Training of Key Persons on Improvement of Content Competence of Mathematics Teachers at Senior Secondary Level for Kerala and Tamil Nadu
(PAC Programme)

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A BRIEF REPORT

The training of key persons to improve the content competence of Mathematics teachers at Senior Secondary level for Kerala and Tamil Nadu teachers was held at RIE, Mysore from 26.12.2003 to 3.12.2003. Eight resource persons (2 external and 6 internal) trained as many as 44 key persons from Kerala and Tamil Nadu.

The transaction mode included one or more of the following :

i) Discussion method

ii) Problem solving approach

iii) Mathematical modeling

Based on the feedback of the key persons, the difficult areas for the training programme were selected. Some written materials were also given so that trainees could pursue and help teachers implement the knowledge gained from the programme in the classroom situation. At the conclusion of the programme, in the valedictory, the trainees expressed their great satisfaction and felt that 5 days for the training is too short a period and that it should be atleast 10 days.

List of enclosures :

i) Time table containing list of Resource Persons and subject areas covered.

ii) Some written materials provided to trainees.

iii) List of participants

REGIONAL INSTITUTE OF EDUCATION, MYSORE-6
(PAC PROGRAMME)

Training of Key persons on improvement of Content Competence of Mathematics teachers at Senior Secondary level for Kerala and Tamil Nadu.

26-12-2003 to 30-12-2003

TIME TABLE

Day & Date	**9.30AM 11.00 AM**	**11.30 AM 1.00 PM**	**2.00 PM 3.30 PM**	**3.45 PM 5.15 PM**
Friday 26-12-03	Registration 9 – 10 Inauguration 10 – 11	Identification of difficult areas	NBB	NMR
Saturday 27-12-03	BSPR	BSU	MVG	BCB
Sunday 28-12-03	DB	DB	MVG	BCB
Monday 29-12-03	GR	NBB	BSPR	NMR
Tuesday 30-12-03	MVG	BSU	BCB	Valedictory

Tea break: 11.00 AM – 11.30 AM, 3.30 PM – 3.45 PM

GR – G.Ravindra – Meaning of Mathematics, Mathematics Modelling.

DB – D Basavaiah – Probability, Computers.

NMR – N M Rao – 3D Geometry, Abstract algebra, Mathematics Laboratory.

BSPR – BSP Raju – Commercial Mathematics, Computing.

BSU – B S Upadhyaya – Boolean Algebra, Number System.

NBB – N B Badarinarayana – Differential Equations.

MVG – M V Gopalakrishna – Conic sections.

BCB – B C Basti – Calculus.

VENUE : A.V.ROOM

(B C Basti)
Academic Coordinator

CONTINUOUS DISTRIBUTIONS

D Basavayya
RIE (NCERT)
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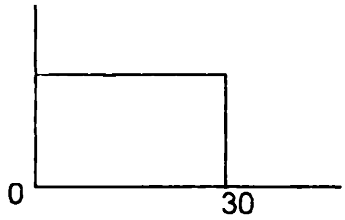
The probability distributions so far considered have applied to discrete variates. When the variate is continuous, a different approach is needed as mentioned earlier. The distribution of continuous variate will be explained with the help of probability density function. To illustrate this, let us consider the time a passenger has to wait at a bus stand if buses run every 30 minutes and if he has no knowledge of the time-table. The variate X is the waiting time in minutes and is obviously continuous. As the passenger does not know the bus departure times, it can be assumed that the length of the time he has to wait is a matter of pure chance and therefore all values of X between 0 and 30 are equally likely. Hence the probability density function of x will be

$$f(x) = 1/30, \quad 0 \le x \le 30.$$

It is certain that x lies in the interval [0, 30] is one. The probability density curve is as shown in the following figure.



