Teacher Instructions: A Shower of Shapes

Grade Level: K – 2

Task: A Shower of Shapes

Standard: Geometry, Spatial Sense, and Measurement

Fold, and cut a 4-inch square of paper into 4 rectangles that are the same size and shape, and 4 triangles that are the same size and shape. Tell how you did this. Then arrange the pieces to make a symmetrical design.

Context – From the Task Author: During the year, my class has had many informal experiences breaking down and building up designs using pattern blocks, Tangram pieces, and geoboards. They have also had more formal lessons during which they have explored shapes and their relationships. I devised this task as an end of the unit assessment of the students' spatial problem solving skills, and their knowledge and use of geometric concepts.

What the task accomplishes…

- This age group loves making patterns and designs, and enjoys the challenge of shape puzzles. This task appeals to both of these interests.
- How the students approach the first part of the task will show the development of their ability to visualize shapes within shapes, and relate parts to wholes. It will also show their comfort with constancy of area, and their sense of congruency.
- Their arrangement of the pieces will show their understanding of symmetry and congruency.
- Their writing will reflect their growth in communication skills, and the extent to which they are building and using the vocabulary of geometry.
- Overall the task will show the students' confidence with spatial problem solving: their persistence, flexibility and creativity, and their ability to deal with a complex task.

What students will do…

- Before doing this task the students were shown a set of 4 rectangles and 4 triangles that had been cut from the original square using all of it, no more and no less.
- I told them that their task was to make all the rectangles and triangles from just one square, and that their rectangles and triangles should be the same size and shape as those I had shown them.
- The students were also told that when they were writing about how they folded and cut their square, they should be as clear as possible, using words and diagrams so that someone following their instructions would be successful.
- When they begin the task, some students will try cutting the pieces one by one from their square using trial and error. Others will be able to visualize the pieces on the whole square by folding before they cut. Others will trace the sample pieces directly onto their square.
- In making symmetrical designs some students will pair up shapes on either side of the page, while others will make designs with the lines of symmetry going through the shapes.

- Some will have one line of symmetry. Others will have more than one. Some will make abstract designs. Others will make pictorial designs, elaborating on them, and giving them titles.

Time Required: 50 minutes

Interdisciplinary Links: Although this task was designed as a geometry assessment, there are useful links that can be made with art and literature, language arts, and social studies. Any work with shapes naturally leads children to want to create pictures and designs using these shapes and to explore the possibilities. One boy in my class suggested we make 'Shape Pictures' as an art project, and we began noticing cut paper art in picture books such as in The Paper Crane, and in the work of Eric Carle.

The task also tied in with an art lesson they had been working on in which they created an overall pattern by repeating shape elements. Or, this task or a similar one could be used as a follow-up to a reading and discussion of picture books such as these. Writing clear instructions is an important language arts goal, and describing how one folds and cuts to make given shapes is a useful vehicle for practicing this skill. The task also has social studies connections. It could be related to Japan and the art of Origami, and to quilting squares and their rich social history.

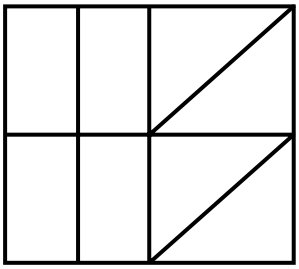
Teaching Tips…

- Have plenty of paper squares available for those students who will use trial and error, and several sheets displaying the set of 4 rectangles and 4 triangles that they are to try and cut from the square.
- A supply of the rectangles and triangles should be made available for students who may need to trace directly onto their square.
- Have students who finish earlier than the rest cut a new square and make a different symmetrical design.
- Towards the end of the work period if there are students who have not yet managed to cut a set of pieces, give them a set so that they can enjoy making their own symmetrical arrangement.
- A nice way to introduce the task is to hold up a 4 inch square and then toss in the air the 4 rectangles and 4 triangles that the students are to cut from it. Literally let them shower down! Then pick the pieces up one by one and display them under the original square.

Suggested Materials:

- Four-inch by 4-inch construction paper squares
- Several sheets displaying in vertical columns or randomly the 4 rectangles and 4 triangles to be cut from the square (see example)
- Sets of 4 rectangles and 4 triangles that can be cut from the square to be used as templates
- Paper and pencil to use for writing instructions and displaying the symmetrical arrangement
- Glue sticks and scissors

Possible Solution…
There are many possible sets of 4 congruent triangles and rectangles that can be cut from the square, but for this task the students were to cut a specific set. The folds for cutting this set are shown below:



There are, however, several different approaches that students may use to cut the square into the rectangles and triangles. Some students may use trial and error to cut the shapes, or arrange and then trace the pieces directly onto their square. Others will be able to fold the square into 4 smaller squares and then fold 2 of these into the rectangles and the 2 other pieces into triangles. There are a multitude of ways in which the pieces can be arranged into a symmetrical design, and the symmetry may be along one or more axes. In telling how they cut the shapes the students can use diagrams, words, or a combination of both.

