



## Back Ground

On that day, a group of people came to see Bambu Studio. I came to know that they were teachers who had come for training. I started explaining our experiments of teaching Maths through games etc., I told the story of squares which I had created which can teach area, four fold symmetry, etc . Suddenly their leader got interested. He introduced himself as the director of Kendriya Vidyalaya Sanghatana, which provides training to practicing teachers from Kendriya Vidyalayas( Central Schools). He was a Phd. He asked me, “Will you be interested in conducting a workshop for our teachers?”

I said , “Why not, let us workout!”

**That is how, ‘INNOMATH’ workshop materialised!**

KV(Kendriya vidyalaya) schools get funded by central Govt. Mainly created as a facility for central Govt employees, to accommodate their children, the schools are located all over the Country! They are better funded with CBSC curriculum. They are able to maintain better standards (especially in Maths and Science) compared to state funded Municipal schools which are governed by each state!

A plan for conducting a workshop for about 30 teachers for a week was worked out.

I had explained with great care, the importance of calling Math teachers and Art, Craft teachers together in 50-50 or 60-40 ratio, They conveniently forgot to call Art and Craft teachers though they had agreed to my proposition.

**I suspect a kind of caste system prevails which segregates ‘Art,Craft teachers’ from ‘Maths and Science’ teachers at various levels!**

These were the very walls we wanted to break through our workshop! But we were helpless. So we had to start with a handicap, which we managed to overcome by inducting few young designers as voluntary participants in the groups formed by teachers at some stage.

# Introduction

The workshop on innovation and experimentation in math is the first of its kind. Teaching maths is about laying a foundation for logical thinking for further learning and application in daily life.

Several children and even parents have developed a 'math phobia' in the current education system. Teachers work with several constraints like large numbers in class as well as inadequate material facilities, yet things are changing with recognition for increased quality in education. The Govt. and parents are realizing the importance of math education. In this scene teachers play a significant role. They will have to take the challenge of transforming math teaching, making it likeable and fun for children.

The workshop was planned to enable teachers for such a dynamic role!

**Preparations:** A team of people were working with me. My earlier experience of teaching creativity to working engineers, M Des students and college teachers came in handy.

Material generated earlier for children's workshops like tasks and games with Tangram, Math challenges in a Puppet, Symmetry with Bamboo, etc., were re-framed to suit this workshop. M.Des and Phd projects done under my guidance on Math. topics provided a good content for the workshop.

Creative sessions covering multiple intelligences, Experiential sessions from chewing a badam to flying as a bird in a meditative imagery session, Group studio tasks, Tasks involving design and making of physical models, PPTs, films and Group presentations were composed for the workshop.

Experts like Dr. Montero, prof. Athavankar and others were contacted. A week long programme was planned and detailed preparations were made over a month. Rathika and Mrudula were working full time helped by Sachin, Sarang and Rudrapaul.

## FACULTY:

Prof. A.G Rao  
Prof. V. Bapat

## CO-ORDINATORS

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Mrs. Indra Jain  
Dr. V.K. Agarwal

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Vinay Wamanse  
Craftsman : Niranjan Rudrapaul

I had given a talk earlier on 'Creative Math Teaching' to the principals of Schools at the training centre, on Dr. Agarwal's Invitation. , Yet, on the third day, during Lunch Dr. Agarwal casually asked me, "You are from Math stream, No?" in Hindi. To his surprise, I said, "No, but I did my Mechanical Engineering which had '7' papers in Maths!". He did not venture the topic further.

*I have fair bit of reading in Maths due to my fascination with Math puzzles(2D and 3D), History of Maths and interest in deeper aspects of maths like Order, Aesthetics, Creativity and Problem Solving.*

## TIME TABLE

Date	9.30 - 10.30	10.30 - 11.30	11.45 - 12.45	2.00 - 5.00	
29.05.2009 Friday	Registration and Inauguration	Talk on methodology -Prof. A G Rao	Creative Introduction	Talk - Mr. Tripathi	Seeing Math Challenge in Tangrams
30.05.2009 Saturday	Creative Session	Being Creative - Prof. A G Rao	Participant`s Presentation	Finding Math Challenges in Toys	
31.05.2009 Sunday					
01.06.2009 Monday	Creative Session	Misconception/Problems	Participant`s Presentation Case Study - Area Game	Creating Experiential Base for removing misconceptions in Math	
02.06.2009 Tuesday	Creative Session	Talk - Dr. Vivek Montero	Participant`s Presentation Case Study - Volume Game	Symmetry - Make Mirror Gadgets	
03.06.2009 Wednesday	Creative Session	Talk - Prof. Athvankar	Participant`s Presentation Case Study - Perimeter Game	Games and Narratives	
04.06.2009 Thursday	Creative Session	Narrative - Sachin Datt	Narrative - Prof. A G Rao	Games and Narratives	

\*Tea break everyday, at 10.30 am and 4.00pm in the auditorium foyer.

\*Lunch served for the participants in the auditorium foyer at 1 pm everyday.

The workshop had four types of Inputs

1. Sessions on Creativity
2. Talks by experts
3. Projects
4. Studio Tasks



Prof.Kannan inaugurated the session.mrs.Indra Jain and me on either side

We started with an informal inauguration by Prof.Kannan, who is involved in Computer based inputs into School Education.

We did not want to teach the teachers as they do in the Schools. We were keen to take them through a journey of 'Enjoyable Learning'.

For the teachers, who had come from all over the country, from Kerala to Jammu and West Bengal to Maharashtra the workshop was new. They did not know what to expect. Many of them were excited.

*We had mixed 1 hour creative sessions, slide talks, Teacher's presentations, guest lectures, films , project presentations and a meditative imagery session. An informal, playful environment was created to bring out creative participation.*



Teachers were selected based on their earlier achievement as good teachers.

One of them, 'Lailambika from Trichur', Kerala had made up songs on Math Themes and got an award for it.

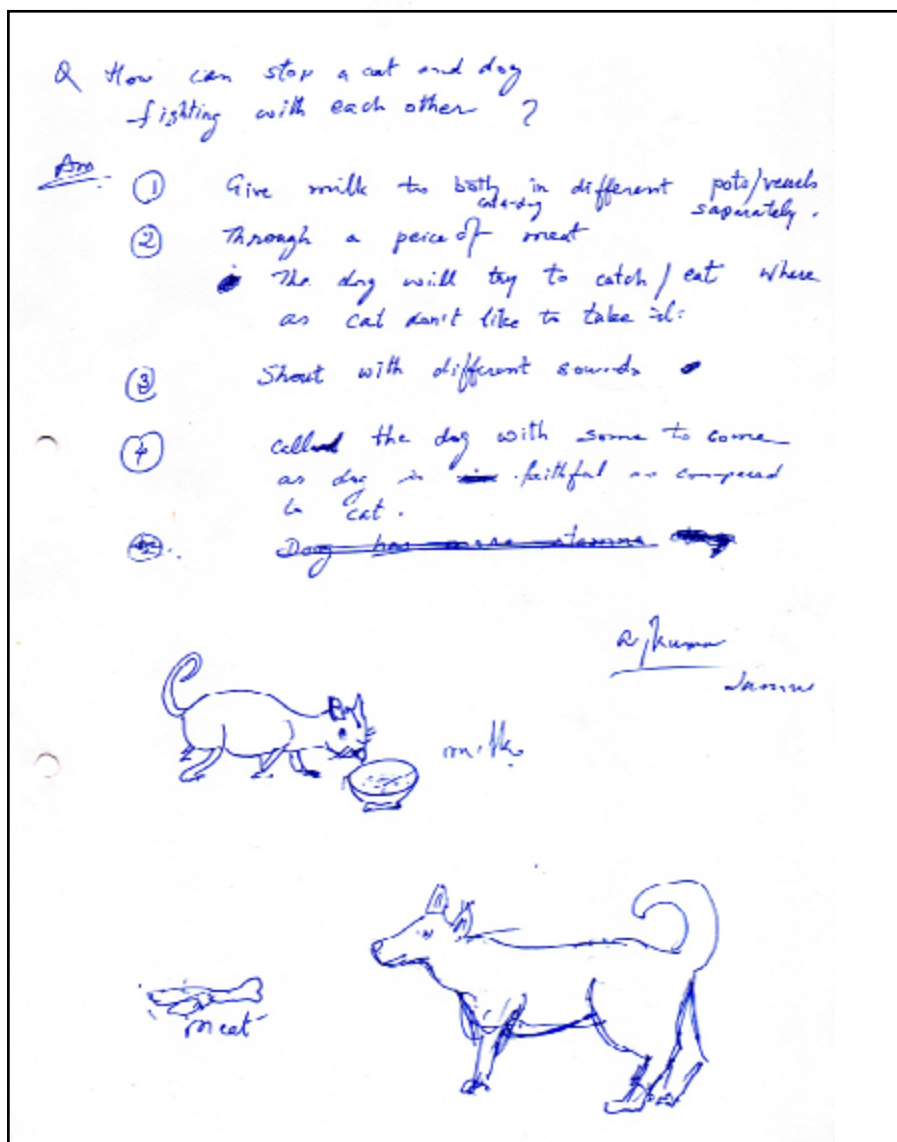
In-spite of their long experience, they did not question our credibility to teach 'Maths' to Children. It made our task easy.

Teachers

*Our major challenge was to unlock creative potentials of the Teachers whose age ranged from 35 to 50. we ensured that an informal atmosphere prevails, starting from the way they introduced themselves. In all these sessions 'humour' plays an important roll in opening up the natural defensive barriers of Individual self Images.*

## Sessions on Creativity

Creative sessions ranged from 40 minutes to 1 and 1-1/2 hours. These were developed over the years. Some are of general nature to open up minds and bring awareness of various sense perceptions. Some were on lateral and metaphoric thinking, as well as strategies for problem solving. Many are connected to Mathematics. They were planned to plug into the day-long sessions as initiators and relief to bring in fresh ways of looking at self and the acquired knowledge.



### 1. Stop Cat and Dog fighting with each other!

The second day's short exercise before my talk on 'Being Creative', was 'How to stop a cat and dog fighting with each other'. I have been using this problem effectively, since I came across it in an excellent book by Edward De Bono showing how children had solved the same problem very creatively.



Stop a cat & dog  
fighting each other.

1. We will keep one of them away from other so that they will not fight with each other.
2. We will beat the cat so that the cat can run away from that place because as compared to dog cat will run away easily.

Vinod Kumar

Only two teachers had used sketches!  
Imagination was lacking in all of them.

30/5/09

SMT. S. L. SHARMA

STOP A CAT & DOG FIGHTING WITH EACH OTHER

- 1) BY GIVING SOME EATABLES TO BOTH TO DIVERT THEIR ATTENTION.
- 2) BY LEAVING SOME MICE IN THAT AREA, (SO THE CAT WILL RUN BEHIND RATS)
- 3) KEEP A BOWL OF MILK OR CREAM AS THE CAT WILL BE ATTRACTED BY ITS SMELL.
- 4) BY BRINGING FLESH/BONES IN FRONT OF DOG.

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How to stop a cat and dog fighting with each other. <sup>Kansalye</sup>

Solution :

- ① Start playing with them to divert their attention
- ② Draw their attention to their food plates
- ③ Keep the mirror reflection of their prey, so that instead of fighting they run to catch their prey.



- ① First of all for fraction of seconds I will observe, why are they fighting to each other
- ② ~~if~~ whatever may be the reason, but I can divert the mind of dog. By throwing eatables to it ~~there~~ sufficiently away from ~~him~~ and will attract the dog toward eatable first. He will start to eat.
- ③ Cat automatically will run and do to fear.

Jan  
Linda Jan

A common solution from Teachers and Children was giving food to dog and cat. in De Bono's experiment, Children had mechanisms and strategies., **where as teachers had none.**

In a solution by a child, when a dog pounces on Cat it presses a lever and its food comes, and vice versa with Cat. So they become friends.

Separating both was another solution common to children and elders.

In addition

Children had thought of ingenious solutions like a Machine with 'love rays,' a 'Brain washing machine,' and a 'Lion to scare both cat and dog,' etc.,

**Master piece was 'Dog wearing a mask of cat and Cat wearing a mask of dog'.**

Showing these solutions by children helps in convincing grown ups that they are lacking in 'Imagination'.

Mrs PREET, CHAUDHARY (Bhopal)

put a bone and milk pot  
in front of them

- \* Throw a stone on them
- \* Use stick
- \* put water on them
- \* make sound of creaking ( Loud sound)

**All the solutions of children had pictures which made a great difference!**

See

Children solve problems / Edward de Bono.

Author: De Bono, Edward, 1933-

Published, London : Allen Lane, The Penguin Press, c1972.



