Changing the Equation:
After-School Math Curriculum

JUMP UP FOR MATH

Based on *After-School Math PLUS*
from the Educational Equity Center at
Academy for Educational Development

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KIT: JUMP UP FOR MATH

This After-School Math Kit includes engaging activities that are fun for both students and after-school staff. Students learn math while working in cooperative, supportive groups facilitated by staff members. Even better, after-school staff don't need to be math experts!

Through these activities, students and staff hone math skills, gain confidence in math, and increase their enjoyment of math.

THIS KIT INCLUDES

■ **Instructions to facilitate 3 activities.** These activities are simplified summaries and extensions of the "After-School Math PLUS: Jump Rope Math" curriculum created by the Educational Equity Center at Academy for Educational Development (AED).
The 3 activities are:
Part 1. How Far Can You Go?
Part 2. Going to Great Lengths
Part 3. Legendary Leapers

■ **Scientist Spotlight** Ask your students "who is a scientist?" and you'll typically get answers that include white lab coats, microscopes, and bubbling beakers. All of these images reflect some aspect of science and STEM (Science, Technology, Engineering, Math), but they don't provide a full picture. We include stories of two STEM professionals that work at Sandia National Laboratories. Read these with your students, and together list some of the activities, skills, and experiences from the stories. What surprises your students? What was unexpected? Does this change how they think of scientists and engineers?

TIPS FOR LEADING ACTIVITIES

- Give students opportunities to share their ideas with you and with each other.
- Make sure to introduce each activity. Learning happens best when learners know what's coming up and why it matters to them.
- Ask open-ended questions, rather than those that have a "yes" or "no" answer.
- Ask questions that inspire the learner to thoughtfully analyze a situation and consider consequences, such as, "What do you think will happen if you do this?"
- Give the learner time to answer the question. Ask the question, then wait. A while. Trust us: thoughtful answers take time.
- When a learner tells you what they think, respond by repeating and paraphrasing what they have said without criticism.
- Don't give too much praise or reject ideas. Telling a learner they are right or wrong can discourage them from generating additional ideas or pursuing deeper exploration.

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Part 1 - How Far Can You Go? **Main Idea**: How far do you think you can skip rope in a minute? For this activity, instead of jumping rope in place, students will be skipping rope. They will make predictions and measure how far a person travels with each turn of the rope.

INTRODUCTION

When introducing this activity, let students know that this is not a competition. Reassure students that their jump-roping skills are not essential; their math skills are! Students will jump rope, collect data, and construct a line graph that can be used to predict change in distance over time.

MATERIALS

- Jump Ropes (1 per group)
- Pencils
- Measuring tape (1 per group)
- Chart paper
- Markers
- Rulers
- *How Far Can You Go? Data Collection Sheet* (1 per group, found on page JU 11)
- Graph paper

ACTIVITY: HOW FAR CAN YOU GO?

STEP 1: DISCUSS (10 MINUTES)

As a group, ask students, "Can you think of examples in sports where the athletes are timed?" Listen to responses. Introduce the activity by telling students they will skip rope (moving forward while jumping rope) and try to predict how far they will go in a given time and then measure it.

Discussion: What is meant by "given time?" How can we measure distance? How can we measure time? Do you think you will skip exactly the same distance each time? Do you think the number of times a person skips rope might vary?

STEP 2: SKIPPING ROPE (20 MINUTES)

Divide students into pairs or groups of three and let each group select a jump rope. Explain that each member of the group will take a turn skipping rope while the others keep time and record the distance jumped on the *How Far Did You Go? Data Collection Sheet*. The groups will measure the distance covered for three different times (e.g., 10 seconds, 30 seconds, 1 minute).

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Give students 20 minutes to take turns skipping rope. Measuring tapes can be used to measure distance and a stop-watch (commonly found on most cell phones) can be used to measure time. For younger children, you can mark a set distance on the floor with tape and have the students time how long it takes to cover that distance.

