Mystery Bags

Goals

- Compare outcomes for different experiments, predict which experiment is more likely to produce a desired result, and justify (orally and in writing) the prediction.
- Describe (orally) how we can use the outcomes from previous experiments to help determine the relative likelihood of future events.

Learning Target

I can get an idea for the likelihood of an event by using results from previous experiments.

Lesson Narrative

To introduce the unit on probability, students play a game to collect data about what is inside bags and then decide which bag is most likely to give a desired result. The process of using previous results from repeated trials to inform the likelihood of future events is one way to estimate probabilities that will be revisited later.

Bags that contain a certain number of colored objects will be used in this unit. To reuse materials already in the classroom, colored snap cubes are recommended, but any items of different colors that cannot be determined by touch will work. If there are not enough suitable items, equal sized pieces of paper can be colored or have the color written on them and used in the bags.

Student Learning Goal

Let's make predictions based on what we know.

Access for Students with Diverse Abilities

- Representation (Activity 1)

Access for Multilingual Learners

- MLR8: Discussion Supports (Activity 1)

Instructional Routines

- Poll the Class

Required Materials

Materials to Gather
- Paper bags: Activity 1
- Snap cubes: Activity 1

Required Preparation

Activity 1:
Prepare enough bags of blocks so that each group of 4 students can have one bag and all groups will have had a turn with each color of bag after three rounds.

- Label one-third of the bags "green" and put 9 green blocks and 3 blocks of another color into each of these bags.
- Label one-third of the bags "blue" and put 8 blue blocks and 8 blocks of another color into each of these bags.
- Label one-third of the bags "red" and put 4 red blocks and 10 blocks of another color into each of these bags.

Lesson Timeline

Warm-up	Activity 1	Lesson Synthesis	Assessment
5 min	30 min	10 min	Cool-down 5 min

Warm-up
Going Fishing

5 min

Activity Narrative

The purpose of this *Warm-up* is for students to use their intuition to think about the upcoming unit on probability. In particular, students guess what type of fish might be caught after knowing the results of the previous 10 fish caught. Although no answer can be given with absolute certainty, the results being heavily skewed towards one type of fish should lead students to the idea that it is more likely to be the most commonly caught fish that will be caught again.

Launch

It may be helpful to explain that there are many types of fish that are caught while fishing for fun or sport. The two types listed in this *Warm-up,* bluegill and yellow perch, are typically found in lakes and caught with the same type of bait. Both of these types of fish are suitable for eating after being caught or they can be released back into the water.

Student Task Statement

Andre and his dad have been fishing for two hours. In that time, they have caught 9 bluegills and 1 yellow perch.

The next time Andre gets a bite, what kind of fish do you think it will be? Explain your reasoning.

Sample response: I think Andre will pull out a bluegill. They have mostly caught bluegills, so it seems like the next one will probably be a bluegill too.

Activity Synthesis

The purpose of the discussion is to show students that no single answer can be certain for this problem, but previous results can help inform the likelihood of future outcomes.

Poll the class regarding the type of fish they think will be caught next. Begin by asking for students who think the next fish caught will be a bluegill, followed by students who think the next fish caught will be a yellow perch, followed by students who think that another type of fish will be caught (or that they will not catch another fish). Display the results from the poll for all to see. Following the poll, ask at least one student representing each group with more than 1 vote for their reasoning. Tell students that we cannot know for certain what the next type of fish will be, but based on the results we have available, it is most likely that a bluegill will be caught next.

Student Workbook

Activity 1

Playing the Block Game

30 min

Activity Narrative

Following the concept developed in the *Warm-up,* students will continue to use the idea that outcomes from previous experiments can help inform the likelihood of an outcome when the experiment is repeated. In this activity, students play a game while collecting data. Bags of colored blocks are set up with different probabilities to win, and students use random chance to collect points when the color of the block they choose matches the color written on the bag. In the discussion, students use the data they have collected during three rounds of the game to make a decision about which bag might be most likely to produce a winning block. As an opening activity, this is meant to motivate students into thinking about the likelihood of events. As such, it is not important to resolve the questions in the discussion into perfect agreement.

