Lesson 4: Restaurant floor plan

Goals

- Choose an appropriate scale and create a scale drawing for a restaurant floor plan.
- Use proportional reasoning to solve problems about the area or volume of different elements of a floor plan and explain (orally) the solution method.

Lesson Narrative

This lesson is optional. In this lesson, students create a scale drawing of the floor plan for a restaurant and solve problems involving proportional reasoning about the area or volume of different elements within the floor plan.

Students can adapt an outline of their floor plan to make it easier for them to incorporate other requirements, such as the spacing between tables and the maximum distance between the tables and the food pickup area. This gives them an opportunity to make sense of the problem. If students choose to use a compass to draw a circle with a radius representing the 60-foot restriction, or if they make physical scale models of tables, they are choosing tools strategically.

As with all lessons in this unit, all related standards have been addressed in prior units. This lesson provides an *optional* opportunity to go deeper and make connections between domains.

Addressing

- Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
- Know the formulae for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.
- Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and cuboids.
- Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.
- Use proportional relationships to solve multistep ratio and percentage problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percentage increase and decrease, percentage error.

Instructional Routines

- Co-Craft Questions

- Compare and Connect

Required Materials

Blank paper
Compasses
Geometry toolkits
tracing paper, graph paper, coloured pencils, scissors, and an index card to use as a straightedge or to mark right angles plus a ruler and protractor. Clear protractors with no holes and with radial lines printed on them are recommended.

Graph paper
Index cards

Required Preparation

Students need access to graph paper, geometry toolkits, and compasses.

Student Learning Goals

Let's design the floor plan for a restaurant.

4.1 Dining Area

Optional: 25 minutes

The purpose of this activity is for students to create a scale drawing for a restaurant floor plan. Students use proportional reasoning to consider how much space is needed per customer, both in the dining area and at specific tables. They try to find a layout for the tables in the dining area that meets restrictions both for the distance between tables and to the kitchen. Students choose their own scale for creating their scale drawing.

When trying to answer the last two questions, students might want to go back and modify the shape of their dining area from their previous answer. This is an acceptable way for students to make sense of the problem and persevere in solving it.

Instructional Routines

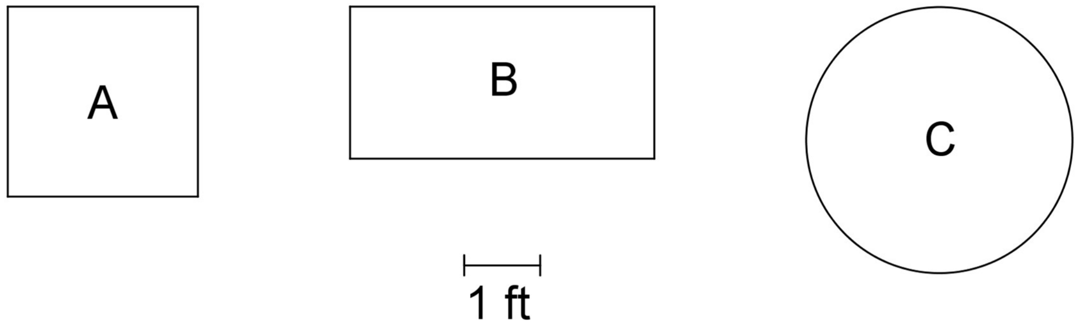
- Compare and Connect

Launch

Provide access to graph paper, geometry toolkits, and compasses. Give students quiet work time followed by partner discussion.

Student Task Statement

1. Restaurant owners say it is good for each customer to have about 300 in^2 of space at their table. How many customers would you seat at each table?



2. It is good to have about 15 ft^2 of floor space per customer in the dining area.

   a. How many customers would you like to be able to seat at one time?

   b. What size and shape dining area would be large enough to fit that many customers?

   c. Select an appropriate scale, and create a scale drawing of the outline of your dining area.

3. Using the same scale, what size would each of the tables from the first question appear on your scale drawing?

4. To ensure fast service, it is good for all of the tables to be within 60 ft of the place where the servers bring the food out of the kitchen. Decide where the food pickup area will be, and draw it on your scale drawing. Next, show the limit of how far away tables can be positioned from this place.

5. It is good to have at least $1\frac{1}{2}$ ft between each table and at least $3\frac{1}{2}$ ft between the sides of tables where the customers will be sitting. On your scale drawing, show one way you could arrange tables in your dining area.

Student Response

Answers vary. Sample responses:

- Table A could seat 3 customers because $30 \times 30 = 900$ and $900 \div 300 = 3$
- Table B could seat 3 or 4 customers because $48 \times 24 = 1\,152$ and $1\,152 \div 300 = 3.84$
- Table C could seat 4 or 5 customers because $\pi \times 21^2 \approx 1\,385$ and $1\,385 \div 300 = 4.61\dot{6}$

a. About 80 customers

b. The dining area could be a rectangle with sides 30 ft and 40 ft. This would give an area of 1 200 ft^2, which is enough space for 80 customers because $80 \times 15 = 1\,200$.

