Ratios, Proportions, and Scale Drawings

v2.0

STEM Fundamentals: Applied Mathematics | Teacher Lesson Plan

Overview:

In this lesson, students will learn about ratios, proportions, and scaled drawings using Kid Spark engineering materials. Then, students will apply what they have learned throughout the lesson to complete a fun design and engineering challenge.

Click here **to explore the entire Kid Spark Curriculum Library.**

Learning Objectives & NGSS Alignment:

- Define ratio.
- Determine the proportional relationship of two ratios.
- Use scale drawings to represent a reduced or enlarged visual of a real object.

Scientific/Engineering Practice - Using mathematics

Crosscutting Concept - Scale, proportion, and quantity

Pre-Lesson Preparation:

1. Prepare enough lesson materials for each team. (Curriculum Packets, Student Engineering Workbooks)
2. Make sure to review content in curriculum packet prior to teaching content.
3. Prepare an example solution for the design and engineering challenge. *Curriculum Packet - Page 4*

Activity Time:

120 Minutes

Note: this lesson can easily be taught over the course of two class periods.

Period 1 - Convergent Learning Activity

Period 2 - Divergent Learning Activity

Targeted Grade Level:

3 - 5

Student Grouping:

Teams of 2

Additional Lesson Materials:

- Curriculum Packet
- Student Engineering Workbook

Kid Spark Mobile STEM Lab:

Young Engineers **OR**
Engineering Pathways

Note: *Two teams can share the engineering materials from one Kid Spark Mobile STEM Lab.*

Convergent Learning Activity:

1. Introduce students to ratios. *Curriculum Packet - Page 1*

   Note: Students should fill out lesson information in their Student Engineering Workbooks as they work through the lesson.

   A **ratio** is a relationship or comparison between two numbers. Ratios express how much of one thing there is compared to another. Ratios can be written as a fraction, using the word "to", or with a colon (:).

2. Instruct each team to locate 5 red blocks and 4 half-beams from a Kid Spark Mobile STEM Lab. Instruct students to assemble the squares shown in examples 1 and 2. *Curriculum Packet - Page 1*

3. Work with students to determine the ratio of length to depth in examples 1 and 2. *Curriculum Packet - Page 1*

4. Discuss how the ratios in examples 1 and 2 are equivalent. *Curriculum Packet - Page 1*

   Equivalent ratios are two ratios that express the same value.

5. Instruct teams to build a square that has a length and depth that is ten times larger than the square in example 1. Make sure students don't disassemble the square as it will be used in the following section. *Curriculum Packet - Page 2*

6. Introduce students to proportions. *Curriculum Packet - Page 2*

   Proportions are statements that express two equivalent ratios.

7. Work with students to determine if the ratios in examples 1 and 2 are proportional by cross multiplying. *Curriculum Packet - Page 2*

8. Instruct students to determine if the large square they built in section 1 is proportional to the squares in examples 1 and 2. Students should cross multiply the ratios to make sure they are proportional.

9. Introduce students to scale drawings. *Curriculum Packet - Page 3*

   A **scale drawing** is a drawing or illustration of a real object which has been reduced or enlarged from its original size, but still proportional to the real object. The proportion by which the drawing of an object is reduced or enlarged is referred to as the **scale ratio**.

10. Instruct students to place a red block on the illustration in example 3. In this example, the illustration is full scale 1:1. Have students look at the scale drawing of the block in example 4. In this example, the drawing or illustration is 4 times smaller than the real object (scale ration 1:4). *Curriculum Packet - Page 3*

11. Work with students to make sure the dimensions of the real block (example 3) and the scale drawing (example 4) are proportional. *Curriculum Packet - Page 3*

12. Instruct students to determine the actual dimensions of the beam shown in example 5. *Curriculum Packet - Page 3*

Divergent Learning Activity:

1. Review the Design & Engineering Challenge with teams. *Curriculum Packet - Page 4*

2. *Instruct teams to use the Kid Spark Design & Engineering Process to develop a solution to the challenge. Curriculum Packet - Page 4, Student Engineering Workbook - Page 3*

   Challenge tips & information :

   - *Two teams will share the engineering materials from one Kid Spark Mobile STEM Lab.*
   - *Encourage students to keep their designs simple.*
   - *Set a time limit on how long students have to complete their design.*
   - *In some instances, you may want to limit the number of engineering materials students have access to out of the Mobile STEM Lab. (Example: Instruct students to pull out X number of engineering materials before the start of the lesson.)*

Lesson Closure:

1. Project presentations - Instruct each team to share the design they created with the rest of the class. Be specific with what information you want students to share. (Example: teams are required to share how each member contributed, scaled drawings of the design, etc...)

