

Lesson Title: Butterfly Gardens

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Curriculum Connections: Science—The Environment (garden design)

Grade Level: 3–4

Journal Article: “Butterfly Gardens” edited by Colleen D. Foster. *Teaching Children Mathematics* 18, no. 9, pp. 526–29

Overview:

The focus of this lesson is the concept of perimeter and area. Using a realistic context, students are asked to design three different shaped butterfly gardens, each with a perimeter of 64 feet. It requires students to build rectangles with a constant perimeter adjusting the area to accommodate an area the school has designated for this purpose. The problem context has students explore what happens to the area of a two-dimensional shape as the perimeter remains the same. It is important that students have some understanding of perimeter and area. This task is designed to help students construct a deeper understanding of the two concepts.

Learning Objectives:

Students will:

- Explore the concepts of perimeter and area
- Find different areas with the same perimeter
- Use strategies such as: partitioning, repeated addition, t-cart, and trial and error

Connecting to the Common Core:

- **3.NBT.A.3** Multiply one-digit whole numbers by multiples of 10 in the range 10-90 using strategies based on place value and properties of operations.
- **3.MD.C.5** Recognize area as an attribute of plane figures and understand concepts of area measurement.
- **3.MD.C.5.B** A plane figure which can be covered without gaps or overlaps by n unit squares is said to have an area of n square units.

- **3.MD.C.6** Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).
- **3.MD.C.7** Relate area to the operations of multiplication and addition.
- **3.MD.C.7.A** Find the area of a rectangle with whole-number side lengths by tiling it, and show that the area is the same as would be found by multiplying the side lengths.
- **3.MD.C.7.B** Multiply side lengths to find areas of rectangles with whole-number side lengths in the context of solving real world and mathematical problems, and represent whole-number products as rectangular areas in mathematical reasoning.
- **3.MD.D.8** Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths and exhibiting rectangles with the same area and different perimeters.
- **4.MD.A.3** Apply the area and perimeter formulas for rectangles in real world and mathematical problems.
- **4.OA.B.4** Find all factor pairs for a whole number in the range 1-100. Recognize that a whole number is a multiple of each of its factors. Determine whether a given whole number in the range 1-100 is a multiple of a given one-digit number. Determine whether a given whole number in the range 1-100 is prime or composite.

Connecting to the Standards for Mathematical Practice:

SMP3: Construct viable arguments and critique the reasoning of others.

Students address similarities and differences between area and perimeter as they present and discuss their solutions to the butterfly garden problem. These discussions allow students to consolidate their understanding and/or confront misconceptions. This task provides an opportunity for reflection, dialogue, and the possibility of reaching consensus.

Materials:

- Markers
- Chart paper
- Colored tiles
- Grid paper
- Copies of Activity Sheets

Instructional Plan:

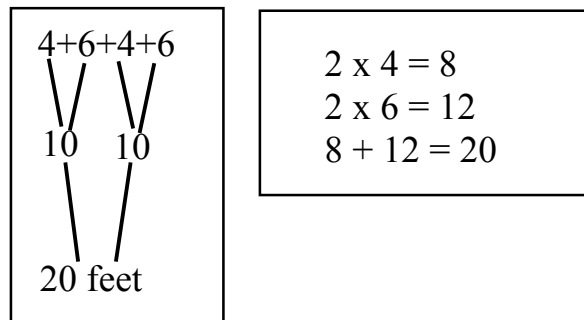
Getting Started:

1. I suggest at least three sessions for this investigation.
 - a. Days one and two, students will work on the questions from the activity sheets, representing their thinking on the chart paper. Students will need to make a **good copy** using another piece of chart paper to **clearly show** their thinking in preparation for the class discussions.
 - b. Day three, students share their posters (chart paper) and explain their findings with the class.
2. Have students work in partners. Try to avoid triads. Three students working together takes away the opportunities for an equal distribution in sharing the work. However, as teachers we know that this is not always possible, but it is something to consider in planning for the investigation.
3. Begin the introduction of the investigation by convening the students in a common meeting area in your classroom. Have them sit with their partner.
4. When asking students the activating questions, have them turn and talk to their partner (approximately 45 seconds). Tell students they are not to just answer the question but rather to discuss strategies they would use to begin the investigation.

Activating:

- Explore the concepts of perimeter and area:
 - Draw or sketch a rectangle with the dimensions of 4 by 6. Suggestions for drawing the rectangle:
 - Have a pre-made perimeter of the rectangle using chart paper that can be displayed on the board
 - Use SmartBoard technology to create the perimeter of the rectangle to display
 - Make the perimeter of the rectangle on the overhead projector using transparent colored tiles
 - Use permanent marker and draw the perimeter of the rectangle on acetate to display on an overhead projector

- As students are answering the questions below, write and sketch what they are describing to the rectangle. Here are some possible questions:
 - How would you label the dimensions of this rectangle?
 - What is the perimeter of this rectangle?



- Turn to your partner and discuss how you could determine the number of square tiles that would cover this rectangle.
- From your discussion, what is the area of this rectangle? Represent student thinking on the board.

$$4+4+4+4+4+4=24$$

$$8+8+8=24$$

$$12+12=24$$

- What is the difference between perimeter and area?

Prior to beginning the investigation with the Butterfly Garden, have students work on Activity Sheets 2A and 2B. This can be done a week in advance. This provides students with a number range more comfortable for them to work with including using colored tiles, grid paper, and markers and providing more experiences in developing understanding with perimeter and area. At this stage it is important that students are able to distinguish between both.

Butterfly Garden Investigation

- Present the problem on Activity Sheet 1. It might be helpful for the class to record the dimensions of part of the area designated space for the butterfly garden. You may want to draw and label the rectangle from Activity Sheet 1.

- Pose the following questions below, encouraging students to turn and talk to their partner to discuss their reasoning before they share their thinking with the class.
 - How can you determine the perimeter of this rectangle which represents the designated space? How do you know?
 - How can you determine the area of this? Explain your thinking.
- After discussing the questions above, be sure students understand that the:
 - Perimeter of the **designated space** for the garden is 100 feet.
 - Area of the **space available** is 600 square feet.

Acquiring

- Present students with Activity Sheet 1 which has the questions they will be investigating.
 - The butterfly garden will have a perimeter of 64. How much area will the butterfly garden cover of the designated space?
 - How much area of the designated space is left over as green space for benches and picnic tables?
- Provide students with markers and large chart paper on which to show their work.
- Encourage students to use grid paper and colored tiles to help them investigate the questions.
- Remind students to use words, diagrams or other methods to explain their thinking.

Applying

- As the students are engaged in the problem, walk around and observe the different strategies students use to find the different perimeters. Ask questions to guide their investigation and help students make sense of the problem. Possible questions include:
 - How many gardens have you designed?
 - What is the perimeter of each garden?
 - What is the area of each garden?
 - How could you use a t-chart to organize your thinking?
 - How do you know your gardens will fit in the designated space?
 - Which of your gardens leaves the most available space for picnic tables and benches?
 - What do you notice is happening with the area as you change the perimeter (dimensions) of your garden?

- Which of your gardens will give you the most area? Least area?
- How do you know?
- Halfway through the problem, ask students to share some things that they are noticing.
- Write these on the board and send them back to work.
- It is important to convene the students with Activity Sheet 1 and a good copy of their poster (chart paper) at the end of this problem task
- Have the partner pairs share their posters with the class and discuss their findings.
- See below for examples that students may come up with for the finding the different combinations of perimeter and different sizes of area for the garden.

Perimeter	Area
$1+1+31+31=64$	$1 \times 31=31$
$2+2+30+30=64$	$2 \times 30=60$
$3+3+29+29=64$	$3 \times 29=87$
$6+6+26+26=64$	$6 \times 26=156$
$8+8+24+24=64$	$8 \times 24=192$
$12+12+20+20=64$	$12 \times 20=240$
$16+16+16+16=64$	$16 \times 16=256$

- Some students may have questions or disagreements. Discussing them allows students to consolidate their understanding and/or confront misconceptions. So allow adequate time allows for reflections, dialogue, and if possible consensus.
- End the Butterfly investigation with as many combinations for the perimeter of 64 and the different possibilities for area. List them on the board for students to compare and consider.

Use Activity Sheet 3 the day following the Butterfly Garden investigation. This may provide teachers with more information for assessing student understanding.

Resources:

- <http://www.thebutterflysite.com/butterfly-gardening-by-area.shtml>
- <http://butterflywebsite.com/butterflygardening.cfm>
- <http://www.ca.uky.edu/entomology/entfacts/ef006.asp>
- <http://www.kidsbutterfly.org/>
- <http://www.enchantedlearning.com/subjects/butterfly/allabout/>
- <http://www.defenders.org/butterflies/basic-facts>

- <http://gardening.about.com/od/gardendesignplans/ig/Butterfly-Garden-Design/>
- www.whatdocaterpillarseat.info/
- <http://gardenswithwings.com/>