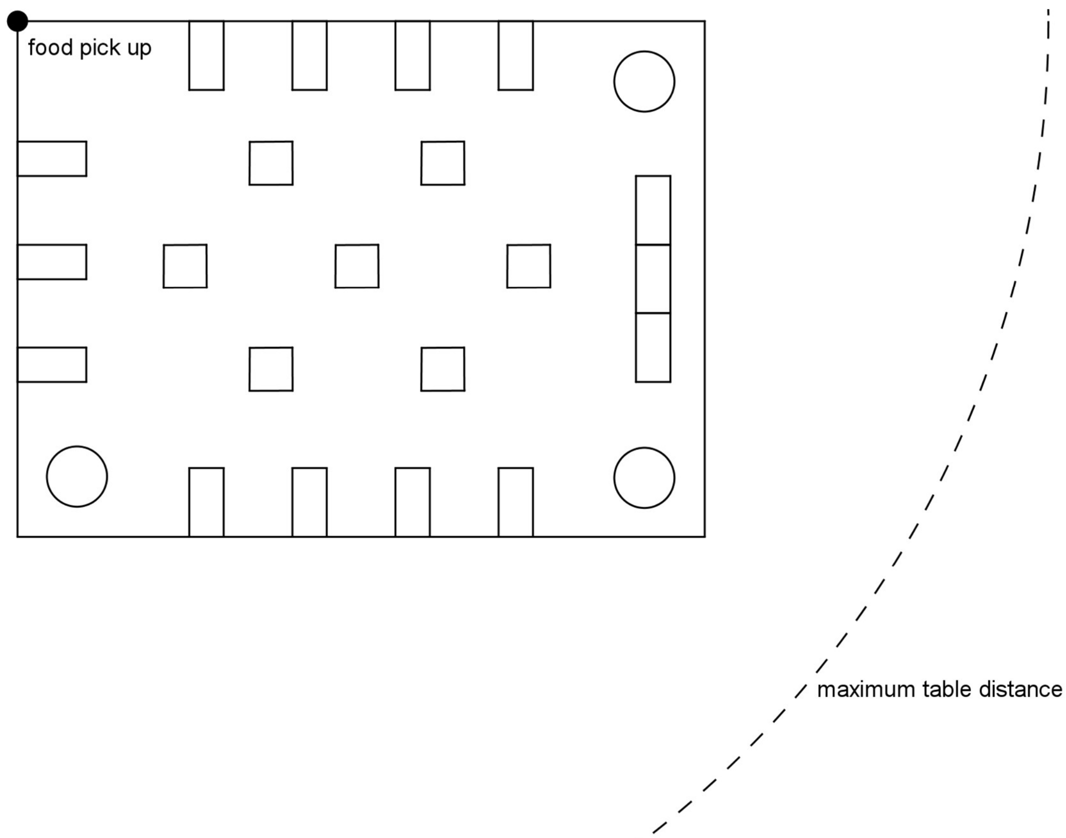
c. Using a scale of 1 cm represents 2 feet, the scale drawing would be a rectangle 15 cm wide and 20 cm long.

– Table A would be a square with sides 1.25 cm.

– Table B would be a rectangle with length 2 cm and width 1 cm.

– Table C would be a circle with a diameter of 1.75 cm.

1. The food pickup area could be a point in the top left corner of the rectangular dining area. A circle centred on this point with a radius of 30 cm represents the maximum distance to a table.



Are You Ready for More?

The dining area usually takes up about 60% of the overall space of a restaurant because there also needs to be room for the kitchen, storage areas, office, and bathrooms. Given the size of your dining area, how much more space would you need for these other areas?

Student Response

Answers vary. Sample response: If the dining area is 1 200 ft^2, then the other areas would need about 800 ft^2 of space. We can represent the fact that the dining area takes up about 60% of the entire restaurant area with the equation $0.6x = 1\,200$, where x represents the area of the entire restaurant. The entire restaurant would cover about 2 000 ft^2, because $x = 1\,200 \div 0.6 = 2\,000$. The other areas of the restaurant would be about 800 ft^2 because $2\,000 - 1\,200 = 800$ or $0.4 \times 2\,000 = 800$.

Activity Synthesis

Ask students to swap with a partner and check that the layout meets the requirements for spacing between tables and maximum distance between the tables and the food pickup area.

Display these questions for students to discuss with their partner:

- Is the scale drawing easy to interpret?
- Does it say somewhere what scale was used for the drawing?
- Is there anything that could be added to the drawing that would make it clearer?

