Fold Paper and Learn Mathematics

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Ask any child to fold a paper in a certain way, immediately she will retort "why should I do it?" It is seen as a burden, a chore and a tedious exercise. But ask the same child to fold and make a boat or a bird using paper and give her some guidance and she would immediately start doing that and she would like to learn happily. After doing the model, try telling the girl that after unfolding the model you can see this angle, this area, this line etc. It would definitely have an element of discovery in it. The process now becomes fun.

Folding paper and creating different shapes is an art known as Origami. Certain paper models contain hundreds of folds and a few complex models in fact require two or three differently folded shapes to be attached together.

Math through Origami is an adventure to see patterns as it literally 'unfolds' before the eyes of the child. This exploration helps to clarify abstract concepts in Math in an enjoyable way. Discarding the exotic models in Origami, let us turn to simple models. I prefer to use those Origami models which do not have more than eight folds for this purpose. Simple and small Origami models are ideal for learning Math.

In our country, Origami has become a folk art but not practiced widely. Nowadays, no one teaches children how to make a boat, a cup, a bird using paper folding. They are lucky if they get to learn from their friends in schools.

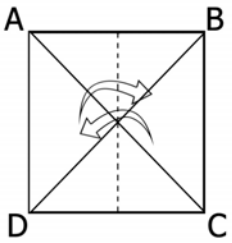
Here I give a couple of examples illustrating Math concepts that can be conveyed by simple Origami models.

> *So the simple peacock actually results in providing explanation for more than ten Math concepts. There are several such models related to the Math curriculum. Hundreds of inexpensive models made by the child would reinforce these concepts.*

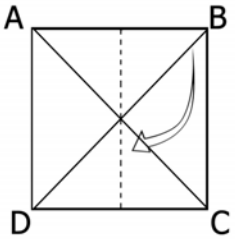
Paper Peacock

Follow these diagrams and make a peacock. You will see here that the symbols used are very simple and self explanatory.

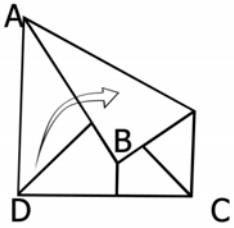
P_1



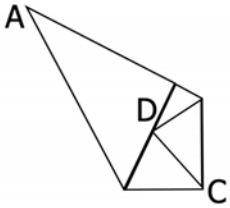
Start with a square paper 10 cm x 10 cm, with diagonal creased.
Fold in half as shown & reverse.



Youngest a middle line fold 'B' to the middle line

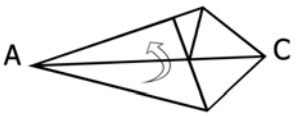


Fold 'D' on to the folded edge



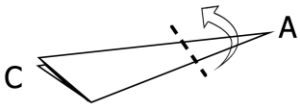
This is the result

P_2

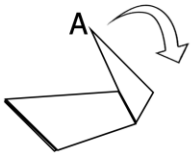


Fold along AC

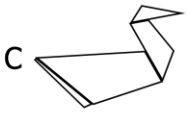
Rotate the model



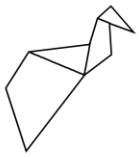
Reverse fold 'A'



Bring 'A' forward in a Reversfold



Sink 'C' to form peacock tail

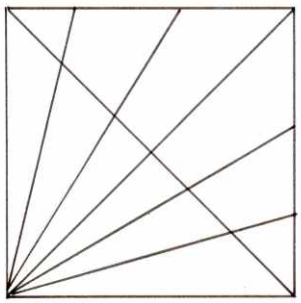


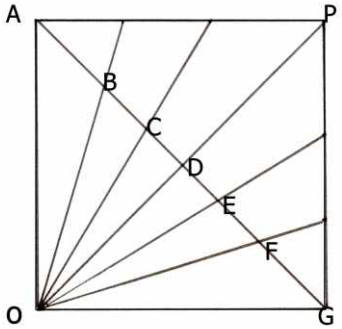
peacock

Having folded a peacock model from a square paper, a child begins to play with it. She may sometimes tear the model. Encourage the child to unfold the model so that the paper is square again. But the folds created in the paper leave their marks. Straight lines, areas, angles etc. Mark these lines with a pencil to highlight them.

Then you will see this…

P_3





Here angle ADG=90 degrees which has been divided into 6 parts of 15 degrees each. Now let us get all angles. We now get six angles (15, 30, 45, 60 and 75 besides 90) and we do not need to use a protractor to measure them. This in itself is a wonder for the child.

The same model can be used to illustrate the following:

1. Division of angles
2. Obtuse and acute angles
3. Acute angle triangle
4. Obtuse angle triangle
5. Isosceles triangle
6. Equilateral triangle
7. Isosceles right angle triangle
8. The sum of three angles in a triangle is 180 degrees
9. The sum of internal opposite angles is equal to exterior angle of the triangle
10. Corresponding angles
11. Vertically opposite angles

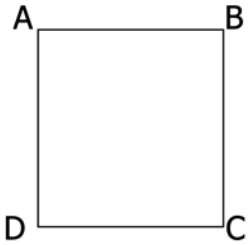
So the simple peacock actually results in providing explanation for more than ten Math concepts. There are several such models related to the Math curriculum. Hundreds of inexpensive models made by the child would reinforce these concepts.