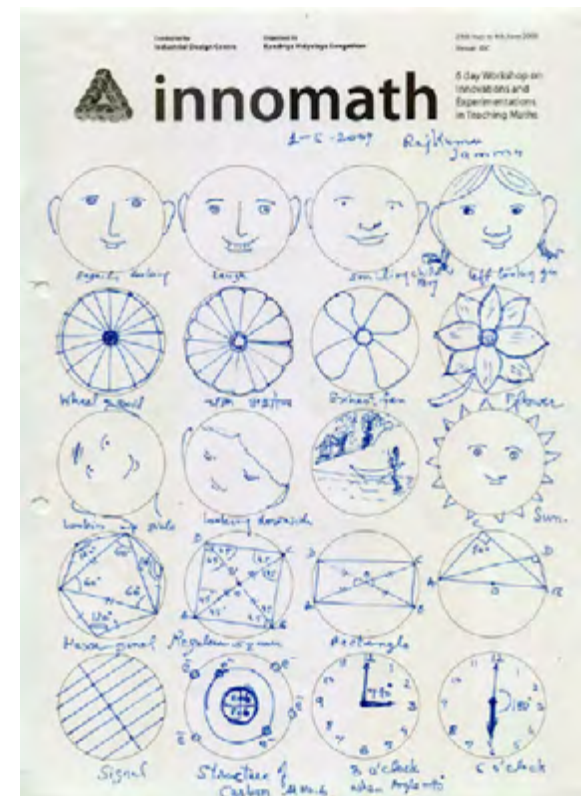
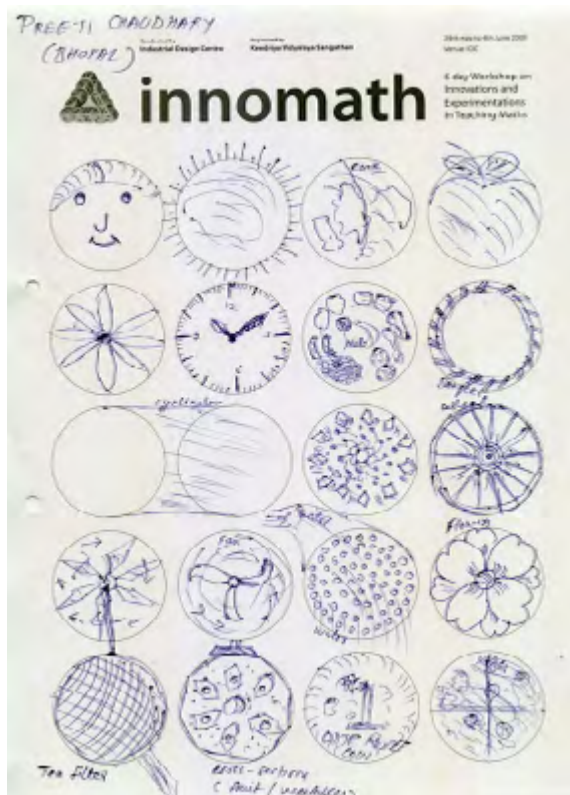
## 2.Circle exercise



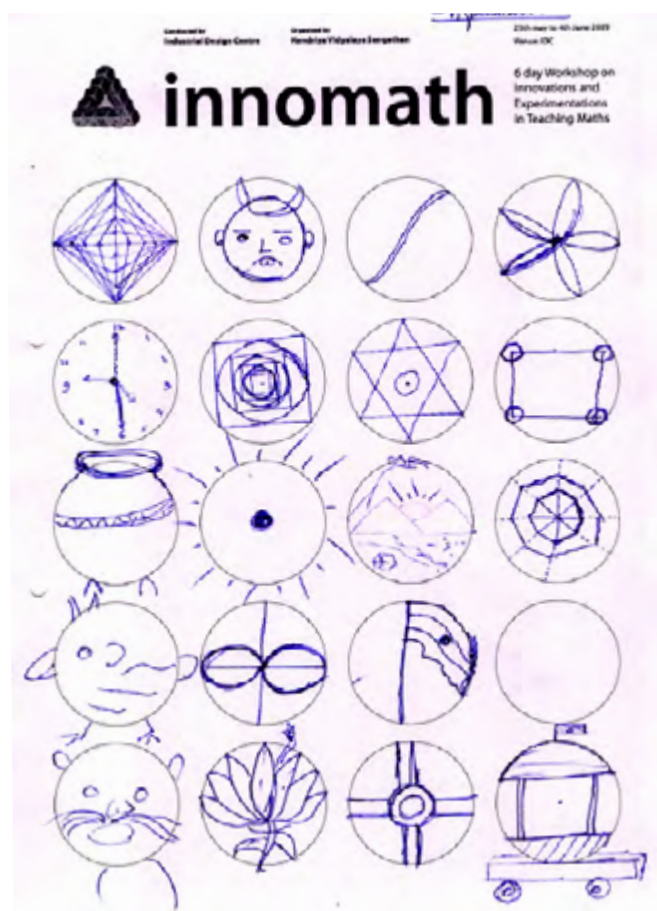
On the third day, we made them do the 'Circle Exercise'. In this task they have to see circle as..... metaphorically for example a 'face'. Since I keep giving this task to many groups like students, children, Engineers from Industry, etc,. We have a base to compare the performance 'as a brain scan of imagination'. Extremes get noticed. One of the teachers had a great difficulty to reach '3' solutions, while another teacher had finished 3 sheets (3x 15).

What was the 'Creative Experience' for the 'Teacher'? There was no evaluation. There were no right answers. A framework was provided for 'Imagination' to flow with little constraints.

This was a new experience to Teachers who were used to right and wrong answers and evaluation based on this value.







But there were multiple operations to match in Thinking. One had to first see metaphorically a 'Circle' in an object, living or non-living, in the surrounding place or a space you can 'enter in to' mentally. For example, I can see circle in a wrist watch, button or a bangle one is wearing. One can see a circle in a cup or saucer while drinking Tea or a Clock on the wall!

Then one can transport mentally into the street seeing circles in the wheels of a vehicle or in a foot-ball kicked by a kid and so on...

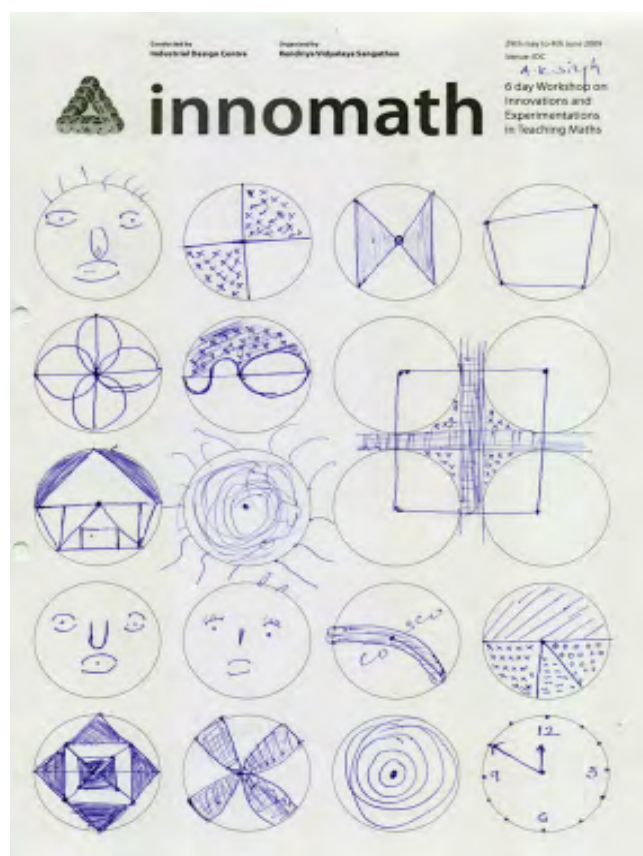
It is experiencing imagination with **level one constraint**.

What one gets trained in is

- Applying one's mind seriously (making a mental effort)
- Moving the mind on thinking in a focused, given direction.

### In addition

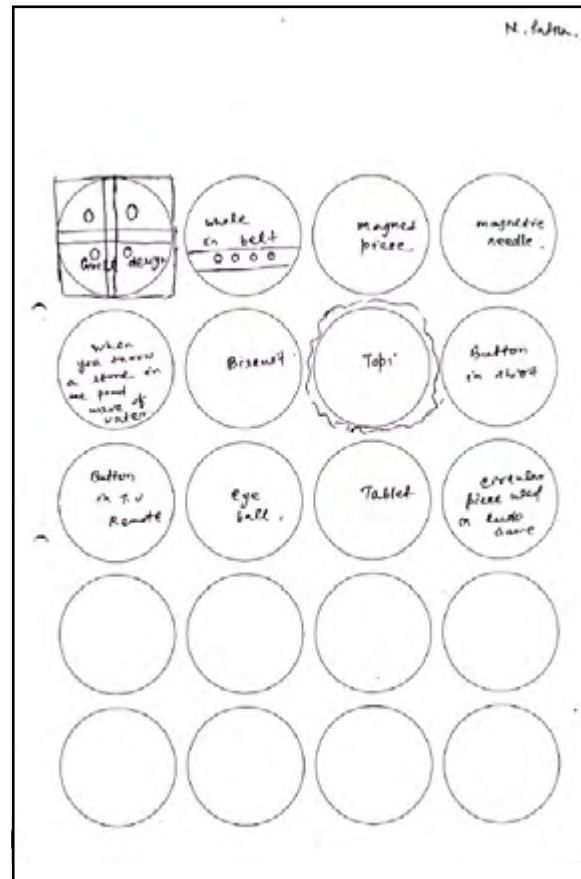
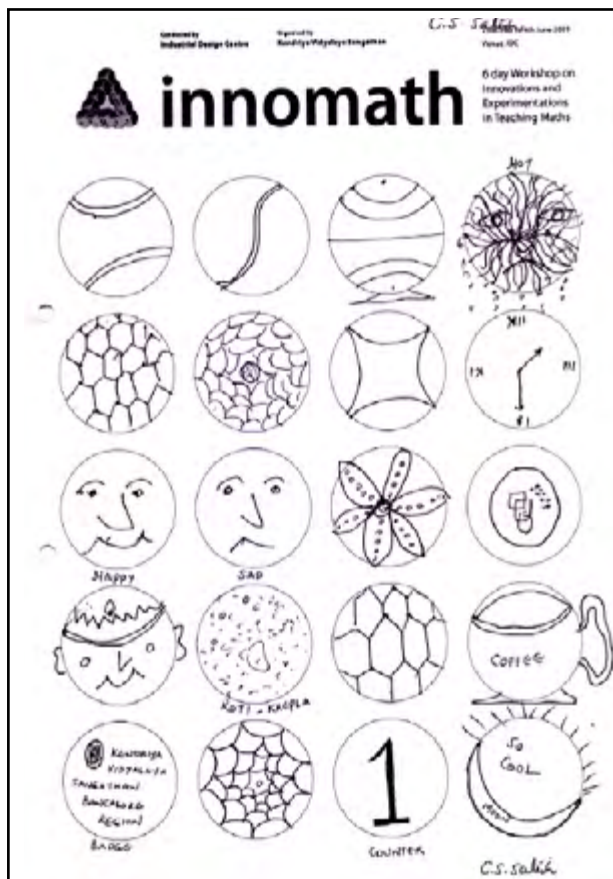
- As people get solutions, it becomes an incentive to think more. Any problem solving activity gives a mental satisfaction and motivation to solve more.
- When one is stuck, then exercising imagination in a particular direction comes in to picture. If it is too complex, person is likely to drift or get distracted with other thoughts!
- Seeing others' solutions helps in secretly admitting one's own limitation, which ego does not allow us to see in normal conditions.







