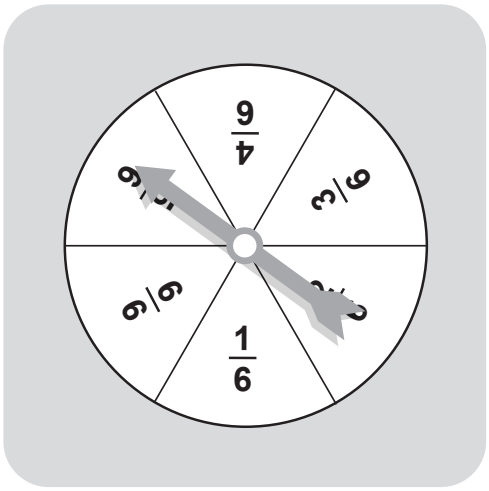
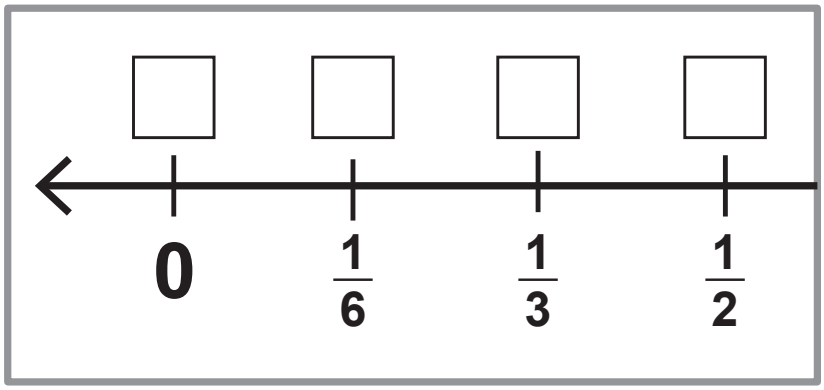
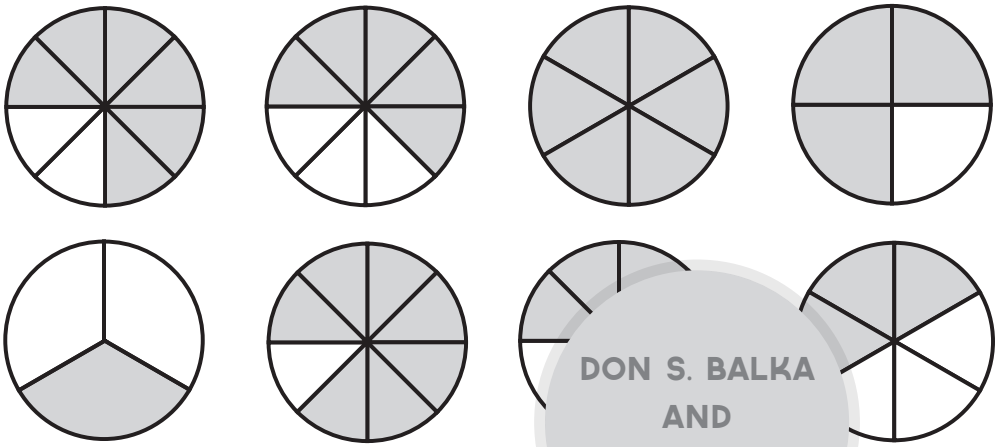
WORKING WITH

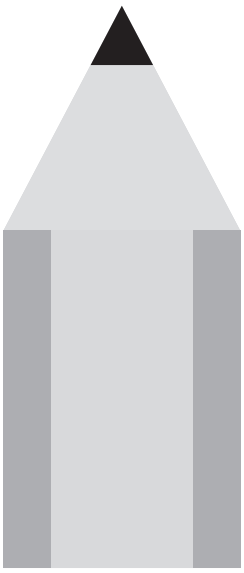
Fraction Number Lines

Games and Activities to Develop Fraction Fluency









DON S. BALKA
AND
RUTH HARBIN
MILES

Contents

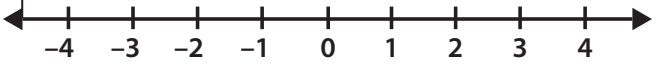
Introduction

As students in Grades 3–5 continue their journey through mathematics, the use of fraction number lines often makes concepts such as relative size, order, fraction equivalence, addition and subtraction of fractions, and decimals much easier to understand. Fraction number lines may help learners visualize these ideas, discover fraction relationships, and develop number sense about fractions and decimals.