2. Lab cleanup - After teams have finished their presentations, instruct them to disassemble their designs and pack all engineering materials back into the labs correctly. *Note: each lab should include a laminated inventory and organization guide to help students pack engineering materials back correctly.*

3. Lesson reflection - If time permits, do a quick recap/review of the lesson.

Assessment/Evaluation:

A. Student Engineering Workbook (12 Points)

B. Design & Engineering Challenge (20 Points)

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STEM Fundamentals: Applied Mathematics | Student Engineering Workbook

Team Members:

1. _____ 2. _____

Total Points	
Workbook:	..... /12 pts
Challenge:	..... /20 pts

Ratios

Fill in the correct information in the spaces provided.

1. A ratio is a relationship or comparison between two numbers. Ratios express how much of one thing there is compared to another.

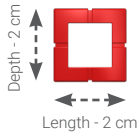
2. Equivalent ratios are two ratios that express the same value.

3. In example 1, what is the ratio of length to depth? 2/2.

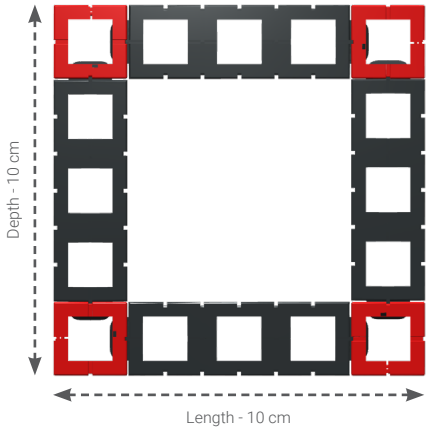
4. In example 2, what is the ratio of length to depth? 10/10.

5. [X] Using Kid Spark engineering materials, build a square that has a length and depth that is ten times larger than the square in example 1. Place a check in the box when this step is complete.

Example 1



Example 2



Proportions

Fill in the correct information in the spaces provided.

6. Proportions are statements that express two equivalent ratios.

7. Cross multiply the ratios in examples 1 and 2.

Ratio - Example 1

length 2 / depth 2

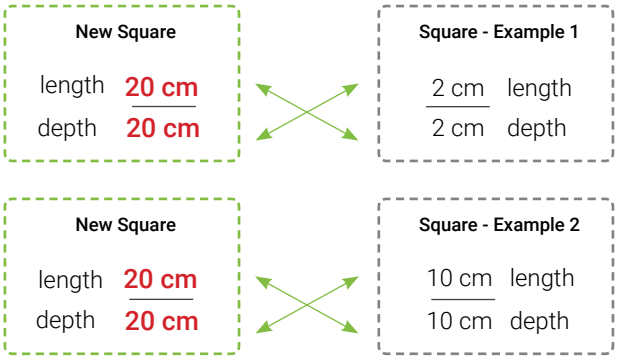
Ratio - Example 2

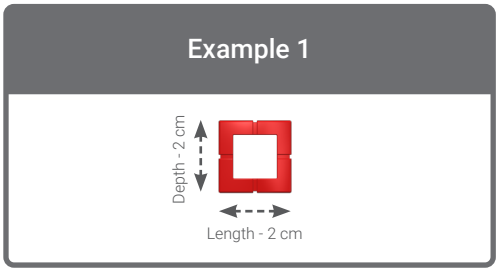
10 length / 10 depth

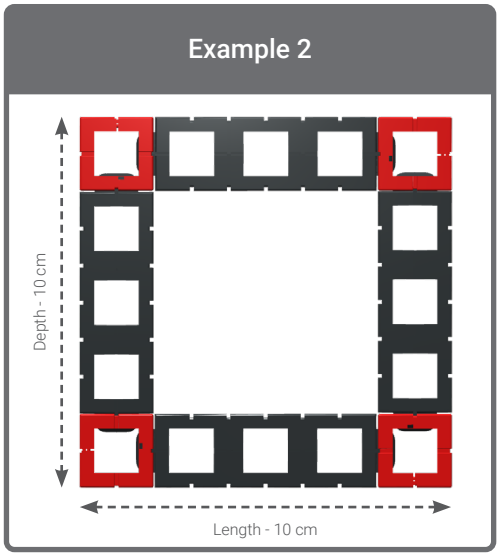
$$\frac{2}{2} \quad \frac{10}{10} \rightarrow 2 \times 10 = 20 \rightarrow 2 \times 10 = 20 \rightarrow 20 = 20$$

8. Are the ratios in examples 1 and 2 proportional? Yes. (Yes or No)

9. In the previous section, each team was challenged to build a square that had a length and depth that was 10 times larger than the square in example 1. Determine the ratio (length to depth) of the new square. Then, make sure the ratio of the new square is proportional to the ratios of the squares in examples 1 and 2 by cross multiplying.