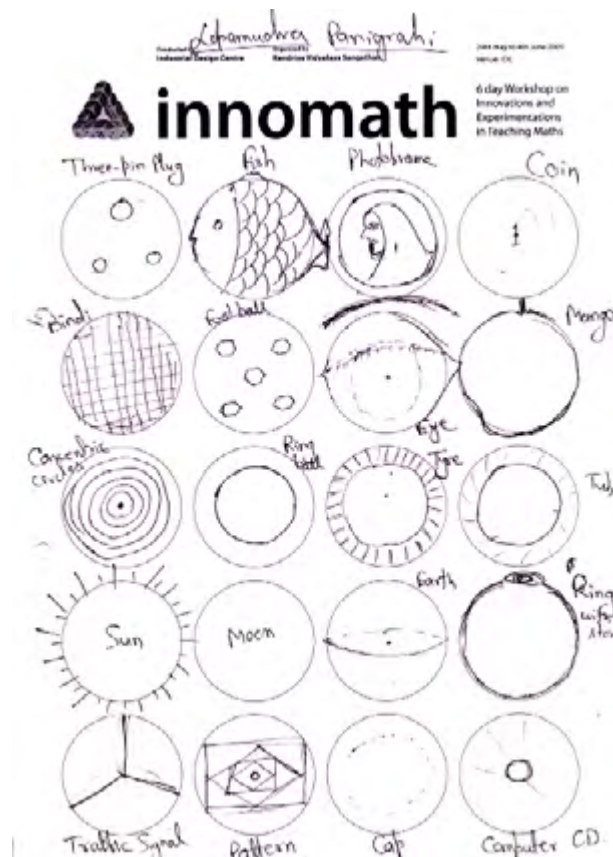
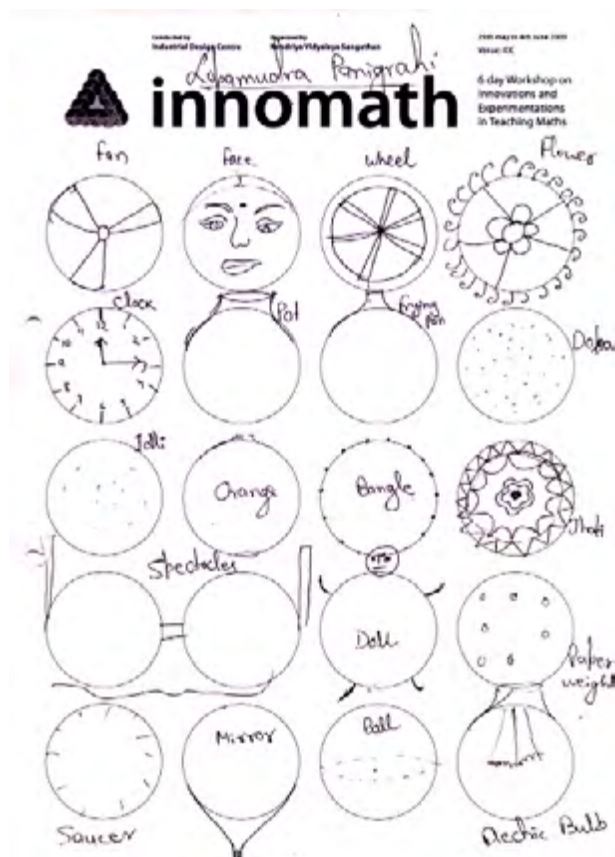
Teachers enjoyed the task. One of them could not complete more than 3 circles in one sheet! Another had completed 3 sheets and wanted one more sheet.



There was one just using written words like Tablet, Biscuit, Button etc. He was able to visualise but not ready to sketch.

*Sketching is a language by itself which acts as a mediator between visualisation in the mind and translation through hand. It is akin to writing in a script. Once a certain proficiency is acquired can give a great advantage in shaping and communicating creative solutions.*





Circle exercise gives some insights of person's deeper thinking as well.

Teachers also saw the other's solutions displayed on the board. This is an important aspect of learning in the culture of design education. Seeing other's thinking opens up one's own mind.



### 3.Experiencing taste

A short, creative experiential session was held soon after the circle task. Each of the teachers were given an 'almond'(badam), asked to hold it in the hand and imagine eating it.

Could they feel the texture as they chew in their imagination?

Did they get the subtle aroma of almond?

Then they were asked to slowly chew and experience the eating.

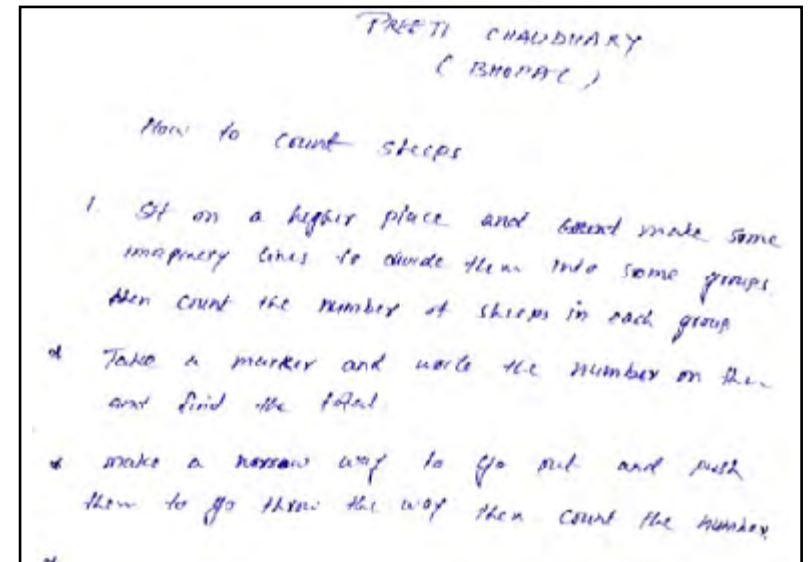
This is a 'Zen exercise', I had created and have been using with my students effectively.

To start with it breaks the routine of a class and brings a new relationship of sharing the food.

One invariably realises how we are often engrossed with thoughts and do not pay full attention.

## 4.Counting the Sheep in an open field

A short problem for 40 minutes was given on how to count sheep in an open field. Some interesting solutions came out. Later they were told how Shepard in Rajasthan solve the problem. They drive the sheep to one side using their dogs. Make one of the sheep to jump. Rest will follow.(sheep mentality?) They comfortably count without moving.

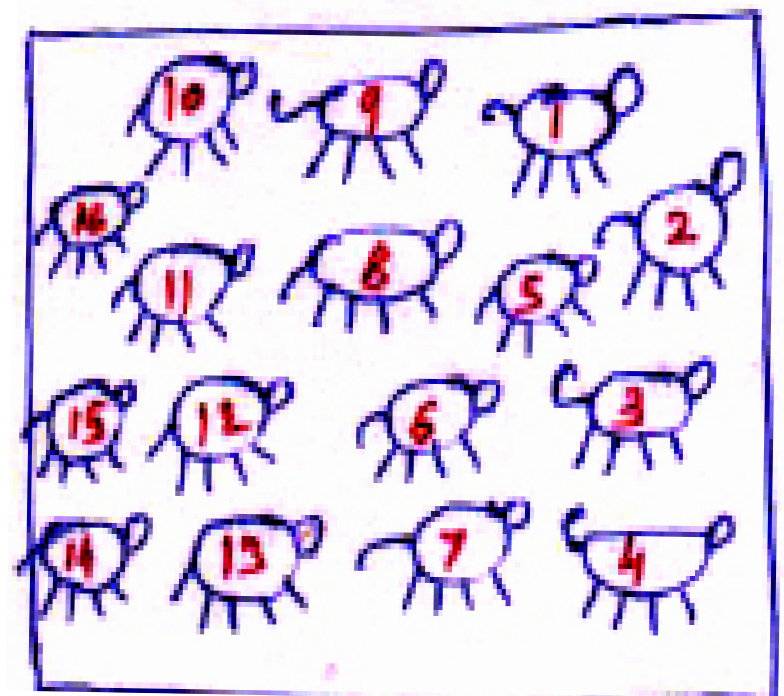


Preeti Chaudhary (Bhopal)

### How to Count sheep?

Sit on a higher place and make some temporary lines to divide them and make some imaginary lines to divide them into some groups

- Take a Marker and write the number on them and find the total
- Make a narrow way to go out and push them to go through the way. Then **count** the number



### Vishnu Laud

#### How to Count the Sheep?

Make sticker of labelling 1,2,3,4,... such that it can be pasted on the body of the sheep. Watch that none of the sheep will remain without stickers. The last sticker number is the total number of the sheep. In this way we can calculate or count the sheep.

Here the total number of stickers used is 16 therefore the number of sheep is 16. In other way I had stickers left with labelling 17, 18, ....Hence total number of is 16.

The other method to count the sheep is that keep all the sheep in the field having boundary with a gate such that the sheep can pass through them. Tell a person so that he can force the sheep to move from the field. The other person will count the number of sheep. This way we can count total number of sheep

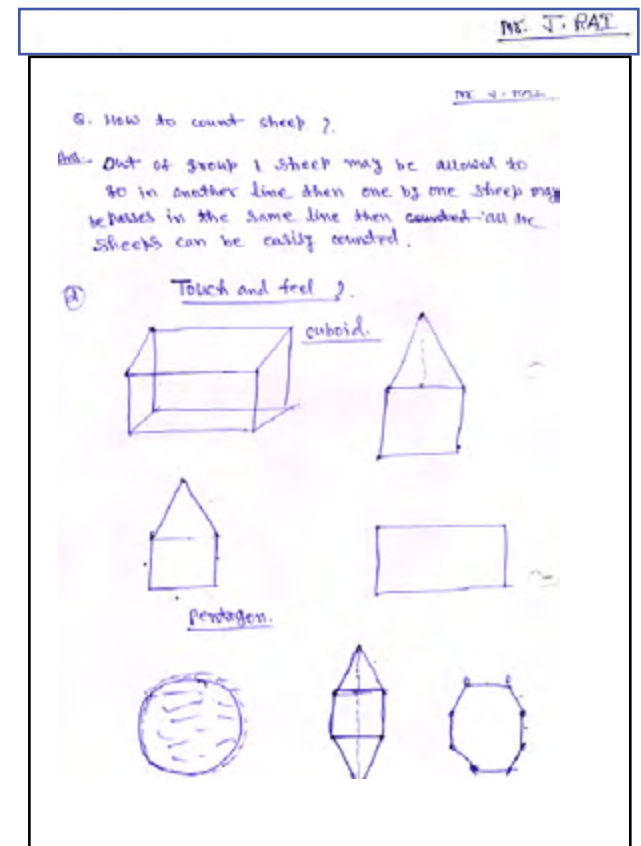


## 5.Experiencing Touch

Touch is a sense often taken for granted and not connected to learning Maths. A creative task was designed to experience and identify geometric shapes with out seeing . Objects with specific geometric shapes like triangles, circles , half circles, squares and rectangles were put in a bag with two openings to insert two hands. Many of the shapes had different textures. Teachers to their delight touched them without seeing and identified the shapes.

Such inputs can be used by teachers in their teaching.

Teachers can introduce shapes creatively to link to their subject in the class. For example rectangular pieces of different proportions can be put in the bag and children can be asked to tell which piece, (identified with texture) has bigger area?




Teachers sensing objects by touch as Rathika and Mrudula facilitate



## 6. Dividing Rectangles

I have been giving a 'problem in Rectangles', which was posed by Wertheimer, in my creativity sessions. Initially students are asked to make maximum number of parts by cutting it with 3 straight lines, then with 4 straight lines, 5 st. lines and 6 st. lines. Since the problem is well defined it is easy to solve graphically by trial and error. As the lines increase rules have to be found. One can see the pattern and create formula for increased number of lines, eliminating the need for constructing geometrically.

*A.R. Lakshminarayana*



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28th May to 4th June 2019  
Session I & II

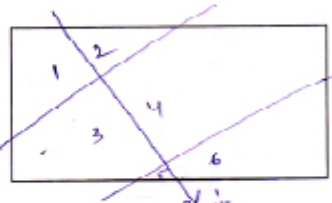
6 day Workshop on  
Innovations and  
Experimentations  
in Teaching Maths

**Creative Exercise:**

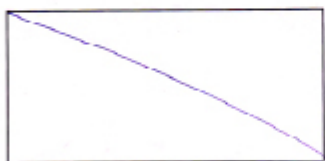
What are the maximum parts that you can divide a rectangle into by using- One line, two lines, three lines, four lines, five lines and six lines.



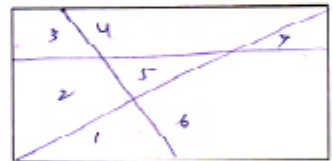
3 lines



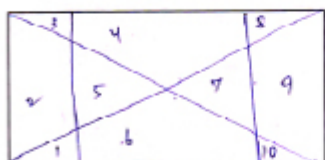
3 lines



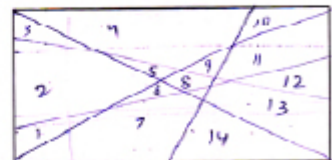
1 line



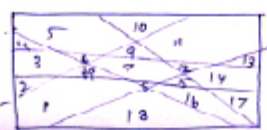
3 lines




4 lines



5 lines




6 lines



6 lines

*Vishnu - Kany*



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**Creative Exercise:**


What are the maximum parts that you can divide a rectangle into by using- One line, two lines, three lines, four lines, five lines and six lines.




1 line




4 lines




2 lines




5 lines



3 lines



6 lines



2, 4, 7, 11, 16, 22...

we will get pattern

## 7. Imagining a problem in a rectangle and solving it!

Teacher: Birendra Kumar, sheet 1

20m

10m

① Find area of rectangle whose length & breadth are 20m & 10m respectively.  
 $\therefore \text{Area} = 20 \times 10 \text{ sqm} = 200 \text{ sqm}$

② Find area of rectangle whose diagonal = 30m and a line drawn from one vertex to diagonal is 15m.  
 $\text{Area} = 2 \times \text{Area of } \triangle = \frac{1}{2} \times 30 \times 15 = 225 \text{ sqm}$   
 (diagonal divides a rectangle into two triangles of equal area)

③ Find perimeter of rectangle whose length & breadth are 20m & 10m respectively.  
 $P = 2(20 + 10) \text{ m} = 60 \text{ m}$

④ Find area of path which is built inside the rectangular garden of length 20m and breadth 15m. Find area of rectangle etc.

