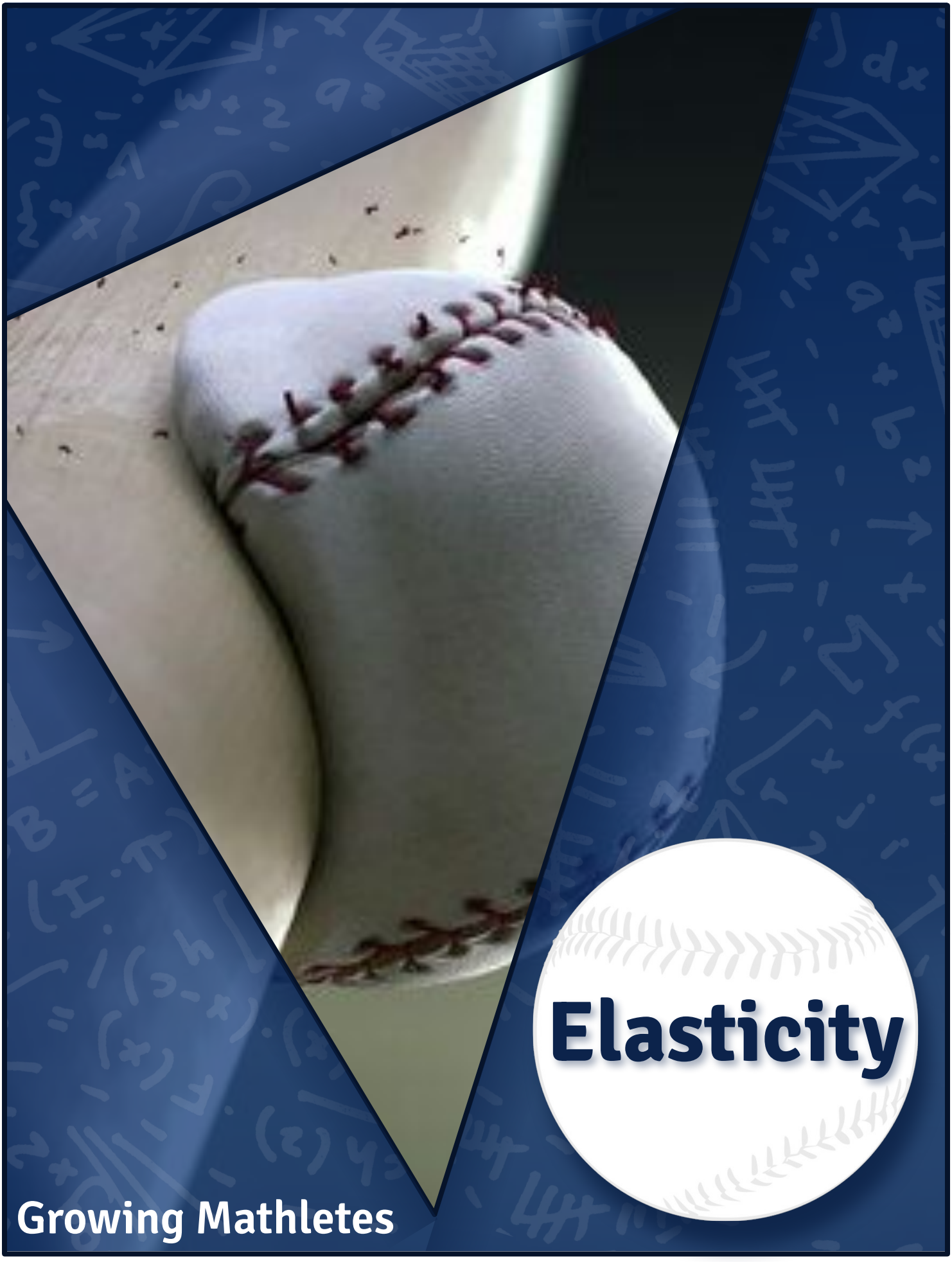


Elasticity

Growing Mathletes

Elasticity Overview

Key Ideas in this Session:

Youth will explore the physical properties of materials (e.g., baseballs, softballs, tennis balls) and their interactions to external forces (e.g., falling onto a hard surface to simulate a bat). Youth will also learn about how their brains are elastic and can grow, learn, and improve.

Driving Questions:

1. How do different factors impact a ball's bounce (e.g., the hardness or softness of a surface, the material the ball is made of)?
2. Our brains can also change like sports balls. How does this help us learn and improve?

Math Standards:

3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units— whole numbers, halves, or quarters. (In this lesson, youth measure lengths using fractions of a foot.)
4.MD.4 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.
6.SP.A.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

Activity	Time	Description
Activity 1	40 minutes	Youth will explore elasticity by repeatedly measuring how high balls made of different materials will bounce when dropped from the same height.
Activity 2	20 minutes	Youth will learn about how our brains, like balls, can also change and grow through the process of neuroplasticity. Youth will describe the malleability of their brain based on a new skill they would like to learn.

Materials

- Non-retractable tape measures (6 ft.)
- Sharpies or thin whiteboard tape
- Masking tape or painters tape
- Three different types of balls (e.g., foam balls, tennis balls, baseballs/softballs)
- Class line plot (white board, large poster paper, or projector screen; with small Post-Its or dot stickers)
- **Worksheet 1** (one copy per youth)

Set-Up

For **Activity 1**, see directions on the next page.