Benchmark Descriptors:
- The benchmark descriptors and rubric are designed to help the teacher analyze student thinking and understanding at each of the four performance levels.
- The descriptors are generalizations of what student work could look like.
- It is not possible to anticipate every answer a student can give, so in scoring student work the teacher must use these generalizations to come to their own conclusions as to where a student is performing on the assessment.
- It is recommended that teachers create their own task specific rubric by listing the specific math skills that would make up each section of the four performance levels.

Novice
- ✓ The novice will be unable to visualize how s/he can cut the square to make the pieces and will need to trace pieces provided by the teacher, cut the shapes and then make some design.
- ✓ The design however will not have the qualities of symmetry.

Apprentice
- ✓ The apprentice might be able to cut some of the pieces, but not all, and may or may not be able to create a symmetrical design with the pieces cut.
- ✓ In any case, the solution will be incorrect or incomplete for part of the problem.

Practitioner
- ✓ The practitioner will successfully cut the pieces and create a symmetrical design with at least one line of symmetry.
- ✓ The student may not have defined the line.

Expert

- ✓ The expert will successfully cut the pieces and create a symmetrical design with one or more lines of symmetry.
- ✓ The student will then identify the lines of symmetry, and may make mathematically relevant comments or observations about an aspect of the solution, such as a triangle is one-half of a rectangle.

APS Mathematical Standards…

- ❖ **The math standards stated for this task are aligned to the APS Draft Standards 2000.**

Geometry, Spatial Sense, And Measurement: Learners will demonstrate an understanding of concepts, properties, and relationships of geometry and measurement through experiences with meaningful mathematical problems, while focusing on identifying, describing, classifying, visualizing, comparing, estimating, and measuring various aspects of shapes and sizes.

Kindergarten:

Geometry: Compare, classify, and arrange geometric shapes and begin to develop spatial sense.

- **Sort and match** shapes according to attributes.
- **Describe** geometric shapes.
- **Model, draw, and classify** geometric shapes and simple solids.
- **Identify** circles, squares, rectangles, and triangles using the proper mathematical terms.
- **Compare** size of plane geometric figures.
- **Build and take apart** pictures, shapes, and structures formed with 2-D and 3-D geometric forms.

Measurement: Develop and use language to compare, measure, and describe lengths.

- **Measure** using estimation and by direct comparison;

First Grade:

Geometry: Recognize, identify, describe, compare, and classify geometric shapes.

- **Observe, describe, identify, and compare** 2-D shapes (rectangles, circles, triangles, squares, hexagons).
- **Develop** vocabulary to describe 2-D shapes (e.g., square, circle, triangle, rectangle).
- **Sort and group** shapes according to common characteristics.
- **Recognize** geometry as a means of describing the physical world.

Measurement: Describe, compare, estimate, and measure the lengths of objects.

- **Develop** language to describe and compare length;

Second Grade:

Geometry: Sort, describe, identify, and analyze geometric shapes and solids and begin to apply spatial sense.

- **Sort, describe, identify, and analyze** shapes and solids by various attributes.
- **Describe** spatial and numerical relationships found among shapes.
- **Develop and apply** definitions for circles, triangles, squares, and rectangles.
- **Compare and build** 2-D (plane) and 3-D (solid) geometric shapes;

- **Identify and describe** lines of symmetry in 2-D shapes;
- **Recognize** geometry as a means of describing the physical world.
- **Explore** the concept of area using common geometric shapes.

