It's Probably a Lot of Fun!

Summary

The students will be able to identify the probability of an experiment as a fraction, decimal, or percent and compare experimental results with theoretical results.

Main Core Tie

Mathematics Grade 6
Strand: STATISTICS AND PROBABILITY (6.SP) Standard 6.SP.5

Materials

Twoheaded coin
Every group of two students will need 4 similar opaque cups, one small marshmallow or similar object, and two dice or one double die
- *Olympic Probability Pieces* (pdf)
- *Score sheet* (pdf)
- *Olympic Probability Game Review* (pdf)

Tape
Scissors
Pencil
Paper or math journal

Books:
- *Pigs at Odds: Fun with Math and Games* by Amy Axelrod, ISBN13: 9780689861444
- *Do You Wanna Bet? Your Chance to Find out About Probability* , by Jean Cushman, ISBN: 9780618829996

Media:
Bill Nye: "Probability" (Disney) is available for free download from UEN at http://www.uen.org/dms/

Background for Teachers

Probability is the likelihood of something happening. Odds are the likelihood of something occurring versus not occurring. The study of probability helps us figure out the likelihood of something happening. The probability of the occurrence of an event can be expressed as a fraction or a decimal from 0 to 1. Events that are unlikely will have a probability near 0, and events that are likely to happen have probabilities near 1.
Suppose we have a bag with 3 red bears and 4 blue bears. To find the probability of drawing a red bear at random, we would first predict that if we reached in the bag to pull a bear out, all outcomes are equally likely. Any bear is equally likely to be pulled out.
To find a basic probability with all outcomes equally likely, we use a fraction with the number of red bears divided by the total number of bears. In this case, we have 3 red bears divided by 7 total bears. The probability of drawing a red bear where all outcomes are equally likely is 3/7. Many times we write this as a decimal so it is easier for students to compare the likelihood of one item to another. As a decimal, 3/7 = .43; as a percent, 3/7 = 43/100 = 43%.
The total number of possible outcomes forms a set called a sample space. In our problem,the sample space consists of all seven bears in the bag, because we are equally likely to draw any one of them. Because each probability is a fraction of the sample space, the sum of the probabilities of all the possible outcomes equals one. The probability of the occurrence of an event is always one minus the

probability that it doesn't occur.
"The probable is what usually happens." -- Aristotle

Intended Learning Outcomes

4. Communicate mathematical ideas and arguments coherently to peers, teachers, and others using the precise language and notation of mathematics.

Instructional Procedures

Invitation to Learn:
Heads or Tails:
Use a twoheaded coin and have students predict whether you will flip a "heads" or "tails" when you flip the coin. Have them write their answer somewhere, then tell them what it was. Do this several times, and if they begin to wonder whether or not something is wrong with the coin, show both sides of the coin. What is the likelihood of flipping a "heads"? What is the likelihood of flipping a "tails"?
Instructional Procedures:
Lesson #1: Pick a Cup
Participants will pair up and play the first probability game, which is using cups to hide a small marshmallow. Each group of two people should have a stack of 4 cups and a small marshmallow. With one cup in front, and a marshmallow underneath it, discuss with the group what the likelihood is of them finding which cup has the marshmallow under it if there is one cup and one marshmallow. Write on the board: 1/1 = 100% likelihood. What if they use two cups, and a marshmallow is hiding under one of the cups? Using just one try, what is the likelihood of finding that marshmallow? It is ½ (one marshmallow, 2 cups). This can also be written as a decimal or percent, which would be .5 or 50%. What if we add a third cup to the puzzle? Now what is the likelihood on the first try of finding the marshmallow? It is 1/3, or .33 or 33%. What if we were to be really tricky and add a fourth cup? On your first try, what would be the likelihood, or probability of finding that marshmallow? It would have decreased to ¼, or .25, or a 25% chance.
What we have just done is predicted, using math, what our chances are of finding that marshmallow on the first attempt. This is called theoretical probability, or what we predict will probably happen. Have students write the vocabulary word and its definition in their math journals. Now try it out to see if it really works or not.
Direct each pair to use one cup and one marshmallow, and have each person see if he/she can identify which cup has the marshmallow under it. Were they all correct? (They really should be.) By raise of hands, how many found it on the first try? "Out of 30 people, 30 found it." That would be 100% accuracy. When we try things out, we now call it experimental probability, because we actually tried what we predicted would happen. Have one of the partners hide his/her eyes while the other person gets out a second cup, then hides the marshmallow under one of the cups. Each person should record his/her results, then share. What was the prediction outcome? Write it on the board. How many were able to find the marshmallow on the first attempt? Record that on the board. Have everyone try it a second, and even a third time, recording how many were able to find the marshmallow on the first attempt.
If we average everyone's scores out of everyone's number of tries, our numbers should better match the experimental probability is. This is called the law of large numbers, which states that the more times we repeat a test, the closer we come to matching the theoretical probability.
Participants should repeat these experiments with a third cup, then a fourth cup. What was the prediction outcome? Write it on the board. Discuss what his/her individual results were, then compare individual results to the group results, then to repeated group results. When mathematicians discuss the law of large numbers, however, they are usually referring to something being repeated thousands, hundreds of thousands, or millions of times. A particular class results may not quite match the

