Lesson 2: Estimating Probabilities by Collecting Data

Student Outcomes

- Students estimate probabilities by collecting data on an outcome of a chance experiment.
- Students use given data to estimate probabilities.

Lesson Overview

This lesson builds on students' beginning understanding of probability. In Lesson 1, students were introduced to an informal idea of probability and the vocabulary: impossible, unlikely, equally likely, likely, certain to describe the chance of an event occurring. In this lesson, students begin by playing a game similar to the game they played in Lesson 1. Now, we use the results of the game to introduce a method for finding an estimate for the probability of an event occurring. Then, students use data given in a table to estimate the probability of an event.

Classwork

Example 1 (10 minutes): Carnival Game

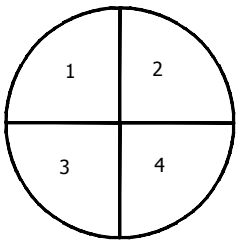
Place students into groups of two. Hand out a copy of the spinner and a paperclip to each group. Read through the rules of the game and demonstrate how to use the paper clip as a spinner.

MP.2 Before playing the game, display the probability scale from Lesson 1 and ask the students where they would place the probability of winning the game.

Remind students to carefully record the results of each spin.

Example 1: Carnival Game

At the school carnival, there is a game in which students spin a large spinner. The spinner has four equal sections numbered 1–4 as shown below. To play the game, a student spins the spinner twice and adds the two numbers that the spinner lands on. If the sum is greater than or equal to , the student wins a prize.



Exercises 1–8 (15 minutes)

Allow students to work with their partner on Exercises 1–6. Then discuss and confirm as a class.

Sample responses to the questions should be based on the outcomes recorded by students. The following outcomes were generated by two students. They are used to provide sample responses to the questions that follow:

Exercises 1–8

You and your partner will play this game 15 times. Record the outcome of each spin in the table below.

Turn	1st Spin Results	2nd Spin Results	Sum

1. **Out of the turns how many times was the sum greater than or equal to ?**

   Answers will vary and should reflect the results from students playing the game times. In the example above, eight outcomes had a sum greater than or equal to .

2. **What sum occurred most often?**

   occurred the most.

3. **What sum occurred least often?**

   and occurred the least. (Anticipate a range of answers as this was only done times. We anticipate that and will not occur as often.)

4. **If students played a lot of games, what proportion of the games played will they win? Explain your answer.**

   Based on the above outcomes, — represents the proportion of outcomes with a sum of or more.

5. **Name a sum that would be impossible to get while playing the game.**

   Answers will vary. One possibility is getting a sum of .

6. **What event is certain to occur while playing the game?**

   Answers will vary. One possibility is getting a sum between and as all possible sums are between and .

Before students work on Exercises 7 and 8, discuss the definition of a *chance experiment*. A *chance experiment* is the process of making an observation when the outcome is not certain (that is, when there is more than one possible outcome). If students struggle with this idea, present some examples of a chance experiment, such as: flipping a coin times or selecting a cube from a bag of cubes. Then, display the formula for finding an estimate for the probability of an event. Using the game that the students just played, explain that the denominator is the total number of times they played the game, and the numerator is the number of times they recorded a sum greater than or equal to .

When you were spinning the spinner and recording the outcomes, you were performing a chance experiment. You can use the results from a chance experiment to estimate the probability of an event. In the example above, you spun the spinner times and counted how many times the sum was greater than or equal to . An estimate for the probability of a sum greater than or equal to is:

_____

Give the students a few minutes to answer Exercises 7 and 8, and then ask each group to share their results. After students have shared their results, point out that not every group had exactly the same answer.

- Ask the students to explain why their answers are estimates of the probability of getting a sum of or more.

MP.6

7. Based on your experiment of playing the game, what is your estimate for the probability of getting a sum of or more?

Answers will vary. Students should answer this question based on their results. For the results indicated above, — or approximately or would estimate the probability of getting a sum of or more.

8. Based on your experiment of playing the game, what is your estimate for the probability of getting a sum of exactly ?

Answers will vary. Students should answer this question based on their results. Using the above outcomes, — or approximately or of the time represents an estimate for the probability of getting a sum of exactly .

Students will learn how to determine a theoretical probability for problems similar to this game. Before they begin determining the theoretical probability, however, summarize how an estimated probability is based on the proportion of the number of specific outcomes to the total number of outcomes. Students may also begin to realize that the more outcomes they determine, the more confident they are that the proportion of winning the game is providing an accurate estimate of the probability. These ideas will be developed more fully in the following lessons.

Example 2 (10 minutes): Animal Crackers

Have students read the example. You may want to show a box of animal crackers and demonstrate how a student can take a sample from the box. Explain that the data presented result from a student taking a sample of crackers from a very large jar of Animal Crackers and recording the results for each draw.