This comes as sequel to the previous task. It has a more challenging poser of finding a problem and solving it. We are used to solving given problems. How do we imagine problems when they are not given?

For Teachers it is relevant day to day issue.

Teachers came out with a variety of solutions(problems). Couple of the responses are examined here.

Seeing on display various responses from their colleagues also opens up one's mind.

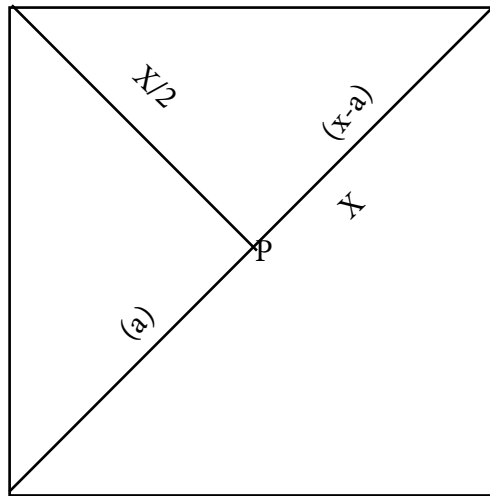
If a colleague next to you can come up with an ingenious solution, so also can you!

This is an effective tool in inducing 'creative thinking'.

Look in the next page for

My comments





Clear beautiful mathematical form is emerging, once we get into variable 'x'. This is the exciting part in Maths. Converting into a variable 'x' can remove fear of unknowns 'x' and incomprehensible formulae.

1. Find the area of rectangle whose length and breadth are 20cms and 10cms respectively.

$$20 \times 10 = 20 \text{ sq.cms}$$

Solution1, is too simplistic.

2. Find area of rectangle whose diagonal is 30cm and perpendicular drawn from vertex to diagonal is 15cm.

$$\text{Area} = 2 \times \text{area of triangle} = 2 \times \frac{1}{2} \times 30 \times 15 = 450 \text{ sq.cms}$$

The second solution is interesting. But with the conditions specified namely, Diagonal 30 cm and perpendicular drawn from vertex to diagonal 15 cm, the rectangle actually become a square.

I think Mr. Kumar has missed an interesting possibility of generalising in Math Language i.e. in terms of variables, rather than leaving with specific dimensions.

- Let us take a general rectangle

Let 'x' be the diagonal let perpendicular drawn from vertex be  $x/2$

And let it divide the diagonal at the point (p) where it touches, into (a) and (x-a) lengths.

- Now Area of Rectangle (or square)

$$\begin{aligned} &= 2 \left\{ \frac{1}{2} \cdot \frac{x}{2} \cdot a + \frac{1}{2} \cdot \frac{x}{2} (x-a) \right\} \\ &= 2 \left\{ \frac{1}{2} x \cdot \frac{a}{4} + \frac{x^2}{4} - \frac{x \cdot a}{4} \right\} \\ &= 2 \frac{x^2}{4} \\ &= \frac{x^2}{2} \end{aligned}$$

Substituting  $x = 30$ , Area =  $900/2 = 450 \text{ cm}^2$

Now, we can question what happens if  $x/2$  varies i.e. takes different forms say  $x/3$ ,  $x/4$ ,  $x/5$  etc. Still it will be possible to draw rectangles and find the algebraic expressions for the areas

For  $x/3$

$$\begin{aligned} \text{Area of rectangle} &= 2 \left[ \frac{1}{2} \cdot \frac{x}{3} a + \frac{1}{2} \cdot \frac{x}{3} (x-a) \right] \\ &= 2 \left[ \frac{x \cdot a}{6} + \frac{x^2}{6} - \frac{x \cdot a}{6} \right] \\ &= \frac{x^2}{3} \end{aligned}$$

We can further extrapolate getting areas

$x^2/4$  for  $x/4$

and

$x^2/5$  for  $x/5$



3. Find the perimeter of rectangle whose length and breadth are 30m and 15m.

$$P = 2(30 + 15) = 2 \times 45 = 90\text{m}.$$

Problem is too simplistic

4. Area of path of width 5m which is built inside the rectangular garden of length 30m and breadth 15m. Find also the area of rectangle.

Area of the path = Area of the rectangle - Area of rectangle excluding path.

$$= (20 \times 15) \text{sq.m} - (10 \times 5) \text{sq.m}$$

$$= 300 \text{sq.m} - 50 \text{sq.m} = 250 \text{sq.m}$$

$$\text{area of the rectangle} = 20 \times 15 = 300 \text{sq.m}$$

Problem '4' is interesting. We had the experience of teaching in a tribal school for a class where children knew the formula for area of rectangle but were not ready to subtract area of smaller rectangle from larger to get the area of the path. We were surprised and discovered that children had not understood concept of area, **the difference between 1 cm and 1 square cm**. - After they used a grid of 1 cm to count the area of rectangle by each square cm they could do the problem with ease. Here also it would be interesting to ask children to generalise in terms of math variables.

Width of rectangle : x

Height : y

Width of path = w

What is the area of path ?

$$A = x \cdot y - [(x - 2w)(y - 2w)]$$

$$= xy - [xy - 2wy - 2wx + 4w^2]$$

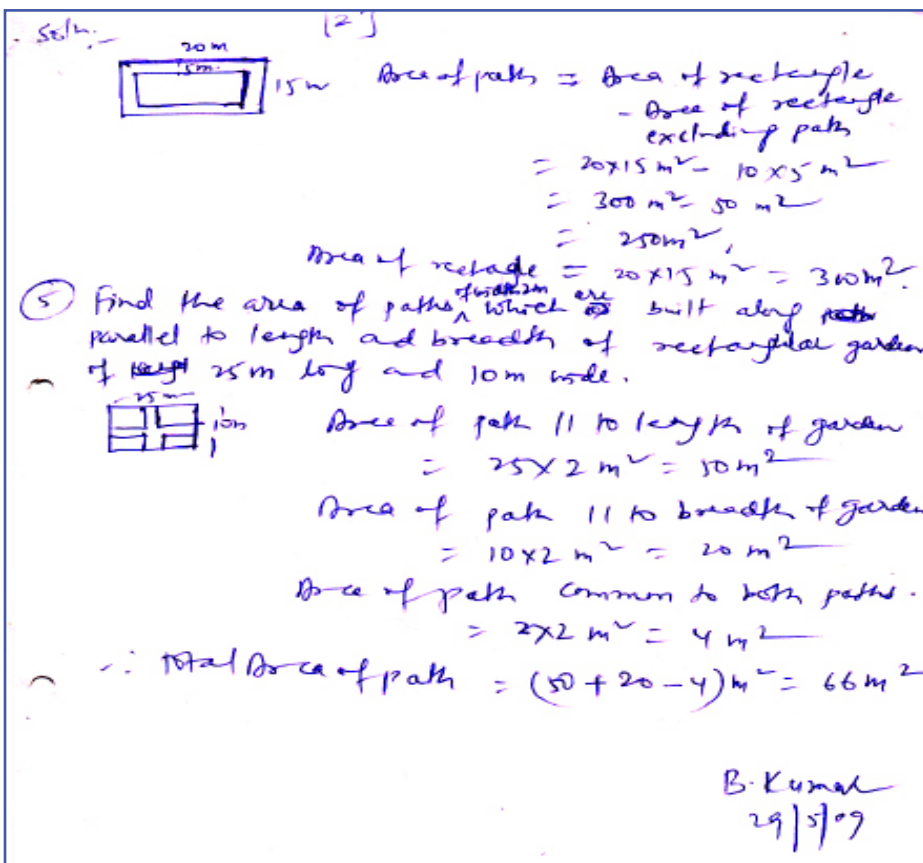
$$= xy - xy + 2wy + 2wx - 4w^2$$

$$= 2w(x + y) - 4w^2$$

For w=5, x=20 and y=15

$$A = 2 \times 5(20 + 15) - 4 \times 5 \times 5 = 350 - 100 = 250 \text{sq.m}$$

Teacher: Birendra Kumar, sheet 2



Soln. (2)

Area of path = Area of rectangle - Area of rectangle excluding path

$$= 20 \times 15 \text{ m}^2 - 10 \times 5 \text{ m}^2$$

$$= 300 \text{ m}^2 - 50 \text{ m}^2$$

$$= 250 \text{ m}^2$$

Area of rectangle =  $20 \times 15 \text{ m}^2 = 300 \text{ m}^2$

5) Find the area of paths which are built along the garden of length 25m long and 10m wide.

Area of path || to length of garden

$$= 25 \times 2 \text{ m}^2 = 50 \text{ m}^2$$

Area of path || to breadth of garden

$$= 10 \times 2 \text{ m}^2 = 20 \text{ m}^2$$

Area of path common to both paths.

$$= 2 \times 2 \text{ m}^2 = 4 \text{ m}^2$$

$\therefore$  Total Area of path =  $(50 + 20 - 4) \text{ m}^2 = 66 \text{ m}^2$

B. Kumar  
29/5/09

Generalised formulae can lead to changing the parameters for different conditions.

For e.g what happens when  $y = 2w$ ?

$$\begin{aligned} \text{Area of the path} &= 2 \cdot w \cdot x + 4w^2 - 4w^2 \\ &= 2w \cdot x \end{aligned}$$

The field loses the inner area. Only the path remains.



5. Find the area of paths of width 2m. which are built along parallel to length and breadth of rectangular garden of 25m long and 10m. wide.

Area of path parallel to length of garden

$$= 25 \times 2 = 50 \text{sq.m}$$

Area of path parallel to breadth of garden

$$= 10 \times 2 = 20 \text{sq.m}$$

Area of path common to both paths

$$= 2 \times 2 = 4 \text{sq.m}$$

$$\text{Area of path} = 50 + 20 - 4 = 66 \text{sq.m}$$

This Problem is interesting to solve visually. It is easy to see overlapping square in the middle and deduct in strips of path.

Again in terms of  $x, y$  and  $w$

$$\text{Area of path} = x.w + y.w - w^2$$

$$A = w(x + y - w)$$

Area of remaining garden (AreaG) will be

$$= 4 \left\{ \frac{(x - w)}{2} \cdot \frac{(y - w)}{2} \right\}$$

$$= 4(x - w) \cdot (y - w) / 4$$

$$= (x - w)(y - w)$$

$$= xy - wy - wx + w^2$$

$$\text{AreaG} = xy - w(x + y - w)$$

No surprising implications can be seen here

\*\*\*

All the teachers came with their own solutions. Unlike design students who dealt with this problem, Teachers had no difficulty in putting down math problems. Couple of them used visual proofs for algebra. There were no unusual, surprising solutions well connected to rectangle as such. But the process opened up their thinking to activate their imagination. Many of them had a good potential to make original contribution to Math teaching.

*I have a plan to put down elaborate comments like these for each in a separate document.*

# Talks by Experts

We had several talks during the workshop. Some were by me. Shri Tiwari and Dr. Vivek Montero from Navanirmiti and my colleague prof Athavankar, gave invited talks. my students made presentations on their educational projects. Prof.Kannan, Prof.G.GRay and Mrs.Priya Srinivasan gave brief talks when they interacted with teachers.



## 1. Introductory Talk

I gave an introductory talk starting with my background and how I got into conducting workshops for children. I explained how design subjects are taught and how 'designerly way of teaching Maths to children had engaged me. I talked about TLP(Teaching Learning Platforms) as a possible new method to teach any subject including Maths in schools. Experiential learning forms the core of TLP.

I introduced our working methodology. Short creative exercises, talks from invited speakers, presentation by Teachers and Group work would be mixed to make it interesting and participatory. All the sessions would be informal and open for discussions. I introduced our team.



## 2. Talk by Shri Tiwari on Navanirmiti-approach

Later on the first day Mr.Tiwari gave a talk on Navanirmiti's approach, using objects and activities to teach Maths. He demonstrated educational tools which they use to teach basic concepts to primary school children. These tools included beads, blocks and units of ten. These are used to teach concepts like numbers, zero, units of ten, counting and remembering numbers in vernacular languages and basic operations of addition and subtraction. Teachers were so excited about the availability of such ready made material, that they put a special effort in getting OK from their principals on phone to buy them by the last day of the workshop.



### 3. Interactive Session with Ms. Priya Srinivasan

Priya heads an organisation called 'Pomagranate Workshop., which organises and conducts experiential learning workshops for Children. I got inducted into conducting workshops for children through them, since 2006.

Now the group has contracts with selected schools to teach 'English in an experiential, creative way.

Their website: [www.pomagranateworkshop.com](http://www.pomagranateworkshop.com)

Teachers enjoyed the interactive session.

