Area or Perimeter: Using Representations for the Real World

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Teachers in third through eighth grade teach area and perimeter simultaneously to their students every year and expect the students to know the difference. Recognizing the concern that teachers have for the lack of knowledge for area and perimeter, as well as their units, we share a lesson that allows the students to connect the terminology and mathematics to the real world. Specifically, we use an enactive, iconic, and symbolic lesson to find the cheapest fence for our garden.

Introduction

Area? Perimeter? Are these often interchangeable concepts in your classroom? As teachers, we have had moments when students confuse these two. From a student's perspective, it is easy to confuse these terms. We teach them at the same time, using the same shapes and we expect students to magically know and remember which is which. "Their difficulties lie in the fact that children simply do not understand the mathematics well enough conceptually to make the connection with the problem-solving situation" (Moyer, 2001, p. 52). How are they supposed to understand the difference when most of the information we provide uses the same vocabulary? It is this problem that we wanted to eradicate by connecting these terms, area and perimeter, to real life curriculum.

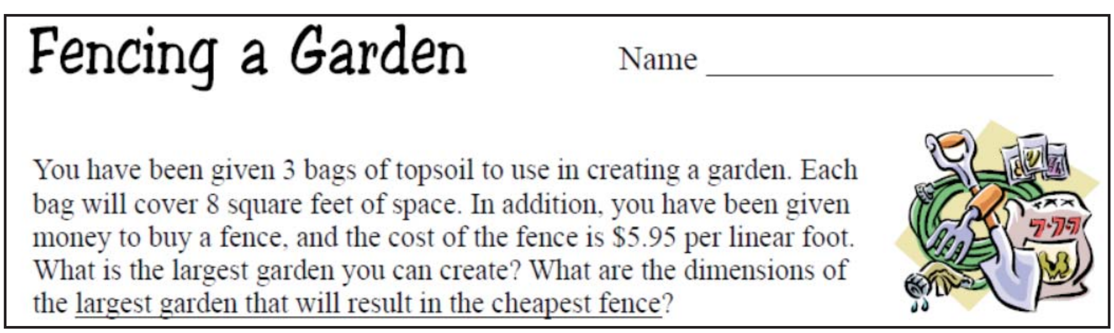
Statement of the Problem

For our task, with fifth grade students, we used a problem created by Candler (2010) (See Figure 1).

The students were given a bag of square tiles to use as the topsoil along with the attached worksheet, a small piece of grid paper to use for solving their problems, and large piece of grid paper to show their final work. Using these tools, they created three different gardens to find the one with the smallest perimeter.

Relevance of the Problem

"The concepts of area and perimeter are part of most people's daily lives, yet in normal conversation, most people rarely use the words perimeter or area with their formal mathematical meaning" (Ferrer, et al., 2001,



Fencing a Garden Name ____________________

You have been given 3 bags of topsoil to use in creating a garden. Each bag will cover 8 square feet of space. In addition, you have been given money to buy a fence, and the cost of the fence is $5.95 per linear foot. What is the largest garden you can create? What are the dimensions of the largest garden that will result in the cheapest fence?

Fig 1 Fencing a Garden Worksheet

> *By moving our desks into the arrangements just discussed students were able to clearly see that the tables were the area and the perimeter was the number of people who could sit alongside each of the tables.*

p.133). Perimeter and area are encountered on a daily basis in the real world. As adults, we have to buy things for our house based on the area of what we are covering, such as paint for the walls or carpet for the floor. Working with perimeter, we decide how much fence to surround a garden, like in our problem, or how much lace is needed to hem a dress. However, students don't really see how these concepts are useful in the real world.

Perimeter and area are taught starting in third grade and continue to be taught into fourth, fifth, sixth, etc. The NCTM standards state that third through fifth grade students should "develop strategies for estimating the perimeters, areas, and volumes of irregular shapes" as well as "select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles" (NCTM, 2000, p. 241). Additionally, as students progress through their education, we expect them to be able make meaning of the units that we attach to perimeter and area, as indicated by the Ohio fifth grade math standard, where students must "demonstrate an understanding of the difference among linear units, square units, and cubic units" (ODE, 2002, p. 147).