Display the table of data.

Ask students:

- What was the total number of observations?
- If we want to estimate the probability of selecting a zebra, how many zebras were chosen?
- What is the estimate for the probability of selecting a zebra?

The main point of this example is for students to estimate the probability of selecting a certain type of animal cracker. Use the data collected to make this estimate.

Example 2

A student brought a very large jar of animal crackers to share with students in class. Rather than count and sort all the different types of crackers, the student randomly chose crackers and found the following counts for the different types of animal crackers.

Lion	
Camel	
Monkey	
Elephant	
Zebra	
Penguin	
Tortoise	
	Total

The student can now use that data to find an estimate for the probability of choosing a zebra from the jar by dividing the observed number of zebras by the total number of crackers selected. The estimated probability of picking a zebra is — or or . This means that an estimate of the proportion of the time a zebra will be selected is , or of the time. This could be written as or the probability of selecting a zebra is .

Exercises 9–15 (5 minutes)

Place the students in groups of 2, and allow them time to answer each question. You may wish to specify in which form they should answer. For this exercise, it is acceptable for students to write answers in fraction form to emphasis the formula. As a class, briefly discuss students' answers. Specifically, discuss the answers for Exercises 11 and 15. Each of these questions involve "or." For these questions, students should indicate that they would add the outcomes as indicated in the question to form their proportion.

Exercises 9–15

If a student were to randomly select a cracker from the large jar:

9. **What is your estimate for the probability of selecting a lion?**

   — —

10. **What is the estimate for the probability of selecting a monkey?**

    — –

11. **What is the estimate for the probability of selecting a penguin *or* a camel?**

    ——— — –

12. **What is the estimate for the probability of selecting a rabbit?**

    —

13. **Is there the same number of each animal cracker in the large jar? Explain your answer.**

    No, there appears to be more elephants than other types of crackers.

14. **If the student were to randomly select another animal crackers, would the same results occur? Why or why not?**

    Probably not. Results may be similar, but it is very unlikely they would be exactly the same.

15. **If there are animal crackers in the jar, how many elephants are in the jar? Explain your answer.**

    — – ***, hence an estimate for number of elephants would be .***

Closing

Discuss with the students the Lesson Summary. Ask students to summarize how they would find the probability of an event.

Lesson Summary

An estimate for finding the probability of an event occurring is

_____

Exit Ticket (5 minutes)

Name _____ Date_____

Lesson 2: Estimating Probabilities by Collecting Data

Exit Ticket

In the following problems, round all of your decimal answers to decimal places. Round all of your percents to the nearest tenth of a percent.

A student randomly selected crayons from a large bag of crayons. Below is the number of each color the student selected. Now, suppose the student were to randomly select one crayon from the bag.

Color	Number
Brown	
Blue	
Yellow	
Green	
Orange	
Red	

1. What is the estimate for the probability of selecting a blue crayon from the bag? Express your answer as a fraction, decimal or percent.

2. What is the estimate for the probability of selecting a brown crayon from the bag?

3. What is the estimate for the probability of selecting a red crayon *or* a yellow crayon from the bag?

4. What is the estimate for the probability of selecting a pink crayon from the bag?

5. Which color is most likely to be selected?

6. If there are crayons in the bag, how many will be red? Justify your answer.

Exit Ticket Sample Solutions

In the following problems, round all of your decimal answers to decimal places. Round all of your percents to the nearest tenth of a percent.

A student randomly selected crayons from a large bag of crayons. Below is the number of each color the student selected. Now, suppose the student were to randomly select one crayon from the bag.

Color	Number
Brown	
Blue	
Yellow	
Green	
Orange	
Red	

1. **What is the estimate for the probability of selecting a blue crayon from the bag? Express your answer as a fraction, decimal or percent.**

   — –

2. **What is the estimate for the probability of selecting a brown crayon from the bag?**

   — –

3. **What is the estimate for the probability of selecting a red crayon *or* a yellow crayon from the bag?**

   — —

4. **What is the estimate for the probability of selecting a pink crayon from the bag?**

   —

5. **Which color is most likely to be selected?**

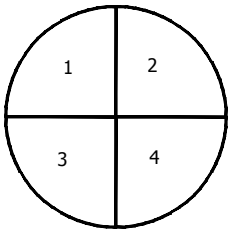
   Brown.

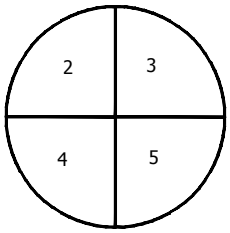
6. **If there are crayons in the bag, how many will be red? Justify your answer.**

   There are out of crayons that are red, or – or . Anticipate – of crayons are red, or approximately crayons.