10. Are the ratios of all 3 squares proportional? Yes. (Yes or No)

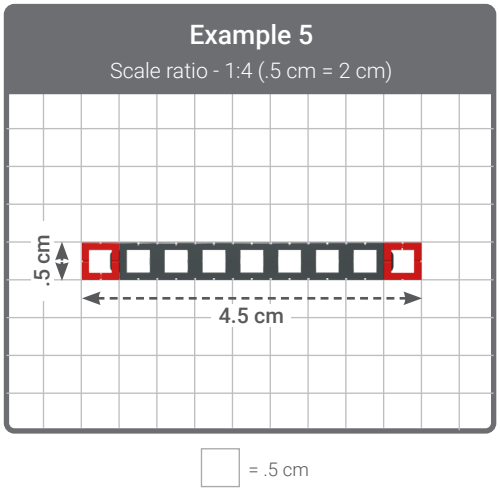
Scale Drawings

Fill in the correct information in the spaces provided.

11. A scale drawing is a drawing or illustration of a real object which has been reduced or enlarged from its original size, but still proportional to the real object. The proportion by which the drawing of an object is reduced or enlarged is referred to as the scale ratio.

12. Determine the actual dimensions of the beam shown in example 5.

Length - 4.5 cm x 4 = 18 cm
Depth - .5 cm x 4 = 2 cm



Design & Engineering Challenge

Follow each step in the design & engineering process to develop a solution to the challenge.
Place a check in each box as each step is completed. Fill in the blanks when necessary.

1. Identify The Challenge

   [X] Challenge: **Design and engineer a simple dog house.**

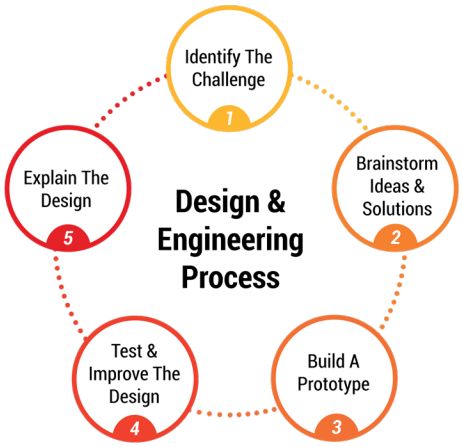
2. Brainstorm Ideas & Solutions

   [X] Discuss design ideas.

   [X] Consider building components.

   [X] Sketch out design ideas on paper.

   [X] Choose the best design.



3. Build A Prototype

   [X] Use Kid Spark engineering materials to build a prototype.

4. Test & Improve The Design

   [X] Look for opportunities to improve the design. (Is it practical, proportional, etc..)

   [X] Review challenge specifications/criteria and grading rubric.

5. Explain The Design

   [X] Complete four scale drawings on the provided half-centimeter grids. *Student Engineering Workbook - Page 4*

   [X] Determine how much the design would need to be scaled up for a real dog to comfortably use the dog house. *Student Engineering Workbook - Page 5*

   [X] Discuss the following items with your team and be prepared to share with the rest of the class.

      a. How did the team arrive at the final design solution? Discuss how each step in the Design & Engineering process was used to develop the design.

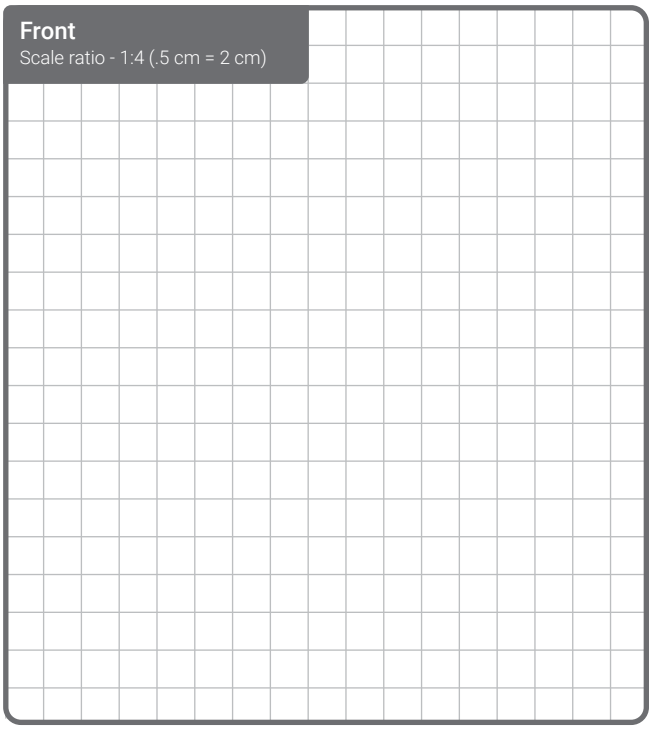
      b. Is the design realistic and well-proportioned? How did each team member contribute towards the overall design? Do you feel like everyone had an equal opportunity to contribute?