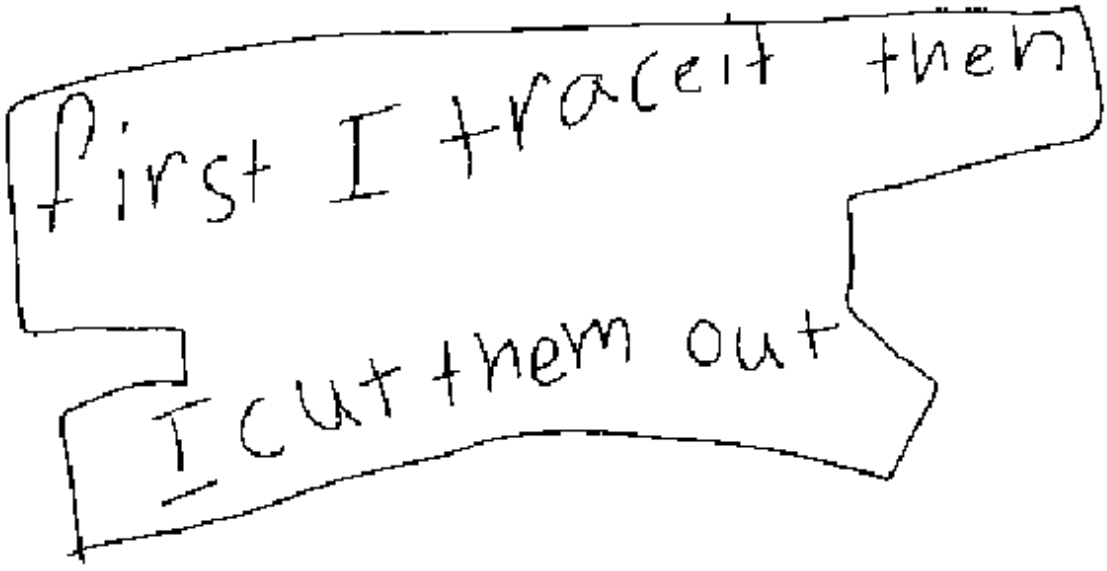
Measurement: Use nonstandard and standard units to compare and measure length.

Benchmark Papers

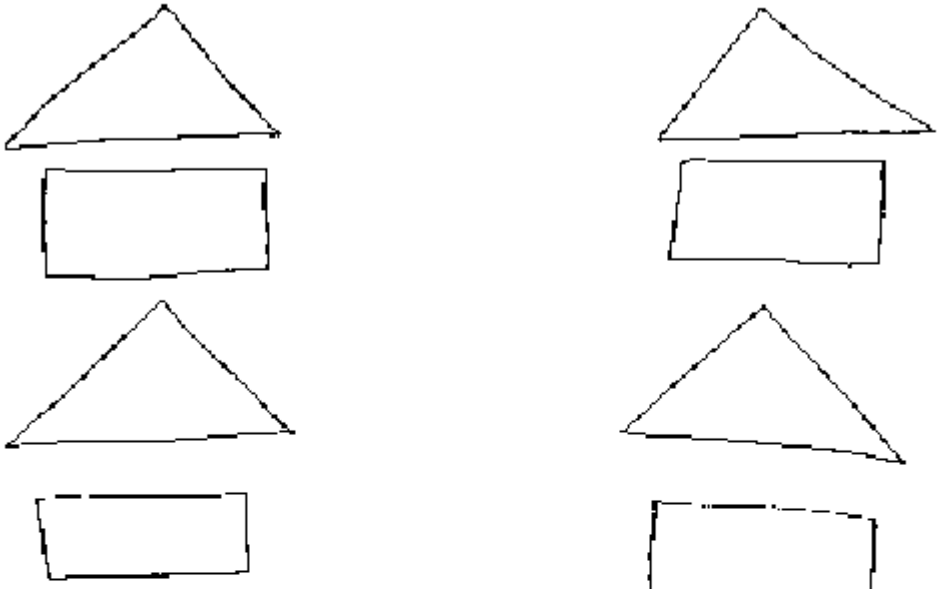
Novice

This student was very uncertain of how to start at all. I suggested he might try using the sample pieces. He immediately took a triangle piece, traced it in the center of the square, and cut it out. When I returned some time later to see how he was getting on, he was happily assembling his "symmetrical design" and seemed unaware or unconcerned that his rectangles were all different sizes and shapes. Also it wasn't clear whether he was aiming for symmetry or whether the placement of the bottom piece was guided by his pictorial interest.

Novice (cont.)



