RESEARCH ARTICLE

USING MATHEMATICAL MODELLING IN SECONDARY SCHOOL CURRICULUM FOR CREATING AWARENESS FOR POPULATION STUDY MATHEMATICS

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ABSTRACT

The rapidly growing population of our nation and its far reaching consequences in economic, social, physical, environmental domains of India is a major cause of concern. Various government projects/programs have been implemented for the past 65years in fields of maternal &child health, family planning, primary education, women empowerment etc. But still Government is yet to achieve its target. India is a huge country and any plan of action can be successful only if it is implemented from grass root level. Universal Education is a global prime target and Mathematics, which is itself an universal subject of education right from primary level, can be used effectively to spread awareness amongst our younger generation regarding the demographic picture of present India. Mathematical models using school mathematics can be used effectively as interesting problems for young India. .Following National Curriculum objectives, in this way Mathematics will be presented in real practical problems which, with various graphs, figures, models will not only be interesting but will be thought provoking and enlightening for our students. These problems will replace imaginary problems and give them an insight regarding our real India and encourage them to find solution in their own way. In this way our future nation builders will be better prepared as future citizens of India.

INTRODUCTION

Population of India (2018) as on 13/6/2018 is 1,360,621,258: Every year, India adds more people than any other nation in the world, and in fact the individual population of some of its states is equal to the total population of many countries. For example, Population of Uttar Pradesh (state in India) almost equals to the population of Brazil. Some of the reasons for India's rapidly growing population are poverty, illiteracy, high fertility rate, rapid decline in death rates or mortality rates and immigration from Bangladesh and Nepal. Alarmed by its swelling population, India started taking measures to stem the growth rate quite early. The efforts though did produce positive results, however, failed to achieve the ultimate goal and the population of India, since getting independence from Britain in 1947, increased almost three times. Whereas India has missed almost all its targets to bring the rate of population growth under control, China's 'Population Policy' in 1978, has brought tremendous results. According to recent estimates as of 1 January 2018, the population of India was estimated to be 1,353,014,094 people. This is an increase of 1.26 % (16,822,650 people) compared to population of 1,336,191,444 the year before.

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Education is essential for effective population control because awareness amongst people is a must. Effective control of the population is vital for the growth of the nation, development of the economy and equal distribution of resources amongst all people. Massive awareness among people is necessary for the successful implementation of family welfare programme. Government of India is trying its level best with different policies, health schemes, family planning programmes for controlling rate of growth of population. But that is however not proving to be enough for our ever expanding population.

It must be realized by us, the citizens of India, that only Government policies, programmes etc will not be effective if proper awareness is not there amongst all Indians regarding the danger of population explosion & its future effects in economic, social, political and allround development of our nation. Due to illiteracy, ignorance of a huge percentage of Indian Community, especially that of rural India, those poor people are still deprived, exploited and poverty stricken. If we see the Millennium Development Goals for World, particularly India, Universal Education for ALL is the first priority. Education can only lead us from darkness to light. Hence our foremost duty is therefore to enlighten our younger generation. Census of India 2011 gives us the following data.

All ages	1210854977 (Head Count)
0-4	112806778
5-9	126928126
10-14	132709212
15-19	120526449

If we consider the percentage of children population of India we will observe that more than 40% of the population is our younger generation, our future citizens of India.

Future India will be created by them, for them and of them: It is our foremost duty to educate them, train them and build them with proper knowledge, skill .Our present population crisis ,its far reaching effects in our life and that we & only we can bring about a change in India ,must be explained & conveyed to them. Any change anywhere in the world will be effective only if it can be implemented at grassroots level. Infact, children of today will grow up and develop to be responsible citizens of India and gearing them up for future is OUR responsibility.

The biggest question that will now arise is how to present this to the younger generation and make them interesting as well as informative. While the factsheets must be included in their curriculum these information must be interesting & practical. They must be able to connect with these topics easily and have practical/hands on experience. This will ensure their involvement in their process of understanding and knowledge and this will eventually lead to self realisation and their awareness. Talking of connection with children, the biggest connection will be through education, hence curriculum and thus subjects. In developed countries like USA, European countries, projects on population counting, census study, using simple techniques has been done by school children. With hands on activities the children learn basic operations using practical problems.

MATERIALS AND METHODS

Developing countries like India can adopt activities at school level and generate interest and awareness regarding population growth& its effect to society .The most convenient way of introducing this is through Mathematics which is daily taught at school level throughout India! Mathematics is such a basic subject, which has tremendous application in all spheres of life. Children all over the world, more so in India, start their education life learning language and mathematics.

A widely popular and useful subject which every Indian child learns daily can be the best medium for propagating the basic ideas of population study and its implications. In 2005, the National Curriculum Framework proposed to introduce Mathematics through a different perspective at school level. It aims at visualizing Mathematics...making it a real world experience. Any boredom with Mathematics must be removed and the child learning the subject must associate to it and find it to be a connection of their own surroundings.

Mathematical modeling is the best way to achieve this purpose: Introducing mathematical modeling to school children will help them not only to gel with the subject but also guide them to the practical /real life situations of India today. What better way can one have to present India Today to our children through interesting diagrams, figures, models of mathematics, which will not only sharpen their maths skills but create a thought process of assessing the problem.

The purpose of this project is to introduce a new system of mathematics curriculum based on Mathematical Models, which will be related to demographic parameters of Indian subcontinent. Through simple Mathematical, models children will have hands-on experience of real life problems faced by our nation and evaluate them through thought provoking questionnaire based on their calculations. Below are given the types of mathematical models, which are designed, for students of middle school and then gradually to senior school. The models are arranged according to level of mathematics curriculum from lower to higher section. These models will use mathematics which is well within the scope of secondary school syllabus. Hence the scope for utilisation and implementation of these models in maths classes is well justified. By this way Mathematics can be used to the maximum extend for a very important social cause...right from grass root level.

RESULTS AND DISCUSSION

MODEL 1: This is the Population Pyramid of India- A graphical display of India's age and sex composition. Denoted by horizontal bars ,it represents the proportion of males & females of each age group. Sum of all such age grs=total population.=100%

Questionnaire

- Let us calculate the sex-ratio of India for the following age groups:
  - Sex-Ratio=Ratio of males to females (SR) 0-4yrs == 57 million/54million =105.5 :100.
  - There are 106 males for every 100 females right from birth till 4yrs. 5-9yrs == 68/62 = 110:100
  - Study the pyramid and find out the S R for age group 10-14 yrs and 15-20yrs.
- At which age groups do you find SR becoming almost same?
- Can you calculate the total male, female population and the population of the whole country?
- What conclusion do you arrive at?
- What may be the probable causes for this sex difference in male-female count right from birth?
- Why do you think S R equals at later age?
- Can you think of any ways by which one can improve this ratio?
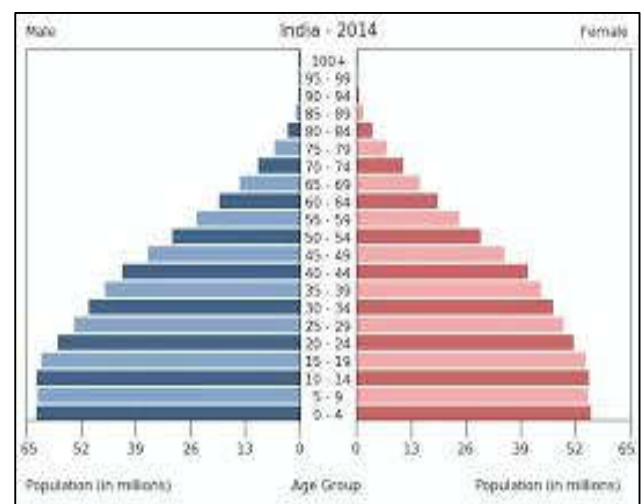
MODEL 2:

Questionnaire: The above models represent the age structures of two types of nations-developed, and developing.

Observe the two pyramids and answer the following

- Which pyramid will represent our country? Which one will represent USA?
- Calculate the male population of both the types separately and find their ratio.
- Repeat the same procedure for female population.
- Can you obtain the total poulation ratio for both?
- Compare the no.of males & females for both nations and find their SR.
- Which pyramid will represent our country? Which one will represent USA?
- If you are given the area of India = 3.3million km^2 and that of USA = 9.9 million km^2, find a relation between the proportions of area with population count of two nations.
- Arrive at your own conclusion.
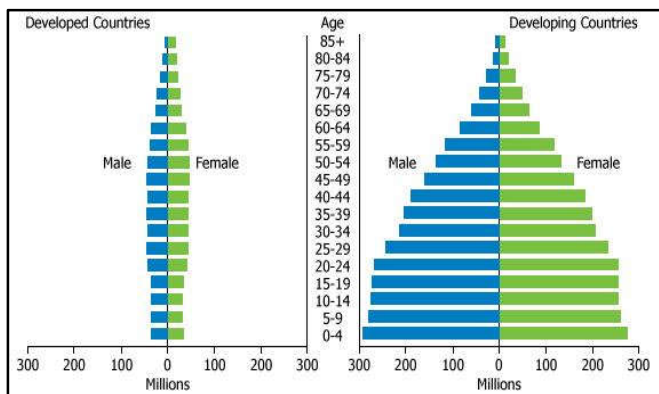
MODEL 3 A:
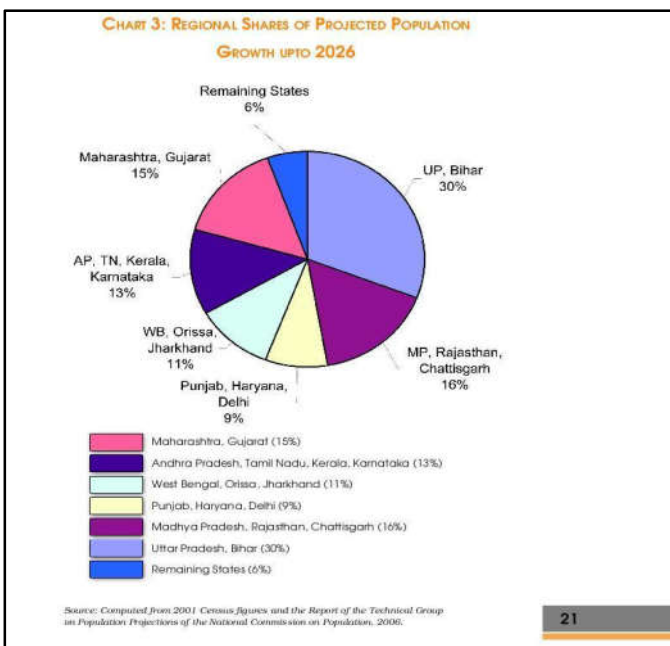
B. POPULATION WITH AREA

No.	States	Area (km^2)	Part of India	% total area	% total pop
1	Rajasthan	342,239	Western	10.41	5.7
2	Madhya Pradesh	308,245	Central	9.37	6
3	Maharashtra	307,713	Western	9.36	9.28
4	Uttar Pradesh	240,928	Northern	7.33	16.5
5	Jammu and Kashmir	222,236	Northern	6.76	1
6	Gujarat	196,024	Western	5.96	5
7	Karnataka	191,791	Southern	5.83	5
8	Andhra Pradesh	160,205	Southern	4.87	4
9	Odisha	155,707	Eastern	4.73	3.5
10	Chhattisgarh	135,191	Central	4.11	2.1
11	Tamil Nadu	130,058	Southern	3.95	6
12	Telangana	114,840	Southern	3.49	3
13	Bihar	94,163	Eastern	2.86	9
14	West Bengal	88,752	Eastern	2.70	7.5
15	Arunachal Pradesh	83,743	Northeastern	2.54	0.11
16	Jharkhand	79,714	Eastern	2.42	2.7
17	Assam	78,438	Northeastern	2.38	2.6
18	Himachal Pradesh	55,673	Northern	1.70	0.6
19	Uttarakhand	53,483	Northern	1.62	1
20	Punjab	50,362	Northern	1.53	2.3
21	Haryana	44,212	Northern	1.34	2.1
22	Kerala	38,863	Southern	1.18	2.8
23	Meghalaya	22,429	Northeastern	0.68	0.24
24	Manipur	22,327	Eastern	0.68	0.22
25	Mizoram	21,081	Eastern	0.64	0.1
26	Nagaland	16,579	Eastern	0.50	0.16
27	Tripura	10,486	Eastern	0.31	0.3

A) Refer to the population projection pie chart above and compare with the total area of the following states :

States	%POP total (1.3 Billion)	Total Surface Area (Sq. Km)	Approx POP/SQ KM
U P + BIHAR	30% pop =400885900	240928+94163 =335091 sq km	1196 people/km^2
MP+RAJAS+CHATTISGARH	16%	DO-	
MAHA+GUJ	15%	DO	
AP+TN+KERALA+KARNATAK			
WB+JHARKHAND	DO		
PUNJAB+HARYANA+DELHI			
OTHERS			

2) Study the table POPULATION WITH AREA B and draw a graph with the instructions given below:
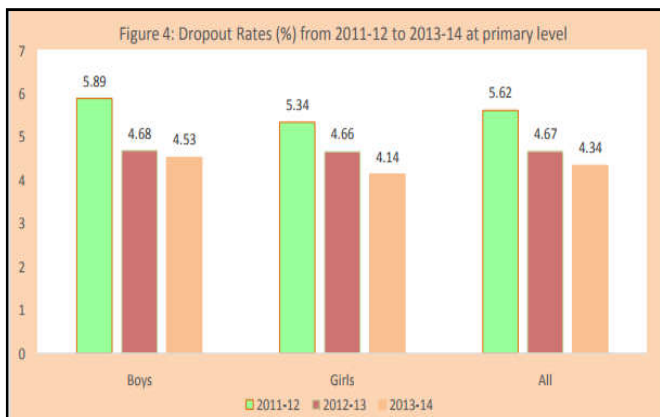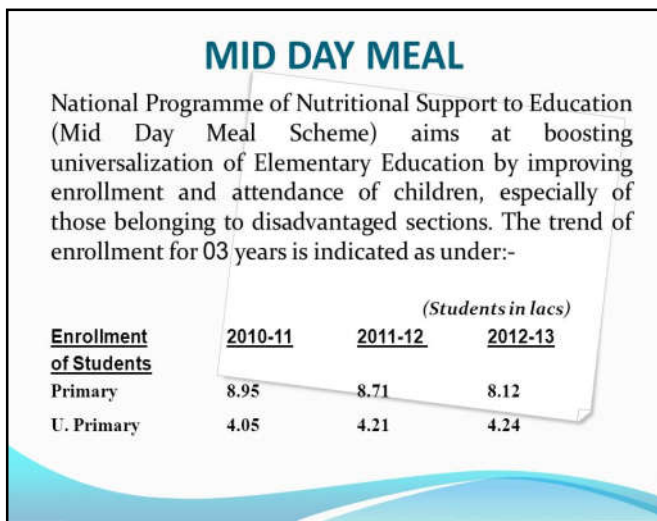
- Take area along X axis and percentage share of population along Y axis.
- From the above table choose 10 states (2 northern, 2western, 2southern,2 eastern,1 northeast,1central) Naming them A,B,C etc plot them against the above axes.
- After your points have been plotted , observe carefully and answer the following questions :
  - Did you get a straight line graph?
  - Is the population distribution uniform as compared to area distribution?
  - Find out the states which have disproportionate population distribution as compared to its area.
  - What do you think can be the impact of such uneven distribution of population, on, country and environment?
  - Suggest possible ways you feel can reduce this land stress.

MODEL 4: Below are given two data charts showing school enrolment and drop out percent in India (MHRD data).We will concentrate for the year 2012-13. Government of India had started Mid Day Meal scheme for schoolchildren to ensure maximum school education. We will concentrate on primary school for the year 2012-13.

Let us try to solve the following.

MID DAY MEAL

National Programme of Nutritional Support to Education (Mid Day Meal Scheme) aims at boosting universalization of Elementary Education by improving enrollment and attendance of children, especially of those belonging to disadvantaged sections. The trend of enrollment for 03 years is indicated as under:-

Enrollment of Students	2010-11	2011-12	(Students in lacs) 2012-13
Primary	8.95	8.71	8.12
U. Primary	4.05	4.21	4.24

Figure 4: Dropout Rates (%) from 2011-12 to 2013-14 at primary level

	2011-12	2012-13	2013-14
Boys	5.89	4.68	4.53
Girls	5.34	4.66	4.14
All	5.62	4.67	4.34

- How many children are enrolled for primary in the year 2012-13?
- Out of the above total if 4.7% children dropped out, how many children actually left school?

- Out of the drop outs how many are boys and how many are girls?
- By the Mid Day Meal scheme, proper food nutrition will be provided to the primary school children. If each child is provided with food with nutritional value of 500 calorie and 15 gm protein daily, let us try to calculate the following:

  - Each child studying in primary class gets how much calorie food and protein intake for one month?
  - Each drop out child is missing how much nutrient per week?
  - Per week how much food is being wasted due to this absenteeism?
  - Draw your own conclusion from above calculations.
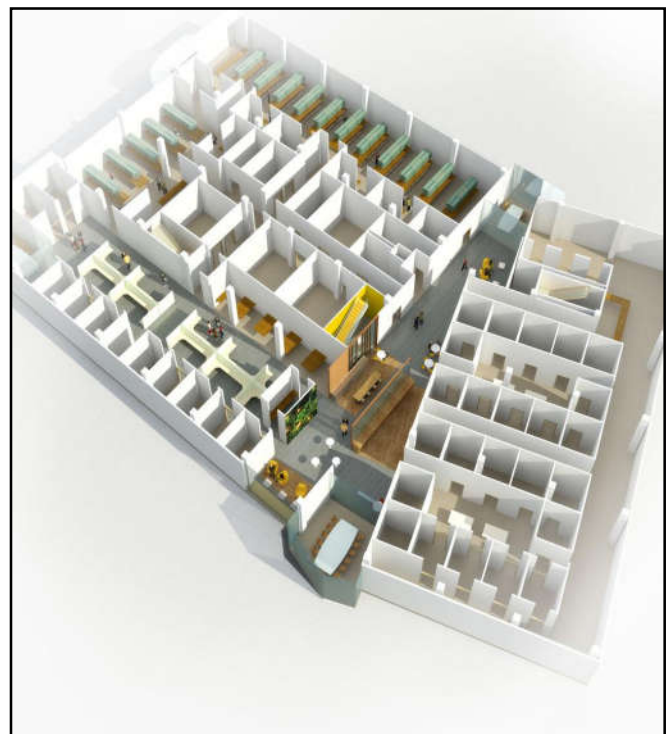- Can you suggest some ideas as how you can motivate your friends to go to school?

MODEL 5

We will now create an architectural plan for a Government Housing Society and try to accommodate a certain number of families in it. For example..

We will follow the following rules.

- The society will be of dimensions 200ft x 210 ft.
- There is 40ft x 100ft area marked for park & playing area.
- There are two types of flats : : 1 bhk : 25ftx20ft for housing max 3 members family (A): 2 bhk : 20 ft x 40 ft for max 5 members family(B).
- There is a 20 ft wide road surrounding the boundary of the inner side of the plot.
- Dist between park & each bldg =20 ft.
- Take 4 bldgs , 2 of each type.
- Maximum of 10 floors can be made.
    - Q) Draw the outline of the housing society.
    - Q) The area has presently 200 families. Can all of them be accommodated?
    - Q) Now 20 families have their own house. They will rent out their flats to others. How many residents are there.
    - Q) Out of those who will reside, 90 are type A families and rest are type B. How many types b families.
    - Q) How can maximum number of people receive flats?
    - Q) If 5 families migrate out which way will you accommodate most of them.

Hints- a) Usual way, with 10 floors, 80+80=160 families can stay.
b) 200 families need flats.; 20 have own house. So 180 families needs flats.
c) 90-typeB –2 bhk, so, all 80 flats used. 10- 1bhk goes to 10 more B fam.
Rest 70- 1bhk goes to type A families. Reverse order can be taken for other option...(model society diagram to be made)
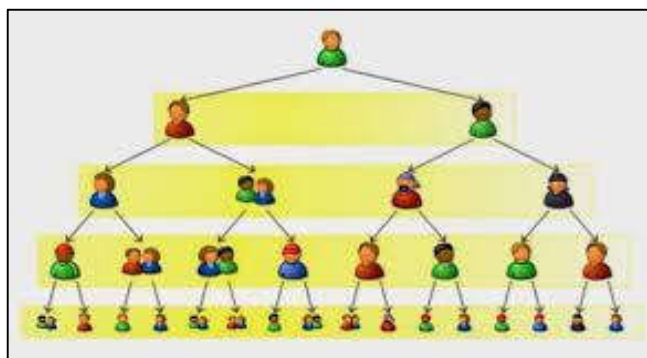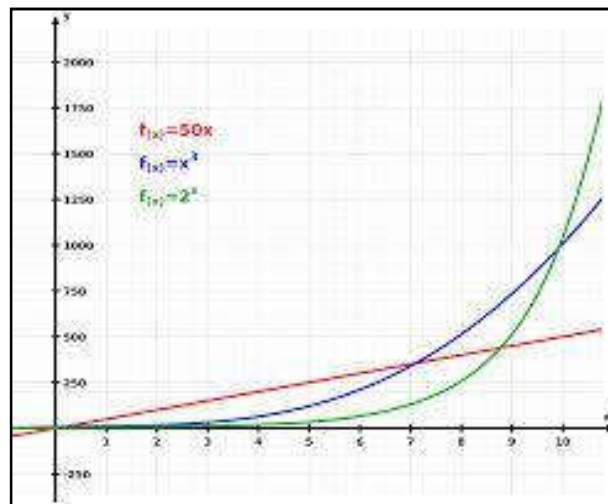
MODEL 6: Let us draw.

Three functions are given to us

A) f(x)   = 50 x   (**linear fn)**
B) f(x)   = x^3 (**cubic function)**
C) f(x)   = 2^x (**exponential   function**)

a)   Using red for linear, blue for cubic, and green for exponential, draw the graphs of these functions on a graph paper with X axis = time =1,2,..10 years and Y axis = function

Graph 1 – Function Graph

b)   Observing the above graph, after a certain time interval,say 10 yrs, which function do you think overtakes the others? [5]

Well, that is how population grows...
Can we draw the exponential growth curve of India?
Let me help ...First let us solve a few questions..
1) Exponential Growth
Exponential growth is any increase in a quantity P using the formula

$$P(t)= P_0 \, e^{(kt)}$$

Where Po is the initial quantity, t is time, k is a constant, P(t) is the quantity after time t, and e^x is the exponential function.
Q1) If a city has a population of 10000 people, and if the population grows continuously at an annual rate of 1.7%, what will the population be in 10 years?

We are given Po= 1000 people and k= .017
P(t)= 10000e^(.017t)
When t= 10 years

P(t)= 10000e^(.017*10)= ~11853people.

Q) Can we now predict population of India after 4yrs, 10yrs,...till 2050?

Q) The graph of this growth(exponential) of population can be drawn easily.
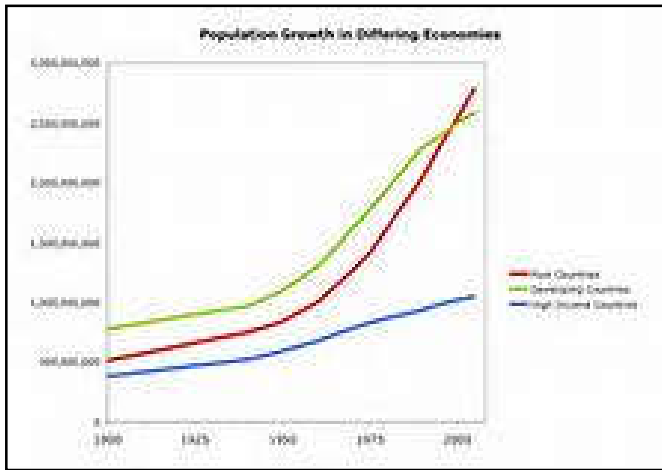
Graph 2 – Growth Curve of three Nations

Q) Studying the above given graph for three nations, what do you infer?

Conclusion

These are some of the examples of models that can included in the maths curriculum of Indian school boards. As these models deals with school level arithmetic, algebra and mensuration topics, they are compatible with student knowledge. Numerous such models can be further created which are compatible with curriculum topics.

I propose that sums like these to be included in the relevant maths exercises, replacing the imaginary problems with these real life problems. The future citizens of India can hereby get to see their real India and prepare themselves to change for better.

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