For **Activity 2**, keep balls available for youth to select.

Growth Mindset Connections

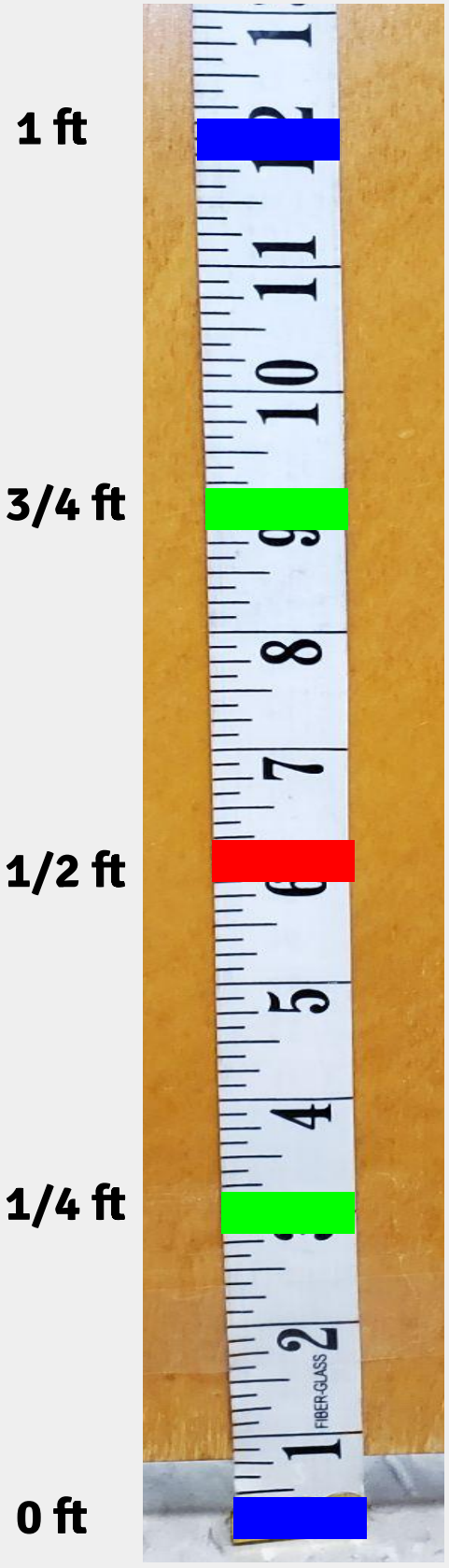
Malleability of the brain. Everyone's brain can adapt to learn new things, just like sports balls adjust to different surfaces.

Activity 1 - Using Repeated Measures to Test Elasticity Set Up

Set Up: Measuring Stations

Prior to the activity, mark fractions of a foot using Sharpies or thin whiteboard tape on the tape measures so that youth can use these marks to measure the height of the the ball's bounce. For example, mark 3 inches as ¼ foot, 6 inches as ½ foot, 15 inches as 1 ¼ feet, etc. We suggest you mark each fraction in a different color for easy visual measuring. For example, mark every whole foot in blue, every ½ foot in red, and every ¼ foot in green (see image to the right).

Tape the marked measuring tapes on a wall so that 0 inches is at the floor and the measuring tape extends upward vertically. Each group should have their own measuring tape, spaced so that groups have plenty of room to do the activity.



Activity 1 - Using Repeated Measures to Test Elasticity Set Up

Set Up: Class Line Plot

Prior to the activity, set up the class line plot:

<u>Option 1: Project a line plot on a screen.</u>

- Display the blank line plot on Slide 11 on a screen or whiteboard.
- Have youth groups plot their bounce height using small Post-It notes directly on the screen or whiteboard.

<u>Option 2: Draw a line plot on a whiteboard or poster paper.</u>

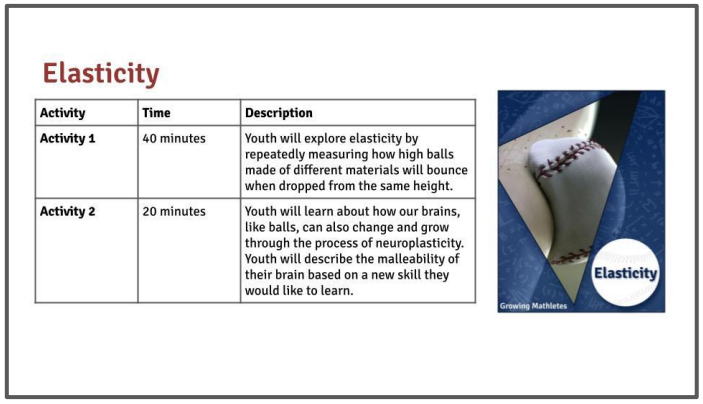
- Draw a line plot on large poster or butcher paper. Label the line plot with measurements (marked in half inch increments) for two different scales - inches and fractions of a foot. The top scale is marked in three inch increments and the bottom scale is marked in fractions of a foot increments ensuring that the range of ball bounce heights is represented.
- Have Post-It notes or dot stickers in three different colors (one for each ball type) available for youth groups to place on the line plot marking the height that each ball bounced in the activity.
- See below for an example.

