

**Some experiences and problems dealing with symmetry
for children - from very young to old !**
Marion Walter, University of Oregon, Eugene, Oregon, 97403, U.S.A

Among the many experiences that children can have both in school and at home are the ones that are indicated below. Details, more examples of each, and other problems will be given at the session.

Reflection symmetry: Experiences and problems using paper.

What will you see when the paper is unfolded?

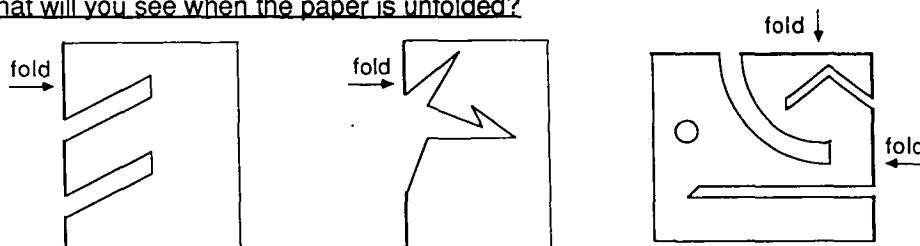


Fig. 1

Predict what you will see when you unfold the paper

Very young children are good at predicting what simple folded cut out pictures, such as half a leaf, will look like when unfolded. Less simple ones challenge even older children. Difficulty can be increased by folding the piece of paper twice or more.

Which shapes can you make by cutting a folded piece of paper?

Which geometric shapes can you make by cutting a piece of paper that has been folded once? Which can you do in more than one way? Two ways? Which could you make by cutting a piece of paper folded more than once? These cutting problems can lead to discussion of some of the simple geometric properties of these shapes.

Experiences and problems with reflection symmetry using mirrors.

Changing and making pictures with one mirror.

Young children are challenged when asked what they can make from given pictures by using a mirror and also when they are asked to make specific things.

Children are also encouraged to let their imaginations roam as they use the mirror to see many different strange and wonderful shapes. They are often very excited when they make new mirror pictures appear and freely describe what they see .

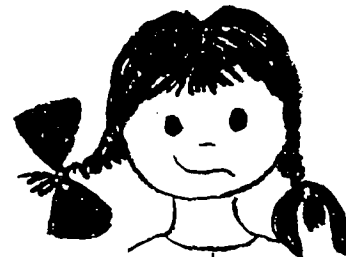
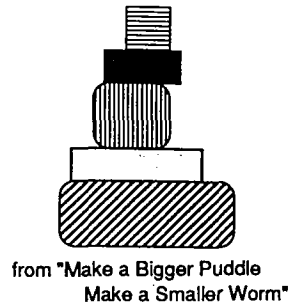


Fig. 2

- a. Can you build a tower that has 8 blocks? 7 blocks?
- b. Can you make the face smile? Look sad? What else can you see?

Mirror Cards and Mirror Puzzles.

I created Mirror Cards during 1963-5 and tested them with children of all ages. They consist of two types of problems. The first is "Which of several pictures can you change, by use of a mirror, to match one given pattern?" The second kind asks the reverse. Given a particular pattern, which of several others can you make from it by use of one mirror. The Mirror Puzzle Book contains puzzles of this second kind. Included are many patterns that are impossible to match.

The fact that a picture has reflection symmetry is not enough to guarantee that it can be reproduced from the GIVEN pattern .

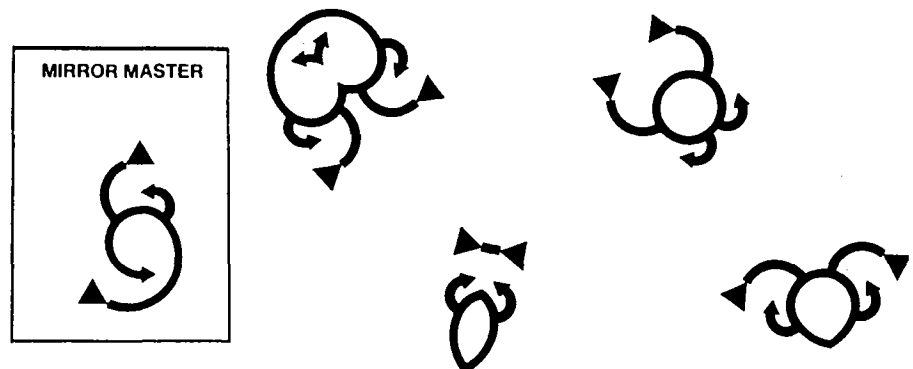


Fig. 3

Which of the patterns shown in Fig. 3 can you make by using the mirror on the pattern called the MIRROR MASTER? The patterns may be in different orientations.

Experiences with half silvered mirrors.

Students can be asked to build a design with blocks, or to draw a design in front of a half silvered mirror. They are then asked to build behind the mirror, without looking into the mirror, what they think the mirror image is.

They can check the correctness of their predictions by looking through the half silvered mirror.