STEP 3: CREATING LINE GRAPHS (10 MINUTES)

Distribute graph paper and tell students that each group will create a line graph to chart the data they collected. Help students label the axes. The x-axis (horizontal) should be time in seconds (1 second, 2 seconds, etc.), and the y-axis (vertical) should be distance in feet or yards (1 foot, 2 feet, etc.). Ask students what numbers they want to put on the x-axis. Can they fit a whole minute on the graph if they include every number from 1 to 60 seconds? Would it be easier to count by multiples (e.g., count by threes or fives)? Let students decide, in their groups, what multiples they'd like to use.

Draw a sample line graph on chart paper. As a class, review and discuss how each point should be added to the graph. Start by finding the x-axis value, then go up from the axis until you hit the y-axis value. It may be helpful to demonstrate using two fingers (one on each axis) and moving them both at the same speed from the axes until they meet; that's where the point on the graph should go. Have students fill in their graphs using their personal data; they should end up with three points on the graph. Have rulers available to help students place their points and connect them. The three points should be connected with straight lines.

Discussion: Ask groups to explain their graphs to the class. Does your line go upward or downward? What does that mean? Did they skip rope further when given more time? How does the graph show this? Give students time to understand and discuss their graphs.

STEP 4: TESTING HYPOTHESES AND MAKING PREDICTIONS (10 MINUTES)

Have students look at their graphs again. Ask them to predict how far they would skip rope in another time on the x-axis (e.g., 25 seconds or 45 seconds). Help each student come up with a prediction based on his or her graph. Then, in their groups again, have students skip rope for the new time and measure their distance to test their predictions. Was their distance prediction accurate? Can they predict how long it takes to jump a certain distance? How can they test this prediction?

Discussion: Have each group share their findings with the class. Did they get the results they predicted? If not, what was different? What are some possible explanations for the difference(s)? Did anyone try to jump farther, faster, or slower? How could that affect their predictions from the graph?

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Part 2 - Going to Great Lengths **Main Idea:** Does the length of jump rope that works for you change depending on your height? Students will test different jump rope lengths to find the length that works best for them. They will measure and record the length of their favorite jump rope, measure and record their height, use the data to create a graph, and look for a pattern. They will then use their graphs to make predictions.

INTRODUCTION

When introducing this activity, let students know that this is not a competition. Reassure students that their jump-roping skills are not essential. Students will use standard and nonstandard units of measure to record the lengths of jump ropes and the height of jumpers. They will compare the preferred length of rope for each jumper to his/her height and look for a mathematical relationship between the two values. They will calculate ratios and determine if there is a consistent ratio between jump rope length and jumper height. Finally, students will make scatter graphs with the class data and use the graphs to determine a ratio and make predictions about the length of rope needed for different heights.

MATERIALS

- Cotton clothesline or other type of rope cut into 10-foot lengths (1 per group)
- Standard measurement tools (e.g., meter stick/yard stick, tape measure)
- Nonstandard measurement tools (e.g., feet, sneakers, hands)
- Graph paper
- Markers
- Colored dots
- Pencils
- *Going to Great Lengths Data Collection Sheet* (1 per group, found on page JU 12)
- *Standard Unit Data Chart* and/or chart paper (1 per group, found on page JU 13)

ACTIVITY: GOING TO GREAT LENGTHS

STEP 1: DISCUSS (25 MINUTES)

Many people jump rope for exercise and for fun. What kinds of jump rope games have you played?

Divide students into groups of four to six people. Give each group a 10-foot length of clothesline and have each student take a turn using it to jump rope. (Students may naturally begin to shorten the length of the rope by wrapping the ends around their hands.)

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Discussion: What is the "best" length for a jump rope? What do we mean by "best?" Does one length of jump rope work for everyone? How would you determine the best length? Some example responses may be: "The best length would let me jump ten times without missing." Or, "The best length would let me jump forever." Encourage students to discuss their ideas fully. Does a jump rope need to be longer or shorter than the person jumping? You may want to demonstrate a rope that is too short or too long.