      c. Is the team prepared to share detailed specifications of the design to others?

Scale Drawings

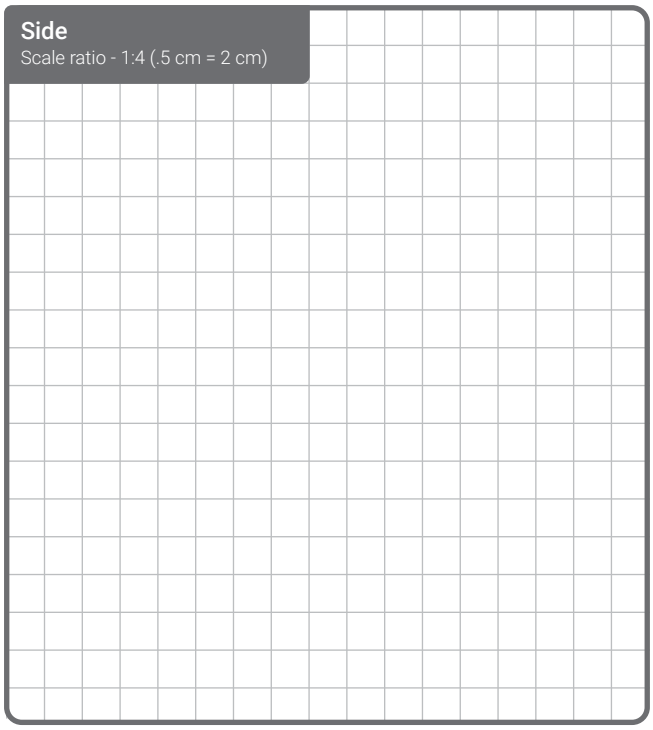
Use the half-centimeter grids to produce scale drawings of the dog house your team designed. Drawings should be simple and to scale.

Front
Scale ratio - 1:4 (.5 cm = 2 cm)



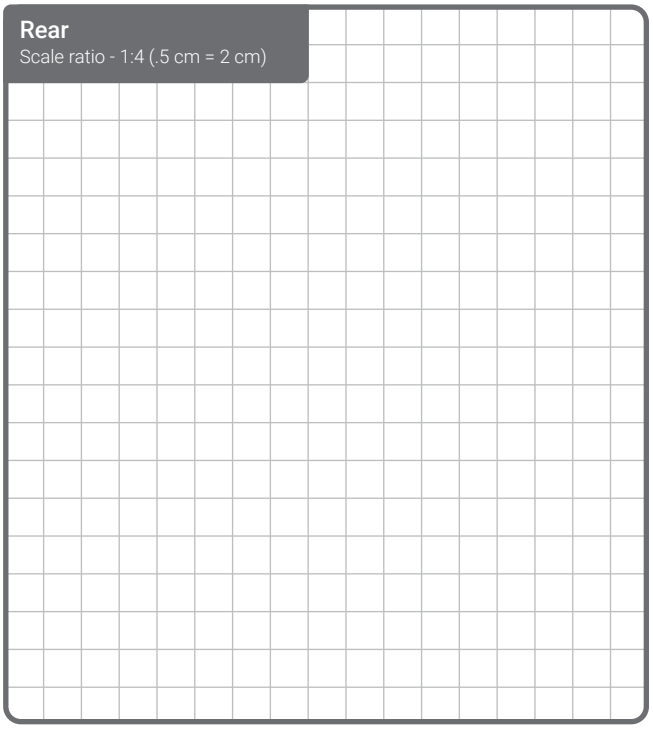
☐ = .5 cm

Side
Scale ratio - 1:4 (.5 cm = 2 cm)