Context

In fifth grade, we began reviewing area and perimeter by using problems in our book and counting side lengths and squares. We wanted students to be able to connect the words, perimeter and area, to the real world. We began with Marilyn Burns's book *Spaghetti and Meatballs for All!* as a lead into our lesson.

Spaghetti and Meatballs for All! is a short story about an older couple, Mr. and Mrs. Comfort, who decided they want to host a dinner party for their family. Mrs. Comfort rents tables and arranges the eight tables perfectly so that all thirty-two guests will have a place to sit. As the first guests arrive, people begin to pull the tables together, in order to sit and socialize better. The company continues to pull tables together until even more people arrive and they realize there are not enough seats for everyone. The family is then forced to move the tables apart to make room for the new arrivals. Finally, when all thirty-two guests arrive, the tables are moved back to Mrs. Comfort's original arrangement of eight separate tables.

After we finished reading this book, we made several of the table arrangements that were presented. We drew the table arrangements on the board and discussed the area of each design (it was always eight), while noticing that the perimeter was constantly changing, depending on where the tables were. After we finished this discussion, we made our desks into the "tables" in the story. By moving our desks into the arrangements just discussed in *Spaghetti and Meatballs for All!*, students were able to clearly see that the tables were the area and the perimeter was the number of people who could sit alongside each of the tables. By illustrating the use of area and perimeter in the classroom, we began to allow students to construct their own knowledge of how perimeter and area actually work and how they are related.

Student Data and Work

After beginning with this book activity, we moved on to our rich task, in which we wanted students to be able to see how perimeter and area can be used in real world applications. Students were then given "bags of topsoil" (square tiles) which they could use to create garden designs. Each group, which consisted of three students, homogeneously grouped, was required to make at least three gardens using their "topsoil." Students were required to have at least one non-rectangular shape, and were expected to trace their garden onto graph paper and label the perimeter and area of the garden. An example of such work is provided in Figure 2.

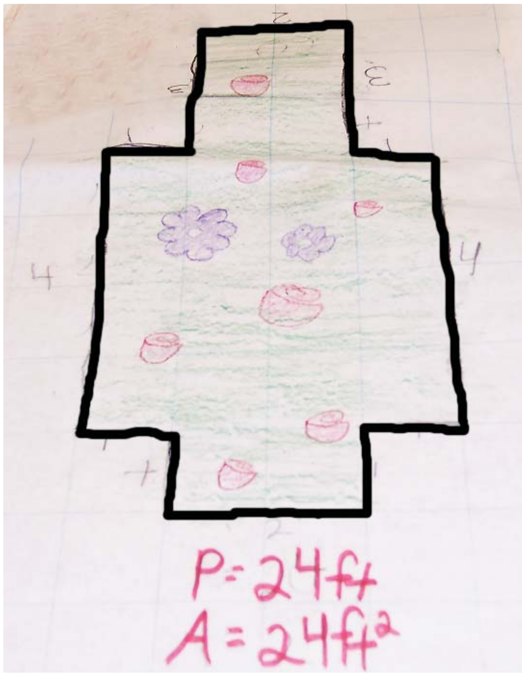


Fig 2 An example of a non-rectangular shape

Finding Area versus Perimeter

When students were finding the area of the shapes, particularly the non-rectangular shapes, they would often count the number of squares that were in the shape. We took this learning opportunity to reinforce the idea that area is counting the number of

Fig 3 Counting tick marks

squares that fit inside the shape; hence area is measured in *square units*. By having students count these one inch squares they were not only able to make the connection that area is the amount of space inside a shape, but that the units are square units, because we simply count the number of "squares" that fit inside our shape. When students were asked the perimeter of their shapes, particularly their non-rectangular shapes, most students made tick marks on the side of figures they were counting (as illustrated in Figure 3). This helped students to see that they were literally counting the length around the shape, or the perimeter.

Students' Mistakes with Units

"One of the most common errors that children make in reporting perimeter and area is in confusing the difference between units and square units" (Moyer, 2001, pg. 57), which became an issue in our lesson as well. During the exploration, the teachers asked many probing questions in order to ensure that students were making connections. With a lower group, the teacher probed the students.

