Probability: How Certain Are You?

Strand: Probability and Statistics

Topic: Predicting the likelihood of outcomes and representing probability as a number.

Primary SOL: 4.13 The student will
- a) determine the likelihood of an outcome of a simple event;
- b) represent probability as a number between 0 and 1, inclusive; and
- c) create a model or practical problems to represent a given probability.

Materials

- Chart paper
- Markers
- 3" x 16" strips of tag board
- Probability Statements activity sheet (attached)
- Number Cube activity sheets (attached)
- Six-sided number cubes
- Scissors
- Glue or tape

Vocabulary

certain, equally likely, event, fraction, impossible, least likely, likely, most likely, possible outcome, predict, probability, sample space, trial, unlikely

Student/Teacher Actions: What should students be doing? What should teachers be doing?

1. Display the terms *impossible, unlikely, likely, and certain*. Discuss with students that some statements are completely certain or will definitely happen, other statements can be interpreted as maybe, or maybe not, while other statements are impossible or will never happen. On chart paper, write the headings IMPOSSIBLE, UNLIKELY, LIKELY, and CERTAIN at the top of four columns. Make the columns wide because you are going to write the students' statements in them.
2. Ask students to help you fill the columns with statements that fit (e.g., under the CERTAIN heading, "Everyone in the class will be marked 'Present' today."; under the UNLIKELY heading, "All boys in the class will have green hair tomorrow."; under the IMPOSSIBLE heading, "All girls in the class will grow three inches overnight.") Continue until there are two or three statements in each column and students can easily see the differences among the categories. Some of the statements may be silly, but that will cause students to think critically about and evaluate the statements. Discuss the fact that it is possible to disagree about the categories into which some statements fit.
3. Group students in pairs, and give each pair a 3" x 16" strip of tag board, the Probability Statements activity sheet, a pair of scissors, and glue or tape. Tell the class that they are

now going to evaluate a collection of statements and decide where those statements fit on their 3" x 16" inch strip, or their "probability line." Have pairs fold their tag board strips into fourths, and instruct them to write one of the four headings (as in step 2) in each section of the strip. Then, have the pairs decide where each statement fits on the probability line and attach it under the agreed heading. If a pair of students does not agree on the category for a statement, the pair should try to come to a consensus while still disagreeing. When all probability lines have been completed, ask student pairs to share their results for each statement. Lead a class discussion of the similarities and differences among the results.

4. Tell the students that mathematicians represent the measure of probability as 0 or 1 or a number between zero and 1. Ask, "What numbers are between zero and 1?" Clarify that we use fractions. Ask the students to identify which statements from the previous activity would represent the probability of zero. After the class discussion, students should recognize that events labeled "impossible" would represent the number zero. Ask the students whether they could identify any statements that would represent 1. Students should identify that the statements labeled "certain" would represent the number 1.
5. Draw on the board a number line segment. Label the left endpoint as 0 and right endpoint as 1. Below 0, write *impossible* and below the number 1 write *certain*. Locate the point for $\frac{1}{2}$, and ask students what a probability of $\frac{1}{2}$ might mean. Listen to their responses and then let them know that the mathematical term is *equally likely*, and write this over $\frac{1}{2}$. Ask the students to identify where the other probability terms, such as *unlikely* or *likely,* would fall on the probability line. Once the terms have been identified and written on the probability line, explain to the students that we are going to use a six-sided number cube to model and determine possible *outcomes* based on an event.
6. Teachers should note that there is much particular vocabulary associated with probability, and you should be precise as you talk with students and present information. In addition, encourage students to use precise language. A word wall or anchor chart will help. Give each student a six-sided number cube or enough for partners to share. Ask the students how they could determine the likelihood of landing on 2? On 5? Then, ask the students if they could identify the total number of possible outcomes or find the *sample space.* Discussion should lead to the fact that there are only six numbers you could roll, and they are 1, 2, 3, 4, 5, or 6, so the *sample space* is 1, 2, 3, 4, 5, or 6. Record this on the board. Now ask students to think about the probability of rolling an odd number. First, have students identify which of those outcomes are odd. Identifying that you could land on a 1, 3, or 5. The chances of rolling an odd number is equal to the chances of rolling an even number. Ask the students whether they could identify a probability term that we could use to describe when one event is equal to another event occurring. Once the students have identified the probability term of rolling an odd number as equally likely as rolling an even number, have the students try and figure out the corresponding fraction ($\frac{3}{6}$ or $\frac{1}{2}$) of rolling an odd number. Another way is to think about having six possible outcomes in the sample space and three of them are the desired outcome, so the fraction for the probability of rolling and odd number

can be written as $\frac{number\ of\ favorable\ or\ desired\ outcomes}{total\ number\ of\ possible\ outcomes}$, which is $\frac{3}{6}$ or $\frac{1}{2}$. When determining the fraction, discuss the importance of figuring out the total number of outcomes and the number of favorable outcomes and what it means when the fraction is simplified. Next have the students do a trial experiment where they roll the number cube 10 times and record their results of landing on an odd number. They can write odd number and even number on their paper and then use tally marks to record which type of number each roll showed. Have a class discussion on the number of times they landed on an odd number compared to the probability of rolling an odd number. For example, the actual (theoretical) probability is $\frac{1}{2}$, and perhaps they roll an odd number, which is $\frac{4}{10}$. What does this mean?