● = foam ball
● = baseball/softball
● = tennis ball

Example Class Line Plot to Represent Ball Bounce Height

Elasticity Introduction

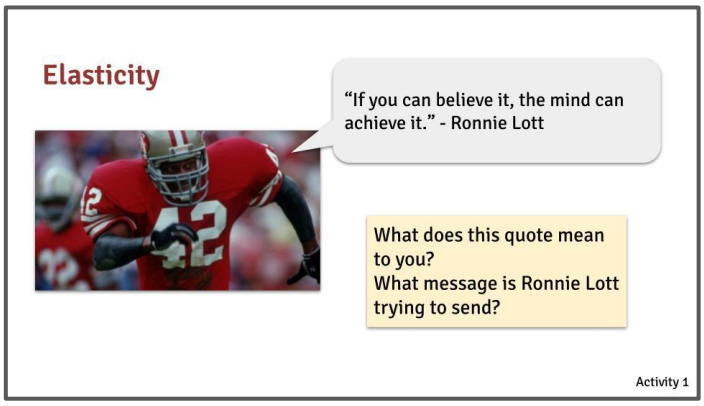
Start the session by providing youth with an overview of the key activities.



Elasticity Youth Slides, Slide 1

Next, share and discuss this quote.

"If you can believe it, the mind can achieve it."
– Ronnie Loft



Elasticity Youth Slides, Slide 2

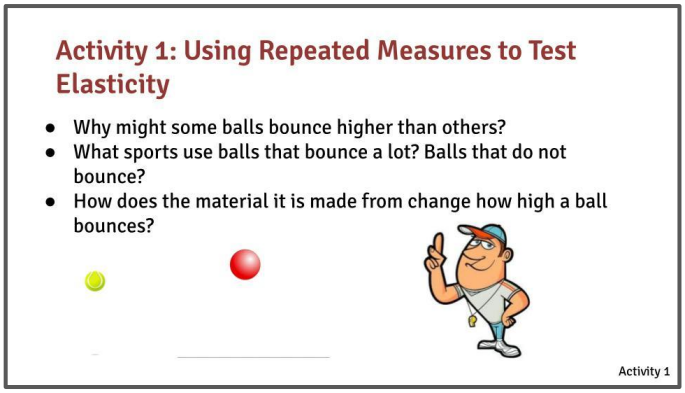
Activity 1 - Using Repeated Measures to Test Elasticity (1 of 8)

Description:	Youth will explore elasticity by measuring repeatedly how high balls made of different materials will bounce when dropped from the same height.
Math Ideas: Mean	The term "**mean**" is used to describe data and **is a metric of central tendency**. Also called the "average," the mean value is found by adding up all the values in a data set and dividing by the total number of values in the set.
Math Ideas: Line Plots	Youth use line plots to compare the bounce height of different balls. A **line plot** is a number line that includes the range in values in the data set. The number line is labeled in equal increments. Youth use these line plot graphs to compare bounce heights to understand elasticity.

LAUNCH: Connecting to Prior Knowledge

Hold up the three balls and ask youth to share which one they think will bounce the highest and why.

- Why might some balls bounce higher than others?
- What sports use balls that bounce a lot? Balls that do not bounce?
- How does the material it is made from change how high a ball bounces?



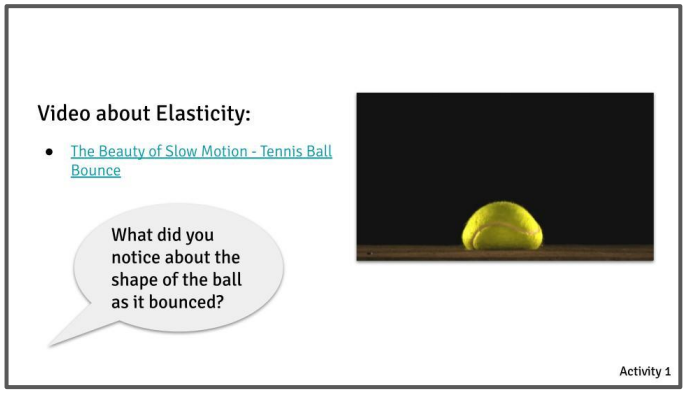
Elasticity Youth Slides, Slide 3

Activity 1 - Using Repeated Measures to Test Elasticity (2 of 8)

Demonstrate Elasticity

Show videos to demonstrate elasticity. **To reduce distraction, do not distribute balls to everyone until after the activity has been demonstrated and explained.**

VIDEO: Elasticity [0:00-0:20]: https://www.youtube.com/watch?v=1yT0hxplVBg

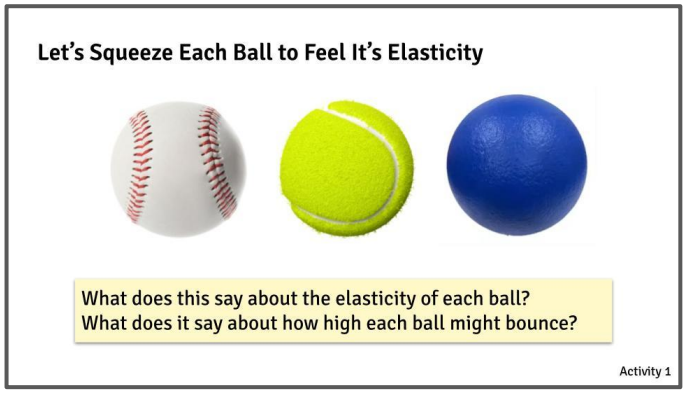


Elasticity Youth Slides, Slide 4

- What did you notice about the shape of the ball as it bounced?
- *Tell youth that elasticity is a physical property of materials which return to their original shape after they are deformed. A ball's elasticity and material composition determine how it "bounces" when it hits the same surface like a bat, dirt, grass, etc.*

Call for three volunteers to come to the front and give each one type of ball (e.g., foam ball, tennis ball, softball/baseball). **Ask each volunteer to feel how much they can squeeze (not bounce) the balls without damaging it** so that it returns to its original shape and describe how they return to their original shape to the whole group.