theoretical, but it is likely to be somewhat similar to it.
Note: In all of these examples, we are comparing a student's chance of finding the cup on the first attempt. The probability changes quite a bit if students keep trying to find the marshmallow, or if the cups are switched each time they make an attempt.
Also, students are great observers. Have the chooser close his or her eyes, or look the other way while the cups are being chosen. It will make it more of a game of chance for them.
Lesson #2: Olympic Probability Game:
This is a game for two players. Each player needs a set of 12 Olympic gods pieces and a number line (Olympic Probability Pieces), a score sheet, a double die or two dice, pencil, scissors, tape, and math journal.
Students will receive an Olympic Probability Pieces sheet and a score sheet. They will need to cut out the Olympic gods cards (12) and number line, then tape the three sections of the number line together to form a long, 112 number line that will be shared between the two players.
The object of this game is to be the first to remove your 12 Olympic gods pieces from the number line to Mount Olympus. To do that, you will place your gods along a number line, with as few or as many gods as you would like on each number. Each player will record on his/her score sheet a circle to show the position of his/her gods on the number # line. One player rolls two dice or uses a double die, and each player removes any god that is on the sum of the dice (only one god may be removed per player per turn). Mark on your score sheet an "X" through the pieces as you remove them. If a number is rolled but you did not have a piece on that number, record an X in the empty box. The winner will be the first to have all gods return to Mount Olympus. At the end of each round (usually when someone wins), both players should tally how many of each number was rolled. Questions to write in the journal after the first round include: How did you decide where to place your gods? Will you place them differently in Round 2? Is the game fair? What is your evidence?
Students will play a second round, then look at the probability of getting each of the numbers on the number line by again counting up the marks of how many times they rolled a "two, three, four, etc." Questions to answer in journal include: Did your changes in where you put the gods change the outcome of the game? Why? Did you see a pattern in which numbers were rolled? How is probability used in the game?
After all groups in the class have finished two rounds, discuss what made the game successful. Have them share the three numbers that were rolled the most. Would this affect where the markers should be placed? Does everyone have the same three numbers?
Use the score sheet to figure out how many possibilities there are of getting each sum with two dice. The top columns would be the possibilities of one die, and the rows would be the possibilities of another die. Have students fill this out like an addition table so that they can see and count how many ways they are to get each sum.
This can then be transferred to filling in the possibilities of getting each sum. It is helpful for students to see that the probabilities can be written as a fraction, a decimal, and as a percent. Also, because fractions are sometimes hard to compare, using decimals or percents make it easier to compare one probability to another.
A class discussion will help students see how close they came to the theoretical probability. You could also come up with a class total of how many of each sum was rolled to see how the larger sample size compares to the theoretical probability.
Vocabulary to include:
Theoretical probability is what should happen by looking at how many times each sum can be rolled. This is usually expressed as a fraction, decimal, or percent.
Experimental probability is what actually happened after students played the game. It does not always follow theoretical probability, but if repeated often enough, should be similar.
Law of large numbers states that if something is repeated often enough, it should get closer to

