Measure Beach Erosion

Number and Operations—Fractions

Grade 4

45 Min.

or

CCSS MATH
4.NF.A.1, 4.NF.B.3C, 4.MD.B.4

TEKS MATH
4.3.E, 4.9.A

QSC
QSC199, QSC1023

LESSON OBJECTIVE
Use line plots to solve problems involving adding and subtracting fractions.

LANGUAGE OBJECTIVES
Understand the words *erosion*, *line plot*, *measurement*, and *number line* and apply them in context.

PREREQUISITE SKILLS
Add and subtract mixed numbers with like denominators.

LESSON OVERVIEW
Students organize measurements involving amounts of beach erosion over different time periods. They create line plots for each time period and analyze their findings.

MATERIALS
- Fraction circles
- Fraction bars
- Vocabulary Knowledge Rating Sheet

Science Background

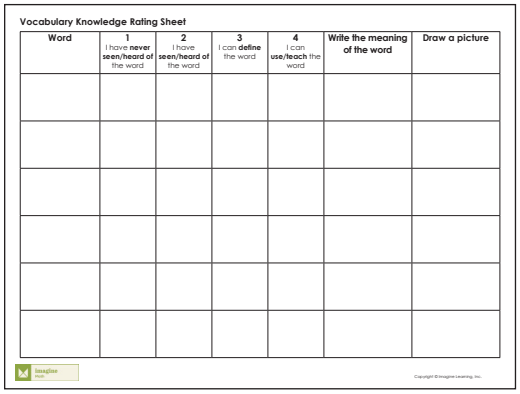
With almost half of the US population living near a coastline, more and more people are affected by coastal erosion. From gradual erosion to the severe hazards produced by strong storms, shoreline erosion results in billions of dollars of damage every year.

In the context of measuring the amount of erosion at a local beach, students reinforce their understanding of adding and subtracting fractions and mixed numbers with like denominators, as well as their ability to recognize equivalent fractions. Students use a line plot to organize and analyze data, and they use addition to check their answers to problems involving subtraction of fractions and mixed numbers.

Vocabulary Knowledge Rating

Before students begin the task, pre-assess student knowledge of words used in the task. Write the words *erosion*, *line plot*, *measurement*, and *number line* for students to see. Ask students to individually say the word and then write the word on a Vocabulary Knowledge Rating Sheet using the ratings from 1–4 as shown. Once students have self-assessed, ask students to write what they think the word means in their own words on their rating sheet. Then, ask them to draw a picture of the word.

Throughout the task, students should discuss the meanings of the words within the context of the situation. At the end of the task, ask students to reassess their word knowledge using the same four-point scale.



Vocabulary Knowledge Rating Sheet

Word	1 I have never seen/heard of the word	2 I have seen/heard of the word	3 I can define the word	4 I can use/teach the word	Write the meaning of the word	Draw a picture

Task Application

In the context of analyzing measurements of beach erosion and representing the data with line plots, students add, subtract, and compare whole numbers, fractions, and mixed numbers. Students use their line plots and subtraction equations to find differences between least and greatest values, and they use addition to check their answers.

Guide students to understand what is meant by "beach erosion." One way to measure beach erosion is to measure the width of the beach at fixed locations on a regular basis. A decrease in beach width from one measurement to the next indicates an increase in beach erosion. In this task, students are given beach erosion measurements that have already been calculated using *beach erosion = current beach width – previous beach width*.

In ***section A***, students make a line plot showing beach erosion measurements. The measurements are expressed as whole numbers, mixed numbers, and fractions. Students complete sentences and answer questions about the line plot. Students who need help comparing and ordering fractions and mixed numbers with like and unlike denominators may benefit from using visual fraction models such as fraction circles or bars.

In ***section B***, students create two line plots to represent the amounts of beach erosion during two different three-month periods. Remind students to complete the titles for their line plots.

In ***section C***, students use the line plots to analyze the data by finding differences between the least and greatest measurements for each three-month period.

In ***section D***, students use addition to check the subtraction problems they completed in section C. If students have difficulty understanding the relationship between fraction addition and subtraction, reinforce visual understanding by demonstrating the relationship using a number line.