7. Distribute the four Number Cube activity cards to each pair of students. Have the students continue to work with a partner to determine the probability of an event occurring using the six-sided number cube. Circulate around the room, making note of misunderstandings or confusion you want to bring out in the whole class discussion.
8. Once the partners have finished the Number Cube activity, discuss the likelihood of those events occurring. Have the students share the probability used to describe the event and the fractional representation used to determine the likelihood of it occurring.

Assessment

- **Questions**
  - What does it mean for outcomes of an event to be "equally likely"? What kind of event would have outcomes that are equally likely? (Flipping a coin: it is equally likely that the outcome will be heads or tails.)
  - If we used a 10-sided number cube instead of a six-sided number cube, would the probability of those events occurring change or stay the same? Why?
  - If you have rolled a 3 four times in a row, what is the probability that you will roll a 3 on the next roll? Explain your thinking.
- **Journal/writing prompts**
  - Create a bag of marbles where the probability of selecting a red marble is equally as likely as selecting a yellow marble. Use pictures and words to explain your answer. Can you create more than one example?
  - Create and model an event where the probability is unlikely to occur and the fractional representation is $\frac{3}{8}$.
  - Explain why probability may sometimes be called chance.
- **Other Assessments (include informal assessment ideas)**
  - Create an event where the probability of selecting an object is impossible or zero.
  - Why can the results of a probability experiment be misleading?
  - Look through a magazine or newspaper and find examples of probability.

Extensions and Connections (for all students)

- Have students investigate flipping a coin to determine likelihood of heads or tails. Be sure they record each flip. Flip the coin 10 times and compare the actual results to the probability. Then flip it 10 more times and combine the flips to determine the results for 20 flips. How did the comparison of the results to the probability change?
- Have students create a large-scale probability line, using a clothesline. Have them place large cards with probability statements on them along the clothesline. Have students stand along a large-scale probability line (or under the probability line created by the clothesline) with sheets of paper displaying probability statements they have written.

Strategies for Differentiation

- Limit the activity cards for number 2 to the first two cards.
- Provide a prepared probability line for student reference.
- Post vocabulary cards.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Probability Statements	
Pizza will be served for lunch today.	At least two students in the class will be absent tomorrow.
The sun will rise tomorrow.	You will ride in a bus before the end of the school year.
You will have two birthdays this year.	You will go to bed before 9:00 tonight.
It will take you more than one hour to do your homework.	You will roll a 4 on a die.
Your school has a principal.	Your teacher will let you have an extra recess today.
On your way home from school, you will see a live dinosaur.	You will ride in a bus before the end of the school year.

Number Cube Activity Cards

What is the probability of rolling a number greater than 2?

a. In the box below list the sample space, or all possible outcomes and circle the favorable outcomes:

b. Identify the fraction or measure of probability for rolling a number greater than 2.

c. Circle the probability term that you would apply to the chance of rolling a number greater than 2.: *impossible, unlikely, equally likely, likely, or certain*

d. Roll the number cube 10 times and keep a tally of your results in the chart below.

1		4	
2		5	
3		6	

How do the results of your trial compare to the probability of rolling a number greater than 2 occurring?

What is the probability of rolling a factor of 6?

e. In the box below list the possible outcomes, sample space, and circle the favorable outcomes:

f. Identify the fraction or measure of probability for rolling a factor of 6.

g. Circle the probability term that you would apply to the chance of rolling a factor of 6.
impossible, unlikely, equally likely, likely, or certain

h. Roll the number cube 10 times and keep a tally of your results in the space below.

1		4	
2		5	
3		6	

How do the results of your trial compare to the probability of rolling a factor of 6 occurring?

What is the probability of rolling a number less than 7?

i. In the box below list the possible outcomes, sample space and circle the favorable outcomes:

j. Identify the fraction or measure of probability for rolling a number less than 7.

k. Circle the probability term that you would apply to the chance of rolling a number less than 7. *impossible, unlikely, equally likely, likely, or certain*

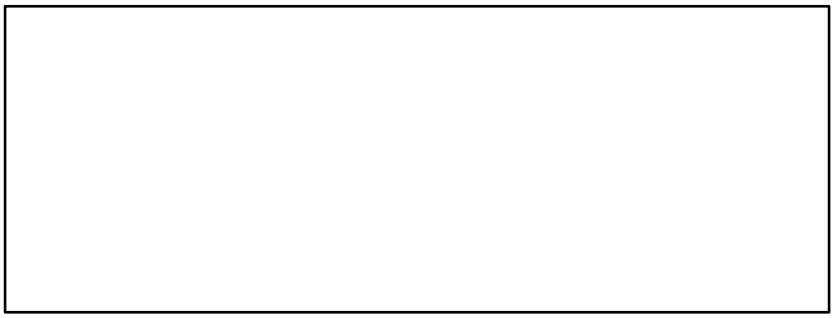
l. Roll the number cube 10 times and keep a tally of your results in the space below.

1		4	
2		5	
3		6	

How do the results of your trial compare to the probability of a number less than 7?

What is the probability of rolling a number greater than 6?

m. In the box below list the possible outcomes, sample space, and circle the favorable outcomes:



n. Identify the fraction or measure of probability for rolling a number greater than 6.

o. Circle the probability term that best describes the probability of rolling a number greater than 6. *Impossible, unlikely, equally likely, likely, or certain*

p. Roll the number cube 10 times and keep a tally of your results in the space below.

1		4	
2		5	
3		6	

How do the results of your trial compare to the probability of a number greater than 6?