Problem Set Sample Solutions

1. Play a game using the two spinners below. Spin each spinner once, and then multiply the outcomes together. If the result is less than or equal to , you win the game. Play the game times, and record your results in the table below.





Turn	1st Spin Results	2nd Spin Results	Product

2. a. What is your estimate for the probability of getting a product of or less?

Students should find the number of times the product was or less and divide by . Answers should be approximately , , or , divided by .

b. What is your estimate for the probability of getting a product more than ?

Subtract the answer to part (a) from , or the answer from part (a). Approximately , , or , divided by .

c. What is your estimate for the probability of getting a product of exactly ?

Students should find the number of times occurred and divide by . Approximately or divided by .

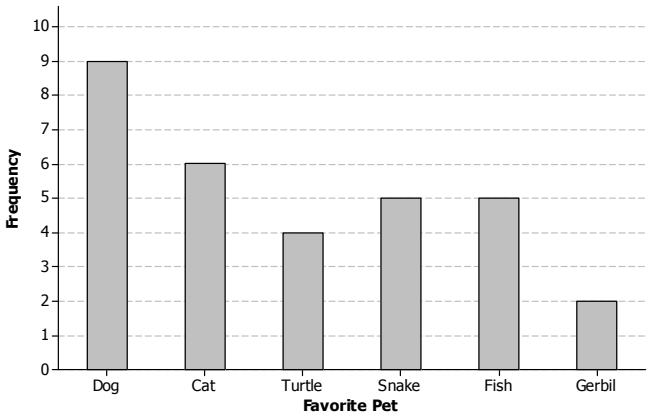
d. What is the most likely product for this game?

Students should record the product that occurred most often. Possibilities are , , , and .

e. If you played this game another times, will you get the exact same results? Explain.

No, since this is a chance experiment, results could change for each time the game is played.

3. A seventh grade student surveyed students at her school. She asked them to name their favorite pet. Below is a bar graph showing the results of the survey.



Use the results from the survey to answer the following questions.

a. How many students answered the survey question?

b. How many students said that a snake was their favorite pet?

Now, suppose a student will be randomly selected and asked what his or her favorite pet is.

c. What is your estimate for the probability of that student saying that a dog is his or her favorite pet?

(Allow any form.) —, or approximately , or approximately .

d. What is your estimate for the probability of that student saying that a gerbil is his or her favorite pet?

(Allow any form.) —, or approximately , or approximately .

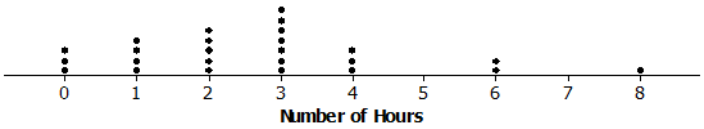
e. What is your estimate for the probability of that student saying that a frog is his or her favorite pet?

— or or .

4. A seventh grade student surveyed students at her school. She asked them how many hours a week they spend playing a sport or game outdoors. The results are listed in the table below.

Number of hours	Tally	Frequency
	| | |	
	| | | |	
	𝍸	
	𝍸 | |	
	| | |	
	| |	
	|	

a. Draw a dot plot of the results.



Suppose a student will be randomly selected.

b. What is your estimate for the probability of that student answering hours?

—

c. What is your estimate for the probability of that student answering hours?

—

d. What is your estimate for the probability of that student answering or more hours?

—

e. What is your estimate for the probability of that student answering or less hours?

—

f. If another students were surveyed, do you think they will give the exact same results? Explain your answer.

No, each group of students could answer the question differently.

g. If there are students at the school, what is your estimate for the number of students who would say they play a sport or game outdoors hours per week? Explain your answer.

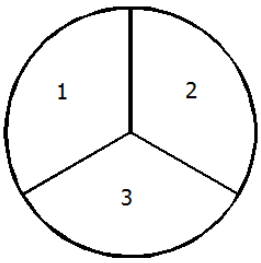
— students. This is based on estimating that of the students, — would play a sport or game outdoors hours per week, as — represented the probability of playing a sport or game outdoors hours per week from the 7th grade class surveyed.

5. A student played a game using one of the spinners below. The table shows the results of spins. Which spinner did the student use? Give a reason for your answer.

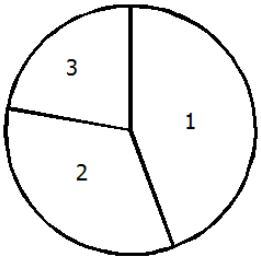
Spinner B. Tallying the results: occurred times, occurred times and occurred times. In Spinner B, the section labeled and are equal and larger than section .

Spin	Results

Spinner A



Spinner B



Spinner C