Scale Ella
Teacher Guide

The *Scale Ella* animation is available on iTunes U (search *"Math Snacks"*) and at www.mathsnacks.org

Topic: Scale factor

Time Required: 1–2 days for 50 min. classes, 1 day for 90 min class

Note: Due to the length of *Scale Ella*, we recommend watching it for the first time at the end of the class period the day before you are planning on doing this lesson. This will allow more class time for discussion during the actual lesson.

Learning Objectives: After watching the animation, completing the activities in the Learner Guide, and completing at least one bonus activity, students will understand that:

- There is a number (the scale factor) that creates the relationship between two items that are being compared to one another.
- Multiplication and division are inverse operations.
- If the scale factor is less than one, the size of an object or a number is being decreased.
- If the scale factor is greater than one, the size of an object or a number is being increased.
- The scale factor can be represented as a decimal, whole number or fraction.

Vocabulary: Scale factor, fraction

Vocabulary in Spanish: Factor de escala, fracción

Materials and Technology required:

- Computer, LCD Projector, Access to Internet or animation

Common Core State Standards Covered

Standard	Standard Description
4.MD.1	Know relative sizes of measurement units within one system of units including km, m, cm…. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two column table.
5.MD	**Convert like measurement units within a given measurement system.**
5.MD.1	Convert among different sized standard measurement units within a given measurement system, and use these conversions in solving multi-step, real world problems.
7.G	**Draw, construct, & describe geometrical figures & describe relationships between them.**
7.G.1	Solve problems involving scale drawings of geometric figures, including computing actual lengths & areas from a scale drawing & reproducing a scale drawing at a different scale.

Preliminary Preparation:

1. Watch the "Teaching with *Scale Ella*" instructional video.
2. Make copies of learner guides for *Scale Ella*
3. Do the problems in each learner guide and compare with answers in the teacher guide.
4. Go to Mathsnacks.com website and make sure the *Scale Ella* animation is working for you. If you are using iPads to view the animation, make sure to download the animation from iTunes prior to class.
5. Print the Scaleo puzzle piece provided, preferably in color, and cut into the appropriate number of pieces. (See bonus activity below.)

Animation Viewing and Discussion Questions

Scaling up:
- What are some of your favorite things? Make a list on the board and try to quantify them. For example, if a student says "animation games," on the board put "hours playing animation games" or "number of animation games." Try to transfer what they say into something numerical.
- What if you could increase the amount you have of these things? Would you want to do that? How could we double the amount of these things? How could we triple the amount? On the board, show that the initial amount would be multiplied by 2 or multiplied by 3.

Scaling down:
- What are some of the things you do not like? Make a list on the board and try to quantify them. For example, if a student says "chores," on the board put hours doing "chores" or "number of chores each day."
- What if you could decrease the amount of these things? Would you want to do that? How could we cut the amount in half? On the board show that the initial amount would be either multiplied by 1⁄2 or divided by 2, to get the same answer.

Tell the students: *Now we are going to watch an animation, and I want you to see if you can figure out how the animation relates to what we just talked about. I also want you to record all of the math vocabulary words you hear during the animation.*

If you are going to show the animation ONLY ONCE WITHOUT STOPPING, use the following questions:
1. What do you think this animation is about?
2. What are some of the math vocabulary words you heard in the animation? (Write them on board.)
3. Let's talk about *scale factor*. What do you think this means?
4. When Scaleo and Scale Ella were making something larger, what were some of the scale factors? What do they have in common?
5. When they were making something smaller, what were some of the scale factors? What do they have in common?
6. So if I want to scale something up, what should the scale factor be? (Answer: Bigger than 1.)
7. If I want to scale something down, what should the scale factor be? (Answer: Between 0 and 1.)
   - It is important that students understand these concepts. Sometimes students will want to scale down using a negative number or subtraction instead of division and multiplication.
8. What operations were they using to scale something up or down? (Answers: Multiplication, division.)
9. Would you ever subtract or add if you are scaling? (Answer: No, only multiply and divide.)

