Rolling Races

Connections to the mathematics TEKS

(4.13)	Probability and statistics. The student solves problems by collecting, organizing, displaying, and interpreting sets of data.

The student is expected to:

(A)	list all possible outcomes of a probability experiment such as tossing a coin

(B)	use a pair of numbers to compare favorable outcomes to all possible outcomes such as four heads out of six tosses of a coin

(C)	interpret bar graphs

(4.15)	Underlying processes and mathematical tools. The student communicates about Grade 4 mathematics using informal language.

The student is expected to:

(A)	explain and record observations using objects, words, pictures, numbers, and technology

(B)	relate informal language to mathematical language and symbols

(4.16)	Underlying processes and mathematical tools. The student uses logical reasoning to make sense of his or her world.

The student is expected to:

(A)	make generalizations from patterns or sets of examples and nonexamples

(B)	justify why an answer is reasonable and explain the solution process.

Mathematics overview

Students collect, record, and organize data into a table and bar graph; formulate questions; and develop strategies and draw conclusions based on the organized data.

Lesson Overview

Students play a game to determine the likelihoods of different outcomes when rolling two number cubes.

Materials

number cubes (two for each group)

blank number lines

counters

Rolling Races recording sheets (a blackline master appears at the end of this lesson)

chart paper for class graph

markers

Lesson resources

Marilyn Burns and Bonnie Tank, *A Collection of Math Lessons, Grades 3-6*, Math Solutions Publications, 1986.

Related resources

Online simulation: nces.ed.gov/nceskids/probability/dice_handler.asp

Set-up *(to set the stage and motivate the students to participate)*

Arrange the students in groups of two. For each pair, set aside

1 pair of number cubes

a blank number line

11 counters

Rolling Races recording sheets (2-3 per pair of students)

Post a large piece of chart paper (or erase a large section of the chalkboard). Draw a vertical line on the left side. Across the top, write "Rolling Races."

1. Begin the lesson by holding up a pair of number cubes. "If I roll two number cubes and add the numbers that come up, what is the smallest

sum I could get?" When the students answer "2", record 2 at the bottom of the left side of the line on the chart paper or chalkboard. "What is the largest sum I could get?" When the students answer "12", record 12 at the top of the left side of the line, leaving room for the possible sums in between. "What about 3? Is a sum of 3 possible? How could I get it?" Continue with 4, 5, 6, etc., up to 12. Ask about 13. "How many possible sums are there when we roll two number cubes and add the numbers that come up?" Verify from the list on the left side of the graph that there are 11 possible sums. (4.13A, 4.15A)

2. Now teach the Rolling Races game to the class. "I'm going to teach you a game that you will play with a partner. I'm going to give you and your partner 11 counters and a blank number line on which you need to record the possible sums from 2 to 12. You need to place your counters on your number line. You can do this in any way you like. You may put one counter on each sum. You may stack all the counters on the same sum. Or you can group them in any other way you like. Once all teams have placed their counters, I will begin to roll the number cubes. When I roll the number cubes, I will call out the sum that comes up. If you have a counter on that number, you remove it. For example, if I roll an 8 and you have a counter on 8, you would take it off. If you should happen to have two or more counters on 8, you would take off only one of those counters per roll. The idea is to be the first team to remove all of your counters. With your partner, talk about how you would like to arrange your counters to try to be the first team to take them all off." (4.15B)

3. When the teams have had a chance to discuss their strategies and place their counters, roll the number cubes to play the game. (4.15A, B)

4. After playing one time, have students discuss their observations. Then suggest that students use their observations from the first game to place their counters for the second game. Roll the number cubes to play the second game and have students discuss their observations from the second game. (4.16A)

5. After playing the game twice, say, "Now that you have had some chances to play the game, it might be interesting to gather some data which may help us play the game better next time." Explain that each pair of students is going to roll a pair of number cubes and record with an X on the Rolling Races recording sheet by the sum after each roll. When one sum reaches the "finish line," they will record each of their rolls with a tally mark on the class graph. Tell students that they may use as many recording sheets as they have time to do in order to collect a large sample of data. (4.13C)

6. After each group marks their sums on a class graph, have the students discuss the results. (For example, it appears that the sums of 6, 7, and 8 occur more often than sums of 2, 11, and 12.) (4.13C)