Definition of "Number Line"

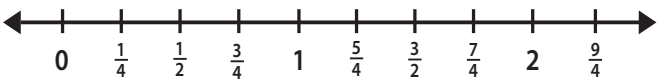
There are numerous definitions and various types of number lines. To begin, we offer the dictionary definition of number line and then expand upon it to make it more understandable for our students in the intermediate grades.

> A number line is a line of infinite extent whose points correspond to the real numbers according to their distance in a positive or negative direction from a point arbitrarily taken as zero (Merriam-Webster, 2014).



To the right of 0 are the positive numbers; to the left, the negative numbers. Every point on a number line corresponds to a real number, and every real number corresponds to a point.

For the primary grades, we generally only use a number line beginning at 0 and extending to the right. As students progress through the grades, they encounter positive rational numbers (or fractions) on the number line and then their decimal equivalents.



In Grade 6, students begin the study of negative rational numbers, first with negative integers, as shown on our first number line (above).

For the purposes of this book, however, we will use a fraction number line that has a starting point of 0 and extends to the right only. We will focus only on 0, positive rational numbers, and their related decimal equivalents.

Types of Number Lines

Our book, *Working with Fraction Number Lines*, provides Grades 3–5 teachers with numerous games and activities involving several types of fraction number lines.

A **floor number line** can be constructed in classrooms that have large open spaces. Fractions or whole numbers printed in large typefaces can be equally spaced and taped to the floor for a variety of activities.

Elementary school students also enjoy **human number lines,** in which students each hold a fraction on paper and align themselves from least to greatest.

A **rope number line** provides opportunities for students to take clothespins and hang numbers in appropriate positions on the rope.

An **open number line,** often called an empty number line, is a visual representation with no scale or predetermined markings. It is used for recording and sharing students' thinking strategies during the process of mental computation. As students create their own number lines from the open number line format, they develop flexibility with mental math strategies. Open or empty number lines allow students to partition or subdivide the number line by a given fraction size to solve problems visually.

A myriad of **printable number lines** are also provided; some are in a game or activity sheet format with missing numbers to be filled in.

Math Standards and Fraction Number Lines

Number lines serve as a great tool for students to focus on specific content and practice standards from the current mathematical standards. The Common Core domain dealing with fractions for Grades 3, 4, and 5 is Number and Operations – Fractions.

There are a variety of fraction standards from non-Common Core states that are similar and specific to number line activities. Students initially recognize that fractions can be used to represent points or distances on a number line. They later compare and order fractions that have unlike numerators and unlike denominators using a number line. Teachers from non-adopting states will have no difficulty finding an appropriate activity to match the focus on fractions and decimals.

(See pages 6–7 for a list of the standards that are covered by the activities in this book.)

Using This Book

In this book, we offer a multitude of games and activities using fraction (and decimal) number lines. Each game or activity lists appropriate standards and mathematical practices and can be played as a whole class, in small groups, or by partner pairs.

In addition to these games and activities, we include five specific assessments that cover the key fraction topics:

- Naming a particular fraction located on a number line
- Finding equivalent fractions on different number lines
- Locating specific fractions on either side of a given fraction on a number line
- Finding the sum or difference of a given fraction and a fraction illustrated on a number line
- Finding the product or quotient of a whole number multiplied or divided by a fraction on a number line.

Each assessment page has no more than six items for ease in administering to or discussing with students.

Beginning Fraction Work

Students in Grade 3 have been exposed to number lines since kindergarten. Students in Grades K–2 worked with number lines that started at 0 and extended to the right, showing whole numbers equally spaced.

In Grade 3, fraction number line activities begin with students subdividing a 0-to-1 number line into fractional parts. Benchmark fractions such as 1/2, and later 1/3 and 1/4, provide points that students are able to visualize and use to locate many other fractions.

Eventually, mixed numbers and their corresponding improper fraction formats are introduced. The fraction number line is extended beyond 1, with students locating numbers such as 9/4 or 3 1/2.