As a class, determine which standard unit of measure you should pick to measure jump rope length and student height (e.g., centimeters, meters, inches, feet). If we didn't have rulers or measuring tapes, what else could we use to measure? Record all suggestions and review the list (e.g., shoe-lengths, actual feet lengths, hand-widths, floor tiles). Explain that these are nonstandard measurements, and have each group pick one to use to compare to the standard unit the class picked earlier.

Distribute the *Going to Great Lengths Data Collection Sheet* to each group. Ask students to measure the height of each jumper using both the standard and nonstandard units of measure and record on their data sheets. Encourage students to take turns so that each student is measured and has a turn to measure and record the data.

Ask each student to jump rope with a piece of clothesline, adjusting the length until it is best for him or her (by wrapping the ends around his/her hands). Have students measure this "best" length of the rope (excluding any excess that was wrapped around his/her hands) with both the standard and nonstandard units and record it on the data sheet next to the student's height.

STEP 2: SHARE FINDINGS (10 MINUTES)

Discussion: Ask each group to share their findings. What nonstandard measures did they use? How did it compare to the standard unit used? Which unit is easier to use? Why do you think there are standard measures?

Explain that nonstandard units can change over time so you can get different measurements of the same thing. For instance, as you grow, your foot and your hand grow too, so using those to measure isn't consistent.

Ask students if they can organize their data in a way that might show a pattern. For instance, by arranging all of the student data by height—from tallest to shortest or vice versa—it might be possible to detect if there is a relationship between the height of a person and the length of the jump rope they need. Using the *Standard Unit Data Chart* or chart paper, create a table by recording each student's data starting with the shortest student and ending with the tallest. Do students see any patterns in the class data? Do the tallest students need the longest jump ropes?

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STEP 3: CREATE A SCATTER GRAPH (15 MINUTES)

Explain to students that the data on the chart paper is organized in a data table. That's one way to organize data to help find patterns and relationships. Another way to organize data to help visualize patterns is to make a graph. On a large piece of chart paper, label the x-axis (horizontal) "Student Height" and the y-axis (vertical) "Jump Rope Length." Help students label the chart with the unit they used for their standard measure. Have each student place a colored dot on the chart where his or her height and jump rope length meet.

When the graph is complete, ask students if they see a pattern in the dots. What does the graph show? Did the shorter students use shorter jump ropes? Did taller students use longer jump ropes? Most likely, the dots don't all fall on a straight line. They are probably scattered around an imaginary line from the shortest students' dots to the tallest. This invisible line is called a ***trend line***, and this type of graph is called a ***scatter graph***. Have a student or two help you draw a straight line on the graph (in pencil) from the shortest jumper's dot to the tallest jumper's dot. Are most of the other dots near the line? If not, can a student help draw a better trend line that most of the dots will be near? The trend line does not necessarily need to intersect (or go through) any of the individual dots; it is a generalization showing a trend in the data.

Are there some dots that are far away from the trend line? These are called ***outliers*** and represent jumpers who don't fit the trend or pattern of everyone else. If there are outliers on the graph, what makes them unique? Did someone short like a really long jump rope? Why? What else might cause someone to be an outlier?

Discussion: Ask the students to describe the relationship between student height and jump rope length. Can students use the information in their scatter graph to predict what length of rope a 6-foot tall jumper would need?

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Part 3 - Legendary Leapers **Main Idea**: What animal can jump the farthest? The highest? For this activity, students will compare their jumping distances with those of other animals and learn about the adaptations that help these impressive leapers.

INTRODUCTION

Animals move to find food, to escape predators, or to find a safe place to live or rest. Jumping is a type of locomotion that requires special adaptations such as long legs, large muscles, modified foot and ankle bones, or spring-like tails. Jumping spiders use a hydraulic system that transfers body fluids to their legs, allowing them to leap several times their own body length. Jumping spiders jump to catch their prey; frogs will jump to escape predators; and a kangaroo uses jumping as its primary mode of locomotion.