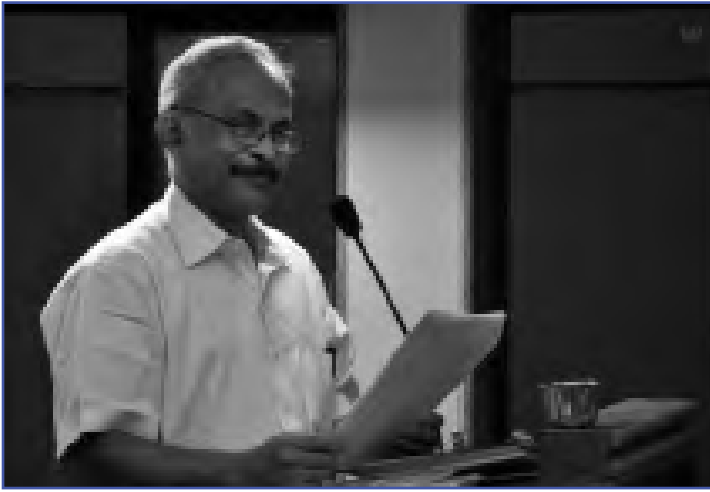


### 4. Talk on 'Being Creative' by a g rao

'Cat and Dog' problem became an effective back ground to talk about 'Conditioning' and how we loose the freedom of thinking uninhibitedly like children. How we get programmed socially, affecting our Creativity was elaborated.

Techniques like Brain storming, mind mapping, seeing Nature (with full attention) and 'Synectics' were introduced in the talk.





## 5. Talk by Dr.Vivek Montero

Dr. Montero, a physicist, trained in TIFR, Tata Institute of Fundamental Research and a Union leader is a founder member of Navanirmiti. He was in close touch with W W Sawyer who has written many books on math teaching. He has many insights of his own in School Education and is the brain behind many of the Math manipulatives and kits, produced by Navnirmiti. He gave a talk on how products developed by them can be used effectively for **innovative math teaching**.

## 6. Game design for Learning by Prof.Athavankar

A senior professor at IDC, Prof. Athavankar is well known for 'Game design'. He has been experimenting how effective learning can take place through games. He talked about methodology of game design and shared his experience with teaching children through games.

Teachers enjoyed playing a game using 'Tangram' which he had developed for a company under a UNDP Design Assistance Scheme.





## 7. Fraction Game with Bamboo strips by prof. a g rao and Rathika

A fraction game using bamboo strips had been developed in Expe bamboo workshop held for children at IDC earlier. Children were encouraged to make the strips for the game and play it later. The game and how it is played was presented to the Teachers.

A fraction die is used to pick a fraction . Concept of addition of fraction in its visual manifestation gets reinforced in the game.

**8. Two Games** , one to learn perimeter designed by Sandeep Maske and another to learn area, designed by Girish Iyer were also presented. These were undertaken as MDes. projects. Prof. Rao, who guided both projects explained how developing and using games for learning could become **collaborative research** between teachers and Designers.

**9. Akarneeti - a game on volume by Sarang.** Sarang Kushale presented a game he had designed under guidance of prof.Rao to learn concept of 'volume'!

## 10. Narratives for Math Learning by Prof.A.G.Rao and Sachin Datt

Narratives can be powerful tools to teach and learn Maths. Prof. Rao gave a talk with examples of narratives based on Math theme.

Sachin Datt, a phd scholar presented an animation film which he had made as a part of his research.

This could remove misconceptions in area and perimeter.



*prof.G.G.Ray with Teachers*

## 11. Math and Science issues in Ergonomics by Prof.G.G.Ray

Prof.G.G.Ray, Head of IDC in 2009, gave talk on issues of Maths and Science in Ergonomics. He emphasised the importance of understanding Maths at School level to enable its use at higher levels later.



## Project 1

### Seeing Math challenges in TANGRAMS

In group of 5 or 6, bring out new math challenges to be solved by children using Tangram pieces (or tans)

Five groups were formed and 'Tangram' was introduced to teachers. Mathematical beauty of Tangram the well known ancient Chinese puzzle with seven pieces was explained.

Tangram is generally known for making different figures like apple to aeroplane by young children with a rule that all the pieces have to be used in making each figure.

In this task teachers were asked to play with the tangram and come up with math challenges in it. The outcome could be a puzzle, a game or any fun activity that they could think of.

Teachers working in groups





Further brief: You are free to make bigger size Tangram or use number of tangrams (as each child in class will have one) you can also think in bigger scale if you like.

Three examples were provided

### 1. Making squares

- Make a square with 2 pieces.
- Make a square with 3 pieces
- Make a square with 4 pieces.
- Make a square with 5 pieces.
- **Make a square with 6 pieces.**(not possible)
- Make a square with 7 pieces.

### Example 2

Games using tangrams and dice :

A dice with tans can be rolled. You get one tangram piece for each roll. Avoid taking unwanted pieces. Whoever completes a shape first, wins.

### Example 3

Make your name with tangram letters and find the total perimeter of all letters.

Study material was provided to each group.



Teachers working in groups

*Note: Lot of information is available on net. NCTM has a good portal.*

*We also had come up with 'a fraction game' in our workshops done through 'Pomagranate Workshop', headed by Ms. Priya Srinivasan.*



Teachers working in groups



Teachers working in groups- Vinay with them

Solving open ended problems in a group was a new experience to the Teachers. They had not encountered such a situation. We attached our design associates with each group. Rathika, Vinay and Sachin joined three groups. This helped to invigorate their thinking with processes like brain storming. Some of the candidates were very enthusiastic. Workshop frame work creates a conducive atmosphere to draw-in reluctant participants.

The first session became a warm-up session. Each group was to present next day. Teachers had enough experience in solving problems in life situations. natural leaderships started evolving slowly.

Teachers working -Rathika with the group



Presentation of 'math Challenges in 'Tangram' took place after the talk on 'Being Creative!' on the second day. As the presentations were taking place, slowly a competitive spirit started developing among the groups. They were learning as they saw other's presentation as well as their own.

Presentations became a  
Reflective platform'

### TANGRAM Presentation

Each group came out with different ideas. Some were inspired or borrowed from net..

But by and large a process of creative group thinking had started and teachers were enjoying the process.

It is important that new problems come from teachers rather than taken from a text book to ensure Teachers' active participation in the class. The excitement of creating Math problems would get rubbed on to children in the class!

Roots of learning maths is in generating a 'math wonder' in the minds of children.

### Group 1



## Group1

1. Make a letter or a number of a single tangram and measure its perimeter.

Make the letter or number using tangram in such a way that its perimeter will be smallest and largest.

2. Find the area of each piece of the tangram and form the relations of the ratios between their areas.

3. There is a field in square shape. Farmer wants to give  $\frac{1}{2}$  of the land to his wife,  $\frac{1}{4}$  to his son and  $\frac{1}{8}$  to each of his daughters. Find the different methods in which he can divide it. Draw these various methods.

4. Find the parts in tangram with

- Similar shapes
- Same area
- Same perimeter
- Compare the perimeter of the shapes with same area and vice versa.

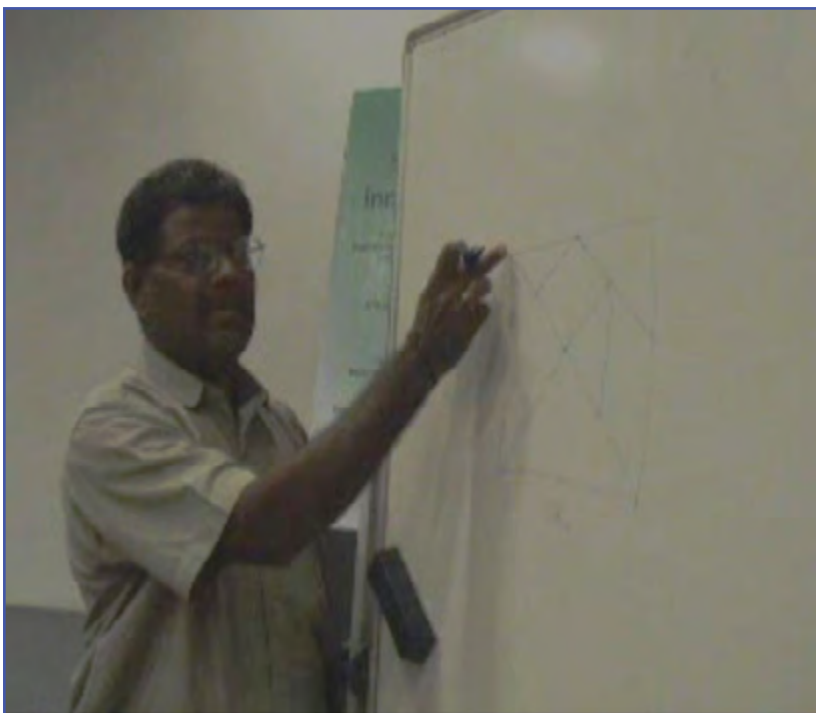
5. Make some symmetrical figures and find the axis of symmetry in them.

## Group2

1. Using tangram prove that area of a parallelogram is equal to the area of a square when it is made up by arranging two identical triangles.

2. Find in each of the cases using trial and error method that in how many ways a square can be made using

- Any 2 pieces
- Any 3 pieces
- Any 4 pieces
- Any 5 pieces
- Any 6 pieces (?)
- Any 7 pieces





## TANGRAM Presentation(contd)



### Group3

1. With the help of 4 pieces, 3 pieces of tangram, show that the area of one piece is equal to the area of three pieces, two pieces respectively.
2. Form a rectangle from the arranged 7 pieces of tangram puzzle (square shape) just by 2 moves.
3. Write with the help of tangram letters with one line of symmetry, two lines of symmetry etc.
4. Make different shapes with the help of tangram like
  - birds
  - swans
  - joker
5. Make square with four pieces in two different ways.



### Group 4

1. Find the area of each part of the tangram if one side of the square is "a". For this children of 9th & 10th std will have to find the relation of each figure with other.



### Group5

1. Prove that the line segment joining the midpoint of a triangle is parallel to the third side and half of its length.
2. Prove that bisectors of pair of opposite angles are parallel to each other.

## Project 2

### FINDING A “MATH CHALLENGE” IN A TOY

#### Background:

Bringing in Craft, to learn Maths could give us an advantage of combining skills of hand with skills of Thinking. I have been dwelling on this idea for sometime. Sudarshan Khanna's book on Folk Toys offered a great resource to experiment. In an earlier workshop with children we had taken a puppet toy. Children made it to the given size. There were links

to be measured and made to size, Body with a rectangular card board. we then asked children to make the toy in double size. The area of the body became 4times when side got doubled. One comes to know the intrinsic relation of length to area.

This got extended to other toys as a problem to find Math challenge. Mrudula, a team member made few toys. We brainstormed to project some possibilities.

*It is important to go through the process yourself when you give open ended problems.*

No doubt students (here teachers) will come out with new answers! Yet it is a good strategy to travel the path yourself to exercise your fantasy as a backup and a lead force.



#### Brief given for the project

Children love making things. Making toys is even more exciting. Making gives children an “experiential understanding”. Finding a “Math Challenge” taking a toy as base is itself a challenge to a teacher!

Five toys from books on folk toys by Sudarshan Khanna, were taken for the project. Each group can choose a toy from the list below.

- a) Puppet
- b) Linked Snake
- c) Jitter bug
- d) Rock and Roll
- e) Pop-up Fan
- f) Any other

Each group will study the toy and then brainstorm to form ideas to create math Challenges in it. Then, make the modified version of the toy





Sharing a joke with prof .Suresh

Prof.Suresh, Dean of Faculty, visited to meet the participants and to find out what was the workshop about.

It is important to create such working environment for 'innovations to happen!

We were thinking: Even we, IIT teachers perhaps need such workshops once in a while.

## Math challenges in a Toy-Working in Groups

Each of the groups started finding Math challenges in Toys.

(contd)

and demonstrate the “Math Challenge”.

Suggested areas of math are Area, Estimation, Proportion, Observation-recording, converting data into graphs, surface generation, and equations etc.

For example- A toy puppet can have characters with different proportions. Calculation of areas required for each, estimating the material required for say 5 puppets, economic use of a given size card-board, etc can become math challenges. Look at the various activities for each topic. It is available on web. CIMT (Creative Innovations for Math Teaching) has lot of help materials for Math teachers you can look at.

For the presentation, each group will find “Math Challenges” based on the chosen toy. They will also make the toy/Modified toy. Feel free to colour the required material, make support charts etc for making an effective presentation.

Ratika with one of the groups







There was an intense participation. Spirit of group competition prevailed.. Those who were on the fringe got drawn in. Women teachers were taking a lead in looking for new materials like beads in addition to what we had given.





# Presentation of Math Challenges in toys

## 1. POP -UP Fan-group3

The toy was to be made by the children and different problems were made up based on the toy. These problems when solved on paper children will start to understand the application of the school syllabus.