Operations with Fractions

For many students, operations with fractions are one of the most difficult topics in the mathematics curriculum. Often students lack experience using number lines as a tool for understanding addition and subtraction of fractions. We have provided activities and games that involve the fraction number line to perform these operations.

Find Those Fractions!

Fraction number lines, and the accompanying games and activities in this book, provide an early tool for students in the intermediate grades to visually understand fractions and to perform operations on fractions. We hope you will find these games and activities to be engaging for your students as they continue their mathematics journey.

—Don S. Balka and Ruth Harbin Miles

Correlation to the Math Standards

Standard	Activity No.
Grade 3	
Number and Operations – Fractions (3.NF)	
Develop understanding of fractions as numbers.	
Understand a fraction $1/b$ as the quantity formed by 1 part when a whole is partitioned into b equal parts; understand a fraction a/b as the quantity formed by a parts of size $1/b$. **(3.NF.1)**	
Understand a fraction as a number on the number line; represent fractions on a number line diagram. **(3.NF.2)**	1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size. **(3.NF.3)**	3, 6, 7, 8, 10,
Grade 4	
Number and Operations – Fractions (4.NF)	
Extend understanding of fraction equivalence and ordering.	
Explain why a fraction a/b is equivalent to a fraction $(n \times a)/(n \times b)$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions. **(4.NF.1)**	11–17, 23
Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as $1/2$. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model. **(4.NF.2)**	12, 15, 18, 19
Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.	
Understand a fraction a/b with $a > 1$ as a sum of fractions $1/b$. **(4.NF.3)**	20, 21
Apply and extend previous understandings of multiplication to multiply a fraction by a whole number. **(4.NF.4)**	24
Understand decimal notation for fractions, and compare decimal fractions.	
Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. **(4.NF.5)**	

Use decimal notation for fractions with denominators 10 or 100. **(4.NF.6)**	22, 23
Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model. **(4.NF.7)**	23
Grade 5	
Number and Operations – Fractions (5.NF)	
Use equivalent fractions as a strategy to add and subtract fractions.	
Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. **(5.NF.1)**	25–28
Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. **(5.NF.2)**	29
Apply and extend previous understandings of multiplication and division to multiply and divide fractions.	
Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. **(5.NF.3)**	
Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction. **(5.NF.4)**	24
Interpret multiplication as scaling (resizing). **(5.NF.5)**	
Solve real-world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem. **(5.NF.6)**	
Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions. **(5.NF.7)**	30

For examples of fraction standards from non-Common Core states that are similar and specific to number line activities, see **www.didax.com/211207.** Examples from the Indiana Academic Standards, Minnesota Academic Standards, Oklahoma Priority Academic Student Skills, Texas Essential Knowledge and Skills, and Virginia Standards of Learning for Grades 3 through 5 are included.

7 Fraction Neighbors

Number of Students

Pairs

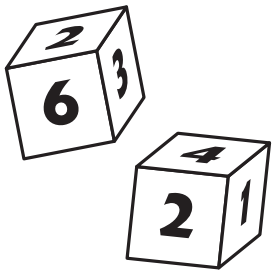
Materials

For each student:

- Fraction Number Line (3rds, 4ths, or 6ths) (pages 116–117)
- Two 1–6 number cubes

Overview

Students form fractions by tossing two number cubes. The fractions they generate are marked off on a number line.



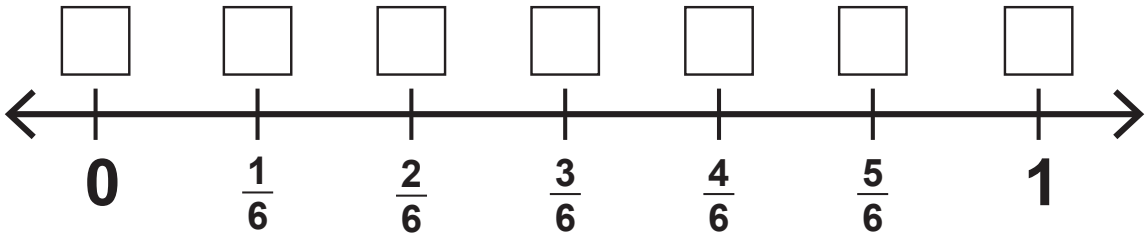
Presenting the Activity

1. Make a copy of the appropriate "Fraction Neighbors" Number Line (3rds, 4ths, or 6ths) for each student.
2. Distribute a fraction number line and two 1–6 number cubes to each pair of students.
3. Say to students:

   "You are going to play a game called 'Fraction Neighbors.'