Students will first compare how far they can jump with the table showing distances that various animals can jump. Next, students will reflect on the relationship between body size and the distance an animal can jump.

In preparation, create a 10-foot-long jumping track by placing masking tape on the floor in a straight line; then place a 5-foot piece of masking tape perpendicular to this, creating a "T" shape on the floor. Mark off 1-foot increments along the 10-foot strip.

MATERIALS

- Tape measure or yard stick
- Masking tape
- Graph paper
- Chart paper
- Adequate flat space to jump
- *Animal Jumping Distance Table* (1 per student, found on page JU 14)
- *Animal Body Length Jumping Table* (1 per student, found on page JU 15)

ACTIVITY: LEGENDARY LEAPERS

STEP 1: DISCUSS (5 MINUTES)

Have students list some ways that animals move: run, swim, fly, soar, glide, jump, slither, crawl, walk, etc. Today we are going to learn about animals that jump. Ask: What animals can you think of that are good jumpers? How do you think you might compare?

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STEP 2: THE LONG JUMP (20 MINUTES)

Have students line up along the 5-foot strip of masking tape. This will be the start line. Ask two students to be spotters along the 10-foot strip of masking tape. Each of the spotters will have paper, pencil, and a ruler. Have students take turns jumping as far as they can, starting from a crouching position. The spotters will record how far each student jumps (use the ruler to measure to the nearest marked increment). Record distances either by using a sheet of paper or by placing tape at the spot of the jump labeled with each student's initials. Make sure the spotters swap with two other students so that everyone gets a turn.

Have each student compare their distance with the *Animal Jumping Distance Table*. Which animals could they out-jump? Compare the results.

STEP 3: BODY LENGTH RATIOS (45 MINUTES)

Ask the students: "Do you think how tall you are affects how far you can jump?" Test this idea. Divide the students into pairs, and have each pair use the tape measure to measure their height in feet. Write this number down.

Create a scatter graph. On a large piece of chart paper, label the x-axis (horizontal) "Student Height (feet)" and the y-axis (vertical) "Long Jump Distance (feet)." Help students label the chart and have each student place a colored dot on the chart where his or her height and long jump distance meet. Is there a relationship? How many students were able to jump farther than their body length? Was anybody able to jump twice as far as they are tall (that is, 2 times their body length)?

Do you think there is a relationship between how big an animal is and how far it can jump? For example, if a grasshopper were the same height as a person, would it be able to jump farther than 2.5 feet?

Hand out the *Animal Body Length Jumping Table*. Demonstrate the following calculation with the entire group: A football field is 100 yards = 300 feet = 3,600 inches long. A grasshopper is about 1 inch long. Compare this to a grown man who is 6 feet 2 inches, which is 74 inches, or 74 times taller than a grasshopper. To compare the jump of the grasshopper to this man, you would multiply 74 x 30 inches = 2,220 inches = 61 yards. In other words, a person-sized grasshopper would be able to jump more than half a football field in a single bound.

Similarly, a rocket frog that can leap 6.5 feet (35 times its own length) is equivalent of a 6-foot human making a 105-foot-long jump. What other comparisons can you make? Have students work in small groups to try to calculate human-sized long jumps for different animals.

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Discussion: Have each group share their findings with the class. Was it difficult to make the calculations? Have each student explain their reasoning and how they worked out their calculations. It's OK if the student didn't finish the calculation or wasn't able to do it correctly; let them tell the group what they tried, and ask the group to listen respectfully. Did each group approach the problem in the same way? What kinds of answers did the group get? Which answers make the most sense and why? Which animal was the most surprising?

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How Far Can You Go?

