger the better!)
- Floor space to lay out the board
- At least 1 biased and 1 random die

How to run the activity:

- Show both dice to the participant(s) – let them feel and roll the dice and ask them to identify which is biased
- Let them decide which dice they wish to play Ludo with. Either a friend of the participant, or the organizer should play with the alternative die.
- Game rules:
 - Participants must roll a 6 to start the game. If a 6 is not rolled, the turn passes to the next player.
 - Once a player has rolled a six, the participant moves their token forward along the track the number of squares indicated by the die roll.
 - If a participant rolls a 6 they get a bonus roll. If the additional roll results in a 6 again, they get an additional bonus roll...
 - The first player to bring their token to the finish wins the game.
 - A shortened version of the game can be implemented by just following the solid waypoints on the Ludo board.

Exploring the activity:

- How did the participant identify the biased die? Did they try rolling both of the dice multiple times to see which was random, and which was not (i.e. a simulation study)?
- Is the bias in the participant’s favour, or against them?
- Why do participants playing with the random die still win?
- What happens over time (i.e. repeating the game)?
- How often do participants using the biased die win?



What's going on?

- Biased die have weights attached to a number internally. It can be trivial to determine which die is biased by simply holding the die, however it is surprising how often participants pick the lighter one as the biased die!
- A fair die has an equal probability (1/6) of landing on each number. This is not true of biased dice which have an unequal chance of landing on each number. The probability of a 6 (or any number) will be different for each biased die.
- Rolling the die multiple times (i.e. a simulation study) helps participants to determine which die lands on the same number more often than it should. Rolling the die multiple times also enables the participant to determine the probability of getting each number – keep a tally of the numbers rolled for 30, 50, 100,... rolls. The number of rolls of each number divided by the total number of rolls will give the estimated probability of getting that number. For example, if you rolled the die 30 times and rolled a '1' six times then the probability of a '1' using that die is $6/30 = 1/5$.
- If the die lands on a 6 more often than the numbers 1-5 then it is advantageous for Ludo where the participant needs a 6 to begin the game, and receives bonus rolls as a reward for rolling a 6. However, participants need to think about whether the biased die is biased in their favour (i.e. 6 is the most frequently occurring number), or not (i.e. any number between 1 and 5 is the most frequently occurring number).
- Even when a participant plays with a biased die, they are not guaranteed to win Ludo. The die only lands on a 6 more frequently than 1 in 6 rolls – it does not land on a 6 every time. Variations such as angle of throw, speed of throw, surface die rolls on etc. all have the potential to influence the result.

Video demonstration:

A video demonstrating this activity is available on the RSS website at www.rss.org.uk/hands-on

Risk assessment:

If played with floor-size Ludo game, the mat can be slippery. Be mindful of slip hazards.

Additional information and taking it further:

Online shop selling biased die: https://www.amazon.co.uk/d/Magic-Practical-Jokes/Novelty-Trick-Loaded-Dice-Party-Filler-Favor/B000P4MVPS/ref=sr_1_1?ie=UTF8&qid=1484733383&sr=8-1&keywords=biased+dice

WikiHow page for playing Ludo: <http://www.wikihow.com/Play-Ludo>

Basic probabilities tutorial within BBC Bitesize:

<http://www.bbc.co.uk/schools/gcsebitesize/maths/statistics/probability1rev2.shtml>

Credits:

Idea & photographs by Laura Bonnett (University of Liverpool).