Watch Out: Common Misconceptions

Students may be challenged when faced with situations requiring them to subtract fractions and mixed numbers with differing denominators. Help them to understand that they can write fractions in equivalent forms. Point out that $\frac{2}{4}$ is equal to the more familiar fraction $\frac{1}{2}$. Ask how writing $\frac{1}{2}$ as $\frac{2}{4}$ could make it easier to subtract $\frac{1}{4}$ from $\frac{1}{2}$. Encourage students to develop the ability to recognize common equivalent fractions such as $\frac{1}{2}$ and $\frac{2}{4}$.

Point out that beaches can also change shape through the process of accretion. This happens when sand or other materials are added to a beach to make it larger. Ask students how they could use addition and subtraction to explore the relationship between beach erosion and beach accretion.

Sample Rubric

Score	Criteria
3	Students accurately complete the line plot and other answers in section A. In section B they create accurate line plots for two different three-month periods. Their answers in sections C and D accurately apply math concepts.
2	Students complete the line plot and other answers in section A with one or two errors, and in section B they create at least one accurate line plot for a three-month period. Their answers in sections C and D apply math concepts with no more than one minor error.
1	Students complete the line plot and other answers in section A with 50% or more accuracy, and they develop at least one accurate line plot in section B for a three-month period. Their answers in sections C and D are mostly inaccurate statements and demonstrate an inaccurate understanding of math concepts.
0	Students present a very limited or rudimentary response to the assignment. They complete the line plot and answers in section A with less than 50% accuracy, make inaccurate line plots or no line plots in section B, and include very general or incomplete answers to the questions in sections C and D.

STEM Activity Suggestions

NGSS SCIENCE	SCIENCE AND ENGINEERING PRACTICE	MATHEMATICAL PRACTICE
NGSS 4-ESS2-1	SEP3	MP5

STEM OBJECTIVE Apply strategies for measuring beach erosion to investigating erosion caused by water moving down a slope of land.

1. **Build Background** Soil erosion can happen quickly when water runs downhill during a heavy rain event. Each year, landslides and mudslides in the United States cause 25 to 50 deaths and over $1 billion in damages. Fortunately, preventative measures can be taken against landslides and mudslides, such as planting additional vegetation on moderate slopes and using netting or retaining walls on steeper slopes.

2. **Introduce the STEM Activity** Present a scenario in which a hillside with a 100-foot border along a school playground is eroding. The distance from top to bottom of the hill varies from 20 to 30 feet, and the steepness of the hillside varies as well.

   Instruct student groups to submit a bid for up to $1,000 to investigate the locations where erosion damage is the greatest and to estimate the rate of erosion. Have student teams research how this type of erosion occurs and how it can be measured, with the goal of creating a work proposal. Work proposals should include (1) a description of work to be performed, with justifications for why that work is necessary; (2) estimated time to complete the work; (3) estimated costs; and (4) two examples, with sample numbers, of the types of measurements to be prepared, using strategies and observations from the Application Task.

3. **Guide Teams** Encourage teams to think about how the equipment used and the number of people completing the investigation can impact the cost and time required to complete the investigation. Remind students to cite their sources at the end of their proposal.

4. **Assess Results** Evaluate the work proposal the group creates, ensuring that it provides evidence of the effects of erosion (**NGSS 4-ESS2-1, SEP3**) and that reasoning habits, as well as strategies from the Application Task, are used to mathematically create the examples with sample numbers (**MP5**).

Answer Key

APPLICATION TASK | **Measure Beach Erosion**

Name: _____

Goal
Use line plots to analyze the effects of beach erosion.

Why Study Beach Erosion?
Beach erosion causes billions of dollars of damage along US coasts each year, especially when there are strong storms.

Connect to Reading

Dirty Work: How Wind, Water, and Ice Shape the Earth

The Stone Forest

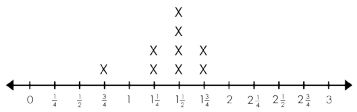
Essential Question **How can we use line plots to solve problems with fractions?**

In this task, you are studying erosion at a local beach. You will organize the data in line plots for different periods and then use the line plots to analyze patterns of erosion.