Launch 👥👥👥👥

Arrange students in groups of 4. Explain or demonstrate to students how to play the game:

- There will be 3 rounds of the game. Each group will get a different bag of blocks for each round.
- Groups are not allowed to look into the bag or take more than one block out of the bag at a time.
- During a round, each person in the group gets 4 turns to take a block out of the bag.
- If the block matches the color that is written on the outside of the bag, the person scores 1 point. When the block is any other color, they do not earn any points.
- After drawing a block, the person puts it back in the bag, shakes the bag to mix up the blocks, and passes the bag to the next person before taking another turn.
- At the end of a round, everyone in the group should record everyone's points from that round and wait for a new bag of blocks with a different color.
- A person wins by scoring the most points.

Distribute bags of blocks. Each group gets one of these bags:

- A bag labeled "Green" that contains 9 green blocks and 3 of another color.
- A bag labeled "Blue" that contains 8 blue blocks and 8 of another color.
- A bag labeled "Red" that contains 4 red blocks and 10 of another color.

Student Task Statement

Your teacher will give your group a bag of colored blocks.

1. Follow these instructions to play one round of the game:

   a. Write the color written on the bag in the first column of the table.

   b. Without looking in the bag, one person takes out one of the blocks and shows it to the group.

   c. If the block is the same color as the bag label, they earn 1 point.

   d. The person puts the block back into the bag, shakes the bag to mix up the blocks, and passes the bag to the next person in the group.

   e. Repeat these steps until everyone in the group has had 4 turns for the round.

2. At the end of the round, record each person's score in the table.

3. After each person in the group has had 4 chances to choose a block, pause so your teacher can give you a new bag of blocks for the next round.

4. Repeat the previous steps to play rounds 2 and 3 of the game.

Sample response:

	color on bag	person 1's score	person 2's score	person 3's score	person 4's score
round 1	Green	3	2	4	4
round 2	Blue	2	3	1	2
round 3	Red	1	2	0	1

Are You Ready for More?

Tyler's class played the block game using purple, orange, and yellow bags of blocks.

- During round 1, Tyler's group picked 4 purple blocks and 12 blocks of other colors.

- During round 2, Tyler's group picked 11 orange blocks and 5 blocks of other colors.

- During round 3, Tyler forgot to record how many yellow blocks his group picked.

For a final round, Tyler's group can pick 1 block from any of the three bags. Tyler's group decides that picking from the orange bag would give them the best chance of winning, and that picking from the purple bag would give them the worst chance of winning. What results from the yellow bag could have led Tyler's group to this conclusion? Explain your reasoning.

Sample response: 8 yellow blocks and 8 other colors. The purple bag appears to have less purple than other colors, and the orange bag appears to have more orange than other colors. If the yellow bag has an equal number of yellow blocks and other colors, someone pulling from this bag would be more likely to win than with the purple bag, but less likely to win than with the orange bag.

Access for Students with Diverse Abilities (Activity 1, Student Task)

Representation: Access for Perception.
Read directions aloud. Students who both listen to and read the information will benefit from extra processing time.
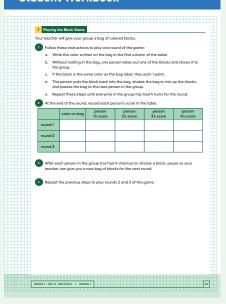
Supports accessibility for: Language, Attention

Building on Student Thinking

Some groups may choose a bag for the bonus round based on their best round rather than looking at the group data as a whole. Tell these students that although they may have been lucky the first time they used that bag, it is helpful to look at how the whole group did with the bag to get a sense of how easy it is to match the block with the bag label.

Student Workbook

Student Workbook

[Student Workbook page reproduction]

1 Playing the Block Game

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1 Lesson Summary

One of the main ways that humans learn is by repeating experiments and observing the results. Babies learn that dropping their cup makes it hit the floor with a loud noise by repeating this action over and over. Scientists learn about nature by observing the results of experiments repeated again and again. With enough data about the results of experiments, we can begin to predict what may happen if the experiment is repeated in the future. For example, a baseball player who has gotten a hit 33 out of 100 times at bat might be expected to get a hit about 33% of his times at bat in the future.

In some cases, we can predict the chances of things happening based on our knowledge of the situation. For example, a coin should land heads up about 50% of the time due to the symmetry of the coin.

In other cases, there are too many unknowns to predict the chances of things happening. For example, the chances of it raining tomorrow are based on similar weather conditions we have observed in the past. In these situations, we can experiment, using past results to estimate chances.

150   GRADE 7 • UNIT 8 • SECTION A | LESSON 1

Access for Multilingual Learners (Activity 1, Synthesis)

MLR8: Discussion Supports.
Display sentence frames to support whole-class discussion: "I agree because …" or "I disagree because …"

Advances: Speaking, Conversing

Activity Synthesis

Tell students that there is a bonus, fourth round. In this round, a block that matches the color on the bag is worth 25 points. Each person will only have one chance to draw a bonus block. In this round, each group will get to choose which bag they would like to draw from. At least 3 people in the group must agree on the bag they will use.