Speaking, Listening, Conversing: Compare and Connect. After students have prepared their scaled drawings of a floor plan, display the drawings around the room. Ask pairs to discuss "What is the same and what is different?" about the scale drawings. To help students make connections between drawings, ask, "What do you observe about our scale drawings that is easier to interpret?". This will help students reflect on how precise and understandable their drawings are for others to interpret.
Design Principle(s): Cultivate conversation; Maximise meta-awareness

4.2 Cold Storage

Optional: 15 minutes

The purpose of this activity is for students to apply proportional reasoning in the context of area and volume to predict the cost of operating a walk-in refrigerator and freezer.

Instructional Routines

- Co-Craft Questions

Launch

Arrange students in groups of 2. Give students 1 minute of quiet think time followed by time to work with their partner to solve the problem.

Action and Expression: Internalise Executive Functions. Chunk this task into more manageable parts for students who benefit from support with organisational skills in problem solving. Check in with students within the first 2-3 minutes of work time to ensure that they have understood the directions. If students are unsure how to begin, suggest that they consider each statement for the refrigerator first, and then for the freezer.
Supports accessibility for: Organisation; Attention Writing, Reading, Conversing: Co-craft Questions. Begin by displaying only the initial text describing the context of the problem and the information about the monthly costs of standard refrigerators and freezers (i.e.,

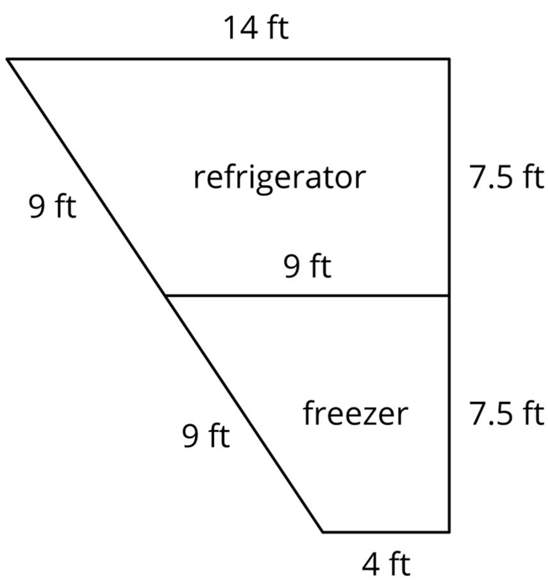
withhold the scale drawing and question about the walk-in refrigerator and freezer).
Ask students, “What mathematical questions can you ask about this situation?” Give groups 2–3 minutes to write down questions they have. As students share their questions, focus on questions that address how to evaluate costs in relationship to the volume of the refrigerator or freezer. This will help students understand the context and identify any assumptions they are making prior to solving the problem.
Design Principle(s): Cultivate conversation; Maximise meta-awareness

Student Task Statement

Some restaurants have very large refrigerators or freezers that are like small rooms. The energy to keep these rooms cold can be expensive.

- A standard walk-in refrigerator (rectangular, 10 feet wide, 10 feet long, and 7 feet tall) will cost about £150 per month to keep cold.
- A standard walk-in freezer (rectangular, 8 feet wide, 10 feet long, and 7 feet tall) will cost about £372 per month to keep cold.

Here is a scale drawing of a walk-in refrigerator and freezer. About how much would it cost to keep them both cold? Show your reasoning.



Student Response

Answers vary. Sample response: The total cost to keep both of these rooms cold would be about £352 per month.

- The walk-in refrigerator covers an area of 86.25 ft^2 because it can be decomposed into a rectangle with an area of 67.5 ft^2 and a triangle with an area of 18.75 ft^2.
- The walk-in freezer covers an area of 48.75 ft^2 because it can be decomposed into a rectangle with an area of 30 ft^2 and a triangle with an area of 18.75 ft^2.

- Let's assume that the refrigerator and freezer shown in the drawings are also 7 ft tall, like the ones given in the example. That means their volumes are 603.75 ft^3 and 341.25 ft^3, respectively, because $86.25 \times 7 = 603.75$ and $48.75 \times 7 = 341.25$.
- In the example, the refrigerator costs $150 \div (10 \times 10 \times 7)$, or about £0.21 per cubic foot to operate for one month, and the freezer costs $372 \div (8 \times 10 \times 7)$, or about £0.66 per cubic foot.
- Therefore, the refrigerator in the drawing would cost about £126.79 to operate for one month because $603.75 \times 0.21 = 126.7875$, and the freezer in the drawing would cost about £225.23 because $341.25 \times 0.66 = 225.225$.
- $126.79 + 225.23 = 352.02$.

Activity Synthesis

The goal of this discussion is for students to practise explaining the assumptions they made and the strategies they used to solve the problem.

First, poll the class on their estimates for the cost of operating the refrigerator and freezer. Discuss whether the different answers seem reasonable.

Next, select students to share their strategies for breaking the problem up into smaller parts.

Discuss what assumptions students made about proportional relationships while solving the problem. (For example, there is a proportional relationship between the volume of a walk-in refrigerator and the cost to keep it cold.)