Egg Carton and Shelter Designs: Constructing Arrays (Grades 3-5)

Objectives:

- Use arrays to write multiplication equations
- Explore arrays with 12 and 24 objects
- Label arrays with correct dimensions
- Apply knowledge of arrays to real world problems

Materials Needed:

- Graph Paper
- Egg cartons, various sizes (optional)
- Plastic Eggs (optional)
- Egg Counters (one inch grid paper)
- Construction paper - 3 sheets taped together width-wise per pair of students
- Dog cage counters (grid paper in small, medium and large sizes)
- Glue Sticks
- Scissors
- Poster Boards (1 per group of 3 or 4)
- Markers, pencils and rulers

Instruction Plan:

In this lesson, students are asked to design a new egg carton that will hold 24 eggs. Students explore different arrays of 24 (1x24, 2x12, 3x8, and 4x6) to decide which array will work the best. Show the class an egg carton filled with plastic eggs. Explain that you have been contacted by the president of the *Yolks & Shells Packing Company*. At the moment, they only package eggs in cartons that contain 12 eggs, but they have noticed some of their competitors packaging eggs of 6 and 18.

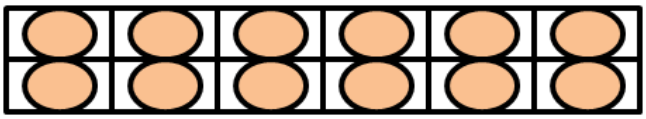
Yolks & Shells Packing Company wants to start selling eggs in groups of 24 and have hired the class to design new egg cartons. They need help in figuring out all of the ways to arrange 24 into rectangles.

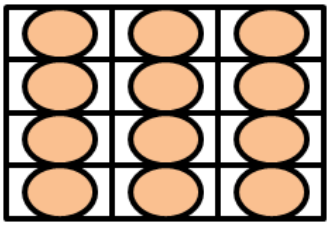
First, assign students to groups of two; this group is their design team. Give each pair a sheet of grid paper and scissors. Have the pair cut out 24 counters.

Demonstrate to the class how eggs are traditionally packaged (in 2 rows with 6 eggs in each row) using a set of counters. Have students do the same. Explain that this expression can be written as

2 x 6 or 2 by 6. Model cutting 12 squares of the grid paper, arranging them into a 2 x 6 array, and gluing the array onto the construction paper. Another option is to draw this on the board for the students to view. Label the sides of the array: 2 and 6. In order to clear any misconceptions, demonstrate to the students that a 2 x 6 array is the same as a 6 x 2 array.

Demonstrate the three ways to arrange 12 eggs in equal rows and columns:





Write the number of rows and columns on each array. Then, write the vocabulary term *array* on the board. Explain that an array is a rectangular set of objects arranged in rows and columns. Draw an example of an array (4 by 4) and an example that is not an array, but that still uses the same number of objects (1 row of 8 and 2 rows of 4 that total to 16) on the board so students can better visualize the difference. This will also be a good time to write and review the words factor and product.

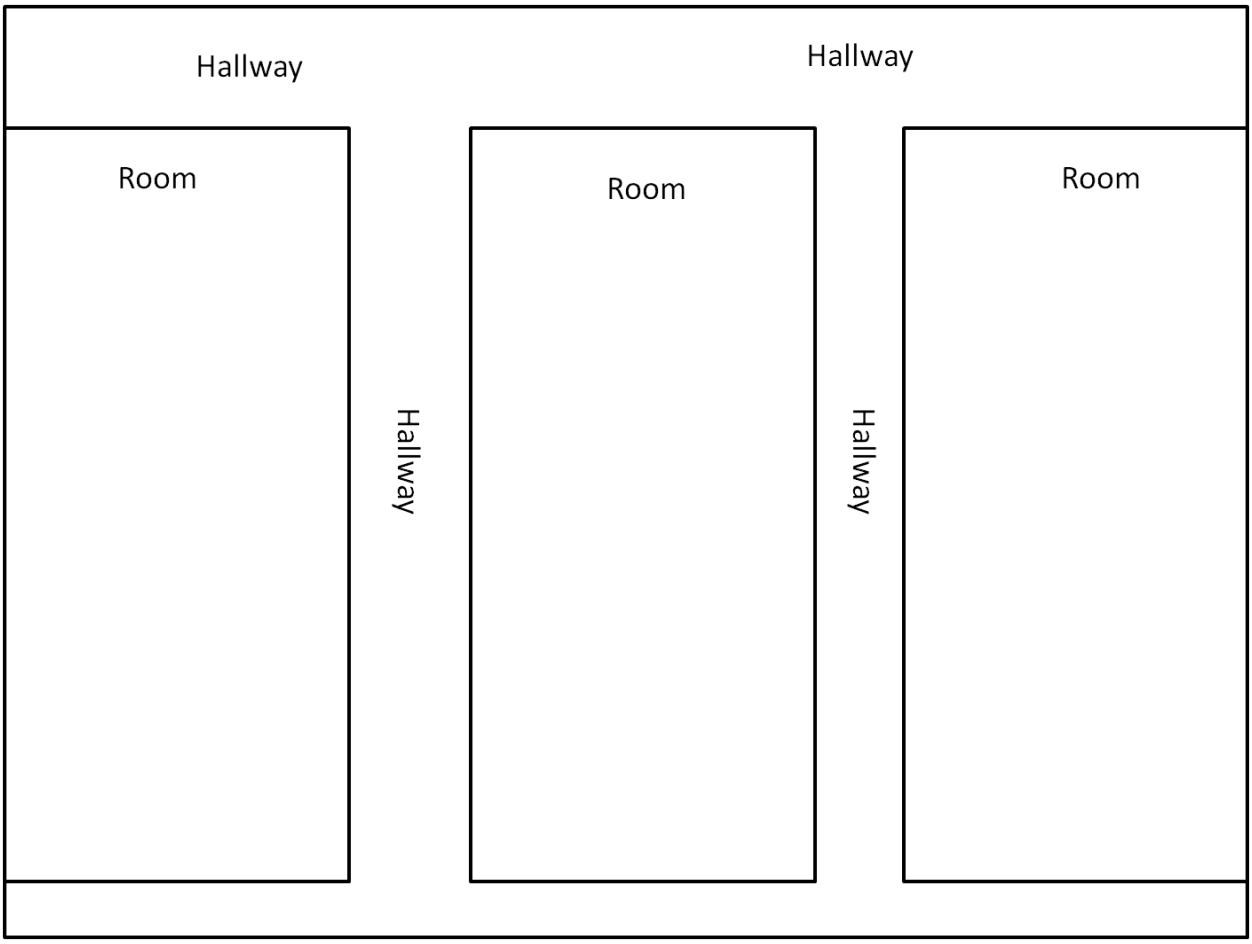
Now ask students to work together with their teams to organize their counters into arrays of 24. Once each team demonstrates all of the possible arrays, they will glue the counters down onto the construction paper. Make sure to point out that each row must contain the same number of counters. Remind students to label their arrays using the number of rows and columns.

Circulate as students are working and identify a pair or pairs that have completed a 4 x 6 array. When students have finished, ask the group or groups that completed a 4 x 6 array to show what they have found. As students demonstrate a 4 x 6 array, explain, “This array has 4 rows (write 4 by the rows) with 6 columns (label the columns with a 6). I can write this as the multiplication statement 4 x 6=24. And what if I rotate the array? What multiplication statement could you write for this rotated array?” (6 x 4 =24). Have other pairs state the arrays they made. If any other arrays were not made, ask students to determine the other possible arrays. Students might

not think to arrange a 1 x 24 array, but show that this is valid. However, students should note that this would not be a very practical egg carton.

Now that the students are comfortable with creating and interpreting arrays, tell the students that they will apply what they have learned about arrays to a different real-world problem about dogs. Ask the students if any of them have dogs, and if any of them have heard of canine distemper? (Canine distemper is a disease that affects dogs that has no cure, so people must vaccinate their dogs and be very careful not to let them catch it).