Give students 5 minutes of small-group discussion to agree on which bag the group will use.

Tell students that after the bonus round they will be asked to explain their reasoning for choosing the bag. It is fine for more than one group to select the same color bag. Identify groups that use the results from the previous rounds to determine which bag will be more likely to draw a winning block.

Allow each group to use the bag they have selected to play the bonus round and total their points.

After all students have played the bonus round, select groups to share their reasoning for choosing which bag to use. Select previously identified students to share their reasoning as well.

Ask students,

💬 *"Is one bag more likely to give you a winning cube than the others? Explain your reasoning."*

Open one of each color bag to reveal the contents. Ask students,

💬 *"Based on what you see now, does this change your answer? Explain your reasoning."*

The green bag should provide the best chance to win points, but it is not essential for the class to come to this understanding at this point.

Lesson Synthesis

Ask students,

💬 *"What are some examples of times you have predicted what will happen in the future based on what you have seen happen in the past?"*

Tell students that in the first half of this unit they will learn about different ways to determine how likely events are to happen. Examining previous results is one of the ways.

Lesson Summary

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Responding To Student Thinking

More Chances
Students will have more opportunities to understand the mathematical ideas addressed here. There is no need to slow down or add additional work to the next lessons.

Cool-down
Jada Draws Even

5 min

Student Task Statement

A large fish tank is filled with table tennis balls with numbers written on them. Jada chooses 10 table tennis balls from the tank and writes down their numbers.

1   3   5   1   3   2   4   1   5   3

A second tank is filled with golf balls with numbers written on them. Jada chooses 10 golf balls from the tank and writes down their numbers.

1   4   5   2   6   2   2   1   4   8

To win a prize, Jada must get a ball with an even number. Should she try to win the prize using the tank of table tennis balls or the tank of golf balls? Explain your reasoning.

Jada should use the tank of golf balls.

Sample reasoning: From the tank of table tennis balls, Jada only gets 2 even numbers out of the 10 she chooses. From the tank of golf balls, she gets 7 even numbers out of the 10 she chooses. There seems to be a better chance of her getting even-numbered balls from the tank that has golf balls.
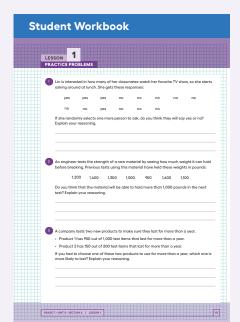
Practice Problems 5 Problems

Problem 1

Lin is interested in how many of her classmates watch her favorite TV show, so she starts asking around at lunch. She gets these responses:

yes   yes   yes   no   no   no   no   no   no   no   yes   no   no   no

If she randomly selects one more person to ask, do you think they will say yes or no? Explain your reasoning.

Sample response: I think they will say no, because most people so far have said no.

Problem 2

An engineer tests the strength of a new material by seeing how much weight it can hold before breaking. Previous tests using this material have held these weights in pounds:

1,200   1,400   1,300   1,500   950   1,600   1,100

Do you think that the material will be able to hold more than 1,000 pounds in the next test? Explain your reasoning.

Sample response: Yes, 6 out of 7 tests were able to, and the one that was not able to was still pretty close.

Problem 3

A company tests two new products to make sure they last for more than a year.

- Product 1 has 950 out of 1,000 test items that last for more than a year.

- Product 2 has 150 out of 200 test items that last for more than a year.

If you had to choose one of these two products to use for more than a year, which one is more likely to last? Explain your reasoning.

Product 1. Sample reasoning: A greater proportion of the test products for Product 1 last more than 1 year.
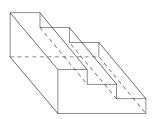
Problem 4

Put these numbers in order from least to greatest.

$$\frac{1}{2} \qquad \frac{1}{3} \qquad \frac{2}{5} \qquad 0.6 \qquad 0.3$$

$0.3, \frac{1}{3}, \frac{2}{5}, \frac{1}{2}, 0.6$

Problem 5

from Unit 7, Lesson 15

A small staircase is made so that the horizontal piece of each step is 10 inches long and 25 inches wide. Each step is 5 inches above the previous one. What is the surface area of this staircase?

2,850 square inches

Student Workbook