Apprentice



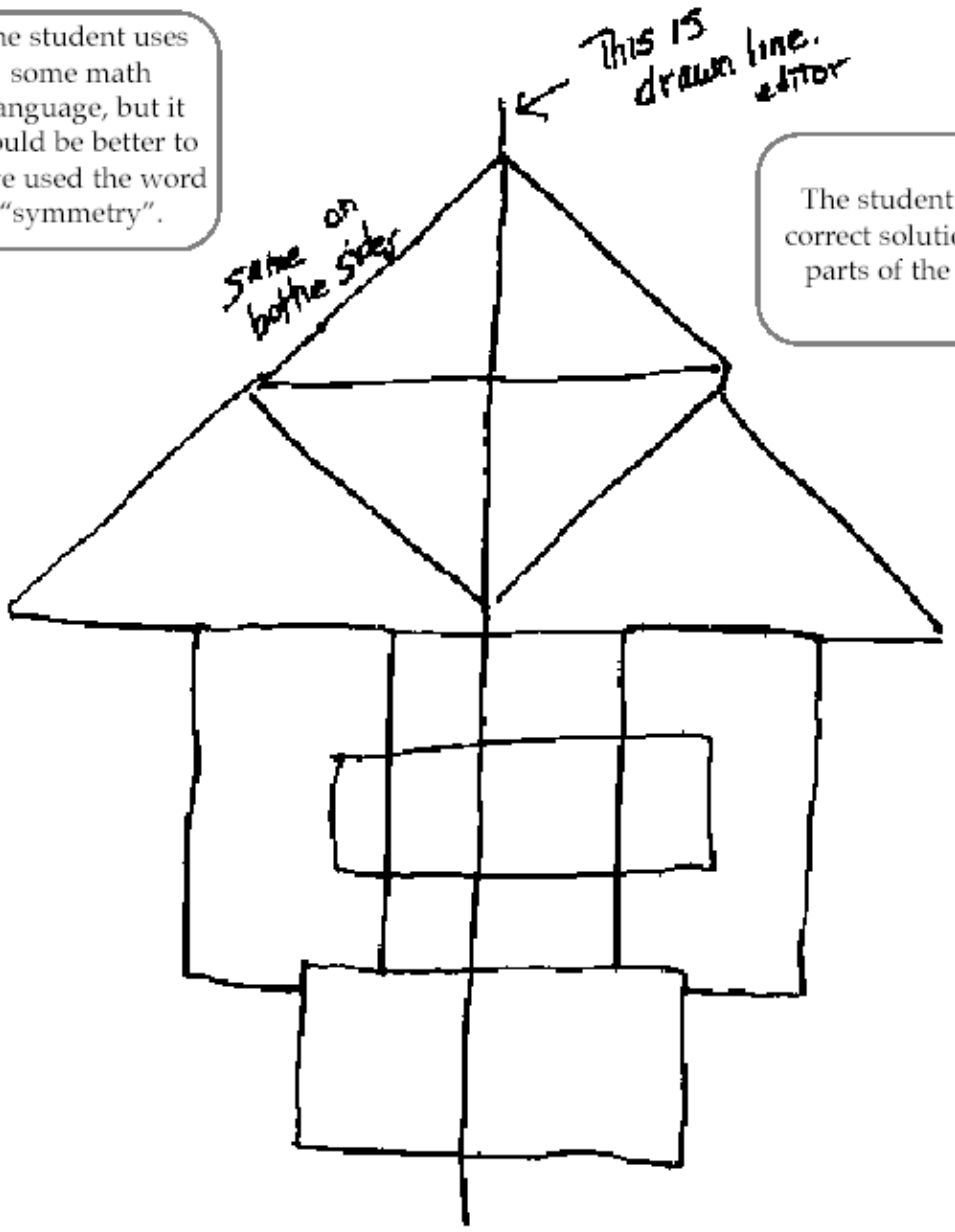
I foled the four eges and cut them off then I cut theeges that where left and then I had a triangel and four D.

The student creates the correct shapes but is unable to make a symmetrical design.

Some math language is used.

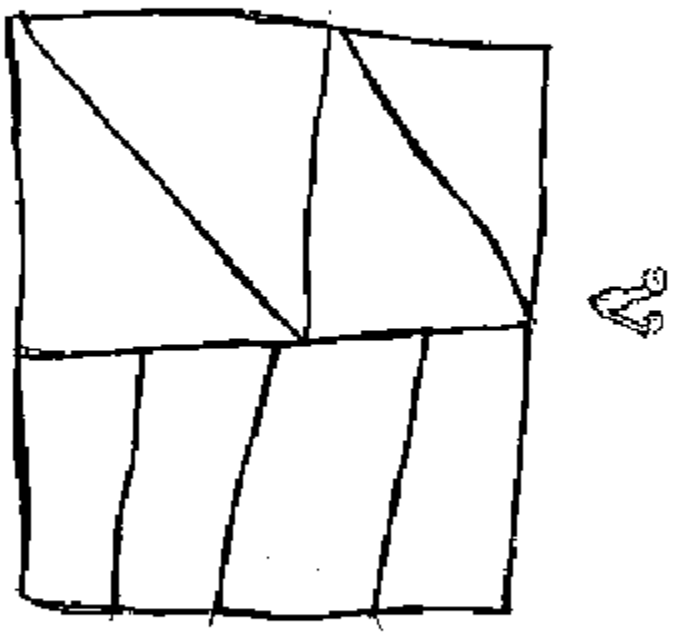
Practitioner

The student uses some math language, but it would be better to have used the word "symmetry".