- What does this say about the elasticity of each ball?
- What does it say about how high each ball might bounce?



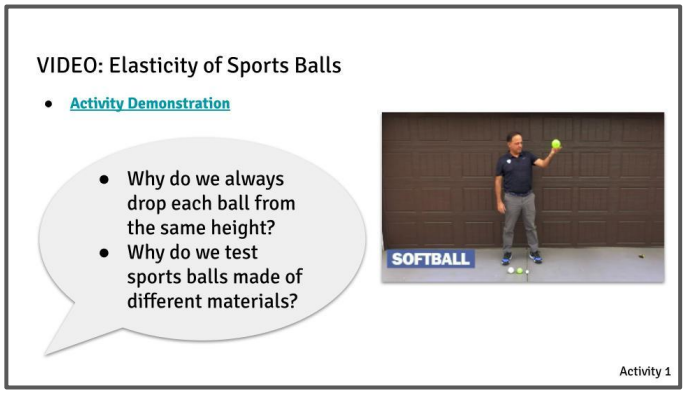
Elasticity Youth Slides, Slide 5

Activity 1 - Using Repeated Measures to Test Elasticity (3 of 8)

Demonstrate Activity

Show a video to demonstrate how to do the activity. Ask youth to observe the example of sports balls being dropped repeatedly from the same height.

VIDEO: Elasticity of Sports Balls Activity Demonstration by Kids [3:03]: https://www.youtube.com/watch?v=KMxFFCnA9qc

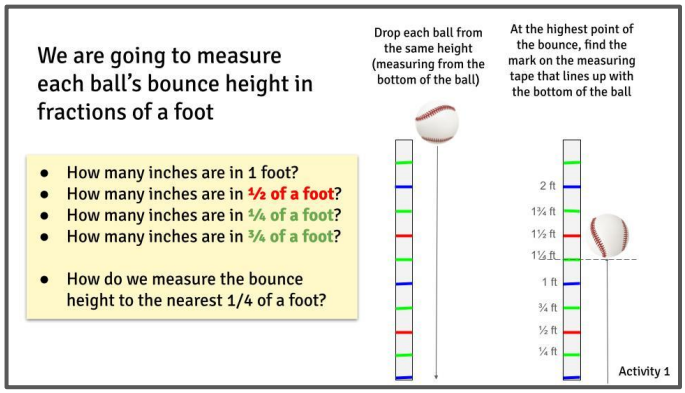


Elasticity Youth Slides, Slide 6

After watching the video, **check youths' understanding of the activity and their task.**

- Why do we always drop each ball from the same height?
- Why do we test sports balls made of different materials?
- How is the height each ball bounces related to the sport it is used for?

Explain that we are going to measure each ball's bounce height in fractions of a foot, from the bottom of the ball. We will estimate the height of the highest point of the bounce using the markings on the measuring tape. In the example on Slide 7, the ball bounced 1 ¼ feet.



Elasticity Youth Slides, Slide 7

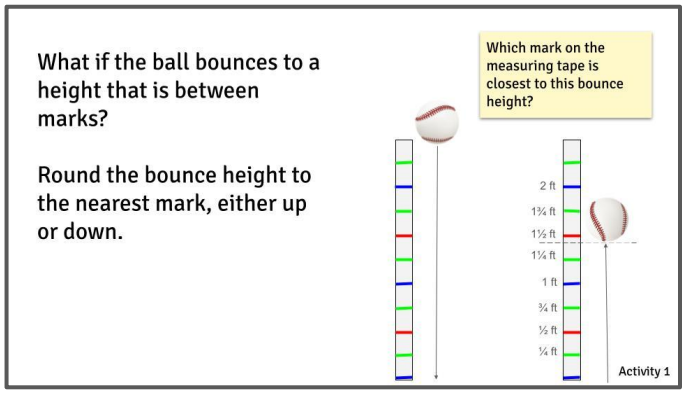
Discuss:

- How many inches are in 1 foot?
- How many inches are in ½ of a foot?
- How many inches are in ¼ of a foot?
- How many inches are in ¾ of a foot?
- How do we measure the bounce height to the nearest 1/4 of a foot?

Activity 1 - Using Repeated Measures to Test Elasticity (4 of 8)

Demonstrate Activity

The ball will be moving, so it is difficult to see exactly where its highest point is. We use the marks on the measuring tape to help us better see where the ball reaches its highest point. But the bounce height might not be exactly at a mark. To estimate the height of the highest point of the bounce, we may need to round to the nearest mark, either up or down.

