After-School Math Plus

Jump Rope Math

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Question
Is there a relationship between jump rope length and the height of the person who is jumping?

Objectives
Students will:
- Work in small groups to problem-solve.
- Use standard and nonstandard measurements.
- Observe the shape that the rope creates as it turns.
- Use multiples of numbers to represent data.
- Create a scatter graph to represent data.
- Observe patterns in their data.
- Use data to make predictions.

Where’s the Math?
Students will use nonstandard and standard units of measurement to record the length of jump ropes and the height of individual jumpers. As they compare the different lengths of the rope to the height of the jumpers, they will look for a mathematical relationship between the two numbers called a ratio. They will use the data collected to create and interpret a graph and identify patterns in the data to help make predictions about the length of a jump rope needed for other individuals. Students will understand the appropriate use of a scatter graph as a representation of a trend in data.

Math Skills Developed
- Using nonstandard and standard units as measuring tools
- Problem-solving
- Recording data
- Graphing
- Understanding ratios and mathematical patterns
- Interpreting data to make predictions

Materials
- Cotton clothesline rope cut into 10-foot lengths (one for each small group)
- Standard measurement tools (e.g., meter stick/yardstick, etc.)

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• Nonstandard measurement tools (e.g., feet, sneakers)
• Chart paper
• Color markers
• Color dots
• Pencils
• Handouts:
  - Data Chart--Nonstandard Units
  - Data Chart--Standard Units
  - Line-Graph Template B

Getting Ready

Be sure you have enough clothesline rope so that each small group will have a 10-foot length. If possible, arrange to conduct the activity in a large space like the gym or cafeteria or outside on the playground.

Math Standards

Content Standards
• Number and Operations: Understand numbers, ways of representing numbers, relationships among numbers, and number systems.
• Measurement: Understand measurable attributes of objects and the units, systems, and processes of measurement.

Process Standards
• Problem Solving: Build new mathematical knowledge through problem solving; apply and adapt a variety of appropriate strategies to solve problems; and monitor and reflect on the process of mathematical problem-solving.
• Representation: Create and use representations to organize, record, and communicate mathematical ideas; select, apply, and translate among mathematical representations to solve problems; and use representations to model and interpret physical, social, and mathematical phenomena.
Introduction

Students will try various lengths of jump rope until they find the length that is best for them. Working in small groups, they will use nonstandard and standard units of measurement to measure the rope as well as the height of the jumper. Then they will record their findings, use the data to create a graph and look for a pattern, and determine if the graph is useful in making a prediction.

It may be helpful to students to review the different types of graphs they have used in this theme before introducing scatter graphs. A bar graph is used to show comparisons, and a line graph shows the relationship between two variables.

A scatter graph is used to identify trends when considering two variables. In this activity students will ask, “Is there a relationship between the height of the jumper and the length of the rope?” By plotting their data on a graph students will determine if there is a direct relationship between the variables or if there is a more general relationship or trend.

Part One: Jumping Rope (10 minutes)

Divide students into groups of four to six. Give each group a 10-foot length of clothesline and have each student take a turn using it to jump. (Students may naturally begin to shorten the length of the rope.) After about 10 minutes of jumping, bring the group back together for a discussion.

Part Two: Large-Group Discussion (15 minutes)

Review the activities that you have been doing with students about jumping rope, e.g., the materials used in jump ropes and the reasons why people jump rope. Ask students, “What do we mean by the ‘best’ length for a jump rope?” “Do you think it is the same for everyone?” “What criteria would you use to determine the best length?” Be sure that everyone understands that criteria are standards or rules by which a judgment (e.g., “best” length) can be made. Ask them to explain their ideas. For example, “The best length would let me jump for two minutes without missing!” Or, “The best length would make it easier to jump.” Students may refer to the ropes that they just used and discuss how they adjusted them to get the best length. Encourage students to discuss their ideas fully. Would a jump rope need to be longer or shorter than the person jumping? You may want to have a student illustrate a rope that is too short and one that is too long. Why is the rope too short or too long?
If a student with a hearing impairment is present in the large-group discussion, have students who are speaking keep their hands raised for a few moments after they begin speaking so that the hearing-impaired student can locate him/her. This helps with lip reading and filtering out extraneous sounds.

