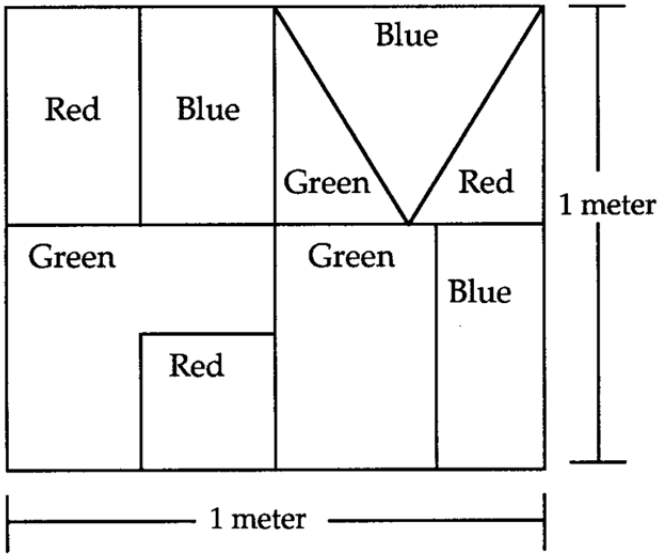
Stained Glass

As part of a school project you are making a stained glass window. Your design is shown below. It measures 1 meter x 1 meter.



You win a contest. Your design is going to be made into a set of 2 stained glass windows at the school entrance. The windows are 2 meters x 2 meters and 3 meters x 3 meters.

The students need to purchase the glass for the new windows. Laura says all we have to do is double the area of the original window to determine the area of the 2 meters x 2 meters. Christine is convinced Laura is wrong. Christine believes the area of the glass they need for the 2 meters x 2 meters is 4 times the area of the original window. Who is right? Explain.

Based on your investigation, what area of glass will they need for each color in the 3 meter x 3 meter window?

Stained Glass

Suggested Grade Span

6-8

Task

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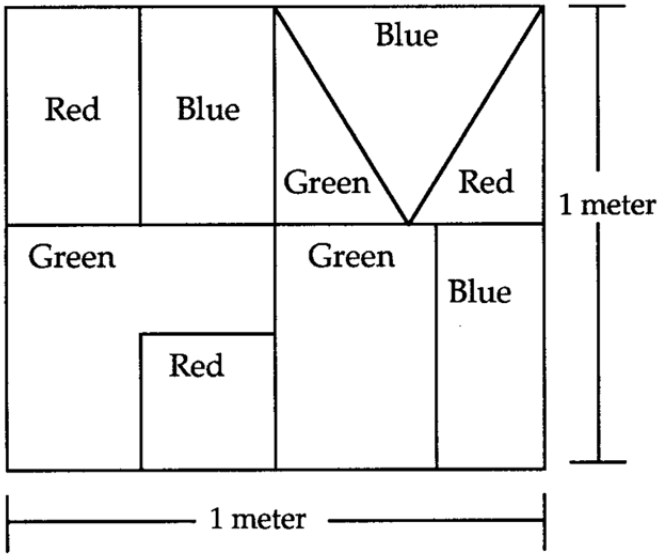

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Based on your investigation, what area of glass will they need for each color in the 3 meter x 3 meter window?

Alternate Versions of Task

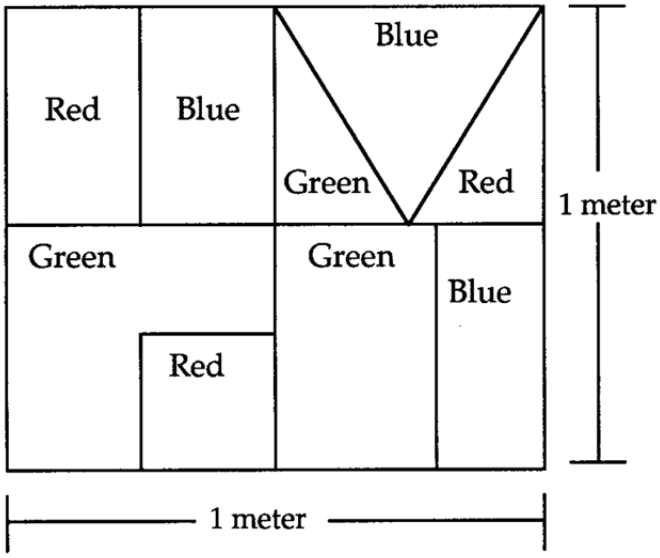
More Accessible Version:

A window measures 1 meter x 1 meter. A window maker decides to make a new window that is 2 meters x 2 meters.