January	February	March
$1\frac{3}{4}$, $2\frac{1}{4}$, $1\frac{1}{2}$	$1\frac{1}{2}$, $1\frac{1}{2}$, $1\frac{1}{4}$	$1\frac{1}{2}$, $1\frac{3}{4}$, $1\frac{1}{4}$
April	**May**	**June**
$1\frac{1}{2}$, $\frac{3}{4}$, $1\frac{3}{4}$	$\frac{1}{2}$, $\frac{3}{4}$, $1\frac{1}{4}$	$\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{2}$
July	**August**	**September**
$\frac{1}{4}$, $\frac{3}{4}$, $\frac{1}{2}$	1, $\frac{1}{2}$, 1	$1\frac{1}{2}$, $1\frac{3}{4}$, $1\frac{1}{4}$
October	**November**	**December**
$1\frac{3}{4}$, 2, $1\frac{1}{4}$	$2\frac{3}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$	2, $2\frac{1}{2}$, $2\frac{3}{4}$

SAMPLE LINE PLOT

Beach Erosion from February to April (inches)



Erosion is measured three times per month.

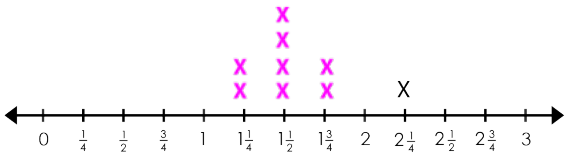
Did You Know? **In 2012, beach width along the Jersey Shore resort area decreased by 30 to 40 feet due to Hurricane Sandy.**

A | Understand

Name: _____

One way to solve this problem is shown. Make a line plot for any three consecutive months and complete the sentence. Some parts of the line plot and sentence are completed for you.

Beach Erosion from January (month) **to March (inches)**



From January to March, the difference between the least and greatest measurements of erosion is $2\frac{1}{4} - 1\frac{1}{4} = 1$ inch.

Think about It Use vocabulary words to complete the sentence.

The line plot shows data about beach erosion. Each X above the number line represents a measurement, in inches.

Explain It What can a line plot show you about the measurements for three months?

Sample answer: A line plot can show you what the measurements are, how many times each measurement occurs, and how the data is spread out from the least to the greatest measurement.

Talk about It Talk about how to solve this problem with a partner. Discuss how the sample solution in ***section A*** meets the requirements of the task.

ACADEMIC AND MATH VOCABULARY

Read each definition. Use these words in discussions and responses to thinking questions.

consecutive: following one after another in order from least to greatest

Examples: 4, 5, and 6 are consecutive whole numbers and 2, 4, 6, 8, and 10 are consecutive even numbers.

denominator: in a fraction, the number below the fraction bar that shows the number of equal-sized parts the whole has been divided into

equivalent: equal in value

Example: $\frac{1}{2}$ and $\frac{2}{4}$ are equivalent because they represent the same location on a number line.

erosion: the gradual destruction of something by wind, water, or other natural forces

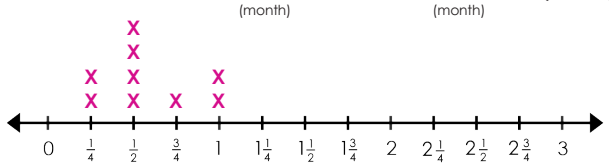
B | Organize

Name: _____

Create two different line plots for any three consecutive months. Choose months that will help you analyze the data. Remember to complete the titles for each line plot.

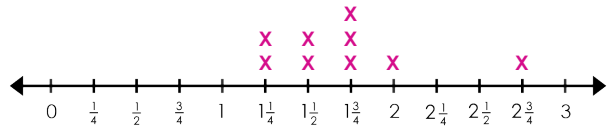
Line Plot 1

Beach Erosion from June (month) **to** August (month) **(inches)**



Line Plot 2

Beach Erosion from September (month) **to** November (month) **(inches)**



Explain It How did you choose the months for your line plots?

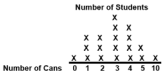
Sample answer: I wanted to compare the erosion in the summer months from June to August to the hurricane season months from September to November.

ACADEMIC AND MATH VOCABULARY *(continued)*

fraction: A number that is expressed in the form $\frac{a}{b}$ where b does not equal 0. Fractions name a part of a whole or part of a set.

line plot: A graph that shows the frequency of data along a number line. Dots or X's are used above the number line to show the frequency of the data.

Example: The line plot shows the number of cans collected by students in Mr. Lane's class.