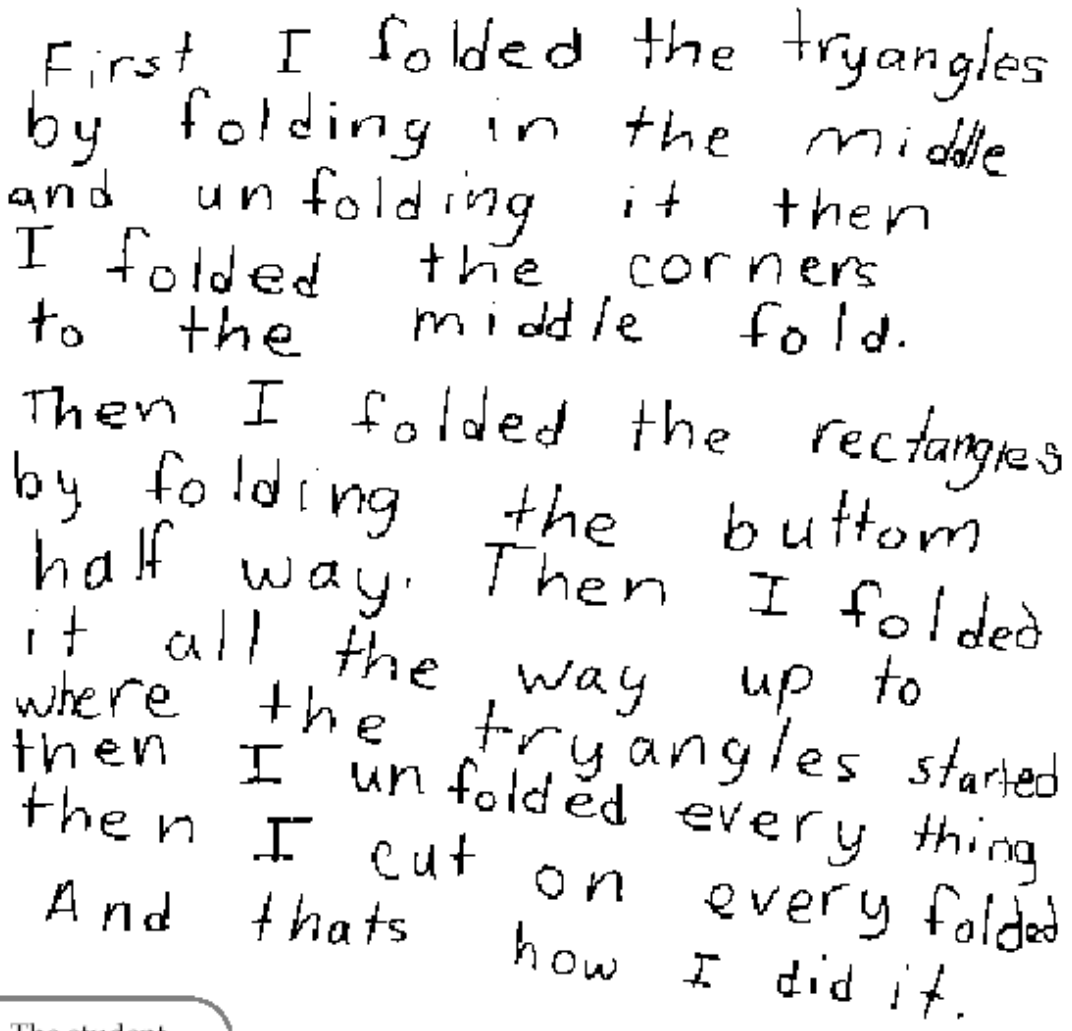


The student obtains a correct solution for both parts of the problem.

Practitioner (cont.)



Expert



The student explains her/his approach and strategy.

The student uses accurate and appropriate math language.

Expert (cont.)