Because the probability curve looks like a rectangle, the distribution is known as Rectangular Distribution. In general, the probability density function of a rectangular distribution is

$$f(x) = \begin{cases} \dfrac{1}{b-a} & a \le x \le b \\ 0, \text{ othewise} \end{cases}$$

The mean and variance of a rectangular distribution :

$$\text{Mean} = \int_a^b x f(x)\, dx = \int_a^b x \frac{1}{b-a}\, dx = (a+b)/2$$

$$\text{Variance} = \int_a^b x f(x) dx - [\int_a^b x f(x)\, dx]^2$$

$$= \int_a^b x^2 \frac{1}{b-a}\, dx - [\int x \frac{1}{b-a}\, dx]^2$$

$$= (b-a)+2 / 12$$

Normal Distribution

We find that observations in the biological, physical and social sciences are often follow a probability law, known as normal distribution. For example, distribution of the length of the leaves in a tree, distribution of the marks of the students, etc. Most of the known distributions can be approximated by this distribution and therefore, this distribution is called as normal distribution. The normal distribution was first discovered in 1773 by De Movre, who obtained this continuous distribution as a limiting case of the binomial distribution and applied to problems arriving in the game of chance. Gauss also obtained this distribution as the distribution of errors in astronomy. Therefore, the normal distribution is also known as Gaussean distribution or distribution of errors. This distribution plays an important role in Statistical theory

A random variable X is said to have a normal distribution if its probability density function is given by

$$f(x) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{-(x-\mu)^2 / 2\sigma^2}, \quad -\infty < x < \infty$$

Here μ and σ are the parameters of the normal distribution. If $\mu = 0$ and $\sigma = 1$, then the normal distribution is known as **Standard Normal Distribution.** Hence the probability density function of a standard normal distribution is

$$f(z) = \frac{1}{\sqrt{2\pi}} e^{-Z^2/2}, \quad -\infty < z < \infty$$

Mean and Variance of Normal Distribution :

$$\text{Mean} = \int_{-\infty}^{\infty} x\, f(x)dx \qquad \text{by definition}$$

$$= \int_{-\infty}^{\infty} x \frac{1}{\sqrt{2\pi\sigma}} e^{-(x-\mu)^2/2\sigma^2} dx$$

$$= \mu$$

$$\text{Variance} = \int_{-\infty}^{\infty} (x-\mu)^2 f(x)\, dx \text{, where } \mu \text{ is mean.}$$

$$= \int_{\infty}^{-\infty} (x-\mu)^2 \frac{1}{\sqrt{2\pi\sigma}} e^{(x-\mu)^2/2\sigma^2} dx$$

$$= \sigma^2$$

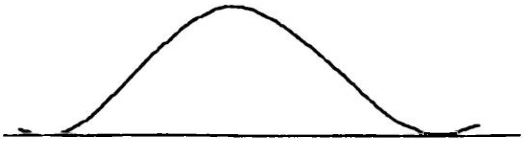
Therefore, in a normal distribution, the parameters μ is equivalent to mean and the parameter σ is equal to standard deviation.

Important Properties of a Normal Distribution :

1. The probability density function is given by

   $$f(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(x-\mu)^2/2\sigma^2}, \quad -\infty < x < \infty.$$

2. Mean = μ and variance = σ^2
3. The probability density curve is a bell shaped curve as given below.



4. The probability density curve is symmetric about mean.
5. The maximum probability density is at the mean value and equal.
6. The mean, mode, median are all equal.

7. P(   ) = 0.6826

   P(   ) = 0.9544

   P(   ) = 0.9973

8. The points of inflection of the probability density curve are

9. $$P(a \le x \le b) = \int_a^b \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\mu)^2/2\sigma^2} dx$$

$$= \int_{(a-\mu)/\sigma}^{(b-\mu)/\sigma} \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}} dz$$

This probability is equal to the shaded area in the following figure :

This area can be obtained by referring the normal tables (pre-prepared) and there is no need of evaluating the integral.

Example : In a normal distribution, 7% of the items are under 35 and 89% are under 63. What are the mean and standard deviation of the distribution ?

Solution : Let X be normally distributed with mean μ and s.d. σ and satisfying the given conditions in the problem.