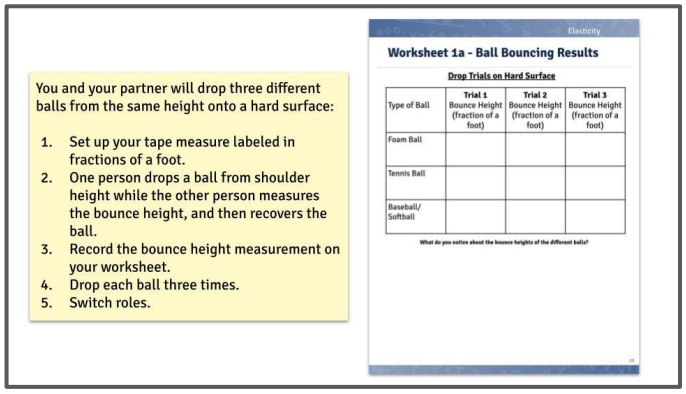


Elasticity Youth Slides, Slide 8

Partner Activity 1: Measuring Elasticity

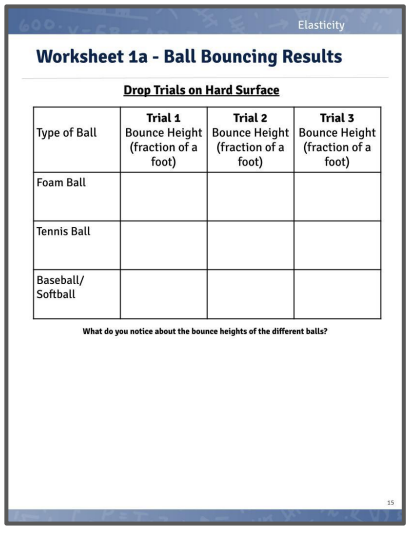
In this activity, youth **drop three different balls from the same height and then record their measurements on their worksheet.**

- Youth drop all balls on the same surface - ideally a hard floor.
- Youth drop each of the balls from the same height (shoulder height, or a specified height such as 4 ft.).



Elasticity Youth Slides, Slide 9

- Youth drop each of the balls three times (three trials) and record the the height of the bounce to the nearest fraction of a foot using the marks on the tape measure.
- Youth rotate roles. One youth drops the ball while the other youth watches the bounce, catches the ball at its highest point, and measures its height. If youth are working in groups of three, the third youth can record the measurement.
- Youth will use **Worksheet 1A** to record their results.



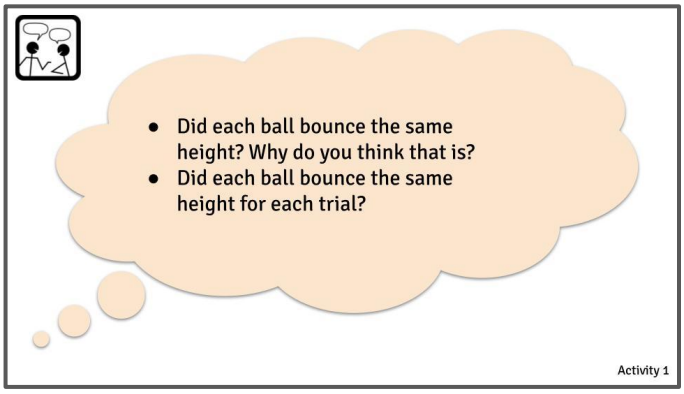
Worksheet 1A

Activity 1 - Using Repeated Measures to Test Elasticity (5 of 8)

Whole Group Discussion:

Ask youth to discuss what they noticed about each ball when it was dropped.

- Did each ball bounce the same height? Why do you think that is?
- Did each ball bounce the same height for each trial?
- How much higher did the tennis ball bounce than the baseball/softball?



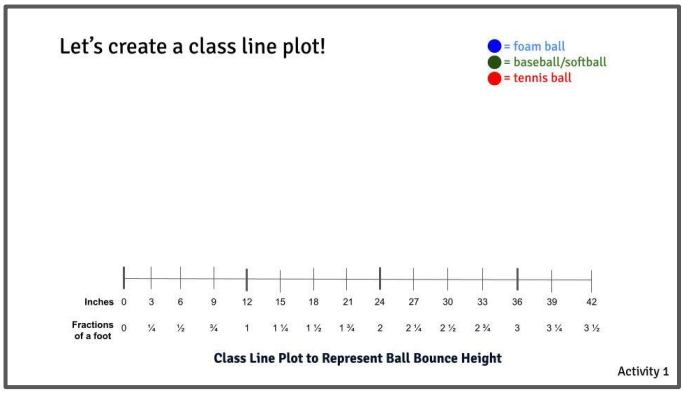
Elasticity Youth Slides, Slide 10

Whole Group Activity: Class Line Plot

Tell youth they will create a class line plot (using Slide 11 projected on a screen or on a white board, or drawn on large poster paper) to show the highest bounce height for each ball (tennis ball, foam ball, and baseball/softball) from each group.

First, youth should review their group data to identify the **highest bounce height** for each type of ball.

Next, youth place a Post-It or dot sticker on the line plot to represent the highest bounce height, in fractions of a foot. Instruct youth to use a different color post-it note or dot sticker for each type of ball (see the example color coding on Youth Slide 11). Each group should place 3 data points on the plot, 1 for each type of ball.