7. After discussing the class graph, have students develop strategies for placing their counters on their number lines, and play the Rolling Races game again to see how their strategies work. (4.16A, B)

Teacher notes *(to personalize the lesson for your classroom)*

Guiding Questions
(to engage students in mathematical thinking during the lesson)

During the game, notice when students have removed most of their counters and are waiting for only two or three numbers on their number lines. You may wish to ask such questions as:

- Which numbers are most of you waiting for? (4.15A)

- Who is waiting for 2, 11, or 12? (4.15A)

- Which sums did I seem to call most often? (4.16A)

- How many possible outcomes are there when you roll the number cubes?

  (Students may think only 11, since there are 11 sums, but use something like the chart below to point out that there are 36 different possible outcomes, some with the same sums. Especially important to note is that rolling a 1 on Die 1 and a 2 on Die 2 for a sum of 3 is counted as a different outcome from rolling a 2 on Die 1 and a 1 on Die 2. This is why sums of 3 are expected to happen twice as often as sums of 2 when you roll two number cubes. This chart is intended for example only. Lead the children to develop a chart similar to this after compiling information.) (4.13A; 4.15A, B)

Die 1

Die 2	1	2	3	4	5	10
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

The outcomes of rolling the number cubes could also be represented with 36 ordered pairs:

Die 1

Die 2	1	2	3
1	(1,1)	(1,2)	(1,3)
2	(2,1)	(2,2)	(2,3)
3	(3,1)	(3,2)	(3,3)

Teacher notes *(to personalize the lesson for your classroom)*

Summary Questions
(to direct students' attention to the key mathematics in the lesson)

When most pairs have had a chance to complete two or three recording sheets, begin a class discussion to connect the likelihood (probability) of each sum to developing strategies for playing the game. Questions for the class might include:

- Which sum occurred the most often? (4.13C)

- Why do you think this happened? Was it just luck? (4.13A, B; 4.16A, B)

- How many possible outcomes are there? (36) (4.13A)

- How many ways can you get a sum of 6? (5 out of 36) (4.13B)

- How many ways are there to roll a 7? (7 out of 36) (4.13B)

- How many ways are there to roll a 2? (1 out of 36) a 12? (1 out of 36) What are they? (4.13B)

- What other sums came up on our class graph? How many ways can you get those sums? (Students might try to tell you that you can roll 9 with a 7 and a 2 and an 8 and a 1. Remind them that they are limited by the numbers on the number cubes.) (4.13A, B)

- Which sums do not appear on our class graph? Why do you think they don't? (4.13A)

- If there are five ways to get a 6, and we have 36 possible outcomes, how can we record this information? What are some of the different forms in which this information could be recorded? (5 out of 36 or 5/36) (4.13B, 4.15A)

- If we were to play the game again, think about how you would arrange your counters to try to win the game. Talk it over with your partner. Write a description of the arrangement you would use and explain why you made those choices. (4.15A; 4.16A, B)

Teacher notes *(to personalize the lesson for your classroom)*

Assessment Tasks *(to identify the mathematics students have learned in the lesson)*

- Give students a description of an activity using 4-sided polyhedrons numbered 1-4, and have them predict possible and expected outcomes and justify their answers.

- Have students make a table or graph for an activity using a die with something other than 6 sides.

- Have students make suggestions to improve the charts or graphs.

- Have students explain how they used the table or graph to design their strategy for playing the game.

Teacher notes (to personalize the lesson for your classroom)

Extensions *(to lead students to connect the mathematics learned to other situations, both within and outside the classroom)*

Students can play the game again to test the strategy they designed and answer the following questions:

- How did your results compare with your prediction?

- How can you explain your results?

- How would your results change if you rolled one die instead of two number cubes and recorded the number that comes up? Predict first, then try it and see.

- What would happen if you use other number polyhedrons? Make a prediction. Try it and see.

- How do you think your results would change if you rolled three number cubes instead of two? Predict first, then try the experiment.

- How many times should you plan to roll the number cubes to get some meaningful results? Record your results and compare with your prediction.

Teacher notes (to personalize the lesson for your classroom)

Rolling Races Recording Sheet

12								
11								
10								
9								
8								
7								
6								
5								
4								
3								
2								

Finish Line!