The line plot shows that 3 students collected 1 can and only 1 student collected 10 cans.

measurement: a distance, size, or other quantity expressed as a number of units

mixed number: a number that consists of a whole number and a fraction

number line: a line where each point represents a number

whole number: a number greater than or equal to 0 without fractions; 0, 1, 2, 3, . . .

C | Solve

Name: _____

Complete the sentences for each line plot.

Line Plot 1

From June (month) to August (month), the difference between the least and greatest measurements of beach erosion is

1 – $\frac{1}{4}$ = $\frac{3}{4}$ inch(es).

Line Plot 2

From September (month) to November (month), the difference between the least and greatest measurements of beach erosion is

$2\frac{3}{4}$ – $1\frac{1}{4}$ = $1\frac{1}{2}$ inch(es).

D | Check

Use addition to check the differences in ***section C***.

Line Plot 1

June (month) to August (month) $\frac{1}{4} + \frac{3}{4} = 1$

Line Plot 2

September (month) to November (month) $1\frac{1}{4} + 1\frac{1}{2} = 2\frac{3}{4}$

Explain It How did you use addition to check the differences?

Sample answer: For each time period, I added the least measurement and the difference. The sum should equal the greatest measurement.

CONNECT TO SCIENCE

Beach erosion can happen gradually over time, and it can also happen very quickly.

Why is beach erosion harmful?

Sample answer: Erosion causes structures on the beach, like houses, to become unstable. Homes and businesses can be lost as a result of beach erosion.

Why would the amount of beach erosion increase at certain times of the year?

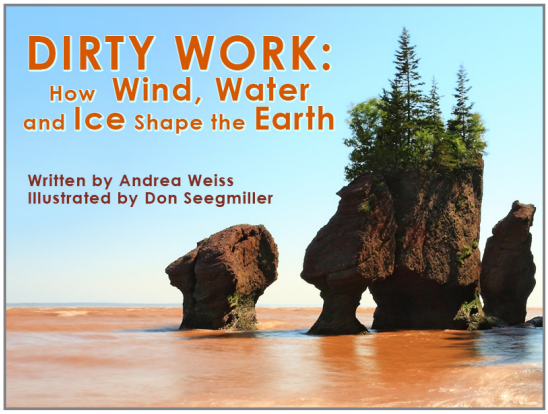
Sample answer: The amount of beach erosion is likely to increase when there are strong storms, so the erosion might be greater during hurricane season.

Extend How could you use the line plot to determine the "average" amount of beach erosion over each of the time periods?

Sample answer: You could find the middle X on the line plot. For example, in the line plot for January to March, the middle X is at $1\frac{1}{2}$ inch, which also happens to be the value with the greatest number of X's.

Name: _____

Dirty Work: How Wind, Water, and Ice Shape the Earth



Written by Andrea Weiss
Illustrated by Don Seegmiller
Lexile®: 840L, 613 words

Have you ever been pelted by rain or snow? Have you ever almost been blown over by the wind? If you were lucky, you had an umbrella or a coat to protect you. But the earth doesn't have that kind of protection. Rain and wind constantly beat against the surface of the earth.

Water, wind, and ice change the shape of Earth's surface all the time through the processes of weathering and erosion. Weathering is a process that breaks down rocks into tiny pieces. Erosion is the process that scoops up and moves those pieces of rock from one place to another.

Rain, Rivers, and Waves

Water is one of the main causes of erosion. When rain falls, some of it soaks into the ground. The rest of the water builds up on the ground in streams. These streams flow downhill and come together to form bigger streams. When water flows, it gathers speed, digging a channel as it erodes the earth in its path. This channel in the earth takes many years to make. But when it gets big enough, it fills up with water and becomes a river.

Over time, the rushing water breaks off small pieces of rock from larger rocks. These very small rocks are called sediment. The water makes the sediment scrape and bump against each other, which polishes the sediment into smooth stones and pebbles. The sediment is then swept away and deposited, or dropped, downstream.

If a river flows fast enough and for a very long time, it may create a canyon. A canyon is a deep, narrow channel with steep walls.

Waves are another way in which water shapes the earth. As waves crash along the shore, rocks break against each other. The waves sweep the rocks back and forth, weathering them into tiny grains of sand. The sand eventually piles up where the water tosses it, and a beach is formed.

