Grade 8
Celebrations Unit
Math Lesson Day 2

Rationale

- The intent of this lesson is to apply the concepts of Probability.

Goals

- Students will design a game of chance.
- Students will be able to analyze the probability of various outcomes in the game.
- Students will be able to determine if the game is mathematically fair.

Standards

***7.SP.7** Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.

a. Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. *For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.*

b. Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. *For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?*

MP.4 Model with mathematics.

MP.5 Use tools strategically.

*Note: Skills and concepts developed in previous grades are often used in application-style problem solving at higher grades.

Objectives

- Students will be able to design a game of chance with a choice of objects.
- Students will be able to calculate probability as ratios and percentages. Calculators permitted.
- Students will be able to evaluate if the game is mathematically fair and support the evaluation with reasoning.
- Students will be able to compare the theoretical probability to the experimental probability.
- Students will be able to critique other games of chance.

Materials

- Practice Probability worksheet-one penny and two different colored number cubes, numbered 1-6
- Paper
- Pencil
- Calculators
- One bag of objects per student group: one penny, two number cubes numbered 1-6, three 3-oz cups, one ping pong ball, 5 large paper clips, 2 rubber bands, deck of playing cards. Other items can be selected.

Procedure

- Begin with a review of Probability, using the Practice Probability worksheet. Ask the students to work with a partner.
- Tell the class that every outside event needs a back-up plan in the event of bad weather. Today they will design simple table games of chance.
- Provide the students with the Activity of the Day instructions.

Teacher & Teachers' Aide Observations During the Group Activity

- It will be a challenge to use some of the objects and create a fair event. The outcome must be measurable for each outcome. Example: When attempting to toss a ball into one of the three cups, there are four possible outcomes-Cup1, Cup 2, Cup 3, or miss.
- Teachers should observe how the students are designing the game, encouraging the students to consider the features that make games fun and mathematically fair.
- The teachers should check if the students are correctly calculating the probabilities.
- Teachers should observe if students are fairly critiquing the game they designed and the other games that they are playing.

Assessment

- The students will demonstrate mastery of the concept of Probability with compound events.
- The students will demonstrate their ability to express probability in ratios and percentages.
- The students will demonstrate their ability to reason about mathematical fairness.

Activity of the Day – Designing a Game of Chance

1. An outside event needs a back-up plan in the case of bad weather. A plan is needed for an activity that can be held in the school cafeteria.

2. You and your partner need to design a game of chance that is simple, mathematically fair and can be played on one cafeteria table. Consider how to make the game fun, engaging, challenging but not frustrating. Be sure to create a name for the game.

3. You are given a bag of objects; select four objects to use in your game. **Example:** If you select the three cups, they are considered as one object. If you select the paper

clips, they are considered as one object. If you select the two number cubes, they can be considered as two objects or one object.

4. The game should have various combinations and various points earned for the combinations. The game needs to clearly state how it can be won or lost.

5. Draw the layout for the game, labeling the objects on your drawing.

6. After the game is designed, calculate the probability of each combination that earns points; express as a ratio and percent. This is called the theoretical probability. A chart can be used to show the probability. You can adjust the design of the game, based upon the theoretical probability.

7. Next, you will need to test the game, playing at least 30 trials and recording the outcomes. Keep score, according to the game design.

8. When the test is completed, calculate the probability of each combination, based upon the 30 trials; express as a ratio and percent. This is called the experimental probability.

9. Compare the probabilities. Write a short paragraph about your comparison.

10. In mathematics, a game is *fair* if all players have an equal chance of winning. Reason whether the game you have designed is fair and support your reasoning.

11. As time permits, allow the students to play each other's games and critique them. Was the game interesting, engaging, challenging? Was the game fair? Was the game too easy or too complicated? Was the game too easy or too difficult to win or lose?

Practice Probability
Single Event

In a game of chance, outcomes are measurable and predictable, and can be expressed as ratios:

Single Event: $\mathbf{P = \dfrac{\underline{favorable\ outcome}}{total\ possible\ outcomes}}$

Example 1: Use a penny. How many total outcomes are possible when a penny is tossed into the air and lands? What are they?

Let's find the probability of the penny landing on heads. Express as a ratio and percent.

P (heads) =

(Read as: "The Probability of the outcome heads equals.")

Is the probability of the penny landing on tails the same?

Example 2: Use **one** number cube, numbers 1-6. How many total outcomes are possible when a die is tossed and lands? What are they?

Find these probability ratios and convert the ratios to percentages.

Event	Ratio	Percent
P(5)		
P(2)		
P(even)		
P(1 or 3)		
P(multiple of 2)		
P(prime)		

Practice Probability

Independent Compound Events

Independent Compound Events: More than one outcome in an event with no effect upon each other. Find the probability of each and then multiply the ratios.

Example 3: Use **two different colored** number cubes, numbered 1-6.

Find these probability ratios and convert the ratios to percentages.

Example 4: Use one penny and two number cubes, numbered 1-6

Find these probability ratios and convert the ratios to percentages.

Event	Ratio	Percent
P(5) and P(3)		
P(3 or 4) and P(odd)		
P(2) and P(even)		
P(sum of 3) and P(prime)		
P(1) and P(less than 5)		
Event	Ratio	Percent
P(heads) and P(5) and P(3)		
P(tails) and P(4 or 6) and P(2)		
P(heads) and P(even) and P(odd)		
P(heads) and P(prime) and P(composite)		