

FUN WITH MATHS THROUGH EXPERIMENTS

TEACHER	Nagarjun Sharma
SCHOOL	Retd. Principal Government Higher Secondary School, Tonk, Rajasthan
PHONE NUMBER	8005-6822-91
E-MAIL	lalitarjunam@gmail.com

Shri Nagarjun Sharma has worked on simplifying the teaching of Mathematics making it fun to learn. He has also authored several books on the subject. Since his childhood, he showed keen interest in automated machines and toys and once even managed to prepare a steam engine. Due to his deep interest in science, he regularly participated in Science Exhibitions. Even after he started his career as a teacher, this interest continued. He would guide children in making new models for use in class and to exhibit in state as well as national-level Science Exhibitions.

Shri Sharma has taken part thrice in the north-western region competition organised by Science and Experiment Department at Nehru Science Centre, Mumbai. Among these entries, his models on Self Railway Crossing Signal System and working models to verify theorems of Geometry received wide appreciation.

Shri Sharma has been providing services to the Rajasthan government as a Science and Maths teacher for the past 26 years, ever since he joined on September 21, 1981. He was then promoted as a secondary level teacher and finally went on to become the principal at the higher secondary level, a post which he held for 2 years.

In 2010, he was transferred to Bhilwara as a Head Master in a government school. Here, he was teaching 9th and 10th standards. In order to utilise his free time constructively, he decided to make some maths TLMs for students. After 3 to 4 months of hard work, he was able to make TLMs for 6 theorems.

TLMs for Theorems

This book of innovations contains figures that are moving, hence, the pages need to be thick and smooth. Each page is laminated and has a transparent plastic page with required line/scale or angle measure, two or three as per the requirement. The 40 pages in the middle have a bulge in the centre and so this book is separated into three sections. The first section of 13 pages thus become the first part; the second part consists of 14 pages and the third part has 13 pages.

Part 1. This part discusses the concepts such as shape of angles, angle type, adjacent angle, complementary and supplementary angle etc. Concepts such as vertical angles, based on parallel lines, the sum of the three angles of the triangle and theorems based on the relation between the exterior angles and the other angles as well as congruency can be shown in working condition.

Part 2. In this part, several concepts are brought to light, such as properties of a triangle, the corresponding angles of equal sides are also equal, the corresponding sides of equal angles are also equal, the sum of the two sides of the triangle is greater than the third side, the angle opposite the largest side of the triangle is the largest angle, etc. All these concepts and related theorems are explained using working models and are included in this part of the book along with the concept that the sum of the four angles of a quadrilateral is 360 degrees.

- Parallelogram-based theorems. In this part, the properties of a parallelogram, such as opposite sides and opposite angles are equal; each diagonal of a parallelogram separates it into two congruent triangles; diagonals of a parallelogram bisect each other; and other such theorem-based concepts are brought to life.
- Midpoint theorem. The midpoint theorem is explained which says that the line joining midpoints of two sides of a triangle is parallel to the third side and is equal to half of the third side. The straight line drawn through the middle point of one side of a triangle parallel to another, bisects the third side.
- Area related theorems. In the same plane, a parallelogram that is made between equal lines or the total area is equal to one or more triangles; understanding the area of the triangle, etc.

Part 3.

- Symmetry related theorem. A line drawn parallel to one side of a triangle divides the

remaining two sides in equal proportion, the bisector line of one angle of the triangle divides the side opposite to the angle in the same ratio.

- Focal point related concepts. Circumcentre, focal point, perpendicular sides of a triangle, concepts based on the circles and the chords, equal chord makes an equal angle at the centre, the chord drawn at the focal point bisects the vertical chord, the equal chords are placed at equal distance from the focal point.
- Relationship between the arc and the angle of the circle. The angle made by any arc of the circle at the centre is twice the angle at the rest of the arc, the angles made by the same arc are equal, the angles opposite the cyclic quadrilateral are complementary.
- Intersection related. The two tangents drawn from a point outside the circle are equal, the tangent drawn at a point on the circle and the angle formed by the chord drawn from the same point are equal to the angle drawn on its alternate circle. The theorems of all the above parts are proven by moving one or two circles.
- An experiment to show that the sum of the three angles of a triangle is 180° . Method of preparation: first, take a blank paper and mark three points on it. Now, with the help of pen and scale, merge all three points with each other to form a triangle. After drawing angles on the three points, mark their names. Now, with the help of scale and scissors, cut out the outer part of the triangle. Cut the remaining triangle into three parts too. This will separate all three angles of the triangle. Now, bringing these three angles together at a point, we see that all three meet on a straight line. In this way, if one repeats this experiment by making triangles of different measurements, the result will be the same

each time, that is, all three angles will always be found on a straight line. This proves that the sum of the three angles of a triangle is always equal to 180 i.e., two right angles.

Shri Sharma first created TLMs with six theorems. The formats were displayed in the Science and Technology Department exhibition and Shri Sharma secured the first place. Subsequently, this work was part of an exhibition which had participants from states like Rajasthan, Delhi, Maharashtra, Gujarat, Madhya Pradesh and Chhattisgarh in the northwest region. The event in Mumbai (Nehru Science Centre) lasted for seven days. In this event, Shri Sharma met a gentleman who was so impressed with his work that he offered him a blank check for this model. Although Shri Sharma immediately turned down the proposal, he understood that this project was worth pursuing in a big way.

In recognition of his work, Shri Sharma was made KRP for Mathematics Teaching Training by the Department. He got a place in the module writing committee of mathematics under the National Secondary Education Campaign and got the opportunity to write a full section of Geometry in the Class 9 and 10 Mathematics textbooks at the Board of Secondary Education, Rajasthan.

At present, this 40-page book remains an experimental book, which mathematics teachers are eager to use to support their lessons. So far, Shri Sharma has produced and distributed about 100 copies; 50 copies have been sent to Maharashtra alone. In this book, almost all theorems of Geometry have been proved by experiment. A maths laboratory has also been set up by making 1.5×1.5 square feet model in a private school in Pune, Maharashtra which was inaugurated by Maharashtra's Education Minister. Shri Sharma has created a math related institute "Boudhayan Sansthan" which conducts free mathematics workshops.



QUESTIONS FOR TEACHERS

1. How should the concept of geometry be explained to students?
2. How can geometry be associated with everyday life?
3. What activities can be undertaken to explain the concept of different shapes?

QUESTIONS FOR TRAINEES

1. What are the benefits of imparting knowledge to children with activity?
2. What must be done to enhance children's creativity?
3. Which group activities can be organized to explain different theorems and concepts of geometry?