   "For this game, you each have a fraction number line that is divided into thirds (or fourths or sixths).

   "On your turn, toss the two number cubes and form a proper fraction or 1.



Grade 3 Math Standards 3.NF.2, 3a; MPS 2

"For example, if you toss a 3 and a 4, you will form the fraction 3/4. If you toss a 6 and a 6, you will form the fraction 6/6, which is the same as 1.

"After you have determined the fraction, locate it on your fraction number line and place an 'X' in the square above the fraction.

"Continue taking turns, forming fractions with the number cubes, and marking the location of the fraction on the number line.

"Keep playing until one of you has three fractions in a row marked—for example, 1/6, 2/6 or 1/3, and 3/6 or 1/2.

"If you form a fraction that you have already marked, you lose your turn.

"If you toss '5' as the higher number (for example, 4 and 5 to make 4/5), toss again.

"The first player to mark three fractions in a row is the winner."

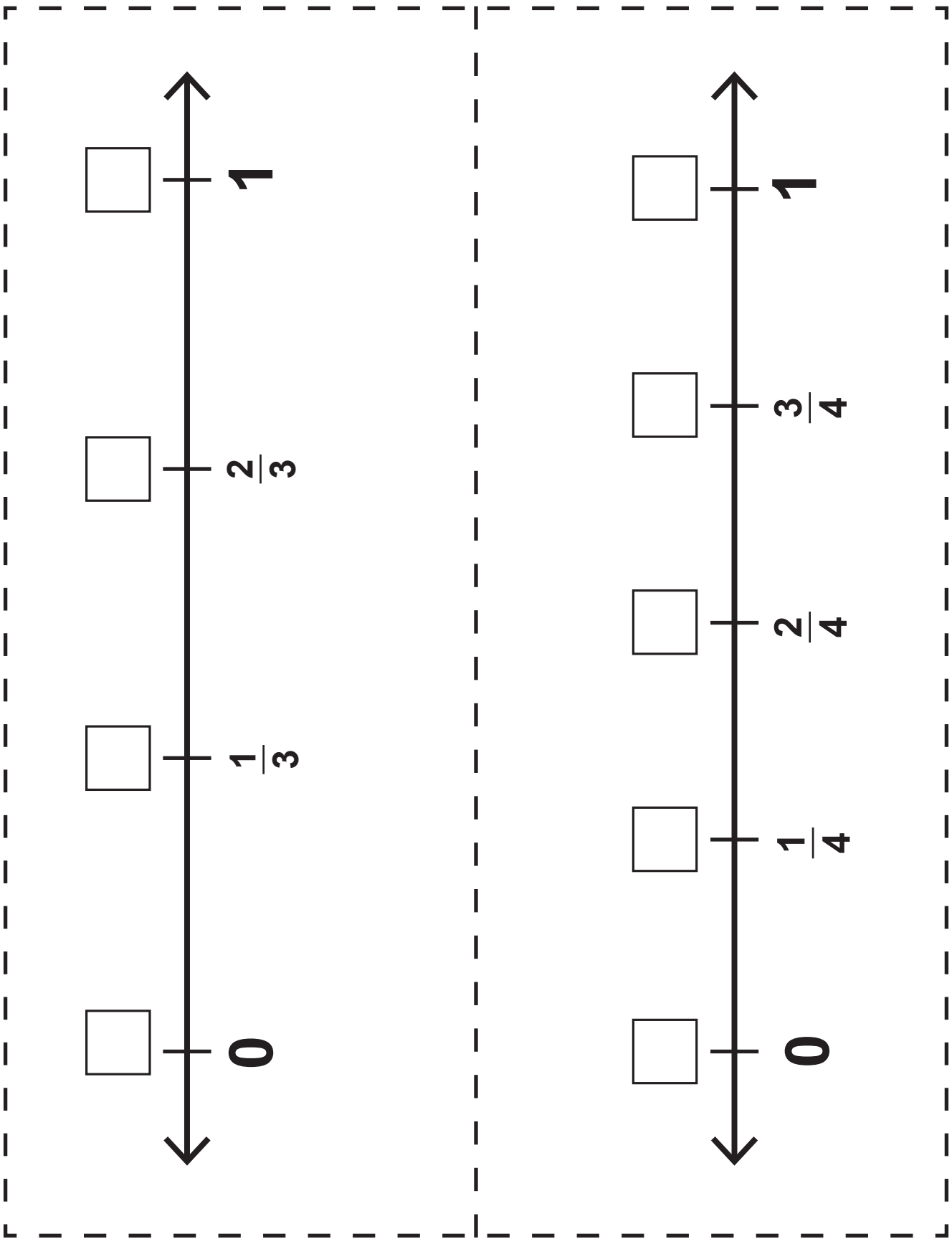
4. Small groups can play the game using the same rules.