If you are able to watch the animation TWICE, and are comfortable STOPPING AND STARTING, show *Scale Ella* a second time, and be prepared to pause and discuss. After one or two vignettes, pause and ask:
1. How do you think Scale Ella and Scaleo's powers are the same? How are they different? Can you provide an example to explain your answer?

Resume animation and play another few vignettes. Pause and ask:
2. Can you think of some examples in the animation where something was scaled up or made bigger? Can you think of some examples in the animation where something was scaled down or made smaller? Do you think Scale Ella's solutions make sense? Why or why not?

Resume animation and let it play until it is over:
3. How would you describe the numbers that scale things up? How would you describe the numbers that scale things down? (Answers: Bigger than 1. Between 0 and 1.)
4. Would you rather have the power to scale things up or down? Explain your choice and give an example of something you would scale in your life.

Learner Guide and Discussion Questions

This Learner Guide is actually very simple and can be done relatively easily by students in the classroom or at home for homework. Make sure to discuss each question with students to ensure proper understanding of the concepts. Question 3 can be challenging and may require some discussion before students begin working. The numbers .05 and 1⁄2 are challenging for some students, and selecting scale factors to increase and decrease the numbers can be challenging.

Concepts covered in the Learner Guide are as follows:
- Scaling up and down (all)
- Using scale factors to increase and decrease numbers (3)
- Relating scale factors to real life situations (4,5)

Day 2 Bonus Activity and Discussion Questions

1. Cut out the puzzle of Scaleo provided below into 12 different rectangles.
2. Divide students into 12 groups. (Note: If the number of students in the class does not lend itself to 12 groups, the puzzle can be cut into any number of pieces. The ideal group size is 2–3 students.)
3. Give each group a piece of graph paper, a ruler, a pencil and colored pencils.
4. Give each group one puzzle piece.
5. Have the class choose a whole number scale factor to make the puzzle bigger. The scale factor should be between 2 and 7. Have the students also pick a scale factor to make the puzzle smaller.
(This should be a benchmark fraction like 1/4, 1⁄2, or 1/3.)
6. Have students scale their puzzle piece using the scale factors selected. Give them a hint: they can scale the rectangle first and then focus on the details within the puzzle piece itself. They will be creating two similar versions of the assigned puzzle piece.
7. Have students draw their scaled puzzle pieces using pencil and then color them in using the colored pencils.
8. When everyone is done with their puzzle pieces, have them put the puzzles together on the board. Students can come up to the board one piece at a time.
9. The result should be a scaled-up version of the original puzzle.

The Bow
(Tie it all together to bring out the main ideas)

1. Is our new puzzle perfect? (Discuss why measurement is so important.)
2. How do you think architects use scale factor? Can you think of any other professions that use scale factor? (Answers might include engineers, contractors, artists, surveyors, teachers [overhead projector], etc.)
3. If you want to scale something up, what has to be true about the scale factor? (Answer: >1) Can someone demonstrate scaling 5 up by a factor of 12? (Have student demonstrate.)
4. If you want to scale something down, what must be true about the scale factor? (Answer: Between 0 & 1.)
5. What are the three different ways you can scale the number 24 down by 1⁄4? (Have a student demonstrate. Answers: Multiply by 1⁄4, divide by 4, or convert 1⁄4 into a decimal and multiply by that.)
6. Can you imagine scaling something up by 100? What would that look like?
7. What about scaling something down by 1/100?
8. When you are scaling an object in two dimensions, like the puzzle, what do you have to remember? (Answer: Scale both the length and width.)
9. When you are scaling an object in three dimensions, like a box of tissues, what dimensions do you have to consider? (Scale the depth, width and height.)

Optional Bonus Homework Problem for Day 2

1. Give students the dimensions of a tissue box (length, width and depth).
2. What are the new dimensions if you scale up the tissue box by a factor of 10?
3. What are the new dimensions if you scale down the tissue box by a factor of 1⁄4?
4. Find another 3 dimensional object, measure it, then scale it up by 4 and down by 1/10 and provide new measurements.

NOTE: **Negative scale factors**: If this question comes up from a student – take time to discuss the fact that scale factors cannot be negative.

Puzzle for BONUS ACTIVITY: This puzzle is 3 in. x 4 in. and can be cut into 12 pieces.