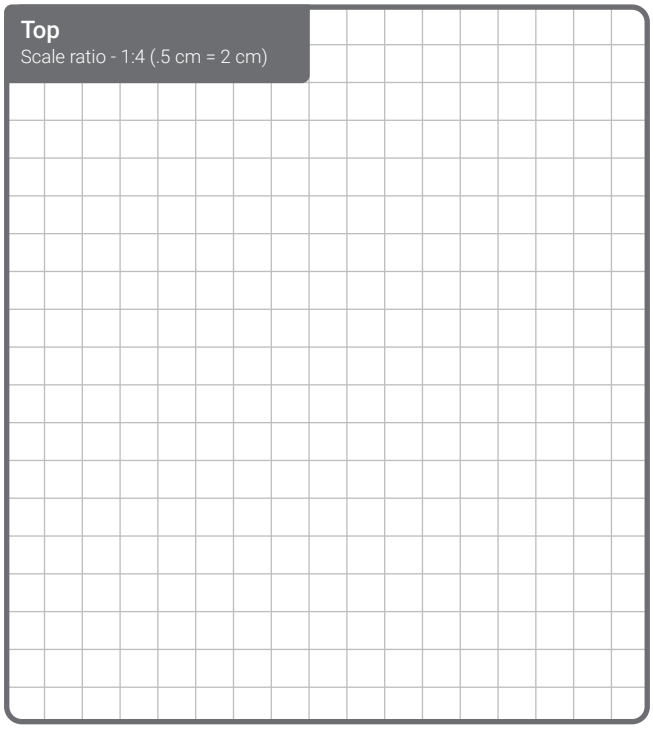
☐ = .5 cm

Rear
Scale ratio - 1:4 (.5 cm = 2 cm)



☐ = .5 cm

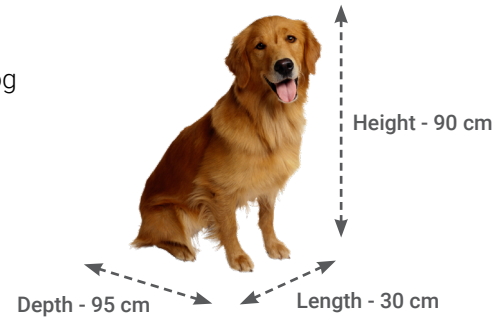
Top
Scale ratio - 1:4 (.5 cm = 2 cm)



☐ = .5 cm

Scaling Up

Determine how much your design would need to be scaled up in order for an average-sized dog (length - 30 cm, depth - 95 cm, height - 90 cm) to comfortably use the doghouse. Teams will need to determine the interior dimensions of the dog house that was built in order to complete this section.



Example:

Example Dog House (Interior Dimensions)	Ratio - 1:10	Real Dog House (Interior Dimensions)	Does the dog fit?	Does the dog fit comfortably?
Length - 14 cm	x 10 =	Length - 140 cm	Yes [X] No	Yes [X] No
Depth - 14 cm	x 10 =	Depth - 140 cm	Yes [X] No	Yes [X] No
Height - 14 cm	x 10 =	Height - 140 cm	Yes [X] No	Yes [X] No

Your design:

Prototype Dog House (Interior Dimensions)	Ratio - __ : __	Real Dog House (Interior Dimensions)	Does the dog fit?	Does the dog fit comfortably?
Length - _____	X _____ =	Length - _____	Yes [ ] No	Yes [ ] No
Depth - _____	X _____ =	Depth - _____	Yes [ ] No	Yes [ ] No
Height - _____	X _____ =	Height - _____	Yes [ ] No	Yes [ ] No

Challenge Evaluation

When teams have completed the design & engineering challenge, it should be presented to the teacher and classmates for evaluation. Teams will be graded on the following criteria:

- **Specifications:** Does the design meet all specifications as stated in the design brief?
- **Team Collaboration:** How well did the team work together? Can each student describe how they contributed?
- **Design Quality/Aesthetics:** Is the design of high quality? Is it structurally strong, attractive, and well proportioned?
- **Presentation:** How well did the team communicate all aspects of the design to others?

Grading Rubric	Advanced 5 Points	Proficient 4 Points	Partially Proficient 3 Points	Not Proficient 0 Points
Specifications	☐ Meets all specifications	☐ Meets most specifications	☐ Meets some specifications	☐ Does not meet specifications
Team Collaboration	☐ Every member of team contributed	☐ Most members of team contributed	☐ Some members of team contributed	☐ Team did not work together
Design Quality/ Aesthetics	☐ Great design/ aesthetics	☐ Good design/ aesthetics	☐ Average design/ aesthetics	☐ Poor design/ aesthetics
Presentation	☐ Great presentation/ well explained	☐ Good presentation/ well explained	☐ Poor presentation/ explanation	☐ No presentation/ explanation
Points	Column Total	Column Total	Column Total	Column Total
Total Points				Total Points /20