Data Collection Sheet

Jumper:	
Time	Distance

Jumper:	
Time	Distance

Jumper:	
Time	Distance

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Going to Great Lengths

Data Collection Sheet

Jumper:		
Height of Jumper	Jump Rope Length (in standard units)	Jump Rope Length (in non-standard units)

Jumper:		
Height of Jumper	Jump Rope Length (in standard units)	Jump Rope Length (in non-standard units)

Jumper:		
Height of Jumper	Jump Rope Length (in standard units)	Jump Rope Length (in non-standard units)

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Standard Unit Data Chart

Student	Student Height (indicate the unit used for measurement)	Rope Length (indicate the unit used for measurement)

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Animal Jumping Distance Table

Animal	Jumping Distance (feet)
Elephant	0
Flea	1
Grasshopper	2.5
Meadow Jumping Mouse	3
Kangaroo Rat	9
Hare	12
Lemur	25
Red Kangaroo	30
Mountain Lion	40

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Animal Body Length Jumping Table

How many times their actual body length can these animals actually jump?

Animal	Body Length (feet or inches)	Ratio of the body length compared to length of jump
Elephant	13 feet	0
Olympic long jumper Michael Powell	6 feet 2 inches	4.76
Impala antelope	4 feet 6 inches	6
Red Kangaroo	4 feet 6 inches	10
Kangaroo Rat	6 inches	12
Meadow Jumping Mouse	5 inches	7
Grasshopper	1 inch	20
Rocket frog	2 inches (can jump 13 feet)	35
Froghopper Insect	.2 inch (can jump 28 inches)	100
Flea	.05 inch	160

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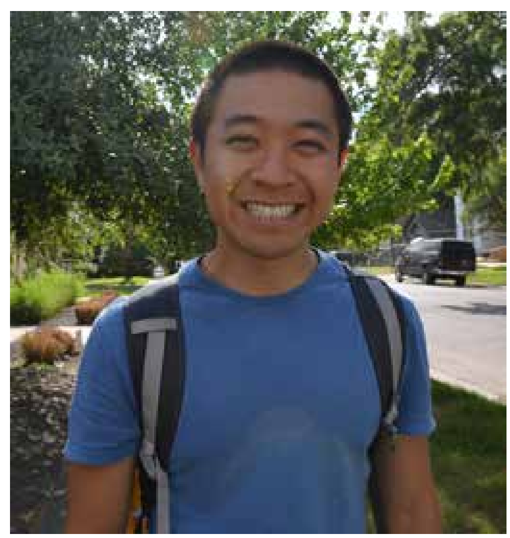
I work at Sandia National Laboratories as a solar energy engineer. My team and I work to invent new technologies to provide electricity to more people, for less money, and in a clean way that doesn't harm the environment. Every project starts with the engineering design process, where we plan out what we need to build. I need math to help me measure components and calculate the amount of materials I need. Math also allows us to calculate how efficient our technologies are at turning the sun's energy into electricity. The math I learned in school provided me with a foundation that helped me better understand science and engineering. Now I get to travel the world and make people's lives better through solar technologies. Sometimes even simple math problems can turn into extraordinary technologies and lead to incredible adventures for whoever dares to solve them!

KENNETH ARMIJO
Engineer

I am a mathematician at Sandia National Laboratories where I am part of a Modeling and Simulation team. We develop computer programs that simulate real events to understand what happens to the electronics. For example, we can study what happens to the body of a car in a collision with modeling instead of having to crash a car. Our simulation helps engineers make safer cars. I use a lot of mathematics in my job! Math is a key component of all computer codes and programs. The math I learned serves as a foundation that lets me create and apply ideas to many fields in science and engineering. I also use math for my hobbies outside of work! I like to play racquetball where I constantly have to calculate the trajectory of the ball. When I hit it, where is it going to go? Will I win the point? I use math to help me win! I prefer to think of all math like a puzzle or a game; once I understand the rules about how to play the game, it becomes fun to try to win! Math homework is the same way; once you understand the ideas behind the numbers, and if you keep practicing, you will become a pro!



ANDY HUANG
Mathematician

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