Teacher: "How did you find the area of your shape?"

Student 1: "We counted the number of squares."

Teacher: "And how many squares did you get?"

Fig 4 Determining area by counting squares

Student 2: "24"

Teacher: "What do the squares represent?"

Students 2: "The area."

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Teacher: "Good, and what are the units on the area."
Student 1: "Um, feet."
Teacher: "Why feet?"
Student 1: "The problem says feet?"
Teacher: "But what did you just count?"
Student 1: "The number of squares."
Teacher: "Oh, so what should the units be?"
Student 1: "Squares. Square feet."
Teacher: "How do you know?"
Student 1: "Because I counted the number of square tiles to get the area."
Teacher: "Good"

Through this conversation we can see, that student 1 used the manipulatives in order to see that the area was made of the number of squares, or that it is square units.

When we reached the end of the unit, and students were given an exam, many more students correctly utilized units, and only two students out of fifty-seven confused the terms perimeter and area.

Summarizing Their Data

As the exploration continued, students drew their three figures on graph paper. Each student was then responsible for finding the cost of their fence. Students multiplied the perimeter of their garden by the $5.95 per linear foot. Once they had found the perimeter of each figure, they were asked to choose the "cheapest" fence. The students would then look at the three costs, and choose their smallest price. This part of the task did not seem to cause a lot of trouble for the students who were able to grasp the idea of perimeter, and the context of perimeter in this problem, meaning the fencing.

After the Lesson

Within this activity students were able to use the terms perimeter and area with real world ramifications. These scenarios not only allowed the students to see they were counting lengths, squares, but it also allowed them to put their meanings into real world contexts. When we reached the end of the unit, and students were given an exam, many more students correctly utilized units, and only two students out of fifty-seven confused the terms perimeter and area.

Revision Analysis

Using a tape measure for perimeter

For some students, it would be helpful to use a soft tape measure to literally "build" the fence around the shape. By doing this students not only experience building the fence (therefore, connecting their knowledge of perimeter going around the outside) to the constructed knowledge that fences are often examples of perimeter. They could do this one of two ways. They could either use little toy fences and connect them around the shape, or they could use the tape measures. If they use the toy fences, that requires knowing how long each toy is, and then multiplying the length of each fence by how many they used. Students using tape measures were then able to see the length was measured using only one dimension, length. Hence, the units are simply feet, not square feet like it is for area (refer to Figure 5).

Building a real garden

While it is not literally possible for us to build a real garden, it would have been helpful to have a small garden in the room. Constructing a garden in a small cardboard box with topsoil would have allowed the students to take their knowledge a step further and see an actual garden, not just a representation with blocks. We would have

Fig 5 Using string to measure perimeter

top soil for the students to use, instead of tiles. They would also have the ability to see the perimeter of the garden is the cardboard box that the garden is in - again, giving students the context needed to make the connection to the real world.

Perimeter Pete

In order to help strengthen the concept that perimeter is the length around the figure, we thought perhaps each group could be given a little Lego man, Perimeter Pete. Once their shape has been constructed, Pete will walk around it and keep track of how many units he has traveled. The image of Pete walking around the shape will hopefully help them remember the concept of perimeter.

Making a chart

Lastly, in order to solidify our students' understanding of area and perimeter, it would have been helpful to have a similar building problem the next day that would allow for the students to fill in lengths, widths, areas, and perimeters to see the relationships in writing.

Conclusions

Overall, the lesson went fairly well. It showed us where the students were struggling and gave us points where we could reteach the concept. The real world context allowed the students to see that these concepts do not just occur in the classroom, or just in school, but they will use them when they are adults. Students were able to work on the problem at their own rate and using their own background knowledge. The use of square tiles gave the students the ability to see that the area never changed. They used twenty-four tiles for every shape, while the perimeter changed depending on the shape of the garden. Putting perimeter and area into a context that students could internalize and use to add to their own previous knowledge of the world allowed students to see the connection between area and perimeter and how they are related.

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