1. Group three had selected pop-up fan to explain concepts of measurement, calculation of surface area, graphs and estimation.
2. Children will be asked to make the toy. This would enhance learning of surface development of the cylinder and practically making things.
3. Find the lateral surface area of smaller cylinder.
- 4 Find the surface area of the visible larger cylinder when the fan is completely open.
5. Find the area of the paper used to make the fan.
6. Find the ratio of the curved surface area of both the cylinders
7. Plot the graph between the downward movement and opening of the fan.
8. How many square centimetres will be required to make such ten toys?
9. Show that downward movement and opening of fan are directly proportional to each other

[Click to watch the Video](#)



Smt. Swarnalata Sharma presenting for the group

group3



### OBJECTIVES

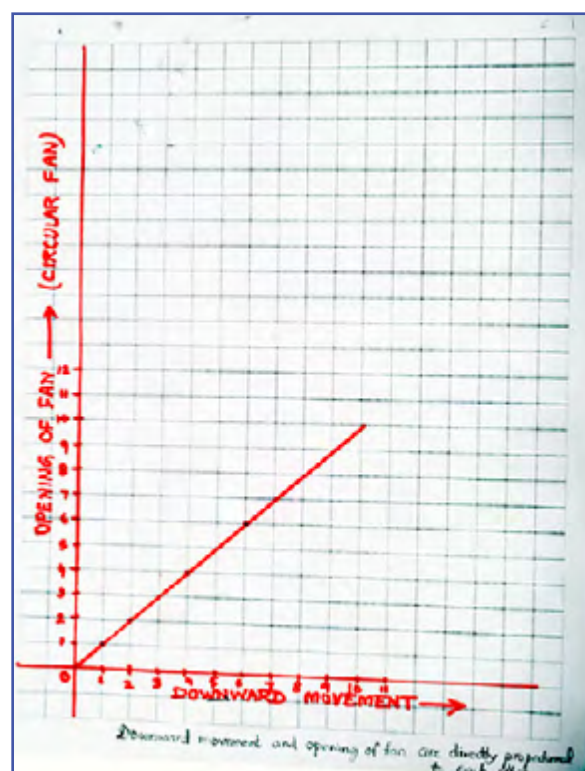
1. Concept of measurement
2. Calculation of Surface area
3. Angles formed between fan-leaves
4. Cost of manufacturing toy.
5. Elasticity — direct proportionality
6. Estimation

### MATERIALS REQUIRED

1. Chart Paper
2. Coloured tapes
3. White A-4 Paper (fan)
4. Scissors
5. Glue
6. Elastic bands
7. Compass
8. Pencil & Eraser
9. Scale
10. Graph Paper

### QUESTIONS BASED ON TOY — POP UP FAN

1. Find the lateral Surface area of smaller cylinder.
2. Find the Surface area of visible larger cylinder when the fan is completely open.
3. Find the area of paper used to make the fan.
4. What is the ratio of curved Surface areas of both the cylinders?
5. Calculate the length of the coloured tape required to be fixed on the bigger cylinder.
6. Plot the graph between the downward movement and opening of fan.
7. Find the total surface area of the toys. Find out cost of toys if the cost of  $1\text{cm}^2$  is Re 0.50. (both white & cream paper)
8. How many  $\text{cm}^2$  paper will be required to make such ten toys?







Smt.Lailambika explaining with her group members  
[Click to watch the video](#)

## 2. Linked Snake 1-group4

Linked snake was selected by the group.  
 This toy was modified to use it to make concentric circles. These circles will be used to draw circles on floor or on board.

1. Compare the areas of concentric circles.
2. When radius is doubled, what happens to the perimeter of the circle made?
3. If the circular path is coloured find the area of the each path.
4. Find the areas and write them in AP.
5. Game: Disassemble it and make different polygons e.g.: regular square, regular pentagon.
6. Such structures can be used to frame vegetable gardens and questions can be posted on finding the cost of painting the frame.

group4



"Child is the father of man" (I)

1.6.09

Presentation by group 4.

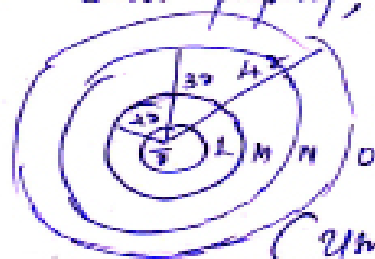
Lailambika  
Group 4.

Toys act as joys in learning.

Our toy, linked Snake, shows

- 1) different sets of parallel lines
- 2) Different types of quadrilaterals eg: square, rhombus etc.
3. Linear pair concept and change in the combination of linear pair component angles can be analysed here.  
A table can be made with different sets of angles.
- \* Angle measurements using protractor help the students in arriving at conclusions
4. Lines of symmetry in each of these quadrilaterals
5. If this toy can be fixed on a pivoted stand, in such a way that it can be rotated, rotational symmetry comes in the as order of rotation.
6. Using the same property, concentric circles can be drawn

[on board.]



$$\begin{aligned}
 \text{Area of 1st } \odot &= \pi \times 1^2 \\
 \text{2nd} &= \pi \times 2^2 = 4\pi \\
 \text{3rd} &= \pi \times 3^2 = 9\pi \\
 \text{4th} &= \pi \times 4^2 = 16\pi
 \end{aligned}$$

(Using Chalk concentric circles can be drawn on the floor)

7.

5th	1st	3rd	
1	20	100	
2	30		
3			

(10)

- Q. 2. Compare the areas of concentric circles. (W)
- When the radius is doubled, what happens to the perimeter of the circle made?
  - If the circular parts are coloured (differently), find the area of each part.

$$\begin{aligned}
 1^{st} &\rightarrow \pi r^2 \\
 2^{nd} &\rightarrow 4\pi r^2 - \pi r^2 = 3\pi r^2 \\
 3^{rd} &\rightarrow 9\pi r^2 - 4\pi r^2 = 5\pi r^2 \\
 4^{th} &\rightarrow 16\pi r^2 - 9\pi r^2 = 7\pi r^2
 \end{aligned}$$

(+ so on if made)

- Identify the areas you found & arrange them in the form of an AP.
- As the game, concentric circles can be made on the floor using colour powder & students can be made to throw arrows (papers) in such a way that those who are able to locate the arrows towards the centre can be rewarded. If more than one succeeds, the child whose aim is nearest to the centre can be rewarded. (Circle pasted on paper)
- Using a stick, transversal property can be analysed.
- Modification: -

1) Dismantle and make different polygons. eg. Square

2) Using the windmill of coconut leaves, a frame similar toy can be made and if it is arranged on a pivoted support, it forms a rotating toy with some simple bells on either side. Even a better toy placed under the fan, moves with sound. A very good fencing can be made by this.

Regular pentagon  
Concave, Convex  
& by joining outer

- Such structures can be used to fence vegetable gardens or fields. Questions can be framed to find the cost of fencing required to protect a square plot of  $4000\text{m}^2$ .
- Students may be asked to observe the growth of plants record their heights at intervals of 1 week or 2 weeks and make a graph connecting their observations.
- Give the toy to students & they may be made to find the area, perimeter and angles etc. of each shape.

21/11

Square sides -  
all sides equal  
each angle 90  
Dia - equal  
Dia - bisect and 90



## Linked Snake-group5

This group also took 'Linked Snake' but modified to connect math with Science.

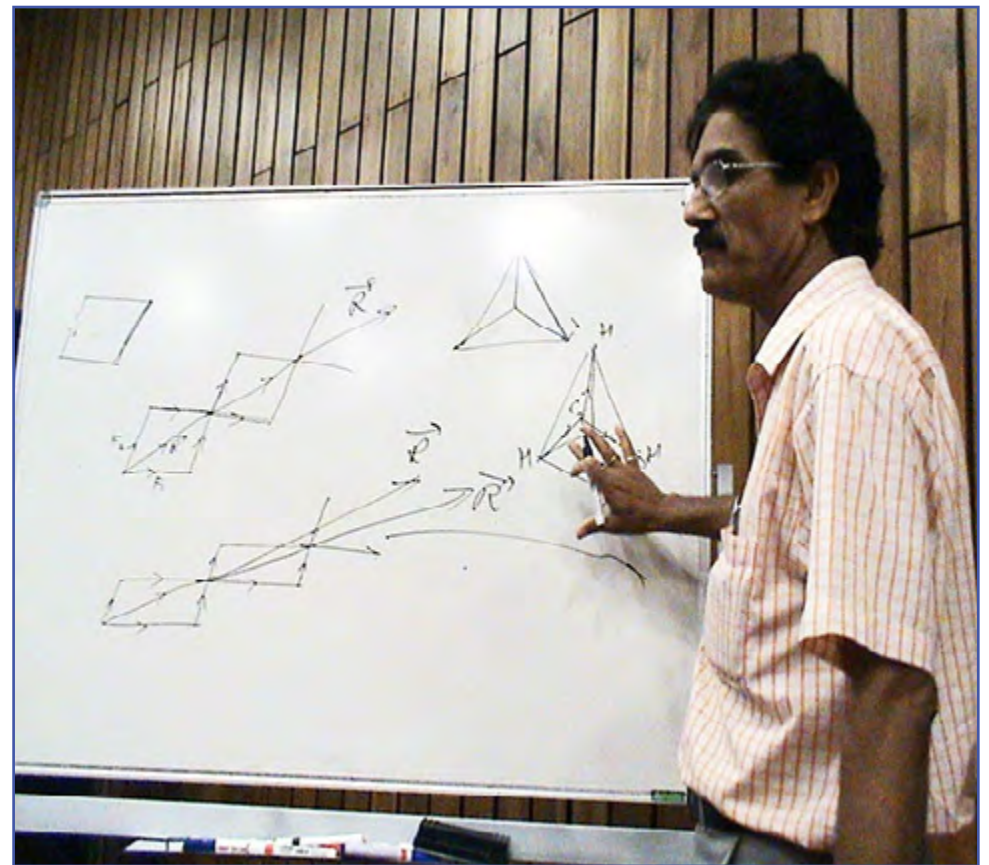
1. What is the length of the snake when linked path forms a square?
2. Find the total area enclosed by the snake.
3. Find the minimum and maximum length of the snake.
4. Calculate the perimeter of the snake.
5. How many lines of symmetry are there in linked snake.
6. Problem: Consider a student is standing near a Mango tree and he has a snake toy with hook on its one end. The snake toy can be stretched upto 20-30 meters and he is standing 10 meters away from the tree, find the heights of the mangoes that can be plugged using the snake toy. Consider that the shape formed in the snake is parallelogram and not rhombus. This toy can be used to explain physics to children.

When Snake has Rhombus links:

The resultant force of the rhombus is in one direction and so the speed of the opening and closing of the snake is more and with less effort.

When Snake has Parallelogram links:

The resultant force of the parallelogram is in two directions because of this the movement of the snake is slow and with greater effort.



Shri. Rajkumar explaining for the group5

[Click to watch the video](#)

group5



30/5/2009

Topic : Linked Snake Group 5

Q1 What is length of the snake when linked path form squares?

Expectation : Student will adjust the snake so that body parts (blocks) in the form of squares.

on measuring each side = 12 cm, each angle = 90°  
In this situation find the outer perimeter of the snake model.

(b) Calculate the total area enclosed by the body of the snake.

Q2 (a) Find the length of the snake when area is minimum. Also find the lines of symmetry.

(b) Find the minimum and maximum length of the snake.

Q3 (a) Stretched the snake forward so that the body parts form a rhombus (parallelogram). Calculate the area enclosed by the body and its perimeter.

(b) Compare perimeter as well as area enclosed by snake in the two situations.

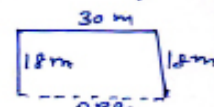
Q4. How many lines of symmetry <sup>are there</sup> when the linked snake model form squares.

(13)

Original sheets (4) presented by teachers can seen in this page and next age.

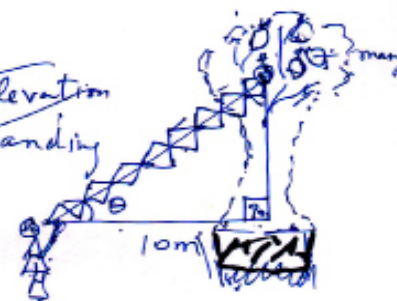
Q5

How many sticks will needed to put a fencing three sides of a rectangular garden open one side length wise. Find the rate of fencing at the rate of Rs 10 per metre.



Q6

Find the angle of elevation when a student standing 10m away from



Q. (a)

A student is standing 10m away from a mango tree. At what angle should he stretched the snake to reach the <sup>lower</sup> mango on the tree. The length of snake is 20m. Ram has

Q. (b)

a snake try with hook in its mouth, which can be stretched from 20m to 30m. Taking length of snake as 20m, 25m & 30m. Calculate the height of mangoes which he can pluck.

(14)

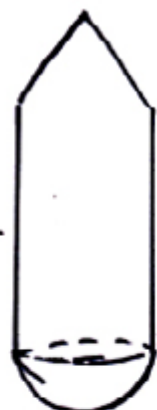






## GROUP-2

### HIT ME TOY



### MATERIAL REQUIRED TO MAKE HIT-ME TOY

Paper, hemisphere, clay.