Heptagon by paper folding

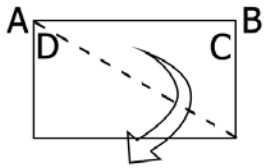
It is very difficult to construct a Heptagon (polygon with seven sides) because the internal angle of a regular heptagon is 128.57 degrees. This cannot be measured with accuracy by any protractor. But you can construct a heptagon by arranging 7 sticks of equal length or by drawing 7 lines on a paper by a process of trial and error.

But using Origami techniques this angle - 128.57 degrees can be obtained very easily. The steps illustrated below will be enough to get this angle from a square paper.

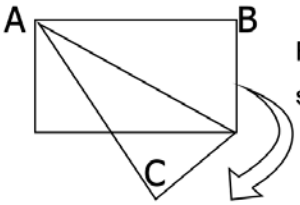
P_4



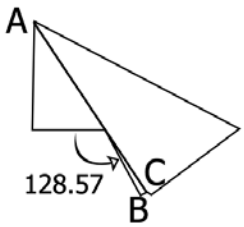
Start with a square paper
Name as A,B,C,D.



Bring CD onto AB



Fold a Diagonal starting from A



The angle shown is 128.57^0

By inter-locking 7 of such folded sheets we can get actually construct a regular heptagon

At a future date, it is possible to imagine a school, where Origami is taught for fun in lower classes. Children can learn 8-10 models in a year. Using the same models Math could be taught in next class. The learning will not be a burden. Learning Math through paper folding is possible even in higher classes. In fact Karnataka Rajya Vigyan Parishath Bangalore has published a book titled “Desk Book on Mathematics through Origami” to explain Math concepts up to Class Ten.

Origami

Origami is an ancient art practiced in Japan. The word comes from 'Ori' which means to fold and 'Kami' which means paper. In olden times, Origami models were used in some rituals. But later it was practiced for pure fun and enjoyment. It is said that paper folding entered Japan from China. There, paper boats are kept in funerary rituals, to carry souls away from this world.

After American intervention in Japan in the 19th century, the Japanese arts and crafts began to get noticed in the West where the new word “ORIGAMI” was coined for paper folded art. Earlier it was known only as 'Paper Shapes'. From then on paper folding art developed rapidly. Now, there are several Origami societies and even magicians present paper folding in their shows. Annual Origami shows are organized regularly all over the world. Computer software have been developed, which provide sequence of paper folding instructions to get the required shape.

There were other cultures who folded paper. Southern Spain has a large population of Arabs called the Moors. These people engaged in crafts like ornament making, metal work, stone work etc. They follow Islamic religion. Therefore human figures are not a priority in their art. Their art is full of lines, angles and geometric designs. These artisans do not learn geometric designs through Math-Geometry but through paper folding. They depend on repetition of patterns or 'Tessellations' as it is known in Mathematics. The designs get repeated in all crafts they do. In Moghul times these Moors were invited to decorate buildings in Delhi and Agra. The filigree work for windows executed in Moghul monuments are handiwork of these Moors. In Origami circles, paper folding techniques from Spain are known as the Moorish tradition.

National Council of Teachers of Mathematics America commissioned Olson, a mathematician from Albert University, to compile all that was available on the subject of Math and paper. This mathematician referred to all papers published till then and wrote a 60 page booklet that contains relevant matter in full measure. The Indian reprint is available at Mathematical Sciences Trust Society, C-766, New Friends Colony, New Delhi – 110 066.

Sunder Row - The Indian Pioneer

Sunder Row was a Head Master in Royapettah High School Chennai in 1870. He must have been a good Math Teacher. We are told that one day, after his retirement, the old man went to Spencer Department Store. He searched for a suitable present for his grandchild. He found a gift pack that was filled with color papers and a small book, detailing how to fold the papers into different shapes of animals, birds etc. But Sunder Row being a Math teacher saw the lines, angles and areas formed when a folded model is opened and made flat. Soon he began to connect the patterns formed with theorems, lemmae, constructions etc that he had taught throughout his working life.

This Head Master began to write down all that could be done with folds in the paper. He covered Geometry syllabus in full. He could relate many more facts of Math to paper folding. Thus a magnificent book titled “Geometric Constructions in Paper folding” came about and was published in 1893.

This was the first book of its kind in the world and caught the attention of Math educators and teachers around the world. Mathematics Teachers Association of America got to know of this book through a German commentary in a magazine. They commissioned two well known Math Teachers to edit this book for American readers. This edition saw 47 reprints and is still getting reproduced all over the world.

But this seminal book is totally unknown in India - for whose children Sunder Row had first published it. For those who are interested, this book can download free from the web site www.arvindguptatoys.com

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VSS Sastry is a serving bank officer with a lifelong passion for Mathematics. He has written twelve books on Mathematics and related activities for children. His book "Origami Fun and Mathematics" (in its third reprint) published by Vigyan Prasar, New Delhi is about using paper shapes to teach Math upto class 10. He has also conducted more than 300 workshops for teachers. His other interests are Aero Modeling, Kirigami and Kites. He can be contacted at vsssastry@gmail.com

Logico- Math Brain Teasers

Ajay is sent to the river to bring water. He is carrying two buckets, one with a capacity of 11 liters and the other with a capacity of 6 liters. The problem is, he is required to bring back exactly 4 liters of water. How can Ajay do that?

Use this space for calculation