TAKE IT TO THE MAT

A NEWSLETTER ADDRESSING THE FINER POINTS OF MATHEMATICS INSTRUCTION

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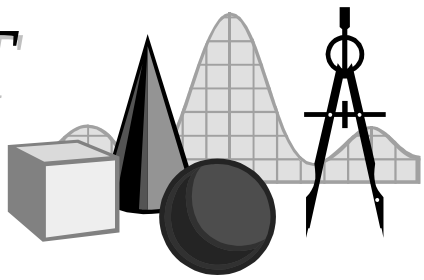

Welcome to Las Vegas, Nevada—"Probability Capital of the World!"

Las Vegas, or all of Nevada for that matter, is a great place to study probability. The State's economy is highly dependent on casino profits from games of chance. We all know that whether it is table games or electronic machines that the odds are in the casino's favor. Or is it probability that is in the casino's favor? In this edition of *Take It to the MAT*, we will examine the relationship between *probability* and *odds.*

Probability is a numerical value that describes the "chance" of a particular *outcome* of some *experiment*. In this definition an *experiment* is not necessarily some grandiose process like we picture in science. A *probability experiment* can be something as simple as rolling a die, flipping a coin, or determining the eye color of the next person that walks through the door.

Outcomes are those results that can occur in the experiment. For flipping a coin the outcomes are heads and tails; for a standard die, 1, 2, 3, 4, 5, and 6; for eye color, blue, green, hazel, brown, etc. The term *event* is used to describe a single outcome or group of outcomes.

Probability of an event can be defined as the ratio between the number of possible outcomes we seek and the number of all possible outcomes, or $\text{probability} = \dfrac{\text{number of favorable outcomes}}{\text{total number of possible outcomes}}$.

In rolling a die, for example, there are six possible outcomes. If we were interested in the probability of rolling an odd prime number, there are two favorable outcomes (3 and 5). So the probability of rolling an odd prime is $2/6$ or $1/3$. We could also express it as $0.\overline{3}$ or $33\frac{1}{3}\%$.

We must understand that probability is a **single** number. When asked what the *probability* of getting "heads" on the flip of a fair coin, many people reply "fifty-fifty." This is incorrect. The probability is one half or fifty percent. The probability is a single value between zero and one inclusive.

When we speak of *odds*, now we can give two values. *Odds* also describe a ratio, but between favorable and unfavorable outcomes. There are actually two types of odds, odds *in favor* and odds *against*, the latter being more commonly used. Odds *against* give the ratio of unfavorable outcomes to favorable ones. (Odds *in favor* express the converse.) In our above die roll example, there are four unfavorable outcomes (1, 2, 4, 6) and two favorable ones (3, 5), so we say the odds *against* rolling an odd prime are 4 to 2. Since both 4 and 2 have a common factor of 2, we can re-express the odds as 2 to 1 if we wish. Essentially we are saying that there are two unfavorable outcomes for each favorable one. The odds can be expressed in a variety of ways such as: two to one, 2 to 1, 2:1, or even $66\frac{2}{3}\%$ to $33\frac{1}{3}\%$. Regardless of how it is written or stated it must have **two** values.

So when people refer to a coin flip as "fifty-fifty" they are really stating the *odds*, not the probability. They are citing the percentage of unfavorable outcomes to favorable ones (or vice-versa in this case). They might just as well simplify it and say "one to one."