**OBJECTIVE:-** To find the S.A. and volume of the solid 'HIT-ME' and to find the manufacturing cost.

**PREPARATION:-** Draw a circle of radius 5 cm on a paper and cut a sector  $216^\circ$  [Calculations:-  
 $2\pi r = L$  (Length of Arc)  
 $2 \times \frac{22}{7} \times 5 = L$  (3)]

## Rock and Roll-group2

This group modified the toy and developed it as an activity that children can perform. This toy teaches surface development of the cone and makes concepts of total surface area also clear.

- They came up with a modified toy that had a cone and a hemisphere.
- Objective of the toy was to teach children surface development of the cone.

### Questions

1. Find the total surface area, volume of the toy.
2. Estimate cost of manufacturing if cost of hemisphere ball is Rs.5 and cost of the paper is 1 rupee.
3. Find the cost of painting the toy.



group 2 with Mrudula

$$2 \times \frac{22}{7} \times 5 = \frac{\theta}{360} \times 2\pi r$$

$$\theta = 216^\circ$$



Make a cone from this sector. Cut a hemisphere from a sphere of radius 5 cm. Put some clay in the hemisphere to fill it & then join the cone on the top of hemisphere. We will get a 'HIT-ME'.

### QUESTIONNAIRE:

- 1) What is the S.A. of the sheet required to make the cone?
- 2) What is the T.S.A. of the toy?
- 3) What is the volume of the toy?
- 4) What is the cost of manufacturing the toy?
- 5) If the hemisphere is filled with the clay as in the figure:-  
  
 Then what is the volume of this clay? [Volume of stone A - Vol. of sphere B]  
 clay
- 6) If He paint the toy, what would be the cost of painting?

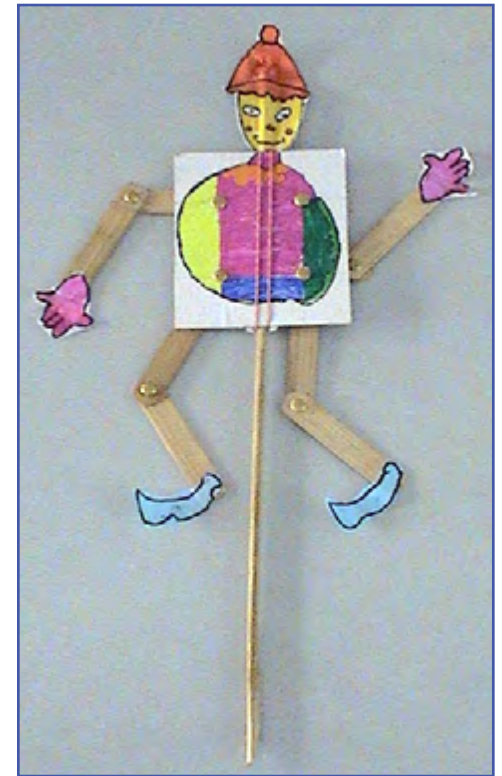
(6)



## Dancing Puppet Toy-group1

The group came up with the concept of dancing puppets that become an aid for teaching addition, subtraction, concept of “zero” and multiplication. The method, as a different procedure, will attract children and help them to understand the concept of multiplication.

1. The group made Puppets with dancing platform.
  2. These puppets were used to teach multiplication, addition and subtraction.
  3. For multiplication of  $3 \times 2$  three sticks in one direction and two sticks in opposite direction will intersect each other. Their intersection points are the answer for the multiplication.
  4. Concepts of acute angle and obtuse angle were also explained by same dancing platform.
  5. The same tool can be used to explain concepts of  $180^\circ$ ,  $360^\circ$ , geometrical theorems of vertically opposite angles, corresponding angles, alternating angles etc.,.
- Sheets in their hand writing can be seen in the next pages.



group1 with prof.rao



- ① With the parts of body's of your doll. show acute, right and obtuse angles. make different types of  $\Delta$  and verify by measuring length of parts. (figures can be made)
- ② With the help of body parts show 11 lines, intersecting or lines. (figures can be made)
- ③ List some congruent parts and similar parts (in two different dolls) (figure can be made)
- ④ Check if your doll is symmetric if not list the changes to be done to make it symmetric. Indicate the line of symmetry.
- ⑤ Area of cloth required to make dress (approx)  
consider the parts arms, legs and body in cylindrical shape.  
Take your doll measure the circumference and height of cylinders converts into rectangles and add to give estimated for the cloth required for making a dress.



7

- ⑥ Think of a method (use geometry) which help to minimize the cloth required to make a skirt and find the cost of cloth required if 1m<sup>2</sup> = ₹ 100 (width).  
Size of skirt is given



method 1  $\frac{1}{2} \times (20 + 20) \times 12 = (20 \times 12) + (20 \times 12) = 240 \text{ cm}^2$

method 2  $\frac{1}{2} \times 20 \times 12 + \frac{1}{2} \times 20 \times 12 = \frac{1}{2} \times 20 \times 24 = 240 \text{ cm}^2$

method 3  $\frac{1}{2} \times 20 \times 12 + \frac{1}{2} \times 20 \times 12 = 240 \text{ cm}^2$



Task (a) Think of method to calculate the minimum requirement of cloth rounded off to nearest 100 and also calculate the cost if 1m<sup>2</sup> = ₹ 100 (cost of 100)

- ⑦ Given if area is given calculate the length of cloth required then find the cost of cloth.

- ⑧ make up your doll



Task - Find (calculate) the number of days a pencil can be used for make up if a 5m line can be drawn by the pencil.

for class 6<sup>th</sup> → measure the length of arc use string  
" 10<sup>th</sup> → calculate arc  $\frac{2\pi r \theta}{360}$  (find  $\theta$  and  $r$ )



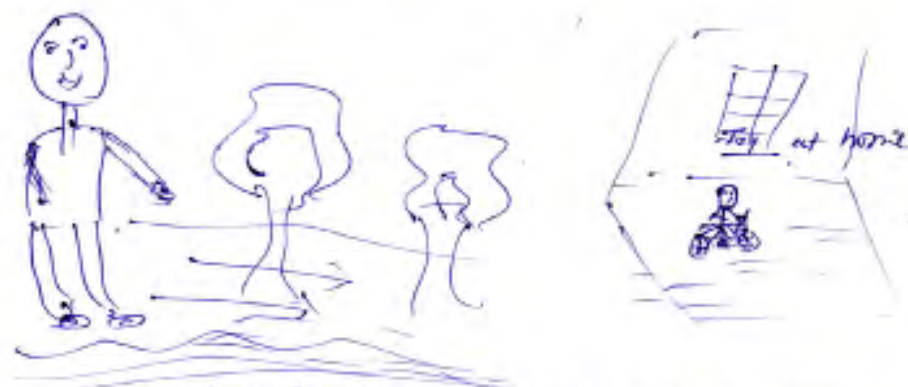
②

By - PREETI CHAUDHARY (ISHOPAL)

8. Mansi's doll is having straight hair one day she took a pencil and hair rolled on pencil to make it curly. If she rolled it five times and each roll reduces the length  $0.5\text{cm}$ . What will be the length of hair if it was  $15\text{cm}$  long.



9. Mansi is going for walking. She wants to carry her doll with her but mother did not allow her while going she put her doll on her bicycle and said I am going for walk and do cycling.



Task - If Mansi walk  $1\text{km}$  and How many revolutions should be made by doll to cover the same distance if the radius of wheel is  $30\text{cm}$ .

⑧

## Studio Task 1

Studio assignments are a typical mode of learning in design education. We introduced studio mode for couple of topics , starting with “Misconceptions’

Studio mode can involve set tasks to be explored, presentations and group work to come with problem-solutions.

### Misconceptions in Maths

• Misconceptions are well known in Maths. Children can form misconceptions based on generalisations when basic concepts are not understood. A correct understanding of the concepts can remove these misconceptions. Experiential Learning can greatly contribute in this endeavour. Young children often think  $\frac{1}{4}$  is bigger than  $\frac{1}{2}$  , as they see 4 which is bigger than 2. Another well known misconception is regarding ‘Area and Perimeter’. Perimeter is measured in length units and is understood easily as it involves addition of lengths. The units of measurements remain same. When it come to area of a geometric figure, unit of measurement changes to a square unit which is fundamentally different from length unit. Many children think if perimeters of two different figures are same the areas would also be same! How this misconception can be removed with a Constant Perimeter Link(CPL an innovation of IDC) is introduced to the teachers. A short animation made by Sachin Datt was also shown to the teachers.

### Creating “Experiential Base” for removing misconceptions: group task

Teachers were given 5 themes to work in groups. Each group has to identify normal misconceptions children have related to the theme and suggest solutions to remove these misconceptions.

Themes

Group1 :Calculations with negative numbers

Group2 : Probability

Group3 : Data Handling

Group4 : Perimeter and Area

Group5 : Fractions.

Teachers were also encouraged to present ‘Misconceptions which they might have observed in their experience and solutions they might have come with.

*This helped teachers to take the role of knowledge creators!*

## Group1

### Addition and Subtraction of integers

1. A number line was used to explain the concept of positive and negative integers.
2. A story of Gods and Demons was made to explain the concept of positive integers and powerful integers.
3. Blocks were used to design an activity to remove misconception of addition and subtraction of integers.

Activities:

Calculate:

- $3-2$
- $3-(-2)$
- $5+(-6)$

Students will take positive units and then add zeros and then remove the negative numbers and the remaining is the answer.







## Group2

The aim was to remove misconceptions in the problems of probability. Specific problems in probability were listed down.

Understanding of

- Sample space
- Impossible event
- Sure event
- Equally likely events

Activities were set to be performed by another group.

1. Toss a coin simultaneously and write possible outcomes and these find the probability of getting (A) At least 1 heads (B) At most one head.
2. A person invites his friend's family for a party with a condition that for the party at least one person should come or at the most one person should come.

## Group 3

Data handling was taken by the group.

Problems like:

- The concept of kink on x axis
  - The scale concept is usually not clear
  - Uniform Spacing in bar graph
  - Framing of Continuous class intervals
  - Degree representation on a pie-chart
- are faced by children and they often tend to do mistakes.

**Activity:**

1. Students can compare the newspaper coverage of different data.
2. Survey of various types of bank accounts and rates of interest offered.
3. By using sticks, x axis and y axis will be shown and students will be asked to stand on the axis on intervals.

What is the figure formed by ABCD?



### Instructions: a

1. Move to point A(2,2)
2. Move to point B(2,5)
3. Move to point C(5,2)
4. Move to point D(5,5)

### Instructions: b

1. Move to point A(3,2)
  2. Move to point B(5,5)
  3. Move to point C(7,2)
- Name the geometrical figure formed?

### Instructions: c

1. Move to point A(0,0)
  2. Move to point B(3,0)
  3. Move to point C(0,4)
- Name the type of triangle formed.  
What is the area formed?  
Each student moves towards his/ her right  
Now locate the co-ordinates.

#### Group4

##### Misconceptions in area and perimeter

###### Activity1:

Students will make the border of the name slip and colour it by different colours. The length of the border is PERIMETER. Measurement of the coloured region inside the boundary is AREA.

Here the misconception between the understanding of area and perimeter is due to lack of understanding.



###### Activity2:

Students are asked to draw different types of figures on graph paper. Plane region of the figure can be divided into unit squares.

Here concept of unit square is explained.

###### Activity3:

Spherical watermelon is cut into 2 equal halves to form 2 hemispheres. It is again cut into thin slices of different radii with centres on the same line.

1. Misconception between area of a sphere and area of a circle.

###### Activity4:

1. Students are asked to develop a cone and a cylinder.
2. This surface development will be used to explain that the total surface area will be: Surface area of the cone + surface area of the cylinder + area of the base of cylinder (area of circle)



#### Group 5

Fractions were demonstrated by the use of paper folding: A paper was folded in multiple ways to explain fractions.

###### Activities:

1. Students will take a paper and cut it into a triangle.
2. Now taking midpoint of each side of the equilateral triangle, they will join the points by folding the paper.
3. The folds will make it a tetrahedron.
4. This will help to explain the concept of  $\frac{1}{2}$ ,  $\frac{1}{3}$ ,  $\frac{1}{4}$ .

## Studio Task 2

### Exploring Symmetry with Hinged Mirrors

‘Play’ is an important part of ‘creative learning’. A teacher needs to go through the process of ‘creative learning’ to teach. We had innovated ‘hinged mirrors’ to learn symmetry and used it successfully in one of the children’s workshops organised through ‘Pomagranate Workshop’. The excitement this product created in a child’s mind was amazing. Siya, Priya Srinivasan’s daughter who was 10 year old at that time, after attending the workshop, would not leave it for days. We had asked to draw Rangoli patterns and see it with the hinged mirrors. Siya would make a new pattern everyday and demand her mother to see it.