Therefore, $P(X < 35) = 0.07$

$(P\ X < 63) = 0.89$ or $P(X \geq 63) = 0.11$

Now these statements can be written in terms of standard normal variate Z to make use of normal tables as follows :.

$P(X < 35) = 0.07 \Rightarrow P(Z < \frac{35-\mu}{\sigma}) = 0.07$

$P(X > 63) = 0.11 \Rightarrow P(Z \geq \frac{63-\mu}{\sigma}) = 0.11$

By referring the normal tab'es for

$P(Z < \frac{35-\mu}{\sigma}) = 0.07$, we get

$$\frac{35-\mu}{\sigma} = 1.48 \qquad (1)$$

And for $P(Z > \frac{63-\mu}{\sigma}) = 0.11$ we get

$$\frac{63-\mu}{\sigma} = 1.23 \qquad (2)$$

By solving for μ and σ from (1) and (2), we get $\mu = 50.3$ and $\sigma = 10.33$. Hence mean = 50.3 and s.d. = 10.33 of the given distribution.

Exercises :

1. Let X be normally distribution with mean 8 and s.d. 4. Find
   i) $P(5 \leq X \leq 10)$
   ii) $P(X \geq 15)$

iii) $P(X < 5)$

2. The mean I.Q. of a large number of children of age 14 was 100 and the s.d. 16. Assuming that the distribution was normal, find
   i) What percentage of the children had I.Q. under 80 ?
   ii) Between what limits the I.Q.s of the middle 40% of the children lay ?
   iii) What percentage of the children has I.Q.s within the range μ + 1.96σ ?

3. In a university examination of a particular year, 60% of the students failed when mean of the marks was 50% and s.d 5%. University decided to relax the conditions of passing by lowering the pass marks, to show its results 70%. Find the minimum marks for a student to pass, supposing the marks to be normally distributed and no change in the performance of students takes place.

Answers :

1.	i) 0.4649	ii) 0.0401	iii) 0.2266
2	i) 10.56%	ii) 91.6, 108.4	iii) 5%
3.	47.375		

MATHEMATICAL MODELING

G Ravindra
RIE (NCERT), MYSORE

A mathematical model is a simplified mathematical representation of a real situation with a mathematical system (a model is something which represents something else). Although a real situation involves a large number of variables and constraints, usually a small fraction of these variables and constraints truly dominate the behaviour of the real system. Thus the simplification of the real system should primarily concentrate on identifying the dominant variables or constraints as well as other data pertinent to problem solving. The assumed real system is abstracted from the real situation by identifying dominant factors (variables, constraints etc) that control the behaviour of the system and such a system always serves as a data for mathematical modeling. A mathematical model is robust if small changes in variables lends to a small change in the behaviour of the model.

The set of natural numbers with usual addition and multiplication form a good mathematical model of a real situations concerned with counting process. Vectors are excellent mathematical models that predict and explain many physical phenomena with perfect accuracy. The concept of direction which is so vague in the physical world is precisely explained by identifying the concept of vector as that of location or coordinate system. (Such an identification is guaranteed by the famous result that every finite dimensional vector space is isomorphic to Euclidean space R^n). We will discuss in greater details some more models in a later section.

Mathematical models are normally thought of as instrument for selecting a good course of action from the set of courses of action that is covered by the model (here a course of action could be a strategy of selecting a content or some such thing). However the models have another very important use: they can be used heuristically (that is an instruments of discovery). They provide an effective tool with which one can explore the structure of a problem and uncover possible courses of action that were previously overlooked. For example vectors as models have lead to discovery of several outstanding and useful results in the vectors space theory. The models concerned with drawing of implication diagram (Venn diagram) of given concepts give rise to some very interesting conjectures and their solution later. A good mathematical model presents many features or many predictors of the data; that is, a good mathematical model is one in which many dependent variables are expressed through functions.

Types of models:

There are three types of models which are commonly used: *iconic, analogue, and symbolic.*

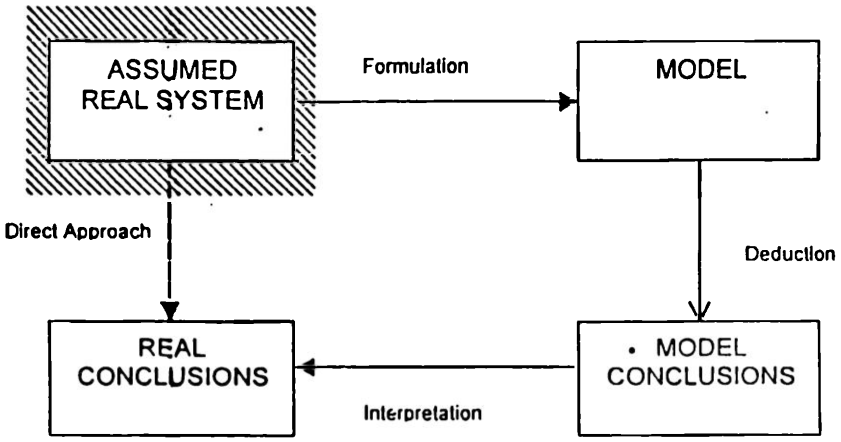
Iconic models are images; they represent the relevant properties of the real situations. For example, Photographs, maps, model aeroplane, drawings of some mathematical objects etc. Iconic model of the sun and its planets in planetorium or model of a field map is scaled down where as a model of atom is scaled up. Iconic models are generally specific, concrete and difficult to manipulate for experimental purposes.

Analogues use one set of properties to represent another set of properties. For example graphs are analogues that use geometric magnitudes and location to represent a wide variety of variables and the relationship between them. Contour lines on a map are analogues of elevation. Bar diagrams are analogues of some statistical information. Flow chart is an analogue of some logical sequence. In general analogues are less specific, less concrete but easier to manipulate than iconic models.

Symbolic models use symbols, numbers to represent variables and relationship between them. Hence they are the most general and abstract type of models. Linear programming model, simple harmonic motion model are some of the examples of symbolic models. Symbolic model are most widely used and result oriented, and the other models (iconic and analogue) are sometimes used as initial approximations which are subsequently refined in to a symbolic model. Symbolic models take the form of mathematical relationships (usually equations or inequations) that reflect the structure of that which they represent.

Process of Modeling

The process of modelling is depicted in the following figure.



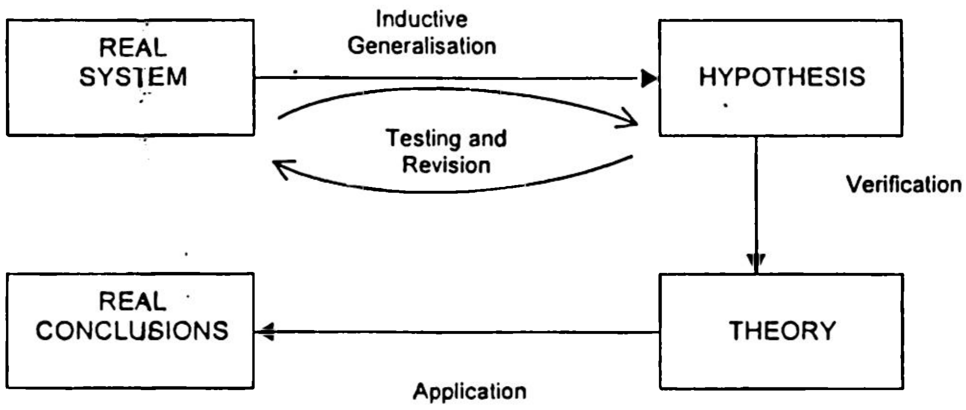
The first step is formulation of the model itself. This step calls for identification of assumptions that can and should be made so that the model conclusions are as accurate as expected. The selection of the essential attributes of the real system and omission of the irrelevant ones require a kind of selective perception which is more an art than a science and which cannot be defined by any precise methodology.

The second step is to analyse the formulated model and deduce its conclusions. It may involve solving equations, finding a good suitable algorithm, running a computer program, expressing a sequence of logical statements - whatever is necessary to solve the problem of interest related to the model.

The final step, Interpretation Involves human judgement. The model conclusions must be translated to real world conclusions cautiously without discrepancies between the model and its real world referent.

Mathematical Modeling in contrast to experimentally based Scientific Method.

The following figure depicts the process of scientific method.



Here first step is development of a hypothesis which is arrived at generally by induction following a period of informal observation. An experiment is then devised to test the hypothesis of the experiments, if the result contradicts the hypothesis, the hypothesis is revised and retested. The cycle continues until a verified hypothesis or 'theory' is obtained. The first result of the process is Truth, Knowledge or Law of Nature. In contrast to model conclusions theories are independently verifiable statements about factual matters. Models are invented; theories are discovered. Thus modeling is very important but certainly not unique method to deal with complicated real world.

Some mathematical models.

1. ***(a number theoretic model)***

In a party of people with atleast two persons, we are always assured of atleast two persons who know same number of persons in the party.

Here the real situation is the party of people in which a person may have an acquaintance with another person. The conclusion is that there are atleast two persons having the same number of acquaintances in the party We now proceed to model the situation as follows:

Let $P_1, P_2 \ldots\ldots\ldots P_n$ be the persons in the party and let d_i be the number of persons known to P_i In the party. Here once the identification of the variables d_i is done, the rest follows by contrapositive argument.

If the conclusion is wrong then there is a set S of n-1 persons in the party such that each has distinct number of acquaintances and each knows atleast 1 and atmost n-2 members In S. That is, each number d_i corresponding to a member in S in unique, and atleast 1 and atmost n-2. This amounts to getting n-1 distinct integers in the set {1, 2,........, n-2}, a contradiction.

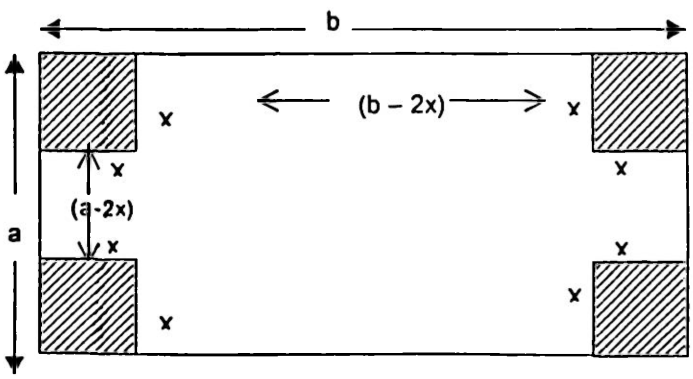
Thus we arrived at the model conclusion by logical sequence of arguments.

2. *(a maxima - minima model)*

Suppose an open box is made from a rectangular piece of tin a sq.mts. by b sq.mts. by cutting out equal squares at each corner and folding up the remaining flaps. What size square should be cut out so that the box will have maximum volume ?

We first draw analogue of the given situation as a prelude to construction of symbolic model (see the following figure).

Analogue of the given situation:



Volume of the open box = $V(x) = x(2-2x).(v-2x)$ a b

Surface area = $ab-4x^2$

First we identify the most significant variable in the given situation. Let x be the length of a side of any of these four squares (all of which are of equal area). The objective is to find a value for x which maximizes $V(x) = x(a-2x)(b-2x)$. $V'=O$ and $V''<O$ imply that the square of dimension $(a+b+\sqrt{a^2+b^2-ab})/6$ be cut out so that the box has maximum volume. Here we note that maximization of surface area $ab-4x^2$ need not imply maximization of volume $V(x)=(a-2x)(b-2x)$.

Applying the same method to the cutout squares, we can make new open boxes with optimal utility. Thus, this model provides a method and solution to make open boxes with optimal use of given rectangular tin sheet.

3. Graphs (Networks) as Mathematical Model:

A graph (or network) is a non-empty set V together with an irreflexive and symmetric relation E on V. The elements of V are marked as vertices and the elements of E are marked as edges (not necessarily straight) joining the vertices in a pair belonging to E. Two vertices are adjacent if they are joined by an edge. For example, if V ={a,b,c,d} and E={(a,b), (a,d), (b,d), (b,c)} the pictorial representation of the graph is as that in the following figure 1.

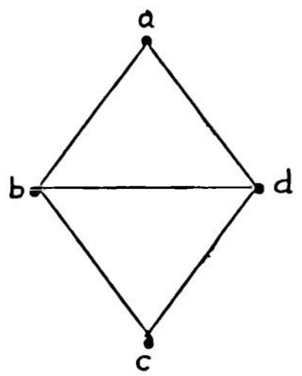


Fig. 1

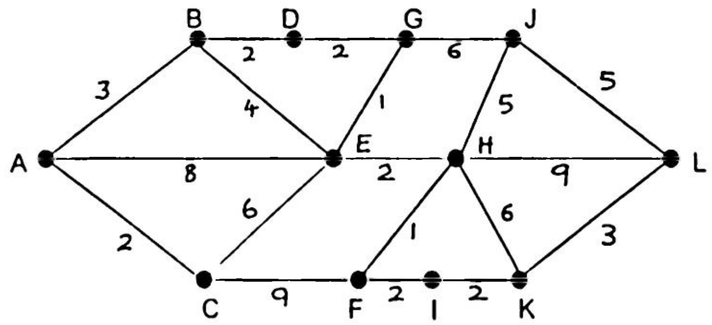


Fig.2

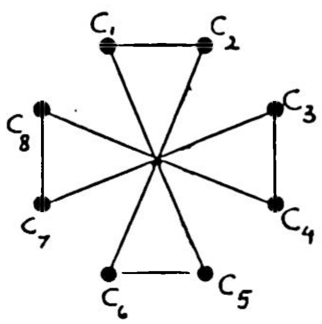
Since the graphs are the most generalized algebraic structure, they often work as excellent models of many real situations. The following examples are just three of those several situations which are easily modeled as graphs.

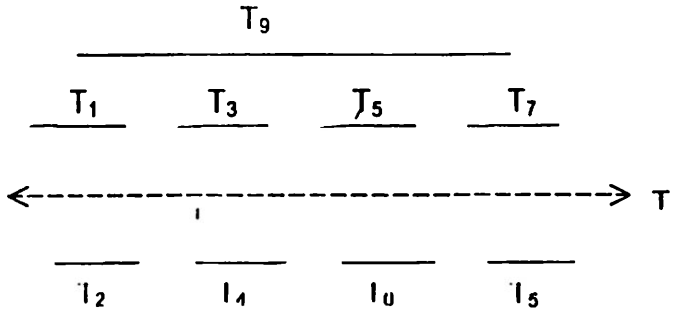
(i) Shortest path problem: Suppose that we have a map of the form shown in the above figure 2 in which the letters A-L refer to towns which are connected by roads. If the lengths of these roads are as marked in the diagram what is the length of the shortest path from A to L?

There are several methods which can be used to solve this problem. Possibly the simplest of these is to make a model of the graph by knotting together pieces of a string whose lengths are proportional to the lengths of the roads. In order to find the shortest path we hold the knots corresponding to A and L and pull tight and measure the distance corresponding to the tight strings. However there is a more mathematical way of approaching this problem using graph theory.

(ii) Scheduling Problem: Consider a collection $C=\{C_i\}$ of course being offered by a major university. Let T_i be the time interval during which course C_i is to take place. We would like to assign courses to classrooms, so that no two courses meet in the same room at the same time.

We treat C_i as the vertices of the graph G in which C_i and C_j are joined by an edge if and only if T_i and T_j have not empty intersection. We colour the vertices of G such that no two vertices joined by an edge have the same colour. Here each colour corresponds to a classroom. For such graph (called interval graphs) there is an efficient algorithm for colouring its vertices with minimum number of colours. In fact for such graphs the minimum number of colours is equal to the maximum number of mutually adjacent vertices.





Time Intervals

(iii) Shortage of Chemicals Problem: Suppose $c_1, c_2, \ldots\ldots\ldots, c_n$ are chemical compounds which need to be refrigerated under closely monitored conditions. If a compound c_i must be kept at a constant temperature between t_i and t_i', the problem is to find minimum number of refrigerators needed to store all the compounds ?

Let G be the interval graph with vertices $c_1, c_2, \ldots\ldots\ldots c_n$ and connect two vertices by a line whenever the temperature intervals of their corresponding compounds intersect. It is not difficult to verify that the intervals (t_i, t_i') satisfy The Helly property (A family of subsets of a set X is said to satisfy the Helly property if pairwise non-empty intersection of members of S imply total non empty intersection of the members of S).

If Q is a clique of G, then the time intervals corresponding to its vertices will have a common point, say t, by Helly property. Therefore a refrigerator set at a temperature t will be suitable for storing the chemicals representing the vertices of Q. Thus a solution to the minimization problem will be obtained by finding minimum clique cover of G. (A clique is a graph in which any two vertices are joined by a line. In fig.1, the sub graphs on {a,b,d} and {b,d,c} will provide a minimum clique cover).

Mathematical modeling plays a great role in teaching Mathematics

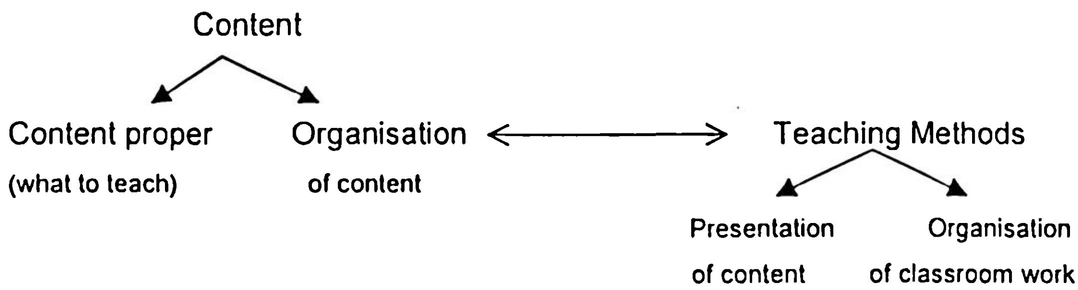
Some of the most important components of teaching a concept in mathematics are:

(i) Motivation for the concept (ii) Simplification of the concept (iii) Problem solving.

Motivation for learning a mathematical concept may be within the mathematics itself or outside the mathematics and a real world situation. For instance, it is very difficult to choose an example of a infinite set from a real world situation; so in such a situation the set of natural numbers can be taken as a motivating factor for the concept of 'infinite sets'. On the other hand a great deal of real world motivate and exemplify several concepts like vector, derivative, integral etc.

By simplication of a concept C we mean breaking of the concept C into simpler sub concepts or more precisely it is identification of meaningful restrictions f on C such that C_f (the restricted C) has a simpler characterization than that of C. Once a concept is simplified into $C_1, C_2, \ldots, C_k$, one is naturally tempted to find various inter-relations among the sub concepts C_i and that is how the concept C in particular and mathematics in general becomes richer.

Content in mathematics can be analysed into content proper (what to teach) and its inner organization, the latter being most closely related to teaching methods. Teaching methods can be analysed into presentation of the subject matter (use of mathematical models etc) and organization of class room work, the former being most closely related to content and mathematical modeling. The analogue model of this para is as follows:



PROBLEM SHEET BY B.C.BASTI

1. Draw and justify Venn Diagram of the following: (i) Continuous functions, (ii) Differentiable functions, (iii) one-one ant onto functions.

2. If N is the set of all natural numbers, then construct a one-one function from N $\times$ N into N by using fundamental theorem of Arithmetic.

3. For any natural number n, prove that $2^n > n$ without using principle of mathematical induction.

4. Prove or disprove:
If r is rational and x an irrational, then r.x is an irrational number.

5. Prove that $\sqrt{2}$ is an irrational number by using fundamental theorem of arithmetic.

6. "No relation is also a relation". How do you justify this statement?

7. Prove that $\lim_{n \to \infty} \frac{1}{n} = 0$.

8. Define f(0) so that $f(x) = \frac{x}{1-\sqrt{1-x}}$ becomes continuous at x = 0.

9. Prove that between any two real nos there is an irrational no.

10. Construct an uncountable set by using only natural numbers.

11. Let $f(x + y) = f(x) + f(y)\ \forall\ x, y \in R$ if f is continuous at 0 then show that f is continuous at any point.

12. Let $f(xy) = f(x)\ f(y)\ \forall\ x, y$. If f is continuous at 1 then show that f is continuous at all $x \neq 0$.

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    Poothotta, Ernakulam Dist.
    Kerala 682 307

24. Sheela Kumari M P
    HSST, Govt. Hr. Sec. School
    Anchalummoodu, Kollam
    Kerala 691 601

25. Jayarani A.G.
    HSST, S N D P Hr Sec. School
    Venkurunji, Venkurunji Post
    Pathanamthitta Dist.
    Kerala

26. S Lalitha
    P.G.Asst.
    Govt. Hr. Sec. School
    Thiruppachetti
    Sivagangai Dist, TN

27. C Thailayee
    P.G. Asst. in Maths
    Govt. Hr. Sec. School
    Attur, Dindigal Dist
    Tamil Nadu 624 701

28. S. Selvi
    P.G. Asst. in Maths
    Govt. Hr. Sec. School
    Vayalogam and Post
    Illupur TK
    Pudukottai Dist, TN

29. P Shanthi
    P.G. Asst.
    N S A G H S School
    Aniyapuram
    Namakkal Dist. 637 017, TN

30. B Srinivasan
P.G. Asst., Govt. Hr. Sec. School
Kilpennathur
Thiruvannamalai Dist. TN

31. T Balaji
P.G. Asst
Gandhiji Memorial Govt.
Hr. Sec. School
Peraiyur
Madurai 625 703

32. A Vijayalakshmi
P.G. Asst., Shree Baldevdas Kirani
Vidyamandir Hr. Sec. School
R.S. Puram
Coimbatore 641 002

33. Johncy T. Kuriakose
HSST, M D S H S S
Kottayam, Kerala

34. Reji Abraham
HSST
St. Behanan's Hr Sec. School
Vennikulam
Thiruvatti, Pathanamthitta
Kerala 669 544

35 Abraham George
HSST Maths
Arackalchirayul (via)
Choommanotharukara Post
Vaikom Kottayam
Kerala 686 606

36. Rajith c.
HSST, I J M Hr Sec. School
Kottiyur, Kannur 570 651

37 P. Periyaswamy
P.G.T.
(3/11, Vadivel Nagar
Near Muniappan Kovil)
Govt. Hr. Sec. School
K. Paramathy 639 111

38. K Nehru
P.G. Asst.
Govt. Hr. Sec. School
Melattur, Thanjavur
Tamil Nadu 614 301

39. K Chandramohan
P.G. Asst.
Govt. Hr. Sec. School
Thandalaiputhur 621 217
Musiri Tk, Trichy Dist.
Tamil Nadu 621 217

40. J Nirmala Devi
PGT in Maths
Govt. Hr Sec. School
Siruvachur
Perambalur Dist 621 113

41. G. Devasahayam
P.G. Asst.
S L B Govt. Hr. Sec. School
Nagercoil
Kanyakumari Dist. 629 001

42. K R Tharanidaran
P.G. Asst.
Govt. Hr. Sec. Schools
Sankaranpandal
Nagai Dist. 609 804
Tamil Nadu

43 Fr. Thomson Grace
HSST (Maths)
Chaluvila Veedu
Thiruppilazhakom Dist.
Kuzhimathicadu
Kollam Dist. Kerala 691 509

44. K Ganesan
P.G. Asst.
Govt. Hr. Sec. School
Kanniyappapillai
Theni Dist.
Tamil Nadu 625 512