theoretical probability.
You may want to explore the following with students.
Probability of rolling each sum:
Read aloud the *Pigs at Odds* book. Dicuss with students what makes a fair game, and some strategies they use have for determining the fairness of a game.
Have them write what they've learned about probability in their journals.
Lesson and Activity Time Schedule:

Lesson #1: Pick A Cup activity is 20 minutes.

Lesson #2: Olympic Probability game is 50 minutes, including preparation time to setup of game pieces.

Activity: Skunk game: 20 minutes.

Total lesson and activity time is 90 minutes.

Activity Connected to Lesson:
Skunk Skunk:
As time allows, other games may be played with the class. Skunk is a fun game in which students try to predict when to stop gaining points before they lose all of their points. For this game, students only need a paper to keep score on and a double dice (or two dice). The teacher will choose the losing number (16). Anytime that number is rolled, students lose all of their points for that round. All students who stop the round before that number is rolled may keep all of their points to add onto the next round. The winner is the person with the most points after playing five rounds of the game. Students make five columns on their paper, labeled S, K, U, N, K. After the "losing" number is chosen, all students stand. They remain standing during each roll of the dice, and sit down whenever they want to be finished with that round. Any time the "losing" number is rolled, anyone who is still standing will lose all points for that round. The second round begins, etc., until all five rounds have been played. Note: The teacher should keep a track of all numbers that have been rolled so that students can discuss the probability of when to sit down.
Variations:
Round 1: 1 point per number rolled on the die.
Round 2: 2 times the points.
Round 3: Add 5 points to total each time.
Round 4: Add 10 points to the final tally for this round.
Round 5: 5 times whatever number shows up.

Extensions

Many online probability games may be found on these websites:

- http://nces.ed.gov/nceskids/chances/index.asp
- http://mathwire.com/games/datagames.html

Another great probability lesson is found on this website:
http://illuminations.nctm.org/LessonDetail.aspx?id=L585

It uses an Apache probability game with three sticks to explore probability in more depth. This lesson also shows an example of how to use a number tree to look at all the possibilities when playing the game.

Special needs/English Language Learners would do best at this game when paired with a partner who can discuss what is happening during all steps of the game.

This could be an integration for studying Greek mythology, or a way for students to remember the 12 major Olympic gods and goddesses.

Family Connections:
Assignments to do with parents:

Probability games are fun for the family to play. Go to some of the websites listed to play games

with the family. Discuss which games are fair, or how to make them more fair.
Any of these games may be a great way to decide who does who chores at home. The winner of the game will have first choice from a list of jobs to be done that week.

Assessment Plan

Preassessment ideas include teacher observations of how each student set up his or her Round One number line. This will show what students understand about probability.
Anecdotal notes and teacher observations made while students are playing the game allow the teacher to check for understanding as well as help those who are in need of extra help.
The Olympic Probability Review is best given on a separate day than when the game was played so students are able to synthesize what was happening, then have another day to discuss what they learned about probability.
Journal entries and the discussion of what students wrote in their math journals after completing the Olympic Probability game will also help students teach each other more about probability.
Another excellent way to integrate language arts while helping the students to synthesize what was learned is to do a fiveminute write at the end of the discussion on probability. Students will write in their math journals for exactly five minutes what they know about probability. For reluctant writers, have them keep writing the same thing if necessary, so that they are writing for the entire time.

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