TAKE IT TO THE MAT

A NEWSLETTER ADDRESSING THE FINER POINTS OF MATHEMATICS INSTRUCTION

Southern Nevada Regional Professional Development Program
April/May 2006 — Elementary School Edition
www.rpdp.net

Of all the topics in the curriculum, probability is likely the one that generates the most anxiety for teachers. There could be many reasons for this, but we will not go into them here. What we will do in this issue of *Take It to the MAT*, is look at key concepts in probability and connections to other areas of the math curriculum.

Let's start with the most basic terms in probability: **possible** and **impossible**. **Possible** merely refers to an event that *can* happen. This is not to say it *will* happen. It is possible that it will rain next Tuesday. It is possible that a fair die[1] will land "6" when rolled. It is possible that there is life on Mars. **Possible** makes no judgment about the *likelihood* of an event.

Impossible means that an event *can't* happen. It is impossible that the sun will rise in the west next Tuesday. It is impossible that a fair die will land "7" when rolled. It is impossible that a table will come to life and walk out of the room.

The next term we should consider is **certain**. **Certain** means that an event *will* happen, without a doubt. It is certain that the full moon will rise around 6:00 p.m. It is certain that a fair die will land on a number greater than zero when rolled. It is certain that there is life in the oceans. An event that is certain is always possible, but an event that is possible is not always certain.

For students, these three terms lay the groundwork for understanding probability. One can picture this on a likelihood scale like the one below.
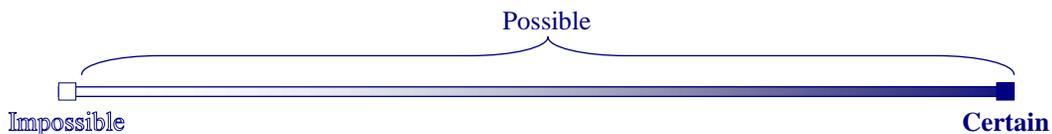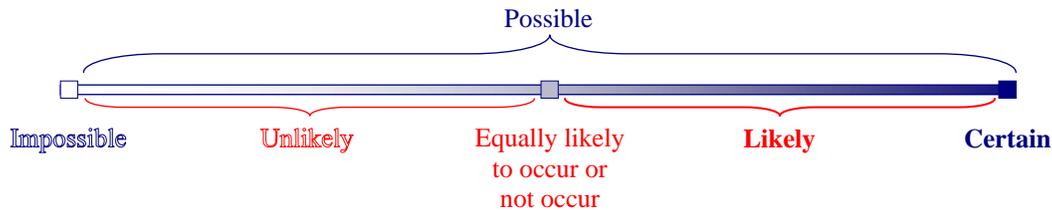

The next step is to understand degrees of likelihood. The two most common terms we use are **likely** and **unlikely**. Those terms are in our books, curriculum, and State Standards. **Likely** is often defined as being an event that will probably happen. OK, what does "probably" mean? Does it mean "possibly?" How about "perhaps" or "maybe?" What do those words mean? We end up trying to define the word **likely** with other words we may have difficulty defining.

A good rule of thumb is that **likely** means an event occurs more often than it does not. It is likely that the high temperature in Las Vegas on the 1ˢᵗ of August will be over 100º F. It is likely that a fair die will land with a number greater than 1 when rolled. It is likely that milk left at room temperature for 3 days will spoil. While **likely** may mean more often than not, it does not describe any single chance of occurrence.

So, if **likely** means more often than not, **unlikely** means an event does not occur more often than it does. It is unlikely that it will snow in Las Vegas on any given day, even in January. It is unlikely that a fair die will land on a composite number when rolled. It is unlikely that a particular planet in our galaxy harbors intelligent life. **Unlikely** also does not describe any single chance of occurrence.

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[1] A six-sided die with faces numbered 1, 2, 3, 4, 5, and 6
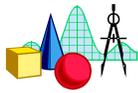
We can expand our likelihood scale to include **likely** and **unlikely**.

Possible

Impossible — Unlikely — Equally likely to occur or not occur — **Likely** — **Certain**
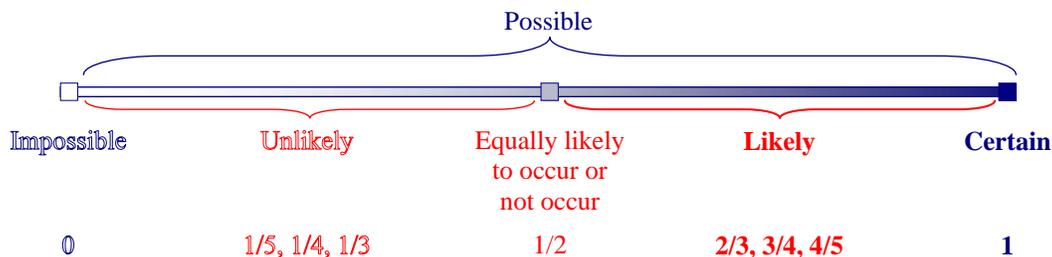
Students should relate these terms to events in their daily lives at home, school, extracurricular activities, etc. Have them describe the likelihood of events like:

- I will not eat Brussels sprouts. (certain)
- Our team will score a run at the baseball game. (likely)
- We will have homework today. (likely—hopefully)
- My brother will beat me at Rock-Paper-Scissors. (equally likely to occur or not occur)
- Hot lunch today will be yummy. (unlikely)
- The goalie will score a goal at the soccer game. (unlikely)
- My teacher will believe that my dog ate my homework. (impossible)

Notice that in our discussion so far, we have yet to consider the word **probability** or any numerical measures of likelihood. For younger students, understanding the concepts of likely and unlikely should precede any discussion of assigning a value to likelihood. Once they have a handle on these terms, we can start talking about probability.

Probability is the assignment of a numerical measure to the likelihood of an event. These are assigned on a scale of zero to one, with zero being **impossible** and one being **certain**. **Unlikely** events have probabilities of less than one-half; **likely** events have probabilities of more than one-half. The more likely an event is to occur, the greater the probability; the less likely the event, the smaller the probability.

Possible

Impossible — Unlikely — Equally likely to occur or not occur — **Likely** — **Certain**

0 — 1/5, 1/4, 1/3 — 1/2 — **2/3, 3/4, 4/5** — **1**

These concepts connect to the understanding of fractions, particularly benchmark fractions. The foundational benchmark fraction is $\frac{1}{2}$, and on our likelihood scale it provides our dividing line between **unlikely** and **likely**. From there, how does $\frac{1}{2}$ compare with $\frac{1}{4}$? How does $\frac{1}{3}$ compare with $\frac{1}{5}$? How do $\frac{2}{3}$ and $\frac{3}{4}$ compare? In each case, which is *more* likely, or *less* likely to occur? That's the same as comparing the fractions and gives another context to do so.