Ask the students if they think taller jumpers need longer ropes. Do shorter jumpers need shorter ropes? Do they think there is a relationship between jumper height and rope length? Ask the students to make predictions about this relationship. Try to categorize their responses (for example, no relationship between jumper and rope size, direct relationship, sometimes a relationship) and ask each student which they think will happen. Chart their responses and label it Hypotheses.

Explain to students that they will be working in small groups to measure the length of a jump rope and the height of the jumper. They need to decide as a whole group which unit measure they are going to use (e.g., centimeters, meters, inches, or feet). Point out that these are standard measurements. Ask, “If we didn’t have access to rulers or measuring tapes, what else could we use to measure?” Make a list of possibilities (e.g., sneaker-lengths, hand-widths). Explain that these are nonstandard measurements. Have each group select a nonstandard measure to use as well.

➤ **Note to Group Leaders:** For the data to be uniform, it is important that every group use the same standard measure. However, each group can have fun with a different nonstandard measure. Encourage creativity! While it may seem obvious to an adult, it may not be so obvious to students that the same unit of measurement (whether standard or nonstandard) should be used for the student and the rope length. If students are measured in Popsicle sticks, then the rope should be measured in Popsicle sticks. If students are measured in centimeters, then the rope should be measured in centimeters.

**Part Three: Small-Group Investigations (20 minutes)**

➤ **Note to Group Leaders:** In order to collect enough data for the graph to show a trend, every student should be measured. Each student should have a turn measuring and recording the data on the data chart. Encourage students to take turns recording and reporting.

**Step 1** Have students assemble back in their small groups and give each group two data charts (one labeled Standard Units of Measure; one labeled Nonstandard Units of Measure), along with a 10-foot length of clothesline rope.
Step 2  
Ask students to measure each jumper’s height first using the standard measure that was agreed upon and record it on the Standards Unit data chart. Ask students to measure each other from their foot to their knee, knee to hip, hip to shoulder, and shoulder to the top of their head. Ask them to add these four measurements together to calculate their total height.

Step 3  
Next, have students measure using the nonstandard measurement tool and record it on the Nonstandard Unit data chart. Remind students to record the name and height of the person being measured on the charts, along with the units of measure.

➢ **Note to group leaders:** Height can be a very touchy subject for many students (especially boys!) and is of particular concern for students who use wheelchairs, who often are viewed as short because they are seated. By measuring the students in segments (e.g., knee to hip) every child’s full height can be measured, and they will have additional practice with measuring and adding.

Step 4  
Ask each jumper to jump rope with the clothesline, adjusting the length until they think it best for him or her.

Again, students with mobility issues may feel excluded here. Be sure to stress that they are simply giving their guess as to what is or would be best for them... let them take the lead as to how that will be determined.

Another possibility would be for two students to hold the rope on either side of (and in front of) the student as if she/he was going to roll over the rope. Then measure the length of that rope.

Step 5  
Have students measure the length of the rope, with the standard and non-standard unit and record it on the data chart next to the student’s height.

Step 6  
Have students rotate roles, until everyone has a turn being measured and jumping, using the same standard and nonstandard unit of measurement for each person.

**Part Four: Sharing Findings (10 minutes)**

Bring the students back into a large group. Ask each group to report on their findings, using the charts to illustrate the data they collected. Begin by discussing the standard and
nonstandard measures they used. Do they see a relationship between the two? Which was easier to use? Why? Why do students think there are standard measures? Point out that nonstandard measures can change over time (for example, a person’s foot will get bigger; hands are different sizes).

Then ask students to organize their information in a way that helps them to see a pattern. For example, one way is to organize the measurements from least to most, or from most to least. Using another data chart, record the name of the shortest student, along with his or her height and rope length. Continue in size order until everyone's data is recorded. Ask students what patterns they see. By organizing the data did they create a pattern?