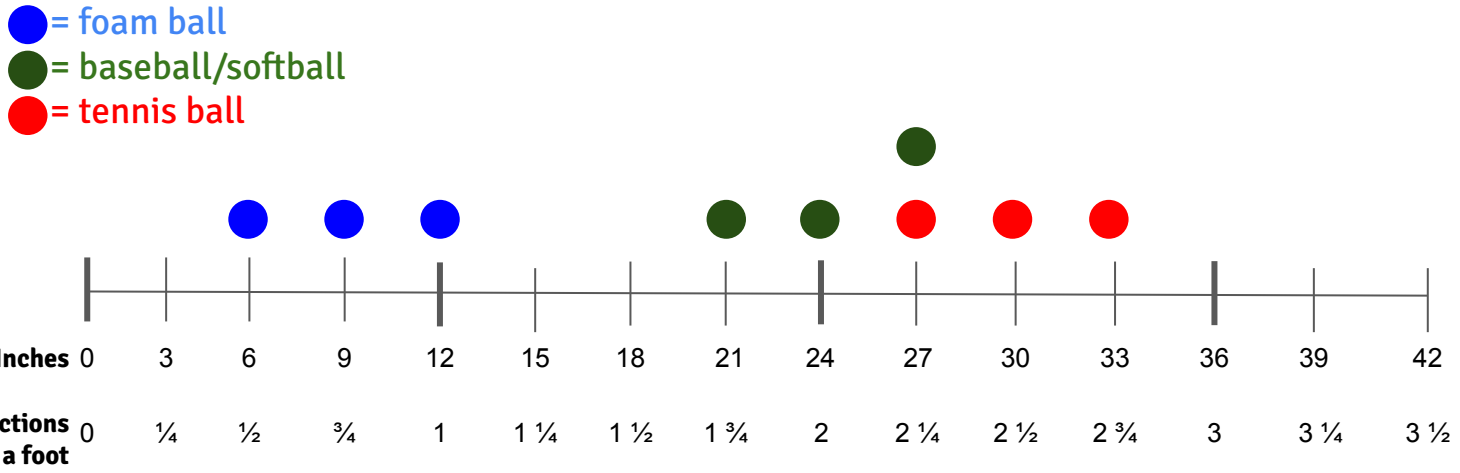


Elasticity Youth Slides, Slide 11

Activity 1 - Using Repeated Measures to Test Elasticity (6 of 8)

Whole Group Activity: Class Line Plot

To show an example, the blue dot stickers below show bounce heights of the foam ball from three different groups. The first dot sticker shows a bounce of 6 in., or ½ foot. The second dot sticker shows a bounce of 9 in. or ¾ of a foot. The third dot sticker shows a bounce of 12 in. or 1 foot. If two different bounces are the same height, youth will stack the dot stickers, such as in the example below, where a baseball/softball and a tennis ball both bounced to a height of 27 in. or 2 ¼ ft.

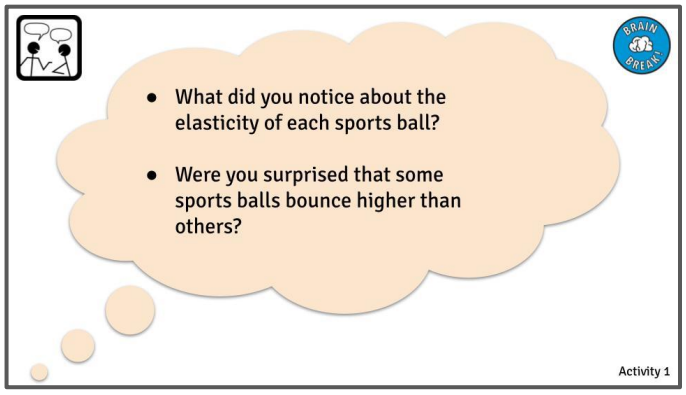


Example Class Line Plot to Represent Ball Bounce Height

Whole Group Discussion:

Ask youth to discuss:

- What did you notice about the elasticity of each sports ball?
- Were you surprised that some sports balls bounce higher than others?



Elasticity Youth Slides, Slide 12

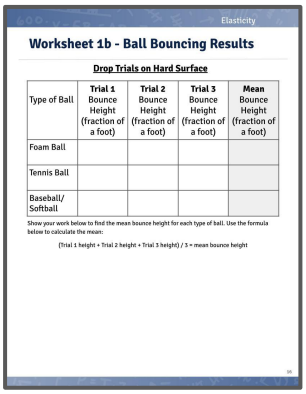
Activity 1 - Using Repeated Measures to Test Elasticity (7 of 8)

Extension (For Grades 6-8) Demonstrate: Finding Mean

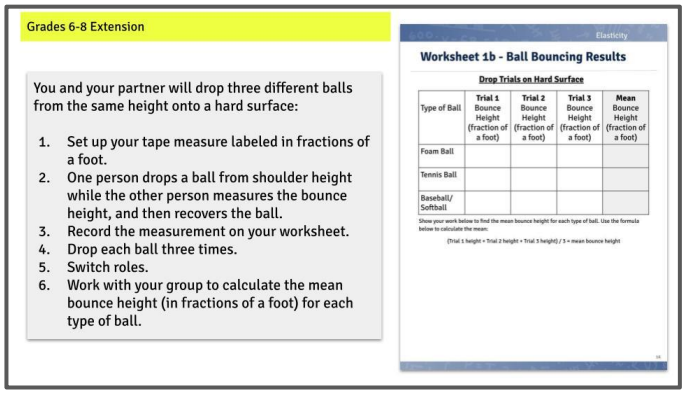
To find the mean bounce height for a given ball type, youth will add the bounce heights from each trial, then divide that total by the number of trials. For example, if a tennis ball bounced 2 ¼ ft in trial 1, 2 ¼ ft in trial 2, and 2 ½ ft in trial 3, add these heights for a total of 7 ft. Then divide by three for three trials to get 7/3 ft or 2 ⅓ ft. This means that the mean bounce height of the tennis ball from these three trials is 2 ⅓ ft.

Youth may need support to rewrite their fractions with a common denominator to find the total. Encourage youth to use what they know about equivalent fractions to support their work. Youth may also need support to rewrite improper fractions as mixed numbers.

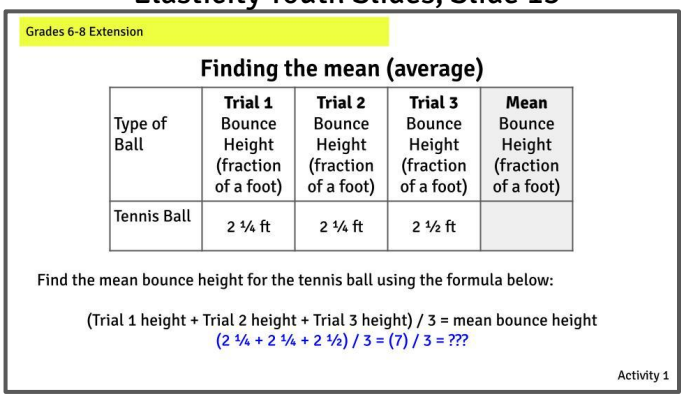
Youth will use **Worksheet 1B (for grades 6-8)** to record their results.



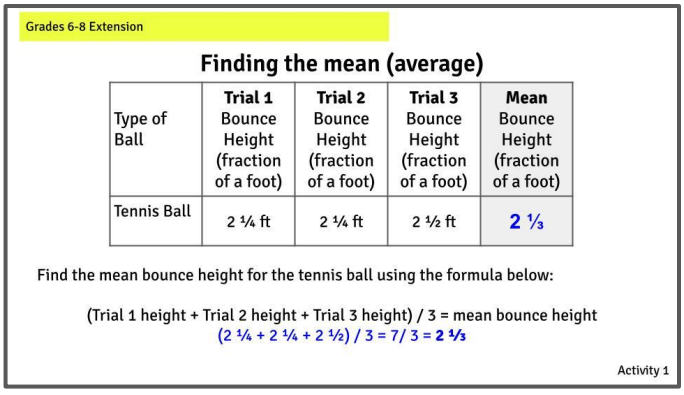
Worksheet 1B



Elasticity Youth Slides, Slide 13



Elasticity Youth Slides, Slide 14



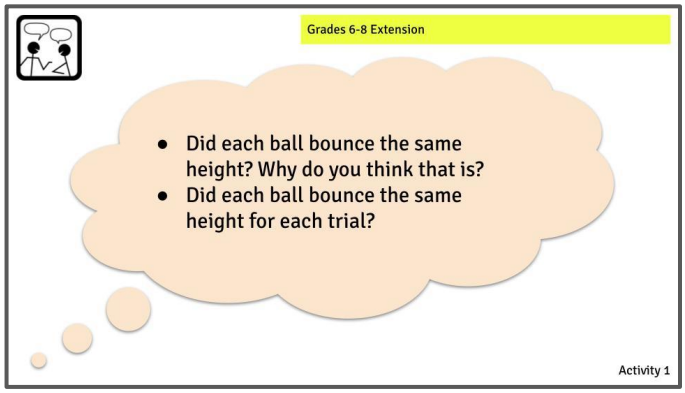
Elasticity Youth Slides, Slide 15

Activity 1 - Using Repeated Measures to Test Elasticity (8 of 8)

Extension (For Grades 6-8) Whole Group Discussion:

Ask youth to discuss what they noticed about each ball when it was dropped.

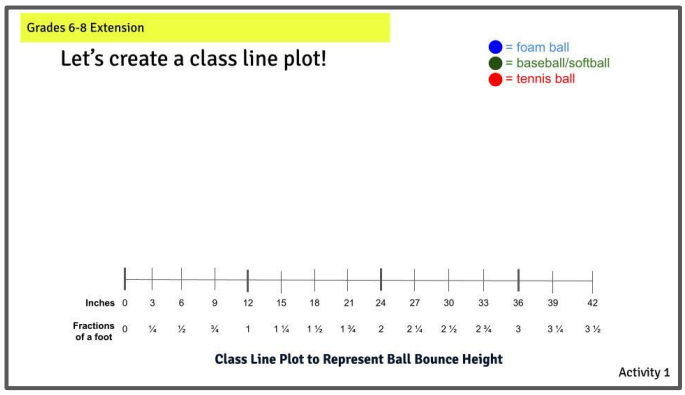
- Did each ball bounce the same height? Why do you think that is?
- Did each ball bounce the same height for each trial?



Elasticity Youth Slides, Slide 16

Extension (For Grades 6-8) Whole Group Activity: Class Line Plot

Ask youth to create a class line plot (using Slide 16 projected on a screen or on a white board, or drawn on large poster paper) to show the mean bounce height for each ball (tennis ball, foam ball, and baseball/softball) from each group. (See the last column on **Worksheet 1B**.)