### Mirror Images

We gave a mirror-pair to each group of teachers and asked them to ‘play and come out’ with suggestions on how to teach Maths or Physics to children using it. All groups got busy with excitement. They could *become children* once again and were thoroughly enjoying the exercise. They came out with interesting suggestions.





## Mirror Images(contd)

### Response of Group5

This group led by Mr. Rajkumar from Jammu was enthusiastic and came out with many suggestions.

1. An Activity to find out number of images that can be seen if a stick is kept in front of mirror-set with 30, 60, 45, 90 degrees between the mirrors.

2. To obtain different geometric shapes like square, pentagon and hexagon with the stick or a pen kept horizontally in front of the mirrors.

Group 5

2-6-2009

Activity :- Take a pair of plane mirrors of equal size joined at the one edge and ~~take~~ take a small straight stick of length approximately 10 cm.

(a) By arranging the mirror at different angles (Kept vertical) find the number images of the stick formed in the mirrors. Record your observations in the given table

(b)

Sr No	Angle $\theta$	No. of Images formed	Type of Polygon formed
1.	90°		* Try to generalise the observation to obtain a formula for finding no. of images.
2.	60°		
3.	45°		
4.	30°		

(B) Now keep the stick horizontally between the mirrors (touching both mirrors) & by adjusting the angles between the mirrors try to obtain the following images  
 (i) Square (ii) Pentagon (iii) Hexagon

page2

Group 5      2-6-2009

① Number of images formed by use of two plane mirrors when angle  $\theta$  is given.

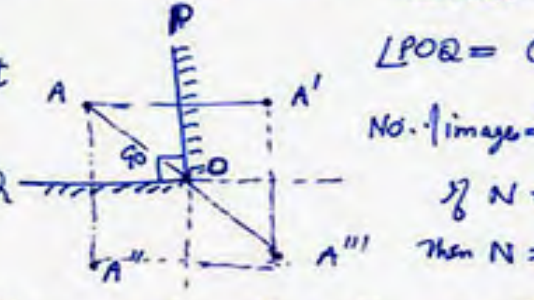

$\angle POQ = \theta = 90^\circ$

Object A

No. of images =  $\frac{360}{90} - 1 = 4 - 1 = 3$  images

If  $N$  = number of images,  $\theta$  = Angle between two plane mirrors  
Then  $N = \frac{360}{\theta} - 1$

Thus  $A', A'', A'''$  are three images of object at A.

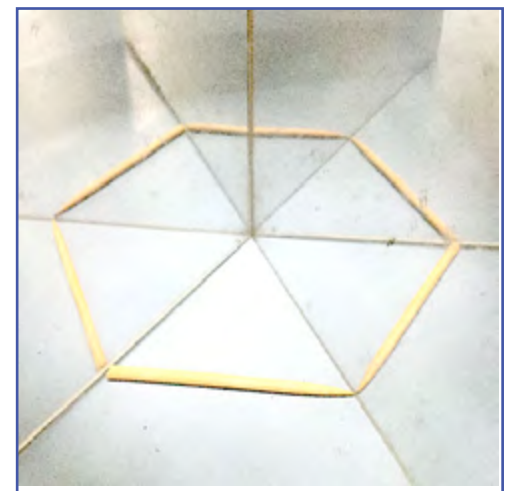



As the angles between two mirrors decrease, Number of images increases.

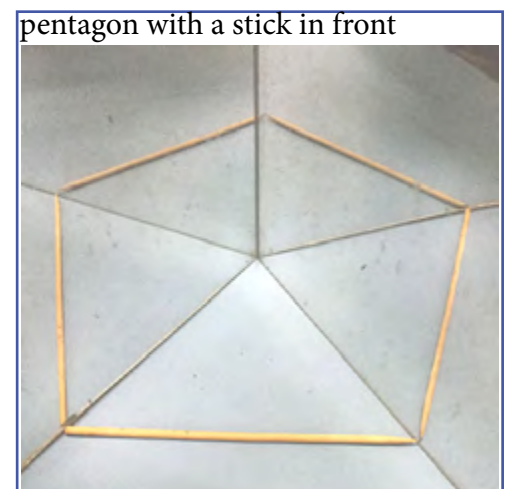
- Concept of infinite ( $\infty$ )  
There are infinite images formed by two parallel plane mirrors.
- Concept of Symmetry
- Letters of English alphabet whose identity remain unchanged after forming mirror image  
**A M I H O T U V W X**
- ~~Find the~~ An object is moving away from the plane mirror in straight line with a speed 'v'. What will be the speed of the image w.r.t. the object.  
Ans (a)  $\frac{1}{2}$  (b) Twice (c) one fourth

Page 2 shows

- the principles of image forming
- Symmetry in letters
- Image speed relationship.



hexagon with a stick in front



pentagon with a stick in front

**Page 3** has puzzles which can be solved with mirrors.

A number puzzle which was introduced in the workshop earlier was used for these puzzles.!

Solve ~~is find the value~~

(i)  $M + M + 8 = ?$

(ii)  $M - 8 = ?$

(iii)  $Q - M = M$  (True or False)

(iv)  $M - Q = Q$  (True or False)

(v)  $Q \times M = Q$  (True or False)

(vi)  $Q \div M = Q$  (True or False)

Solutions ~~with the help of mirror image~~

(i)  $1 + 1 + 3 = 5$

(ii)  $4 - 3 = M = 1$

(iii)  $2 - 1 = M = 1$  (True)

(iv)  $4 - 2 = Q = 2$  (True)

(v)  $2 \times 1 = Q = 2$  (True)

(vi)  $2 \div 1 = Q = 2$  (True)

Group 5 Raj Kumar  
Jammu  
2/6/2009



## Feedback from Smt.Kausalya

### Feedback of the Course

The course duration was less. If the duration was more, we could ~~see~~ learn a lot to make a mathematics classroom lively.

We could innovate teaching aids / learning materials and could develop in the laboratory.

The use of toys and nature in the teaching of mathematics was really useful and developed an innovative mind and thinking strategy in the teaching - learning process.

Dr Vivek montek explanation of ~~the~~ using the materials / teaching aids to teach different concepts. ~~very~~ in maths was very interesting and useful. ~~which was very useful~~

Prof kannan who explained the use of Scitab was ~~so~~ very effective and interesting.

The games session by Prof UA Atharankan was really an innovative session which helped us to plan games to different concepts.

The students of Prof Rao were very helpful and creative. ~~And~~ Their coordination

## Feedback

General Feedback was very good! Teachers were happy. They saw it as a great opportunity. Some wanted more of such workshops. Few feed backs are given here..

But unfortunately no 'Initiatives' came from K.V.S for further workshops.

8 years have passed since then. No networking happened.

Couple of Teachers from this group got Individual Awards.

But for a greater effectiveness,-  
Forming Teacher communities  
and using net communication  
would be only way out!

was excellent.

The sessions of Prof Rao were marvellous. I think if ~~you~~ I had the opportunity to be for some more days, then I would have learnt more..

If given a chance to attend an workshop, to I will be glad and grateful.

#### Suggestions

- ① Duration of the workshop to be increased.
- ② To organise an workshop to make Teaching/ learning materials and games.

Kausalya

### Feedback from Smt.Kausalya

The course duration was less. If the duration was more, we could learn a lot to make a mathematics classroom lively.

We could innovate teaching aids/learning materials and could develop in the laboratory. The use of toys and nature in the teaching of mathematics was really useful and developed an innovative mind and thinking strategy in the teaching learning process.

Dr. Vivek Montero's explanation of using the materials/teaching aids to teach different concepts in maths was very interesting and useful. Prof Kannan who explained the use of scilab was very effective and interesting.

The games session by Prof. U A Athavankar was really an innovative session which helped us to plan games for different concepts.

The students of Prof. Rao were very helpful and creative. Their co-ordination was excellent.

The sessions of Prof.Rao were marvellous. I think if I had the opportunity to be some more days then I would have learnt more.

If given a chance to attend a workshop I shall be glad and grateful.

#### Suggestions

1. Duration of the workshop to be increased
2. To organise a workshop to make Teaching/ Learning materials and games.

## Feedback: Birendar Kumar

Initially I was least interested to join 6 days workshop on innovations and experimentations in teaching maths. But slowly I got more interest in doing innovation and project with our group. It is a great thing, what I feel. But due to some limitations and restrictions in our school activity for example finishing the syllabus in time for producing better results (qualitative and quantitative). Still I feel, I am not free to do all these things. As far as IDC, IITB is concerned it is an excellent platform to learn new things, get new ideas. Many more things about which I have not thought yet, I started to think now. I personally am grateful to Prof. A. G. Rao and his team associates for his valuable ideas, teachings and co-operation. Now I can say about me that I am innovated and ready to do innovation. Talks given by Mr. Tripathi and Prof. Kannan and Prof. Athawankar were very useful. Even film presented by Sachin Datt and Sarang were very interesting. Every moment, I feel was creative.

At last, I would like to give thanks to KVS, Ziet also to provide such a platform like IIT, IDC Bombay to learn new things.

### FEED BACK

Initially I was least interested to join 6 days workshop on Innovations & Experimentations in teaching Maths. But slowly I got more interest in doing innovation and project with our group. It is a great thing, what I feel. But due to some limitations and restrictions in our school activity for example finishing the syllabus in time, producing better results (qualitative & quantitative) still I feel, I am not free to do all these things. As far as IDC, IITB is concerned it is excellent platform to learn new things, get new ideas. Many more things about whom I have not thought yet, I started to think now. I, personally, am grateful to Prof. A. G. Rao and his team associates for his valuable ideas, teachings and co-operation. Now I can say about myself that I am innovated and ready to do innovation. Talks given by Mr. Tripathi and Prof. Kannan and Prof. Athawankar were very useful. Even film presented by Sachin Datt and Sarang were very interesting. Every moment, what I feel was creative.

At last, I would like to give thanks to KVS, Ziet also to provide such a platform like IIT, IDC Bombay to learn new things.

Birendra Kumar  
416107



*All the feedbacks were written with feelings We could see the importance and need for such 'interactions'. Personally it was a satisfying workshop for me. It did lead to more workshops and a year long project called 'Doors of Learning'.*

*I am thankful to all the teachers and members of my team who took great interest and won the hearts of the Teachers!*

*The task of bringing the report was not easy after so many years, though much of the groundwork was done by my team members. None from the team were accessible. Missing details took lot of time to decode. Shilpa ,who is currently helping me on this venture tried to get in touch with some teachers.*

*We are very enthused to discover that*

- Smt.Swarn Latha Sharma got a president award\* for her teaching innovations.*
- Shri. Rajkumar form Jammu got a state award.*

*Our hearty congratulations go to them!*

*We feel 'INNOMATH workshop' had a role in these achievements.*

There is plan to bring out this document into a book form with more details and reflections left out due to space constraints!

*' Acharya devo bhava'!*  
*'Think Teachers as Gods' - a sanskrit saying !*



Smt. Swarnlata Sharma, TGT-Mathematics, from Kendriya Vidyalaya, Moradabad (U.P) receiving the National Award from the President Dr. Pranab Mukherjee on 5th September, 2014,

### Teachers who attended INNOMATH Workshop

- |     |                      |                            |
|-----|----------------------|----------------------------|
| 1.  | M A Kausalya Bai     | Bangalore, Karnataka       |
| 2.  | A Gurusamy Pandian   | Chennai                    |
| 3.  | Jwala Rai            | Shillong, Meghalaya        |
| 4.  | D K Singh            | Chhindwara, Madhyapradesh  |
| 5.  | Vinod Purohit        | Jodhpur, Rajasthan         |
| 6.  | K R Lailambika       | Thrissur, Kerala           |
| 7.  | Satyendra Prasad     | Patna, Bihar               |
| 8.  | Vishnu kumar leua    | Gandhinagar, Gujarat       |
| 9.  | Swarn Lata Sharma    | Moradabad, Uttarpradesh    |
| 10. | Rahul Srivastava     | Lucknow, Uttarpradesh      |
| 11. | Shrikant K Kendurkar | Pune, Maharashtra          |
| 12. | P K Srivastava       | Lucknow, Uttarpradesh      |
| 13. | T S Sonawane         | Nasik, Maharashtra         |
| 14. | A K Singh            | Bhopal, Madhyapradesh      |
| 15. | Preeti Chaudhary     | Bhopal, Madhyapradesh      |
| 16. | Birendra Kumar       | Dibrugrah, Assam           |
| 17. | Raj Kumar            | Gandhinagar, Jammu         |
| 18. | Lopamudra Panigrahi  | Balasore, Odisha           |
| 19. | Nita Patra           | Kharangpur, Wesh Bengal    |
| 20. | Pushpavathi          | Secunderabad, Andrapradesh |
| 21. | K Dasgupta           | Kolkata                    |
| 22. | Indra Jain           | Mumbai                     |
| 23. | Parveen Dhaliwal     | Chandigarh, Punjab         |
| 24. | Vishnu Sagar Sharma  | New Delhi                  |
| 25. | C S Satish           | Bangalore, Karnataka       |