Assessing Student Responses

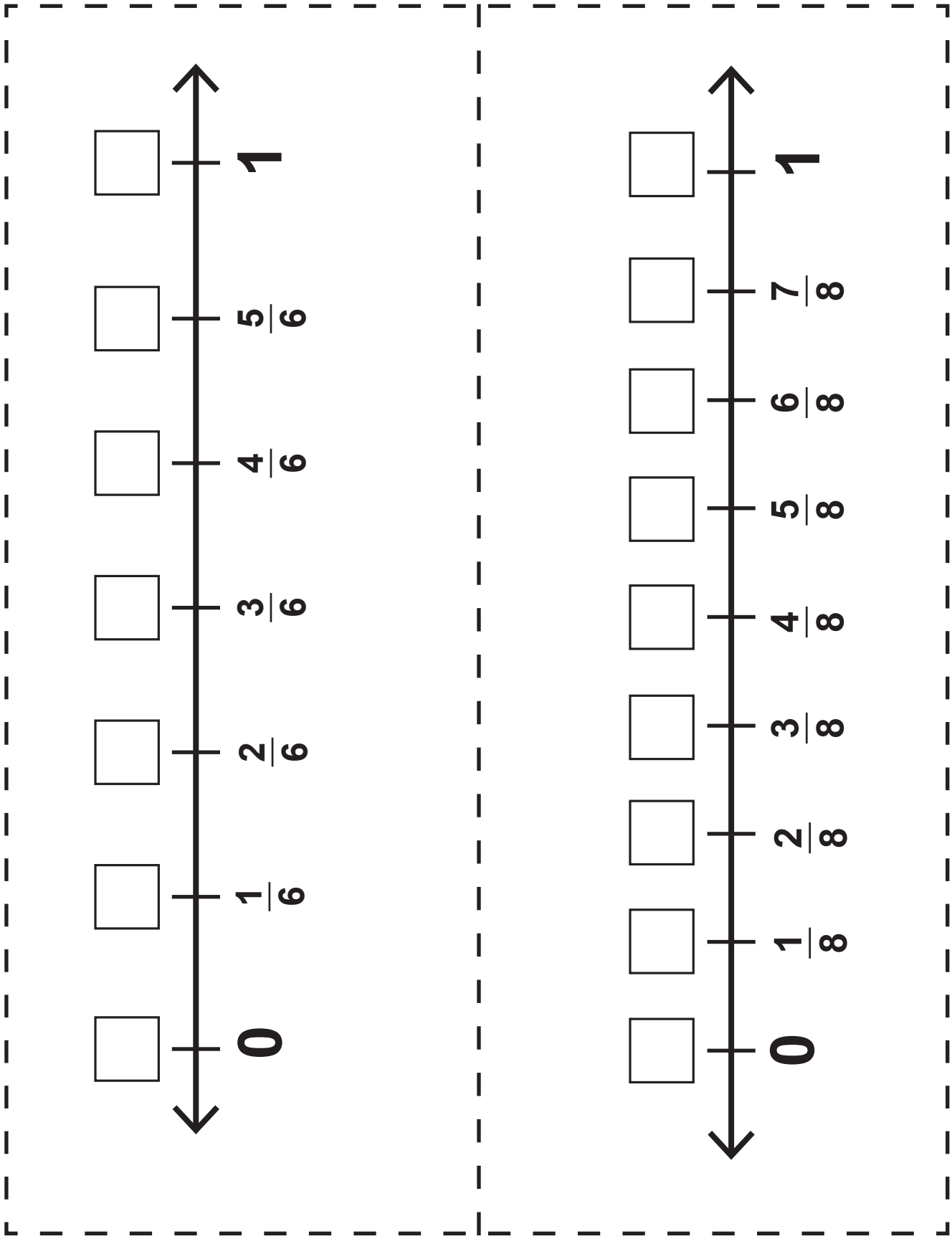
The following questions will help you assess your students' responses to the activity:

- Were students able to correctly translate the numbers tossed with the number cube into fractional amounts?
- Were students able to locate the fractions on the fraction number lines?
- Were students able to find equivalent fractions on the fraction number lines (2/6 = 1/3, 3/6 = 1/2, 4/6 = 2/3)?
- Were students able to recognize the fractional equivalents of 1?

"Fraction Neighbors" Number Line – 3rds, 4ths



"Fraction Neighbors" Number Line – 6ths, 8ths



24 Fraction Jump

Number of Students

Pairs

Materials

For each pair:

- "Fraction Jump" Cards (pages 150–152)

For each student:

- "Fraction Jump" Recording Sheet – 6ths and 8ths (page 153)

Overview

In this activity, students make "jumps" on a number line to find the product of a whole number and a fraction.

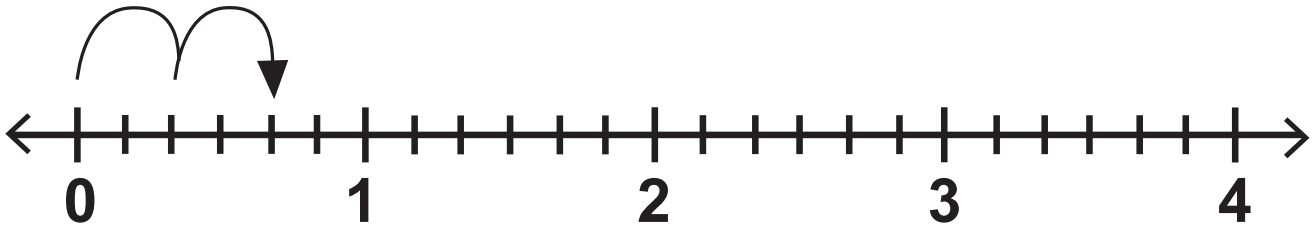
$$2 \times \frac{1}{3}$$

Presenting the Activity

1. Make a copy of the "Fraction Jump" cards for each pair of students.
2. Divide the class into pairs. Distribute a set of "Fraction Jump" cards to each pair.
3. Say to students:

   "You and your partner have a set of 'Fraction Jump' Cards. Partner 1 will shuffle the cards and deal eight cards facedown to each of you.

   "Each of you has a 'Fraction Jump' Number Line and Recording Sheet.



Grade 4–5 Math Standards 4.NF.4a–b; 5.NF.4a; MPS 3, 4

"'Fraction Jump' is not a game. You and your partner will be checking each other as one of you multiplies a whole number by a fraction.

"For example, suppose we have a number line marked in fifths. If you drew a card that said '4 × 2/5,' what would you do?"

(Give students a chance to respond.)

"You would first make a jump from 0 to 2/5 on your number line, and then you would make three more jumps to find the product." (Demonstrate on the board.)

"What would the product be? (8/5) What is the mixed number for 8/5? (1 3/5)

"Partner 2 starts by turning over the top 'Fraction Jump' Card. Partner 2 shows how to multiply the whole number times the fraction by making jumps on the number line.

"If Partner 1 agrees on the product, Partner 2 writes the multiplication sentence on the recording sheet.

"The two of you will take turns drawing a card and showing how to find the product until you have used all of your cards.

"Then, we will discuss each of the 16 problems to find out if you all agree on the products."