Part Five: Creating a Scatter Graph (15 minutes)

Explain to students that, using the data from their Standard Unit charts, they are going to create a graph, which is another way to record the information they gathered. Using the template, help students label "Student Height" as the x axis and "Rope Length" as the y axis.

A graph is created by finding a value for either axis and then finding the corresponding value on the other axis. If the jumper’s height is 150 centimeters (5 feet), find 150 centimeters on the x axis (Student Height), then find the value for rope length (e.g., 240 centimeters, or 8 feet) on the y axis. Follow the lines for those values until they intersect. Place a colored dot on that spot. Repeat for each student.

> **Note to Group Leaders:** It is sometimes helpful to use multiples of numbers to indicate a unit on a graph. For example, if height was measured in inches and each unit on the graph represents an inch, the graph would have to be enormous! Instead, a multiple can be used. If each unit represents 10 inches, then the graph can be 10 times smaller. It may be helpful to have prepared examples of the graphs using different multiples as units on graphs. For example, one graph might use 5 inches per unit, and another might use 10. This provides a visual aid for students to see the difference in graph size as the units change.

When all the dots are in place, ask students if they see a relationship in the data. Do most of the dots representing tall jumpers also represent longer jump ropes? Do most of the dots representing shorter jumpers also represent shorter rope lengths? Students will likely see that most of the dots don’t fall on a straight line but are scattered around an imaginary line from the first few dots to the last few. This is called a scatter graph. Ask students to draw a line (in pencil) from the tallest jumper to the shortest jumper. Do most of the other dots cluster around this line? Can the students draw a line that most of the dots cluster around? Although all the dots don’t fall on the line, they show a trend or generalization.

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For example, generally, a taller person will need a longer jump rope. Tell students that the dots farthest from the line are called “outliers” and represent jumpers who don’t fit into the pattern. Ask students to discuss why the outliers are unique. Are some of the jumpers especially good athletes? New jumpers? Jumping the rope in a different way? Ask students to think about other examples of outliers. (For example, if the students collected data on how fast people could run, Olympic runners would be outliers.)

Ask students if their data shows a relationship between student height and rope length. Refer to the chart with their hypotheses. What does their graph tell them? Can students use the information in the scatter graph to predict what length a rope jumper who is 6 feet tall would need? What information does the graph convey?

- **Note to Group Leaders:** It is important for students to realize that gathering data is not about looking for a “right answer.” If the data they collect does not match their hypothesis (e.g., the taller the jumper, the longer the rope), that is OK. They should not try to make the data “fit”–instead, they need to analyze the data, consider why the outcome may have differed from their expectations, and perhaps revise their hypothesis. This is what scientists and mathematicians do all the time!

Remind students to write down any questions they have on the “Our Questions about Jumping Rope” chart.
Literacy Extensions

- Have students create a group story about a “giant who wants to jump rope.” Ask questions to get them started, such as “How tall is the giant?” “What would a giant use as a jump rope?” “How would you describe the sound of a giant jumping rope?” Then have students write a comparison story about an “elf who wants to jump rope.” What if the giant and elf were friends and wanted to jump rope together?

- Read How Big is a Foot? written and illustrated by Rolf Myller (New York: Random House Children's Books, 1991), a humorous look at the need for standard measurements.

Equity

It is important to think about what would be most equitable and fair in assigning roles to students for small-group work. Be sure that girls and boys and students with and without disabilities are active participants. Be sure to address any teasing that might occur over being short or being tall; make clear that this is not a competition about “who’s the shortest” or “who’s the tallest.”

Reflecting on the Activity

- Did each student have a turn to jump and be measured?
- Did students understand the difference between standard and nonstandard measures?
- Were students familiar with line graphs? Scatter graphs?
- Is there additional information students need in order to understand a line or scatter graph?
- Did students understand that they were collecting data, not looking for a right answer?