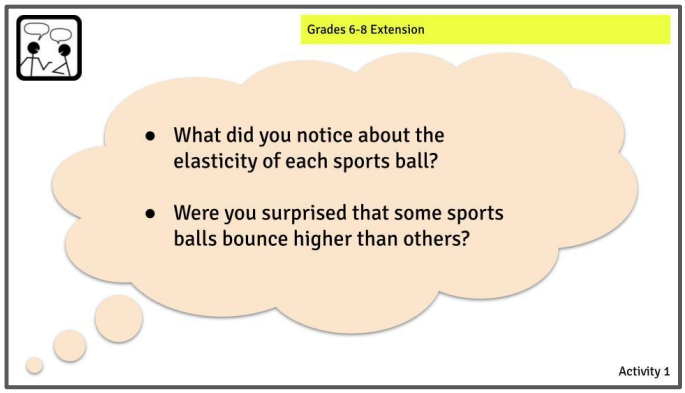
Elasticity Youth Slides, Slide 17

Youth then place a Post-It or dot sticker on the line plot to represent the bounce height, in inches, in different colors for each ball (see the example class line plot on page 5). Youth should chose the mean (average) recorded bounce height for each ball to record on the class line plot (so each youth group places 3 marks total on the plot).

Whole Group Discussion:

Ask youth to discuss:

- What did you notice about the elasticity of each sports ball?
- Were you surprised that some sports balls bounce higher than others?



Elasticity Youth Slides, Slide 18

Activity 2 - The Malleability of the Brain (Growth Mindset Connection) (1 of 1)

Description: In this activity, youth learn that when they practice something or take on a new challenge, their brains grow more connections.

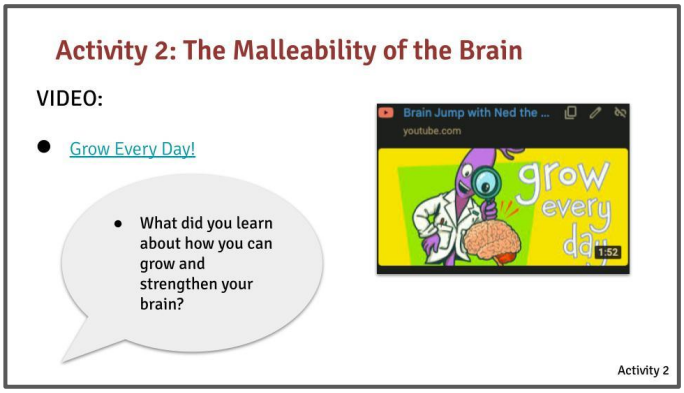
Growth Mindset Idea: Everyone's brain can adapt just like different balls to their respective sport. The elasticity of the balls is a metaphor for the brain adjusting and adapting as learning occurs.

Connecting to Prior Knowledge:

Show youth video of how youth can grow, stretch and expand their minds.

VIDEO: Challenges Grow your Brain (0:00 - 1:51)
https://www.youtube.com/watch?v=g7FdMi03CzI
Ask youth to discuss why the malleability of the brain is important.

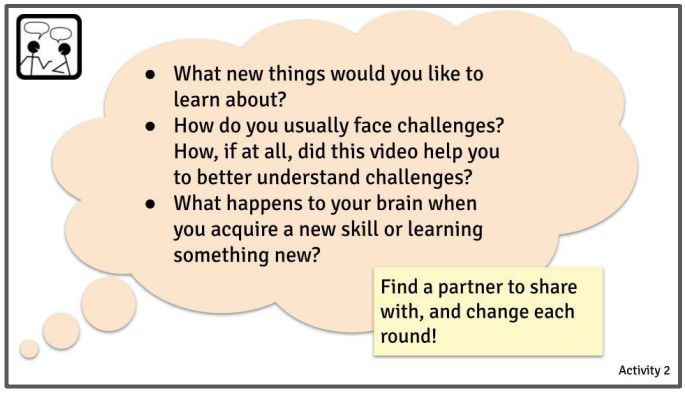
- What did you learn about how you can grow and strengthen your brain?



Elasticity Youth Slides, Slide 15

Reflection Questions

Wrap up the activity with a reflective discussion activity by having youth brainstorm some new things they would like to try as their brains continue to grow and learn. Ask youth to stand up and walk around the room until the facilitator calls out for them to stop and pick a partner (try saying "toe-to-toe" or "elbow-to-elbow"). They will rotate between partners to share their ideas about each of the following reflection questions (one question per rotation):



Elasticity Youth Slides, Slide 14

- What new things would you like to learn about?
- How do you usually face challenges? How, if at all, did this video help you to better understand challenges?
- What happens to your brain when you acquire a new skill or learn something new?

Worksheet 1a - Ball Bouncing Results

Drop Trials on Hard Surface

Type of Ball	**Trial 1** Bounce Height (fraction of a foot)	**Trial 2** Bounce Height (fraction of a foot)	**Trial 3** Bounce Height (fraction of a foot)
Foam Ball			
Tennis Ball			
Baseball/ Softball			

What do you notice about the bounce heights of the different balls?

Worksheet 1b - Ball Bouncing Results

Drop Trials on Hard Surface

Type of Ball	**Trial 1** Bounce Height (fraction of a foot)	**Trial 2** Bounce Height (fraction of a foot)	**Trial 3** Bounce Height (fraction of a foot)	**Mean** Bounce Height (fraction of a foot)
Foam Ball				
Tennis Ball				
Baseball/ Softball				

Show your work below to find the mean bounce height for each type of ball. Use the formula below to calculate the mean:

(Trial 1 height + Trial 2 height + Trial 3 height) / 3 = mean bounce height