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The candle under the beaker gets extinguished because the oxygen in the air inside the beaker has been used up.

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Contents

Do You Know ?

According to the 86th Constitutional Amendment Act, 2002, free and compulsory education for all children in 6-14 year age group is now a Fundamental Right under Article 21-A of the Constitution.

EDUCATION IS NEITHER A PRIVILEGE NOR FAVOUR BUT A BASIC HUMAN RIGHT TO WHICH ALL GIRLS AND WOMEN ARE ENTITLED

Give Girls Their Chance !

EDITORIAL

The current issue comprises articles from various fields of science contributed by researchers and academics from the field of science education. It is our endeavour to promote science education and knowledge to help young science enthusiasts and our readers. The first article is "Problem-based Learning in Basic Physics – V", this article is a sequel to Part IV which has been published in the March 2014 issue. This article in the series, touches upon the areas of electricity and magnetism. The article "Chem-riddling: Effective Pedagogy for Teaching Chemistry at Senior Secondary and Undergraduate Level" highlights the idea that teaching chemistry to students can be done in an innovative way, through riddles. The author has suggested new pedagogy through which students can understand new information by relating it to the already existing one.

"Experience of Teaching about the Components of the Air at the Elementary Level" is an article based on a first-hand classroom experience which the author had during her school visit. The article discusses about the attempt made by the author to help the students understand about air as a mixture of various gases. "An Investigation into the Conceptual Understanding of Students about the Content of EVS at the Primary Level" is an article which is based on an investigation conducted in three English medium schools and seven Hindi medium schools. The article highlights how students in Hindi medium schools have lower conceptual understanding of EVS compared to that in the English medium schools.

This issue also contains an article on applied mathematics titled "Projectile Motion of a Cricket Ball from Bowling to Over Boundary in Cricket". The article deals with Projectile Motion in the game of Cricket. The article "Science Teachers at the Upper Primary Level in Direct Conversation with Textbook Developer during Video-conferencing: An Experience" talks about how the current NCERT textbooks were developed by the team consisting of teachers, subject experts, representatives from various government and non-governmental organisations following the NCF – 2005 guidelines. These guidelines require teachers and experts to conduct orientation programmes . The article recommends video-conferencing as an effective way to reach out to a larger number of teachers and experts.

The research paper titled "Preliminary Study on Environmental Awareness of Students with the Implementation of Environmental Education in Schools in India" elaborates the students' awareness about the environment, environmental concerns, impact of human activity on environment and how lack of awareness impacts the environment.

In addition to the articles and research papers, there are some informative and fun science snippets given in the"Science News" and "Web Watch" sections for our readers.

We wish our readers a very productive and happy reading.

Empowerment of Girl Child, Responsibility of All

PROBLEM-BASED LEARNING IN BASIC PHYSICS - V

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In this article, fifth in the series, we present problems for a problem-based learning course in the area of electricity and magnetism. We present the learning objectives in this area of basic physics and what each problem tries to achieve through its solution.

In this article, fifth in the series, we present problems on electricity and magnetism. Methodology and philosophy of selecting these problems have already been discussed (Mody and Pradhan 2011).

To review the methodology in brief, we note here that this Problem-based Learning (PBL) starts after students have been introduced to formal structure of physics. Ideally students would attempt only main problem. If they find it difficult, then depending upon their area of difficulty, right auxiliary problem have to be introduced by teacher who is expected to be a constructivist facilitator. Teacher may choose as per her/his requirement or may construct questions on the spot to guide student to the right idea and method.

Problems on Electricity and Magnetism

Learning Objectives

1. Coulomb's law: electric force, electric field and electric potential.
2. The fact that force and field are vectors whereas potential is a scalar and how they are to be calculated due to charges: individual and configuration.
3. Capacitor as a storage device for charge and energy and its role in different circuits.
4. Ohm's law and Kirchhoff's laws for current distribution in a dc electric circuit.
5. Biot-Savart's law and calculation of magnetic field due to different current configuration.
6. Electromagnetic induction and calculation of induced emf.
7. To understand mathematical structure dealing with above-mentioned points.

Electrostatics

Problems

1. Three point charges q, 2q and 8q are placed on a 9 cm long straight line. Find the positions where the charges should be placed such that the potential energy of the system is minimum. In this situation, what is the electric field at the position of the charge q due to the other two charges? [JEE 1987]

- This problem involves calculation of electric potential energy and electric field due to simple distribution of point charges.

  Tasks involved in this problem are:

  (a) To find number of possible ways in which three charges can be arranged along a straight line.

  (b) To calculate potential energy for each distribution, minimise potential and see which configuration gives minimum value of potential energy.

  (c) To calculate electric field at the site of 'q' for minimum configuration.

2. The distance between two positive charges q and 4q is '*l*'. How should a third charge Q be arranged for it to be in equilibrium? Under what conditions will the equilibrium of the charge Q be stable or unstable?

   - This problem involves balance (equality) of the forces due to two charges separated by a distance on the third charge.

     Tasks involved in this problem are:

     (a) To equate Coulomb's force due to two charges on the third charge and estimate the distance at which that happens.

     (b) To see that there are two solutions to a quadratic equation which in this case is not so obvious.

     (c) To understand that the solution for a point in between correspond to stable and outside correspond to unstable equilibrium.

3. Two fixed charges –2Q and Q are located at the points with co-ordinates (-3a, 0) and (+3a, 0) respectively in the xy-plane. (a) Show that all the points in the xy-plane where the electric potential due to the two charges is zero lies on a circle. Find its radius and the location of its centre. (b) Give the expression for potential V(x) at a general point on the x-axis and sketch the function V(x) on the whole x-axis. (c) If a particle of charge +q starts from rest at the centre of the circle, show by a short qualitative argument that the particle eventually crosses the circle. Find its speed when it does so. [JEE 1991]

   - This problem involves calculation of potential due to two charges in a plane. Finding locus of all the points at which potential is zero. Sketching the potential as a function of x. Seeing what happens to a charge at the centre of the circle.

     Tasks involved in this problem are:

     (a) To calculate potential as a function of (x,y) in a plane due to two charges.

     (b) To find locus of zero potential points.

     (c) To plot potential for points on x-axis.

     (d) To find out whether charge +q would cross the circle.

4. Two isolated metallic solid spheres of radii R and 2R are charged such that both of these have same charge density σ. The spheres are located far away from each other, and connected by a thin conducting wire. Find the new charge density on the bigger sphere. [JEE 1996]

   - This problem involves redistribution of charge till potential on the two surfaces become equal, and finding new distribution.

     Tasks involved in this problem are:

     (a) To find total charge and potential on each sphere.

(b) To decide criteria for distribution of charges when two spheres are connected by a conductor.

(c) To find new charge distribution.

5. A conducting sphere S_1 of radius r is attached to an insulating handle. Another conducting sphere S_2 of radius r is mounted on an insulating stand. S_2 is initially uncharged. S_1 is given charge Q, brought in contact with S_2, and removed. S_1 is recharged such that the charge on it is again Q; and it is again brought into contact with S_2 and removed. This procedure is repeated 'n' times. (a) Find the electrostatic energy of S_2 after n such contacts with S_1. (b) What is the limiting value of this energy as $n \rightarrow \infty$? [JEE 1998]

- This problem involves generalisation of the process to large n value of what was done in problem 4. above.

Tasks involved in this problem are:

(a) To follow the procedure in problem 4. above repeatedly and see how it can be generalised for some 'n' trials.

(b) To find what would happen after large number of steps.

6. Three concentric spherical metallic shells A, B and C of radius a, b and c (a < b < c) have surface charge densities σ, $-\sigma$ and σ, respectively. (i) Find the potential of the three shells A, B and C. (ii) If the shells A and C are at the same potential, obtain the relation between a, b and c. [JEE 1990]

- This requires students to know how to calculate the potential at a point inside a sphere, outside and on the sphere due to surface charge.

Tasks involved in this problem are:

(a) To know that electric field inside a surface spherical charge distribution is zero and hence potential should be constant.

(b) To add potential at each shell due to the each of the three shells.

(c) To use condition given in part (ii) to get relation between (a), (b) and (c).

7. A 20 pF parallel plate capacitor with air as medium is charged to 200 V and then disconnected from the battery. What is the energy U_i of the capacitor? The plates are then slowly pulled apart (in a direction normal to the plate area) so that the plate separation is doubled. What is the mechanical work done in the process? What is the new energy U_f of the capacitor?

8. A 3μF parallel plate capacitor is connected to a battery of 400 V. The plates are then pulled apart as in P (7) above, so that the capacitance value becomes 1μF. This operation is carried out while the capacitor is still connected to the battery of 400 V. Calculate the mechanical work done. Account for the loss of energy of the capacitor.

9. In the problems P (7) and P (8) above what happens if dielectric slab or a metallic block is introduced instead of moving the plates.

- In problem 7, charge is conserved and work has to be done to move capacitor plates apart against electrostatic attraction, which increases energy stored in the capacitor.
- In problem 8, voltage remains constant as battery remains connected but capacitance and hence charge on the capacitor decreases. Reverse current flows and battery gets charged.

- Dielectric and metallic block both would be pulled in due to surface induced charges. In case of dielectric energy would increase due to increase in capacitance whereas in case of metallic plate if thickness were less than capacitor plate spacing would reduce effective distance between two plates and hence energy stored would increase.

Tasks involved in these problems are:

(a) To know how energy of a capacitor depends on C, Q and V.

(b) To know when to use charge and energy conservation.

(c) How does dielectric and conductor slab affect the geometry and charge or energy stored in the capacitor?

Electric Current

10. In the circuit shown in Fig. 1 the voltage measured across 2 K resistor was found to be 6 V, find it across 3 K. Find the resistance of the voltmeter. What would be the voltages measured if voltmeter was ideal?

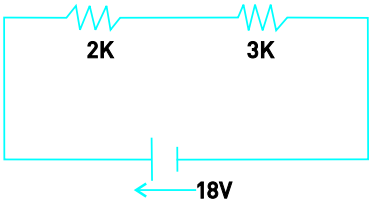


Fig. 1

- This problem makes students familiar with use of Ohm's law
- It conveys limitation of measuring device; in this case it is voltmeter and how its resistance affects measurement.

Tasks involved in this problem are:

a. To apply Ohm's law and Kirchhoff's law to the circuit.

b. To recognise contribution of voltmeter in the circuit due to its finite resistance.

11. In the circuit shown in Fig. 2 below, find current through each of the resistors. [Theraja]

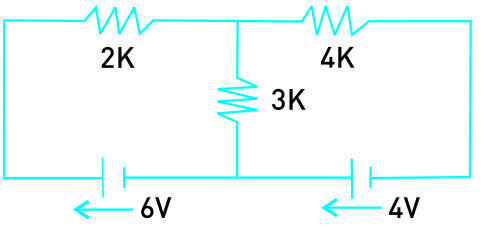


Fig. 2

- This problem involves application of Kirchhoff's laws for loop and junction to find current through each branch in the circuit.

Tasks involved in this problem are:

(a) To apply Kirchhoff's laws for loop (voltage) and junction (current).

(b) To solve the equations thus obtained to get current through each resistance.

- This problem is touchstone in the same sense as an inclined plane problem. It familiarises students with application of Kirchhoff's laws for loop and junction.

12. Twelve resistors each having resistance of value R are connected in the configuration of a skeleton cube. Referring to Fig. 3, find the effective resistance offered between points (i) A and F (ii) A and G (iii) A and B

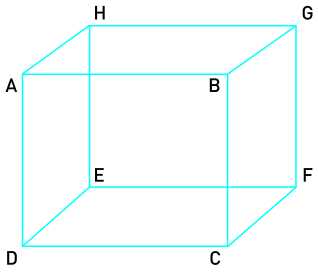


Fig. 3

- This problem shows the effectiveness of a network, familiarizes students with application of Kirchhoff's law and teaches how potential difference is path independent and how to exploit symmetry of the situation.

  Tasks involved in this problem are:

(a) To use symmetry to see how current gets distributed through different elements.

(b) To apply Kirchhoff's law (as an alternate method) to distribute current.

(c) To use the fact that potential difference between two points in a circuit is independent of the path chosen.

(d) To equate it to potential difference across effective resistance and hence evaluate the effective resistance.

Magnetism

13. A square loop of wire of edge 'a' carries a current *i*. Show that the value of B at the centre is given by, $B = 2\sqrt{2}\mu_o i / \pi a$. Also find magnetic induction at any point on the axis.

14. A wire in the form of a regular polygon of n sides is just enclosed by a circle of radius 'a'. If the current in this wire is '*i*', show that the magnetic induction at the center of the circle is given by $B = (\mu_0 ni/2\pi a) \times \tan(\pi/n)$. Show that as $n \rightarrow \infty$ this result approaches that of a circular loop.

- Problems 13 and 14 involve application of formula arrived at for magnetic field due to a current-carrying wire of finite length.
- Problem 14 involves generalisation to n-sided polygon and checking if the result matches with circle if 'n' is large.

  Tasks involved in this problem are:

(a) To find angles subtended by straight conductors of finite length at the point (centre of a regular polygon).

(b) To calculate magnetic field due to one such side and hence 'n' sides.

(c) To let 'n' be very large and see if result reduces to that of a circle.

15. Find magnetic field at any point on the axis of a circular current carrying loop.

- This problem involves calculating magnetic field on the axis of a circular loop using Biot-Savart's law.

  Tasks involved in this problem are:

(a) To apply Bio-Savart's law to a current - carrying loop.

(b) To work out direction of field due to diametrically opposite elements.

(c) To find out which component contributes and which one gets neutralised.

(d) To integrate to final value of B-field.

16. Current flows around the cubical wire frame in the figure given. What is the direction and magnitude of the magnetic field at the centre

of the cube? [Hint: you may find it useful to employ superposition principle.][InPhO 2004]

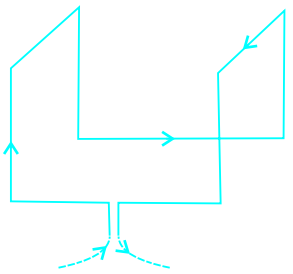


Fig. 4: Skeleton Wire

- This problem is an extension of problem 13 but in 3-dimension but can be easily solved if one focuses on symmetry consideration.

Tasks involved in this problem are:

(a) To recognise what happens if missing wires were there.

(b) To recognise that missing wires put back effectively adds nothing to the problem but facilitates viewing as combination of squares.

(c) To find magnetic field of a square loop at a point on its axis and superpose all such contributions vectorally.

Electromagnetic Induction

17. A metal rod OA of mass m and length r is rotating with a constant angular speed w in a vertical plane about a horizontal axis at the end O. The free end A is arranged to slide without friction along a fixed conducting circular ring in the same plane as that of rotation. A uniform and constant magnetic induction **B** is applied perpendicular and into the plane of rotation as shown in Fig. 5. An inductor L and an external resistance R are connected through a switch S between the point O and a point C on the ring to form an electric circuit. Neglect the resistance of the ring and the rod. Initially the switch is open.

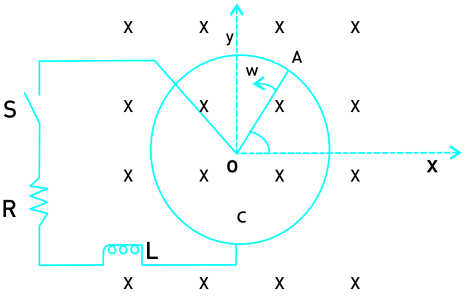


Fig. 5

(a) What is the induced emf across the terminals of the switch?

(b) The switch S is closed at time t = 0.

(i) Obtain an expression for the current as a function of time.

(ii) In the steady state, obtain the time dependence of the torque required to maintain the constant angular speed, given that the rod OA was along the positive X-axis at t = 0. [JEE 1995]

- This problem requires students to use Faraday's laws and Lenz's law to find induced emf and induced current in the rod.
- The problem also involves working of an LR circuit and effect of gravity on the rotating rod.

Tasks involved in this problem are:

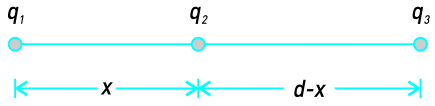
(a) To calculate induced emf using Faraday's laws and Lenz's Law.

(b) To find current knowing the fact that given circuit is an LR circuit.

c. To incorporate the fact that rod is in vertical plane and hence is under influence of gravity and calculate the torque needed for constant angular speed.

Solutions

1. Electrostatic Field and Potential



$$V = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1q_2}{x} + \frac{q_2q_3}{d} + \frac{q_3q_1}{(d-x)}\right)$$

For potential to be minimum :

$$\frac{\partial V}{\partial x} = 0 \Rightarrow x = \frac{d}{1 \pm \sqrt{q_1/q_3}}$$

: negative solution ruled out (as it means $x > d$)

q_1	q_2	q_3	x	$V/(1/4\pi\varepsilon_0)$
q	$2q$	$8q$	6.65	$7.998q^2$
$2q$	q	$8q$	3.0	$3.778q^2$
q	$8q$	$2q$	5.27	$6.029q^2$

2nd arrangement indicates the minimum configuration.

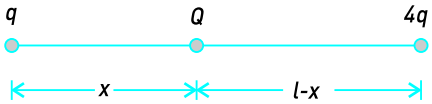
Alternatively

Since potential energy depends on q_1q_2, large charges should be kept apart. This also gives 2nd arrangement as mentioned. Substituting all the values: $d = 9$ and $q_1 = 2q$ and $q_3 = 8q \Rightarrow x = 3$ cm. Electric field in this situation at q due to the other two will be:

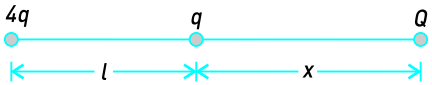
$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\left(\frac{2q}{x^2}\hat{i} - \frac{8q}{(d-x)^2}\hat{i}\right) = 0$$

2. Static Equillibrium

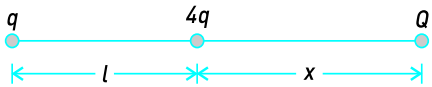
Arrangement 1



Arrangement 2



Arrangement 3



Naturally it is only 1st arrangement that can be equilibrium as 2nd and 3rd arrangement means same direction of force due to each charge.

In 1st arrangement : $\frac{qQ}{x^2} = \frac{4qQ}{(l-x)^2}$ equating the two forces.

$\therefore (l-x)^2 = 4x^2 \Rightarrow l - x = +2x$

$\therefore x = l/3$ *or* $x = -l$ the second solution is ruled out any way.

Thus at $x = l/3$ charge will be stable (along the line of charges) irrespective of sign of Q.

3. Electric Potential

(a) $V(x,y) = \frac{1}{4\pi\varepsilon_0}\left(\frac{-2Q}{\left[(x+3a)^2+y^2\right]^{1/2}} + \frac{Q}{\left[(x-3a)^2+y^2\right]^{1/2}}\right)$

$V(x, y) = 0 \Rightarrow 4[(x-3a)^2+y^2] = [(x+3a)^2+y^2]$

Which gives :

$x^2 + y^2 - 10ax + 9a^2 = 0$: Circle with centre : $(5a, 0)$ and radius $r = 4a$

(b) On x – axis : y = 0

$$\therefore V(x) = \frac{Q}{4\pi\varepsilon_0}\left[\frac{-2}{|x+3a|} + \frac{1}{|x-3a|}\right]$$

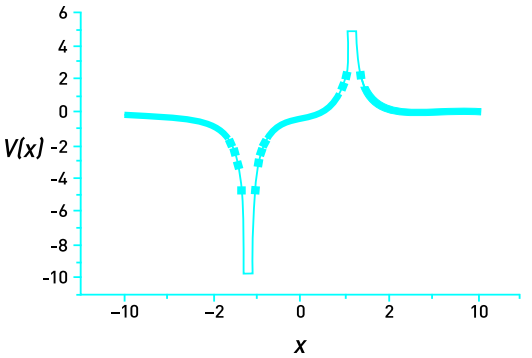


Fig. 6

(c) For q at $(5a,0)$: force

$$F = \frac{qQ}{4\pi\varepsilon_0}\left\{\frac{1}{(2a)^2} - \frac{1}{(8a)^2}\right\} = \frac{7}{32}\frac{qQ}{4\pi\varepsilon_0 a^2}$$

in positive x-direction.

K.E. at $(x = 9a)$ + P.E. at $(x = 9a)$ = P.E. at $(x = 5a)$

$$\Rightarrow v = \left[\frac{qQ}{4\pi\varepsilon_0(2ma)}\right]^{1/2}$$

4. Electrostatics and Surface Charge Distribution

$Q_1 = 4\pi R^2\sigma$ and $Q_2 = 4\pi(2R)^2\sigma$

$V_1 = Q_1/4\pi\varepsilon_0 R = \sigma R/\varepsilon_0$ a nd similarly $V_2 = \sigma(2R)/\varepsilon_0$

When the two spheres are connected, charge transfer takes place till both the potentials become equal such that total charge is conserved.

$Q_1 + Q_2 = Q_1' + Q_2'$ with σ_1 and σ_2, respectively, such that $V_1' = V_2'$.

This gives $\sigma_1 + 4\sigma_2 = 5\sigma \Rightarrow \sigma_1 = 5/3\sigma$ and $\sigma_2 = 5/6\sigma$

5. Electrostatics and Surface Charge Distribution

Step I: $Q = q + q_1$ (here q is the charge on S_1 and q_1 is charge on S_2 after first contact)

and $q/r = q_1/R \Rightarrow q_1 = Q\left(\frac{R}{R+r}\right)$

Step II: $Q + q_1 = q' + q_2$ (here q' is the charge on S_1 and q_1 is charge on S_2 after second contact)

and $$\frac{(Q+q_1) - q_2}{r} = \frac{q_2}{R}$$

$$\Rightarrow q_2 = (Q+q_1)\left(\frac{R}{R+r}\right) = Q\left\{\left(\frac{R}{R+r}\right) + \left(\frac{R}{R+r}\right)^2\right\}$$

repeating the procedure gives the nth step:

$$q_n = Q\left\{\left(\frac{R}{R+r}\right) + \left(\frac{R}{R+r}\right)^2 + \ldots + \left(\frac{R}{R+r}\right)^n\right\}$$

(a) $$U_n \frac{1}{2}\frac{q_n^2}{4\pi\varepsilon_0 R} = \frac{Q^2}{8\pi\varepsilon_0 R}\left\{x\left(\frac{1-x^n}{1-x}\right)\right\}^2$$

where $x = \left(\frac{R}{R+r}\right)$

(b) as $n \to \infty$ $x^n \to 0$

$$\therefore U_{n\to\infty} = \frac{Q^2}{8\pi\varepsilon_0 R}\left(\frac{x}{1-x}\right)^2 = \frac{Q^2}{8\pi\varepsilon_0}\frac{R}{r^2}$$

6. Electrostatics

(i) Potential at A due to B and C :

$$\frac{1}{4\pi\varepsilon_0}\left[\frac{-\sigma.4\pi b^2}{b}+\frac{\sigma.4\pi c^2}{c}\right]$$

due to A itself : $\frac{1}{4\pi\varepsilon_0}\left[\frac{\sigma.4\pi a^2}{a}\right]$

$$\therefore V_A=\frac{\sigma}{\varepsilon_0}(a-b+c)$$

Similarly : $V_B=\frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{b}-b+c\right)$ and

$V_C=\frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c}-\frac{b}{c}+c\right)$

(ii) $V_A=V_C \Rightarrow a-b+c=(a^2-b^2)/c+c$

$\therefore c=a+b$

7. Electrostatics: Capacitance

$U_i = ½\ CV^2 = 4\times10^{-7}$ J

Since plates are disconnected from the batteries, Q remains constant and hence $U=(½)(Q^2/C)$ where $C=\varepsilon_0 A/d$ and since d is doubled, C gets halved and $U_f = 2U_i$

The additional energy comes from the work done in moving plates apart. Thus work done $W = U_i = 4\times10^{-7}$ J and $U_f = 8\times10^{-7}$ J

8. Electrostatics: Capacitance

As p.d. across capacitor plates remain constant, mechanical work done is zero.

$\Delta U = \Delta(½\ CV^2) = ½\ (\Delta C)\ V^2 = -0.16$ J

The loss of energy indicate that energy returned to the battery.

9. Electrostatics: Capacitance

In Fig. 7 if dielectric or metallic block is introduced, they effectively increase capacitance. However, charge on the plate remains same. Due to induced charges on the surface of block, it will be pulled inside. Capacitor will do some work in pulling. This would reduce energy stored in the capacitor.

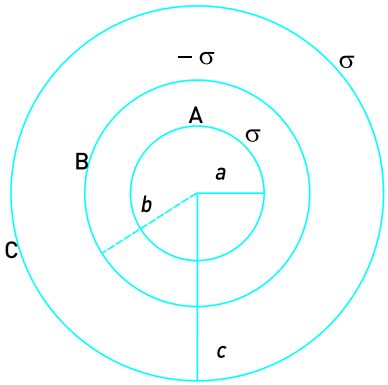


Fig. 7

In Fig. 8 too if dielectric or metallic block is introduced, they effectively increase capacitance. However, this time voltage difference across the plates remains same. Capacitor will still do some work in pulling, but more charge would flow to the plates from the battery which also provides the additional energy that is (i) stored in the capacitor and (ii) used for doing work.

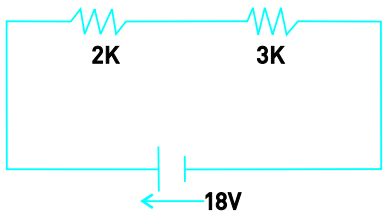


Fig. 8

10. Electric Current: Ohm's Law

Let resistance of voltmeter be *R*. *2R/(2 + R) and 3K* divides voltage in the ratio *1 : 2*

$\therefore 2R/(2+R) = 3/2 \Rightarrow R = 6\ K.$

Thus across *3 K,* effective resistance will be *2 K.* Thus voltage measured will be *9 V.*

An ideal voltmeter would measure these voltages to be *7.2 V* and *11.8 V.*

11. Electric Current: Kirchhoff's Laws

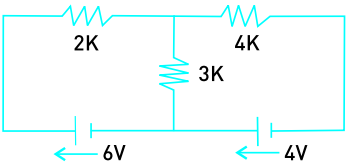


Fig. 9

Let $E_1 = 6\ V$ and $E_2 = 4\ V$

Let current through *2 K, 3 K* and *4 K* be i_2, i_3 and i_4, respectively.

According to Kirchhoff's law for junction (current) : $i_2 = i_3 + i_4$

According to Kirchhoff's law for loop (voltage) : $E_1 = 2i_2 + 3i_3$ and $E_2 = -3i_3 + 4i_4$

Solving which we get : $i_2 = 27/13\ mA$, $i_3 = 8/13\ mA$ and $i_4 = 19/13\ mA$

12. Effective Resistance

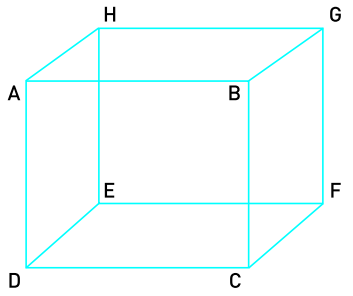


Fig. 10

This problem involves dividing current *i* at entry point using symmetry and combining at exit point. Voltage drop between the two points to be calculated along any chosen path and to be equated to *ix* .Where *x* is the effective resistance to be calculated.

Ans: (i) 5R/6 (ii) 3R/4 and (iii) 7R/12

13. Magnetism

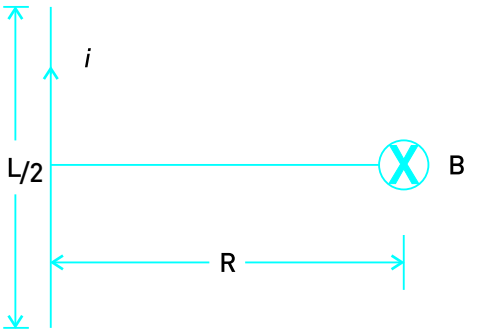


Fig. 11

The magnitude of the magnetic field at a distance *R* from a conductor of length *L* carrying current *i* is given by $B = \frac{\mu_0 i}{4\pi R} \frac{L}{\sqrt{R^2 + L^2/4}}$

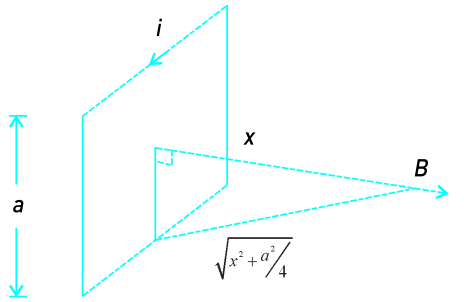


Fig. 12

Refering to the Fig. 12, magnetic field at a point on the axis at a distance *x* from the center of the

square loop of size *a* is given by

$$B = \frac{\mu_0 i a}{\pi\sqrt{x^2 + a^2/4}\sqrt{x^2 + a^2/2}}$$

Thus at the centre of the square loop

$$B = \frac{2\sqrt{2}\mu_0 i}{\pi a}$$

14. Magnetism

For a polygon of *n* sides inside a circle of radius *a* : in the formula in above problem $L/2 \to a \sin(\pi/n)$ and $R \to a\cos(\pi/n)$ which gives $B = \frac{n\mu_0 i}{2\pi a}\tan\frac{\pi}{n}$

Thus as $n \to \infty$: $B = \frac{\mu_0 i}{2\pi a}$ same as result known for circular loop.

15. Magnetic Field at any Point on the Axis of a Circular Current-Carrying Loop

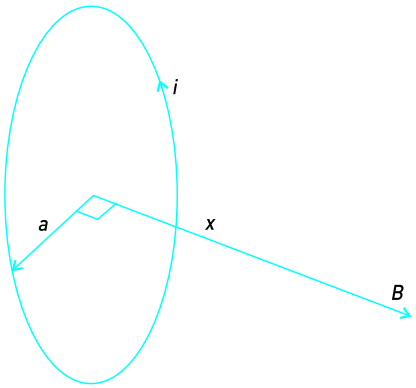


Fig. 13

Using Biot-Savart's law it can be shown that component perpendicular to axis cancels that due to diametrically opposite element and parallel component adds up. Thus resultant field works out to be $B = \frac{\mu_0 i a}{2(a^2 + x^2)^{3/2}}$

16. Magnetic Field at Centre of the Skeleton Cube

The straight forward application of Biot-Savart's law for six straight conductors of finite length

(taking care of directions gives : $B = \frac{2\mu_0 i}{\sqrt{3}\pi a}$

The problem can also be viewed as entire cube : the missing sides added would contribute zero current any way.

17. Electromagnetic Induction

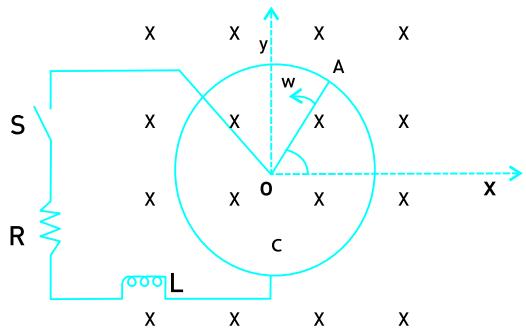


Fig. 14

(a) $E_{induced} = -\frac{d\phi}{dt} = -\frac{d}{dt}(BA) = -B\frac{d}{dt}(A) = -B\frac{d}{dt}(\frac{1}{2}r^2\theta) = -\frac{1}{2}Br^2\omega$

(b) (i) $I = \frac{E}{R}(1 - e^{-Rt/L})$

(ii) $I_{steady} = E/R$ as $t \to \infty$ $\therefore$ $I_{steady} = \frac{Br^2\omega}{2R}$

$\tau_1\omega = P = I_s^2 R = \frac{B^2 r^4 \omega^2}{4R}$: dissipating across *R*

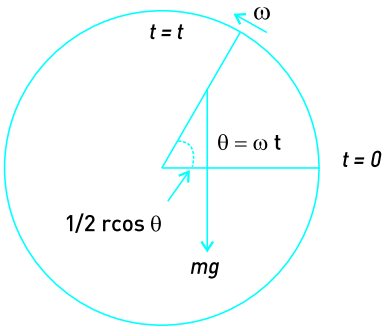


Fig. 15

$$\tau_2 = \frac{mgr}{2}\cos\theta = \frac{1}{2}mgr\cos\omega t \ : \text{ against gravity}$$

$$\therefore \tau = \tau_1 + \tau_2 = \frac{B^2 r^4 \omega^2}{4R} + \frac{1}{2}mgr\cos\omega t$$

References

JEE. Joint Entrance Examination for Admission to IIT.

INPHO. Indian Physics Olympiad.

Mody, A. K. and H. C. Pradhan . 2011. Problem Based Learning in Basic Physics–I. *School Science* 49 (3) September .

CHEM-RIDDLING: EFFECTIVE PEDAGOGY FOR TEACHING CHEMISTRY AT THE SENIOR SECONDARY AND UNDERGRADUATE LEVEL

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Teaching general chemistry is considered as a dull and boring activity especially in a classroom wherein students lack passion for the subject. In chemistry, there are several facts in the form of reactions, properties, preparation, uses, etc., which make it difficult for the student to grasp and assimilate the right perspective, resulting in monotony in teaching-learning. Under these circumstances, attracting the attention of the students and engaging their minds need innovative teaching methods. The author has been experimenting since last five years on teaching chemistry through riddles based on chemical principles and facts at senior secondary level. Riddling is a constructivist pedagogical tool. It reveals that learning can take place only when the learner relates the new information to his/her already existing knowledge, and perceives learning as a product of self-organisation and reorganisation of existing ideas. The author is hopeful that this method may interest chemistry teachers in schools and colleges and they may adopt it in their teaching programmes. Nine exemplar riddles that are discussed below are the part of several years of practice.

Keywords: Riddling, Constructivism

Introduction

In India, it has been felt since last few years that the craze for basic sciences is gradually declining at alarming rate due to growth of professional courses, engineering courses and other job-oriented courses. On the other hand there are less takers for chemical sciences as major subject at UG and PG levels in leading colleges and universities, which is evidenced form a declining number of secondary school students electing to study chemistry at the school leaving certificate level (senior secondary level), declining number of science students at the tertiary level selecting 'chemistry' as a major course at the B.Sc. level, a declining chemical industry in terms of gross productivity both for the domestic and export markets. This pessimistic public image of 'chemistry' has been systematically accentuated by the media and, most significantly, progressively declining government support for education and tertiary education in particular, coupled with declining financial support for scientific research, particularly by 'fundamental'/basic research.

This political apathy followed by pedagogical rigidity has resulted in poor image of chemistry in public as well as amongst learners. Today chemistry teaching is unpopular and irrelevant in the eyes of students. It does not promote higher-order cognitive skills, which leads to gaps between students' need and teachers' teaching.

We have to bear in mind that learning chemistry is learning to talk with chemistry. The specialised language of chemistry does not only include declarative and procedural concepts, critical terminologies, but also carries an ideological position with reference to certain epistemological criteria. The process of becoming a good chemist involves adapting to a scientific way of thinking and working by participating in chemistry activities, practising chemistry and overall developing a chemistry culture over time.

Chem-riddling

Most students find chemistry as most difficult subject. As a result of which students alienate themselves from the beautiful panorama of the subject and finally drop out from the subject. The riddling method is intended to give students more insight into how concepts are integrated in a sequential way so that it can help them to arrive at concrete conceptualisation needed to solve problems faced by them. Here, teacher is a facilitator encouraging students to participate in self-construction of knowledge by presenting views and critiquing those of others. When a teacher asks students for riddle formation, this means she/he encourage students to present and discuss alternative analysis of concepts and alternative ways of solving tasks, rather than checking if they have the 'correct' solution. Ultimately this makes students feel confident and it facilitates students' natural urge for scientific inquiry and explorations, i.e., self-paced learning. Also, this enables the teacher to establish good scientific knowledge-construction practice in classroom.

Riddling: A Constructivist Paradigm

Constructivism is derived from latin word *construere* which means to arrange or to give structure. It is a learning theory that reveals construction of new ideas, knowledge by connecting the prior experience and understanding by herself/himself. National Curriculum Framework (NCF)–2005 strongly advocates this as a way of teaching-learning. It states, child-centred pedagogy should be followed, giving primacy to children's experiences, their voices and their active participation; and knowledge will be the outcome of the child's own activity. In science education constructivists believe the students are active learners who come to science lessons already holding ideas about natural phenomena, which they use to make sense of everyday experiences, ideas about life process which they experience in course of their daily life, etc. The process of riddle making provides a vibrant platform for the learner to self-construct conceptual understanding in a vivid manner. Riddling can be done by engaging students in intense conceptual discussion and open questions aimed at eliciting justifications. The teacher may challenge students' ideas, pointing out limitations and inconsistencies. These two roles plead for an active teacher

engaging as a 'partner' to student groups running their own debates.

Example 1

I am a light, highly reactive gas.

I'm used as automobile gas.

I produce water vapour as exhaust gas.

I am the fuel of Millions' first choice. Who am I ?

Explanation: Hydrogen gas (H_2) is considered as the future fuel. I do not produce any pollution as automobile run by hydrogen gas only produces water vapour i.e.
$2H_2(g)+O_2(g) \rightarrow 2H_2O(l)+572kJ$ $(286kJ/mol)$.
It is an exothermic reaction, Hydrogen gas is highly inflammable and burn in air at a very wide range of concentrations between 4 to 75 per cent by volume.

Example 2

I am very abundant in nature and found in every organic matter.

You can see me in many forms like graphite, diamond and fullerene.

It is possible through the property of catenation. Who am I?

Explanation: Carbon. Through this teacher can cover concepts like: abundance of carbon, allotrope, allotropic forms of carbon, catenation, composition of organic matter, etc. Carbon is the 15th most abundant element in the Earth's crust, and the fourth most abundant element in the universe by mass after hydrogen, helium, and oxygen. It is present in all known life forms, and in the human body carbon is the second most abundant element by mass (about 18.5 per cent) after oxygen. The abundance, together with the unique diversity of organic compounds and their unusual polymer-forming ability at the temperatures commonly encountered on Earth, make this element the chemical basis of all known life. Different allotropic forms are: (a) Diamond, (b) Graphite, (c) Lonsdaleite, (d) C_6 (Buckminsterfullerene or buckyball), (e) C_{540}, (f) C_{70}, (g) Amorphous carbon, and (h) single-walled carbon nanotube or buckytube, etc.

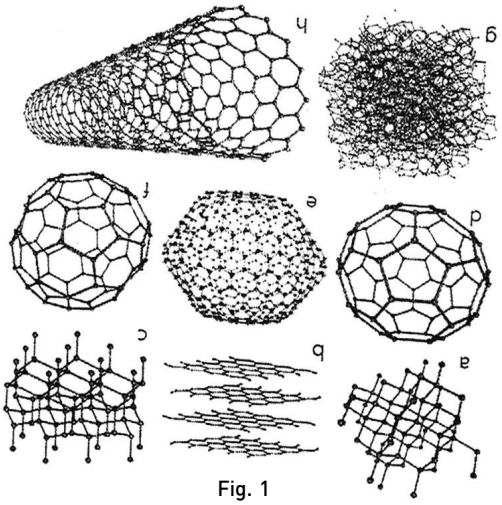

Fig. 1

Example 3

I am liquid in and colourless.

Less viscous, lighter than water.

People use me as I am cheaper than petrol.

Also used for storing sodium metal. Who am I?

Explanation: Kerosene. Concepts covered are viscosity, density, fossil fuel, use of Kerosene as common fuel, combustion reaction/oxidation reaction, etc., viz., Kerosene, a thin, clear liquid formed from hydrocarbons, with a density of 0.78–0.81 g/cm^3, is obtained from the fractional distillation of petroleum between 15°C and 275°C resulting in a mixture of carbon chains that

typically contain between 6 and 16 carbon atoms per molecule. Major constituents of Kerosene include n-dodecane, alkl benzenes, and naphthalene and its derivatives. Combustion of Kerosene is an exothermic reaction.

$$C_{12}H_{26}(l)+{}^{37}\!/_{2}\,O_2(g)\rightarrow 12CO_2(g)+13H_2O(g);\ \Delta H^{\circ}=-7513kJ$$

Example 4

In global warming phenomenon I am in 1:2:2 composition.

It comprises two different halogens and carbon.

With UV rays I undergo chemical disintegration. Who am I? (chlorofluoro carbon)

Explanation: CF_2Cl_2 (Freon-12/Du Point) Concepts covered: Global warming, green house gases, UV ray, decomposition reaction, Montreal protocol, ozone layer depletion, uses of CFCs, etc. A chlorofluorocarbon (CFC) is an organic compound that contains only carbon, chlorine, hydrogen and fluorine, produced as a volatile derivative of methane and ethane. It is also called as Ozone Depleting Substance (ODS) and it depletes ozone layer and causes skin cancer due to direct penetration of UV rays. it also causes environmental pollution. The most important reaction of the CFCs is the photo-induced scission of a C-Cl bond:

$$CCl_3F-CCl_2F+Cl$$

The chlorine atom, written often as (Cl) behaves very differently from the chlorine molecule(Cl_2). The radical Cl is long-lived in the upper atmosphere, where it catalyzes the conversion of ozone into O_2. Here ozone decomposes to oxygen. Montreal protocol restricted the use of ODS and safe use of alternate to CFCs which are conventionally used for refrigeration and aerosol.

Example 5

I am the lightest part of an atom.

I was discovered by J.J. Thomson.

I am in outer part of an atom and initiate many chemical reactions. Who am I?

Explanation: Electron. