Butterfly gardens

Caterpillars and butterflies require different food sources: leafy plants and nectar, respectively.

Butterflies are beautiful insects for students to study. Unfortunately, some kinds of butterflies are on the endangered species list because their natural habitats are disappearing. Members of our school community are concerned about this dilemma, so we decided to plant a butterfly garden.

When we think of planting a garden, we may tend to think of planting fruits and vegetables. Planting a butterfly garden is becoming a popular hobby and supports efforts to help these lovely creatures. Different plants attract different butterflies, so researching which butterflies are found in the local area is an important endeavor. As students started to explore how to plan our school garden, they discovered that in the life cycle of a butterfly, the larvae (caterpillars) require leafy plants for food and mature butterflies require plants that provide nectar.

Students take on the roles of builder and gardener in this activity, enjoying the opportunity to design their own butterfly gardens.

Problem scenario

Imagine that our school has decided to develop a butterfly garden in an area that gets sun for long periods throughout the day and is sheltered from the wind. This location makes it easy for butterflies to feed.

We will use plastic edging to show where the garden will go and how large of a space we will use. The edging measures 64 feet in length. The school has designated an area 30 feet by 20 feet that we can use. This area is large enough to plant the garden and have some green space left for benches and a picnic table.

See the questions on the activity sheet (**p. 529**).

Classroom setup

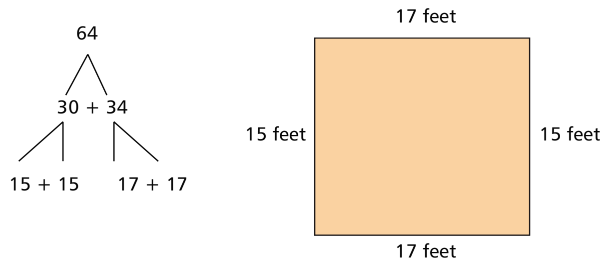
Before students engage in the problem scenario, explore the concepts of perimeter and area with them and ensure that they have a developing understanding (see **figs. 1–3** in the sidebar). Convene students in a meeting area to introduce the context and describe the problem scenario. On the board, record the dimensions of the area designated for the butterfly garden. Label two opposite sides 30 feet and the two remaining sides 20 feet. Pose questions such as those listed below, encouraging students to turn to a partner to discuss their reasoning before they share their

Where's the math?

The problem context has students explore what happens to the area of a two-dimensional shape as the side dimensions change but the perimeter remains the same. It is important that students have some understanding of perimeter and area. This task may help them construct a deeper understanding of the two concepts.

As students determine the length and sides of the rectangle, some may divide sixty-four into two equal parts and divide each of those parts in two more parts to get the measure of each side (see **fig. 1**).

FIGURE 1



To determine the area for the diagram in **figure 1**, some students may know that 15 feet × 17 feet will equal the area of the rectangle, 255 ft.². However, the strategies that students use may differ. Students may partition both 15 and 17 (see **fig. 2**).

FIGURE 2

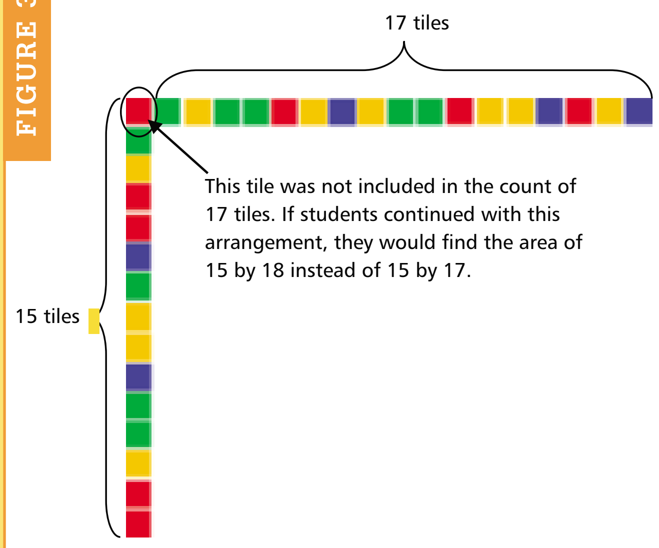
15×17

$(10 + 5) \times (10 + 17)$

$$\left.\begin{aligned} 10 \times 10 &= 100 \\ 10 \times 7 &= 70 \\ 5 \times 10 &= 50 \\ 5 \times 7 &= 35 \end{aligned}\right\} 100 + 70 + 50 + 35 = 255 \text{ ft.}^2$$

Other students may use repeated addition to determine the area of the garden. If students use colored tiles, they may lay out a column of 15, a row of 17, and continue the process to determine the area. Some students may not include the first tile of the column in the count of 17 tiles, therefore making a row of 18 instead of 17 (see **fig. 3**).

FIGURE 3



Notice how students determine the measure of each side to find the perimeter. Are they arbitrarily choosing numbers? Are they thinking strategically? Some students may organize their thinking in a t-chart format and begin to see the relationship between perimeter and area (see **table 1**).

TABLE 1

Measure of length	Measure of width	Area
7	25	175
8	24	192
10	22	220
16	16	256

As students engage in this problem scenario, ask them to explain the thinking they have put on the chart paper. More math may be revealed from this process than they have shown on paper.

ideas with the class. This gives students opportunities to explain their thinking, experience talking about math, and be exposed to different ideas or strategies that can be incorporated into their own work.

1. How can you determine the perimeter of the rectangle that makes up the garden?
2. How can you determine the area of the rectangle that makes up the garden?
3. If we change the dimensions of the rectangle but keep the same perimeter, does the area remain the same? Why, or why not?
4. The butterfly garden will have a perimeter of 64 feet [*write* perimeter—64 feet *on the board*]. How much area of the designated space will the butterfly garden cover?
5. How much area of the designated space is left for green space, benches, and a picnic table?

The latter two questions need not be answered at this point because as students work through the task, they explore what happens to the area as the side dimensions change but the perimeter remains the same. After discussing the previous questions, be sure students understand the following:

- **Perimeter** of the designated space for the garden is 100 feet.
- **Area** of the space available is 600 square feet.

Present students with the activity sheet, which includes the questions they will be investigating. Have them work on this problem with a partner. Supply them with markers and large chart paper on which to show their work. Remind them to use words, diagrams, or other methods to explain their thinking. Encourage students to use grid paper and colored tiles to help them investigate the questions.

As students engage in the problem, walk around and observe their different strategies. Ask open-ended questions to guide their investigation and help them make sense of the problem. Halfway through the problem, stop students from working and ask them to share some things they are noticing. Write these observations on the board, and then send students back to work. It is important to convene the students with their activity sheet at the end of this problem task and discuss their findings. Refer to the Where's the math? section for important mathematical ideas to introduce into the discussion.

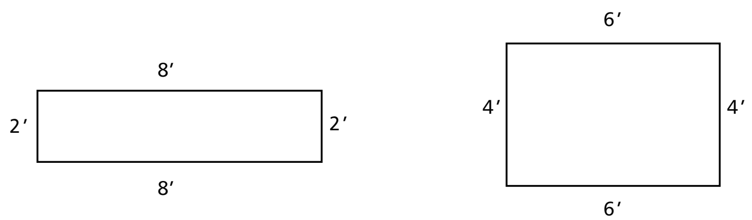
Extensions

Students can further explore this problem by answering the following questions:

1. Eight feet of edging was packaged in a bundle. How many bundles were bought?
2. The total cost of edging purchased was $42.00. How much did each bundle cost?
3. What are the dimensions of a garden covering one-quarter of the designated area?
4. What are the dimensions of a garden that covers one-third of the designated area?

FIGURE 4

Instructing students to investigate different perimeters can differentiate the task for them.



Have students investigate different perimeters within your classroom. Here is a chance to differentiate the task to meet students' various needs. For example, some students may require a smaller numeral range. Have them investigate smaller gardens for backyards or window boxes. Using the number 20, students may take advantage of what they know about pairs that are compatible to 10 to determine the measure of two sides (see **fig. 4**).

Share your students' work

Try this problem in your classroom. We are interested in how your students responded to the problem, what problem-solving strategies they used, and how they explained or justified their reasoning. Send your thoughts and reflections—including information about how you posed the problem, samples of students' work, and photographs showing your problem solvers in action—by **July 15, 2012**, to Problem Solvers department editor **Drew Polly**, COED 370, 9201 University City Blvd., Charlotte, NC 28213; or e-mail him at **drew.polly@uncc.edu**. Selected submissions will be published in a subsequent issue of *Teaching Children Mathematics* and acknowledged by name, grade level, and school name unless you indicate otherwise.

RESOURCES

The Butterfly Site. "Gardening by Area." http://www.thebutterflysite.com/butterfly-gardening-by-area.shtml.

Mikula Web Solutions. 1995–2011. "The Butterfly Website." http://butterflywebsite.com/butterfly gardening.cfm.

The University of Kentucky College of Agriculture: UK Entomology. 2010. "How to Make Butterfly Gardens." http://www.ca.uky.edu/entomology/entfacts/ef006.asp.

Edited by Colleen D. Foster, cfoster@wsd1.org, a grades 3–8 math support teacher for Winnipeg School Division in Manitoba, Canada. Each month this section of the Problem Solvers department features a new challenge for students. Readers are encouraged to submit problems to be considered for future columns. Receipt of problems will not be acknowledged; however, those selected for publication will be credited to the author. Find detailed submission guidelines for all departments at **www.nctm.org/tcmdepartments**.

Name______________________________

Butterfly Gardens

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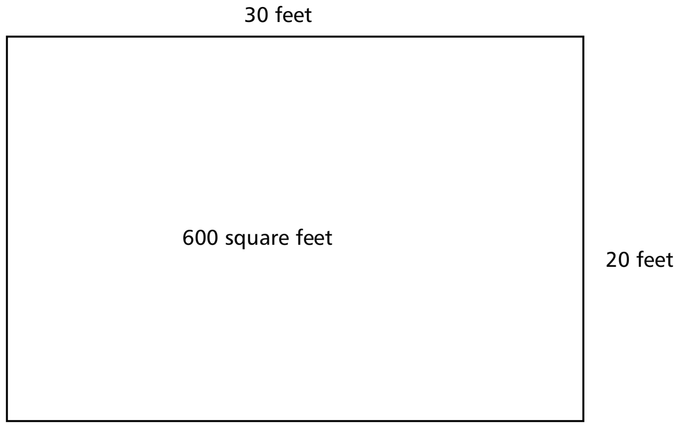


1. Determine the area of at least three gardens that have a perimeter of 64 feet.

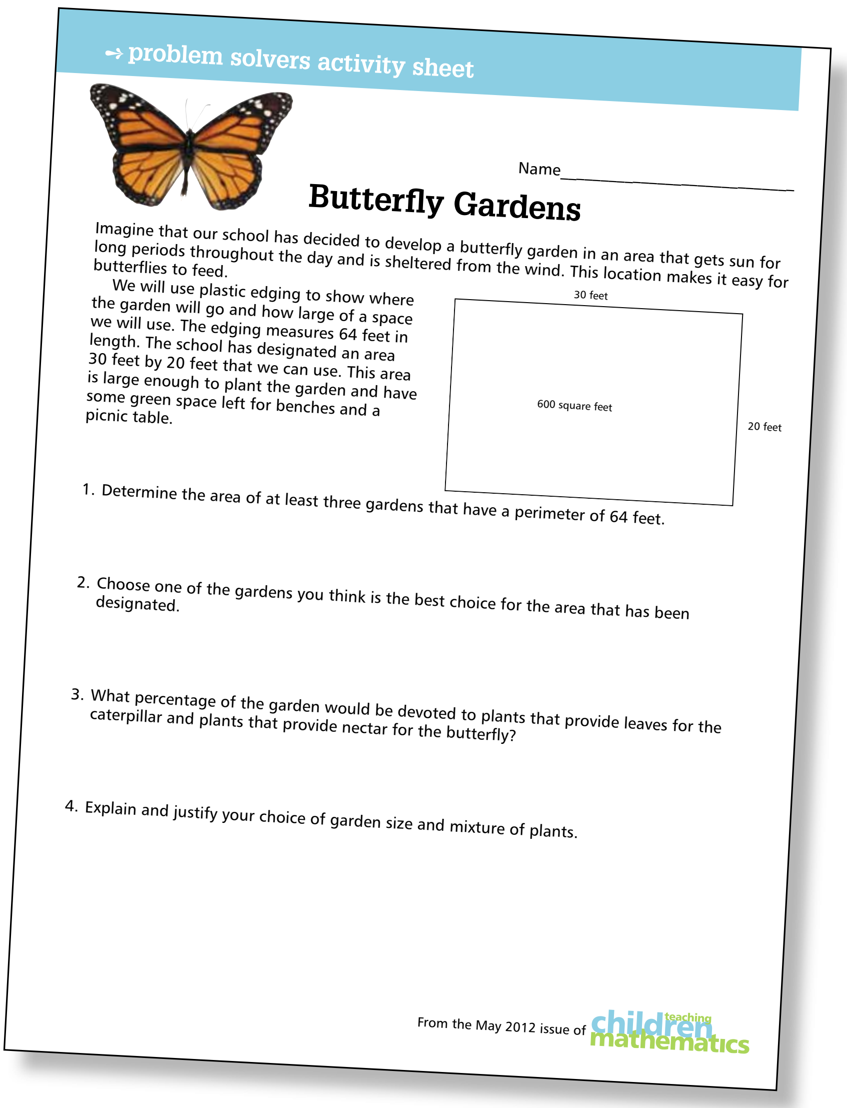
2. Choose one of the gardens you think is the best choice for the area that has been designated.

3. What percentage of the garden would be devoted to plants that provide leaves for the caterpillar and plants that provide nectar for the butterfly?

4. Explain and justify your choice of garden size and mixture of plants.

Butterfly gardens

The **May 2012 problem** scenario has students explore what happens to the area of a two-dimensional shape as the side dimensions change but the perimeter remains the same. To access the full-size activity sheet, go to **www.nctm.org/tcm**, Back Issues.


problem solvers activity sheet

Name________________

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From the May 2012 issue of teaching children mathematics

Fourth graders explored this task in Melissa Little's class at Shady Brook Elementary School, Kannapolis, North Carolina. Toward the end of a unit in which Little's students had explored area and perimeter concepts, she co-taught the lesson with Problem Solvers: Solutions department editor Drew Polly. Students were seated in small groups and had access to one-inch-square tiles, paper, pencils, and grid paper. Little's class included students with a wide range of ability levels, and the groups reflected this variety.

Before posing this task, Little and Polly had observed that approximately half of the eighteen students could successfully distinguish between area and perimeter concepts when presented with tasks similar in nature to the Butterfly Gardens task. Little believed that more experiences solving real-world tasks would help her students further develop their understanding of the differences between area and perimeter.

Rectangles with a perimeter of sixty-four feet

Little began by asking students to find the dimensions of three rectangular gardens with a perimeter of sixty-four feet. Although the original task had asked students to also find the area of these rectangles, Little and Polly decided to focus on the relationship between the side lengths of a rectangle and its perimeter. Students used a variety of approaches to this task, including creating rectangles with square tiles and calculating possible perimeters using numerical approaches.

Creating rectangles with tiles

Students in the groups that decided to use rectangular tiles each grabbed a handful of tiles and immediately started building rectangles on their desks. Earlier in the week, students had used this approach while solving similar tasks involving smaller perimeters, and they reported feeling comfortable with this strategy. One student noted, This is just like the Rabbit Pen problem that we did on Monday. I just need to build a rectangle and play around with the size until I get a perimeter that is sixty-four.

As students built the rectangles with tiles, many noted that sixty-four feet was significantly larger than the perimeters that they had worked with earlier in the week. As a result, some students expressed frustration at the amount of time it was taking to build their original rectangle.

While they worked, students discussed how many tiles should be on each side of the rectangle. One particular discussion revealed some students' confusion regarding perimeter and area. Some students in one group insisted that sixty-four square tiles in any rectangular configuration would have a perimeter of sixty-four units. Overhearing this discussion, the adults stopped by the group to ask students about their idea.

Little: Tell me about what you are doing.
Student 1: We know that we need a perimeter of sixty-four feet, so we are building a rectangular border with sixty-four tiles.
Little: Why do you think that will work?
Student 2: Every tile counts as one for perimeter, so if we have sixty-four tiles, we will have a perimeter of sixty-four.

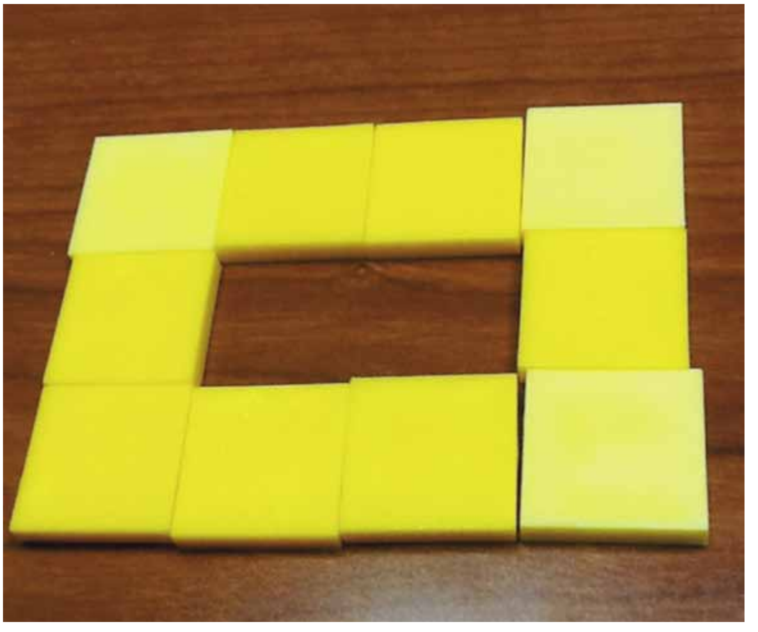
Little suspected that students' misconceptions concerned the corner tiles of the rectangle, as outlined in the original article. Polly agreed. When counting perimeter, students had counted the corners as two units, one unit on each side. And, because a rectangle has four corners, students' rectangles were actually four units larger than they expected them to be. That is, by creating a rectangular border using sixty-four tiles, students had made a rectangle with a perimeter of sixty-eight units. To address this misconception, Polly handed the students ten tiles and asked them to count them.

Student 3: There are ten tiles.
Polly: When you make a rectangular border, what will the perimeter be?
Students: [*in unison*] Ten.
Polly: Go ahead and make the rectangular border and count the perimeter.

Students made a rectangle that was four units across and three units tall (see **fig. 1**). Students counted the tiles, but they disagreed on the count. Student 1 insisted that the corner tiles be counted only once and got a perimeter of ten. However, student 2 insisted that since the corner tiles were on two sides of the rectangular border, they should be counted twice, which would be a perimeter of fourteen.

FIGURE 1

To address the misconception that led students to count the corner tiles twice, Polly had one group use ten tiles to determine the perimeter of a rectangle.

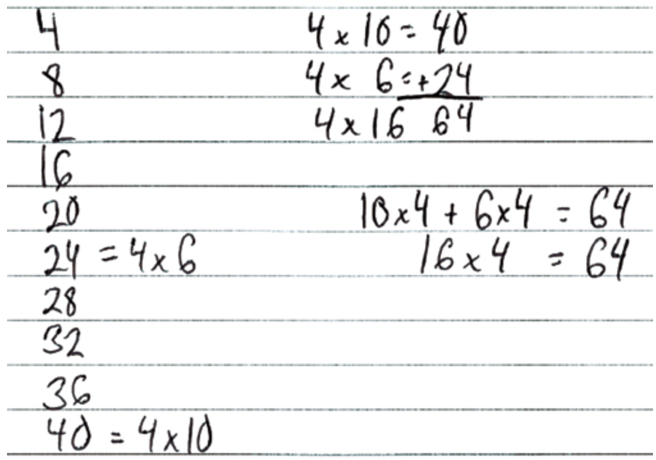


Student 3: Remember, we have checked our work by adding up the sides. If we add up the sides of this rectangle, we would get four plus three plus four plus three, which is fourteen.
Student 1: [*looking confused*] How can that be correct? We only used ten tiles.
Student 2: Let's start at the upper left corner and move across, counting the edges.

Student 1 counted the first four tiles across, then three along the right side of the rectangular border, saying the number, "Seven." As he moved around the bottom of the rectangle, he paused and said, "Ten," realizing that his answer was too small. He then continued to count the

FIGURE 2

Students determined how many times four will go into sixty-four.



edges, ending at the top left corner when he said the number, "Fourteen." When Little asked the students what this result meant for their original problem, student 1 responded, "We do not need to use sixty-four tiles."

Student 2 added, "We think we will need to use sixty tiles to make our different rectangles, since each tile counts once except for the four corners, which will count for two units."

As this group continued to work, students used sixty tiles to make a 16 unit × 16 unit rectangular border, which they also recognized as a square. They then rearranged their tiles to make a 17 unit × 15 unit rectangular border as well as an 18 unit × 14 unit rectangular border. Student 1 commented, "I feel like we can keep using this approach to keep finding answers." Little and Polly encouraged them to continue to find more answers to this part of the task.

Calculating with paper and pencil

Other groups took a computational approach to finding the different rectangle dimensions. A few students immediately recognized that sixty-four is a multiple of four, and they used their knowledge of a rectangle to find the most square-like figure.

Polly: Tell me what you are working on.
Student 4: We know that a rectangle has four sides and we have a perimeter of sixty-four. We are trying to see how many fours will go into sixty-four in order to find our first answer.
Polly: What have you found?
Student 5: We know that there are ten fours in forty and that forty is twenty away from sixty-four.
Student 6: We know that there are six fours in twenty-four, so we think that there are sixteen fours in sixty-four.
Polly: How could we show *that* on our paper?
Student 6: We think that sixteen times four equals sixty-four, but we really did ten times four and then six times four and added those answers.
Student 4: What if we wrote it like this? [*He used the paper to show his calculations.*] (See **fig. 2**.)
Polly: So, how does knowing this help us with our original problem?
Student 5: One of our answers could be a rectangular garden that is sixteen feet long and sixteen feet wide. When we multiply sixteen times four, that is sixty-four, which is our perimeter.

After talking with this group of students, Polly was curious to see how they would find other solutions. Would they use their first strategy, and if so, how?

Polly: What other solutions can you find?
Student 5: In rectangles, opposite sides have to be equal, which means that we are always adding up two of the lengths and two of the widths.
Polly: Can the rest of you explain what she just said?
Student 4: It sounds like we just need to find the length and the width and double that to get our perimeter.
Student 6: Wait, does that mean that if we want to find rectangles with a perimeter of sixty-four, we need to find out what two numbers we can add and then double to equal sixty-four?
Student 4: Maybe. Let's work backwards by using sixteen [*their first answer*]. What do we double to get to sixty-four?
Student 6: Thirty-two plus thirty-two equals sixty-four.
Student 4: OK, and sixteen plus sixteen equals thirty-two. I wonder if it will work with other numbers that add up to thirty-two?
Student 5: Thirty plus two equals thirty-two. If we double thirty-two, we will get sixty-four. So

we could have a rectangle that is thirty feet one way and two feet the other way, couldn't we?

Polly: Do you want to draw that to see? [*Student 6 draws it on paper.*]

Student 4: The perimeter would be thirty plus two plus thirty plus another two.

Student 5: Thirty plus thirty is sixty. Two plus two is four. If we put them together, we do get sixty-four.

Student 6: Here is the rectangle. You two are right. It does equal sixty-four.

Real-life connections

Time limitations allowed the class to explore only rectangular dimensions that had perimeters of sixty-four. In their final discussion, the teachers asked, "Which of your dimensions would make the best garden?"

Many students felt that the 16 foot × 16 foot garden made the most sense. One student commented, "The square garden just seems the best looking to me."

Student 5 added, "The ones that look more square seem to be more realistic. We don't really see gardens that are really long and skinny like the one that is thirty feet by two feet."

This task gave students a great opportunity to explore the concept of perimeter. Given more time, they could have explored more of the real-life connections that were embedded in the original problem.

Edited by **Drew Polly**, **drew.polly@uncc.edu**, an assistant professor in the Department of Reading and Elementary Education at the University of North Carolina in Charlotte. Each month, this section of the Problem Solvers department discusses classroom results of using problems presented in previous issues of *Teaching Children Mathematics*. Find detailed submission guidelines for all departments at **www.nctm.org/tcmdepartments**.