Laura says all the window maker has to do is double the area of the original window to determine the area of the one that is 2 meters x 2 meters. Christine is convinced Laura is wrong. Christine believes the area of the glass they need for the 2 meter x 2 meter window is 4 times the area of the original window. Who is right? Explain.

More Challenging Version:

As part of a school project you are making a stained glass window. Your design is shown below. It measures 1 meter x 1 meter.



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Based on your investigation, what area of glass will they need for each color in the 3 meter x 3 meter window? A 4 meter x 4 meter window? A 5 meter x 5 meter window? For any square window?

Context

This task was discovered in the new *Grade Eight Guide to Diversity of Content and Problem Solving Tasks* recently published by the VISMT (The Vermont Institute of Science, Mathematics and Technology) Opportunity to Perform Committee. As these sixth- and seventh-grade students had just worked on adding and subtracting fractions and I just received this document, I wanted to try this task.

What This Task Accomplishes

This task gives students an opportunity to add and multiply fractions, convert fractions to percents, compute fractional parts of a given area and convert linear measurement to area.

What the Student Will Do

Students used geoboards, geopaper, graph paper and freehand sketches to determine the effect of enlarging a stained glass design. They determined the fractional part of the window glass needed in each of the three colors, based on their determination of glass needed in the original design.

Time Required for Task

1-2 hours

I broke the task down by first asking the students to find the fractional part of the original window design which would contain each of the three colors. This took from 10 to 30 minutes. Next I gave them the task as it appears here. This took one class period and some additional independent time to complete the write-up and revisions.

Interdisciplinary Links

Students working in Technology Education or Art classes could link this task to tasks in these content areas. Having the students actually manufacture the window in cardboard and tissue/cellophane would help emphasize the increased area going from a linear measurement of one meter to three.

Teaching Tips

Students will be more successful at this task with a sound foundation in adding and multiplying fractions. Asking students to think about actually ordering the glass and getting it to the manufacturing site should elicit extensions to their solutions. Previous use of geoboards for finding fractional area will be beneficial to students, as will visual methods for finding fractions on a line (see Expert student's work).

Suggested Materials

- Geoboards
- Geopaper
- Graph paper
- Colored pencils
- Fraction bars

Possible Solutions

As you double the length of a side, you quadruple the area. You will need nine square meters of glass for a 3 x 3 meter window. You will need two 1/4 square meters of red, two 13/16 square meters of blue and three 15/16 square meters of green glass.

More Accessible Version Solution:

See the solution to the original version.

More Challenging Version Solution:

See the solution to the original version, and…

The student should indicate that as the dimensions increase by one meter, the area increases exponentially:

1 x 1 = 1 (12)

2 x 2 = 4 (2^2 or 4 times bigger)

3 x 3 = 9 (3^2 or 9 times bigger)

4 x 4 = 16 (4^2 or 16 times bigger)

5 x 5 = 25 (5^2 or 25 times bigger)

n x n = n2 (n^2 or n^2 times bigger)

Task Specific Assessment Notes

Novice
There was no Novice in my class for this particular problem. A Novice would not show an understanding of the problem and might well use a strategy that is not useful in solving the problem. They might be able to communicate their reasoning.

Apprentice
This student uses a rather cumbersome strategy for finding the area of the two x two window. S/he never does state whether Christine or Laura is correct. The attempt at a general rule is interesting if not correct and is not in fact followed in finding fractional parts. Correct solutions are found for the three x three window. The student does not label area measurements in square units. S/he does accurately label the table as well as the diagrams.

Practitioner
While this student did not document the work done on the geoboard to find the fractional parts on the original one x one meter window, s/he does label each part on page one. The student uses dot paper to enlarge the pattern to two x two and makes an interesting comment about the original design fitting in 1/4 of the two x two window. This verifies the solution for the two x two window. Having drawn the two x two window, the student is able to calculate glass needed for the three x three without diagrams. The student does not make any comments on the solution.

Expert
This student is able to solve both parts of the problem visually and verifies the solution with computation. S/he labels and titles all diagrams. There is solid mathematical language. While the explanation of operations is very concrete, describing each step of multiplying fractions in tiny detail, it is accurate and is an example of a common developmental level of sixth graders. The student's comments about transporting and storing the glass pieces are meaningful observations about the solution. Comparing one's own body size to the glass size leads the reader to believe that the solution to the task holds meaning for this student.