Play and problems with two hinged mirrors.

Use the hinged mirrors. Place one coin between them to see 4 coins, or 6 or 5. After a while students predict how far to open the mirrors to see say 6 or 8 coins. Explore what you see when the object itself does not have symmetry. Move the object closer to one mirror - closer to the other - into the middle. What do you notice? Draw one line and use it to create a regular 4 sided, 5 sided 6 sided figure. (Regular polygon means that the polygon has equal angles and equal sides). Can you make a 6 sided polygon that is not regular? Can you make star shapes?

What happens with two mirrors is sophisticated. Experiments can help one understand what is going on.

The Kaleidoscope can be a topic on its own and I expect there is someone who will talk on different types.

Experiences and problems dealing with rotation symmetry.

One way to introduce rotation symmetry through a problem is to ask "Are there ways of cutting a square into two congruent halves other than the usual ways? Activities can lead children to find out the secret for drawing more interesting halves of squares. Children can get an intuitive feeling for point symmetry and how it differs from reflection symmetry as they discover the secret of drawing such halves.

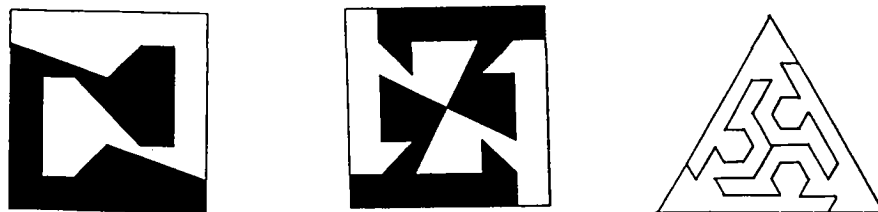


Fig. 4

Making more interesting congruent parts

They explore 3 fold or 4 fold or other rotation symmetry when they explore unusual ways of cutting an equilateral triangle into three congruent parts or a square into four congruent parts and in general a regular n sided figure into n congruent parts.

Work without mirrors that leads to rotation and reflection symmetry.

Other activities, starting with visualizing shapes in 3 and 2 dimensions can lead to work in symmetry. Such motivated problems suitable for school children may also be discussed.

Symmetry in our surroundings.

Children can be encouraged to look for, draw or photograph symmetric images that they find in their surroundings--be they natural or man made. I recently photographed man made symmetric objects - hubcaps of car wheels in the U.S.A. and coalhole covers in streets in England. They lend themselves to much study of plane symmetry. Every region in the world will have its own special symmetrical objects.

What might children be learning when they work with problems of the type described?

I will discuss this in my session, but let me say here that even people who know all the rules of reflection are not always correct in their predictions and are sometimes surprised. Work gives students experience with and intuitive knowledge of reflections, rotations and the difference between them. They learn about geometric concepts and the properties of geometric shapes on an intuitive level. This will be discussed in the session.

Some comments on the indicated activities.

In all of the activities we start with explorations and problems and not with definitions as so often is done in mathematics classes. In all the mirror work, the children can predict what they will see and immediately check their predictions. If not correct, they can amend their solution by moving the mirror. This work may be the first time that children encounter problems whose answer is 'it cannot be done'. It is often the children who are labelled 'poor' at school work who excel in this kind of visual work. Mirror puzzles can be made very easy so that very young children can do them and they can be made so hard that even some members of this conference will be challenged !

Play and problems with mirrors forming prisms and pyramids can be done by children but I expect will be covered by others and so I have not included it.

BIBLIOGRAPHY (SHORT - only of own work pertinent to session)

- Walter, M. (1966), "An Example of Informal Geometry: Mirror Cards." The Arithmetic Teacher, Vol. XIII, No. 6.
- (1967), "Some Mathematics Ideas Involved in the Mirror Cards." The Arithmetic Teacher, Vol. XIV, No 2.
- (1968) "Polyominoes, Milk Cartons and Groups." Mathematics Teaching, #43, 12-19.
- (1981), "One Mirror, Two Mirrors..." Mathematics Teaching, #76, 54-56. (Note misprint on page 56-triangular not square pyramid.)
- (1984), "Coal Hole Covers." Mathematics Teaching, #107, 6, 7. (Photographs)
- (1984), "Wheels." Mathematics Teaching, #109, 10-11. (Photographs)
- (1971), Make a Bigger Puddle. Make A Smaller Worm. London: Andre Deutsch Ltd., New York: M. Evans Co. and in several other languages. Ages 3-6
- (1971), Look At Annette. London: Andre Deutsch Ltd., New York: M. Evans Co. and in several other languages. Ages 3-6.
- (1975), Another. Another and More. London: Andre Deutsch Ltd., (recently out of print but hope to republish.) Ages 6 up.
- The Mirror Puzzle Book. Stradbroke, England: Tarquin Publications, and in several other languages. Ages 7 to 99.
- (1989), Take Two Mirrors---. Stradbroke, England: Tarquin Publications. Ages 7 to 99. In press.