Name: _____

Blowing Winds

Wind is another cause of weathering and erosion. When the wind blows, it sweeps away loose soil, sand, and other sediment. Wind blasts these particles against other rocks and surfaces. This can turn a jagged cliff into a gentle hillside, especially if the cliff is sandstone. Sandstone is a soft rock formed from tightly packed grains of sand. It weathers easily.

In drier, flatter areas, the wind may create a sandy desert. Wind cuts rock formations into unusual shapes. Imagine yourself blowing a small pile of dirt. Because there is so little dirt, you could blow all the dirt away. Wind does this to the desert, but because the desert is so big, it takes a very long time to notice a change. The desert is constantly being sculpted and changed by the wind.

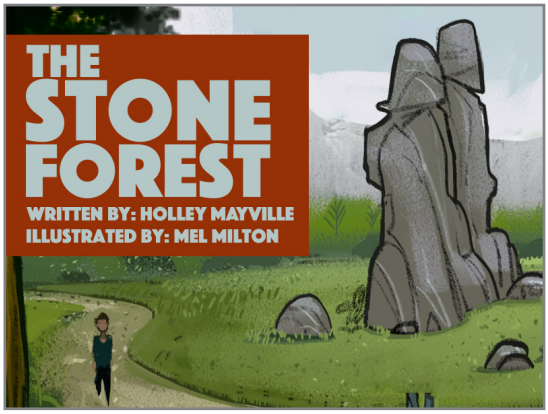
The Force of Ice

Ice causes weathering and erosion in two ways—one small and one large. The first way is when water seeps into cracks in the ground and then freezes. As the water freezes into ice, it expands or gets bigger, and pushes away the ground around it. The water turns into a small wedge of ice that breaks apart the rocks and dirt.

But the largest and most powerful form of ice erosion happens when ice forms a glacier. A glacier is a huge sheet of ice that slowly moves over land downhill, like a giant river. The ice picks up rocks and other materials that scrape the land as they pass over it. Then they are deposited where the ice melts.

Name: _____

The Stone Forest



Written by Holley Mayville
Illustrated by Mel Milton
Lexile®: 810L, 406 words

The Tale of Ashima

Once upon a time, a beautiful girl lived among the Yi people of southern China. Her name, Ashima, meant "more valuable than gold." Ashima was a happy girl until a greedy warlord wanted to marry her. Because she would not marry him, the warlord kidnapped her. Ashima's friends and family were heartbroken.

Ahei, a brave young man from Ashima's village, rushed to help Ashima escape from the warlord's palace. But as they ran away, they were caught in a terrible storm. The storm caused the river to flood. Ashima and Ahei were separated by the rushing water. He called and called for her, but he only heard his own shouts echoing back.

The next day Ahei went to the spot on the river where he last saw Ashima. There he found a large, gray stone in the shape of a girl. He knew it was his Ashima. Whenever he missed Ashima, he would call and sing and talk to the stone girl. The only reply was the echo of his voice.

The Stone Forest

The legend of Ashima is hundreds of years old, but you can still visit Ashima today.

This legend is set in a region of Southern China famous for unusual rock formations. Many, many years ago, a shallow sea covered giant deposits of limestone. As time passed, the sea evaporated. The limestone, which is more fragile than most other kinds of rocks, was exposed to the weather.

Wind and rain weathered away the softer parts of the limestone. Towers of hardened limestone were left behind. Today only the hardest parts of the limestone remain.

These limestone formations are located in a place called Shilin. Shilin covers almost 190 square miles of southern China. There are walls, bridges, columns, and

Name: _____

towers of stone. “Shilin” means “Stone Forest,” a name that comes from the tall limestone formations that resemble tree trunks.

The gray limestone trunks tower over emerald leaves of living trees. Visitors can stroll across smooth, grassy lawns and beside streams and ponds. Flowers bloom among the stones in an explosion of jewel colors. Shilin is so unique and beautiful that it is one of the most popular places to visit in all of China.

Visitors to Shilin can see a lone column of stone standing beside a tranquil pond. This stone column resembles a girl wearing a kerchief. She has a rice basket on her back. People say that if you call out to her, you can hear an echo—a remnant of Ashima’s voice whispering back.