Tell students that the Friends of Campbell County Animals need their help designing a new shelter. The Friends have found that the arrangement of their old shelter made the dogs susceptible to a canine distemper outbreak, so they need to redesign the dog showroom. For canine distemper, it is important to decrease the chances that dogs could touch each other while they are in their cages. But there are also many dogs and a limited amount of space, and so students need to use the space efficiently. The shelter wants to have three different show rooms for the dogs. Below is an example of an outline for what the shelter's three rooms could look like.



For each room, there needs to be an array* of 16 cages, and each room needs to be labeled by dog size. Thus, there should be a separate room for small, medium, and large dogs. The cages and arrays should be sized according to the dog size. Ask students to think about what other factors might be important to consider in their design? (Example - space for volunteers to easily get to the cages to feed the dogs) The students should work through their ideas for the shelter on graph paper and using the dog cage counters**, first. When they make a final decision of the design they want, they can use the pencils, rulers, markers and the poster board to draw the final design. They need to make sure that each room is labeled by the dog's size. On the poster board, the students should also label the sides of the arrays of cages and describe them with words. The students can also feel free to use their creativity to embellish their posters, once the arrays are complete.

*For advanced students, the teacher may choose to change these rules slightly to say that there needs to be a total of 16 cages, but they can be arranged in multiple arrays, as long as the arrays

add up to 16. For example, the cages could be arranged in four arrays of 1 x 4, one array on each wall.
**For advanced students, the teacher may choose to distribute graph paper for the students to cut apart, instead of dog counter grid paper. The teacher explains that one unit of graph paper = 6 inches, and that they should cut out cages for the dogs in small, medium and large sizes based on what they think the dogs will need. Point out that each cage will be represented by an array of graph paper squares.

After pairs of students have designed their shelter, they need to present their design. The students should explain how the design is the best to lessen spread canine distemper and to show the dogs to the potential adopters, and any of the other reasons their design is superior. Once all the pairs have presented their ideas, the class should vote on the best design.

Assessment and Extension:

Assessment:

1. At the end of the activities, give each student a blank sheet of graph paper. Ask them to draw and label all of the arrays for the number 18. Provide counters for students to use as they work.
2. Write the numbers 4, 6, 8, 9, 10, 12, 15, 16, 18, 20, 21,24, 28, 30, 34, and 36 on index cards. Place them in a bucket. Ask groups to pick a card and find all of the different arrays that are possible for each shape. Create a class chart for all of the numbers.

Extension:

- Have students look for patterns in arrays of numbers that are multiples of each other (e.g., 6, 12, 18, and 24). An example of such a pattern would be that all arrays of 24 can be arrived at by doubling one side of an array of 12.

Extension for 4th and 5th Grade

4th Grade:

- Tell the students that *Yolks & Shells Packing Company* wants to try an experimental design where each container can have 36 eggs. Ask the students how their design for the 36 eggs is different and similar to the grouping of the 24 eggs.
- Refer to Extension Worksheet for 4th Grade

5th Grade:

- *Yolks & Shells Packing Company* wants to be revolutionary and try for a container that will cover an entire shelf in a refrigerator. This container should hold 72 eggs. What are the different arrays that could be made? Are all of these feasible? Do you think it is smart for the company to try this new idea?

- Refer to Extension Worksheet for 5th Grade

TN Math Standards:

3rd Grade:

Interpret products of whole numbers.

Use multiplication and division within 100 to solve word problems in situations involving equal groups.

Solve two-step word problems using the four operations. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.

4th Grade:

Interpret a multiplication equation as a comparison.

Multiply or divide to solve word problems involving multiplicative comparison.

Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators.

5th Grade:

Fluently multiply multi-digit whole numbers using the standard algorithm.

Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators.

Solve real world problems involving multiplication of fractions and mixed numbers.

Source:

Willman, L. 2015. *Egg Carton Designs: Constructing Arrays to Begin a Study of Multiplication*. Classroom Resources: Illuminations, National Council of Teachers of Mathematics.

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