4. Additional card sets can be created using 3/8 and 5/8 for one deck. The products will still be less than 4.

Assessing Student Responses

The following questions will help you assess your students' responses to the activity:

- Were students able to correctly show multiplication on the number line?
- Were students able to find the correct product?

"Fraction Jump" Cards

$2 \times \frac{1}{2}$	$3 \times \frac{1}{2}$
$4 \times \frac{1}{2}$	$5 \times \frac{1}{2}$
$2 \times \frac{1}{4}$	$3 \times \frac{1}{4}$
$4 \times \frac{1}{4}$	$5 \times \frac{1}{4}$
$2 \times \frac{1}{8}$	$3 \times \frac{1}{8}$

"Fraction Jump" Cards

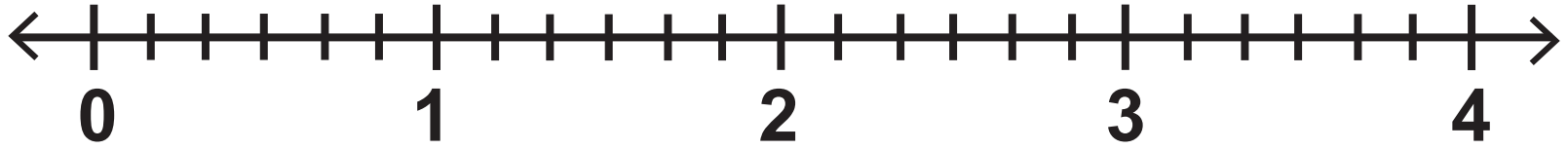
$4 \times \frac{1}{8}$	$5 \times \frac{1}{8}$
$2 \times \frac{1}{3}$	$3 \times \frac{1}{3}$
$4 \times \frac{1}{3}$	$5 \times \frac{1}{3}$
$2 \times \frac{1}{6}$	$3 \times \frac{1}{6}$
$4 \times \frac{1}{6}$	$5 \times \frac{1}{6}$

"Fraction Jump" Cards

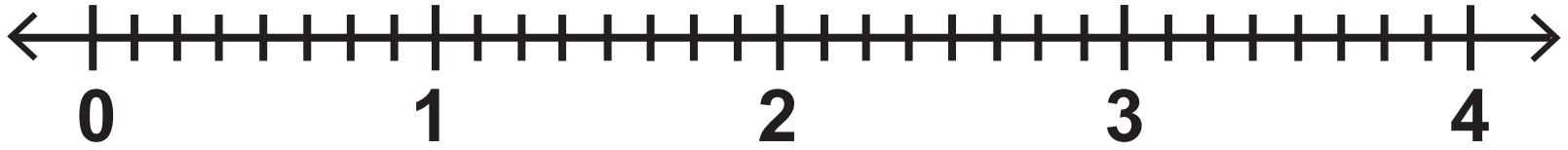
$2 \times \frac{2}{3}$	$3 \times \frac{2}{3}$
$4 \times \frac{2}{3}$	$5 \times \frac{2}{3}$
$2 \times \frac{3}{4}$	$3 \times \frac{3}{4}$
$4 \times \frac{3}{4}$	$5 \times \frac{3}{4}$

"Fraction Jump" Recording Sheet

6ths



8ths



Number Sentences:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

29 Fraction Baseball

Number of Students

Entire class divided into two teams

Materials

For the class:

- "Fraction Baseball" Spinner Sheet (page 160)
- Spinner, or paper clip and pencil

For the teacher:

- "Fraction Baseball" Word Problem Cards (pages 161–165) to project
- Document camera (if available)
- 4 objects representing the 4 "bases"

For each student:

- Scratch paper and pencil
- Commercially available fraction rectangles or circles (optional)

Overview

In this lively game, the entire class solves word problems involving addition, subtraction, multiplication, and division of fractions in a baseball format.

Grade 5 Math Standards 5.NF.2, 6, 7c; MPS 3, 4

Presenting the Activity

1. Make one copy of "Fraction Baseball" Word Problems Cards and cut the cards apart.
2. Make one copy of the "Fraction Baseball" Spinner Sheet. If a spinner is not available, use a paper clip and pencil as the spinner.
3. Place objects to represent the four bases of a baseball diamond around the room.
4. Divide the students into two teams. Designate one team the **home team** and the other team the **visiting team.**

5. Designate a scorekeeper.
6. Ask students to use their own scratch paper and pencils to solve the problems. Provide fraction circles or rectangles (with moveable pieces), if needed.
7. Say to students:

   "We're going to play a game of 'Fraction Baseball.' The visitors' team will be up first.

   "To begin the game, the first batter on the visiting team walks up to home plate and spins the spinner to determine his or her first 'hit.'

   "If the batter spins a **single, double, triple,** or **homerun,** the batter reads the word problem aloud for all to hear. The whole class begins solving the problem. When the batter has solved the problem, he/she shares how the problem was solved. If the class agrees that the batter is correct, the batter moves to first, second, third, or home base, depending on the spin. If not correct, the batter is out.

   "If the batter spins a **walk,** the batter walks to first base. No word problem is given to the player.

   "If the batter spins an **out,** the batter is out.

   "Just like in real baseball, the visiting team will keep spinning and solving problems until the team has three outs. Then it's the home team's turn. Our scorekeeper will keep score for all to see.

   "We will play two innings to determine the winning team."

Assessing Student Responses

The following questions will help you assess your students' responses to the activity:

- Were students able to correctly solve the fraction word problems?
- Were students able to correctly simplify and add or subtract the fractions?
- Were students able to recognize when a problem called for multiplication or division of a whole number by a fraction?
- Were students able to correctly perform the multiplication or division?

"Fraction Baseball" Word Problem Cards

I ate $\frac{1}{6}$ of a box of cereal. My brother ate $\frac{1}{3}$ more than I ate. Altogether, what fraction of the box of cereal did we eat?

Maria drank $2\frac{1}{2}$ glasses of juice. Donnie drank $3\frac{3}{4}$ glasses of juice. How many glasses of juice did they drink altogether?

Yesterday, Timothy rode his bike $15\frac{3}{4}$ blocks. Today he plans to ride his bike $15\frac{7}{8}$ blocks. Altogether, how many blocks will he ride?

LaShanda worked for $1\frac{7}{12}$ of an hour on her homework. Brian worked for $1\frac{3}{4}$ of an hour. Who spent more time on their homework, and how much more time?

Two puppies weigh $5\frac{7}{8}$ and $4\frac{1}{10}$ pounds. What is the difference in weight of the two puppies?

Andrew worked $8\frac{1}{2}$ hours on Monday and $2\frac{1}{6}$ hours on Tuesday. What is the difference in hours he worked on the two days?

A cake recipe uses $4\frac{2}{5}$ cups of flour. If the baker begins with 8 cups of flour, how many cups are left after the cake is baked?

The longest carrot in the bag is $10\frac{1}{4}$ inches long. The shortest carrot is $6\frac{1}{12}$ inches long. What is the difference in inches?

"Fraction Baseball" Word Problem Cards

Yesterday Mia walked $\frac{1}{2}$ a mile. Today she walked $\frac{9}{10}$ of a mile. How far did Mia walk altogether?

A cake mix calls for 1 cup of water. Mom pours $\frac{1}{4}$ cup of water into the batter. How much more water does she need to pour into the batter?

For my recipe, I used $\frac{1}{2}$ cup of brown rice and $\frac{7}{8}$ cup of white rice. How much more white rice than brown rice did I use?

Lucy spent $\frac{3}{4}$ of an hour cleaning her room. Betsy spent $\frac{1}{8}$ of an hour cleaning her room. How much more time did Lucy spend on cleaning than Betsy?

Two bags of candy weigh $1\frac{5}{6}$ lb and $2\frac{1}{3}$ lb. What is the difference in weight of the two bags of candy?

A blue ribbon is $4\frac{2}{3}$ inches long. A white ribbon is $5\frac{1}{6}$ inches long. How much longer is the white ribbon than the blue ribbon?

William finished $\frac{3}{8}$ of his math homework problems. Sean finished $\frac{1}{3}$ of the problems. Together, what fraction of the problems have they finished?

The longest pencil in my pencil can is $7\frac{1}{8}$ inches long. The shortest pencil is $3\frac{1}{4}$ inches long. What is the difference in length of the two pencils?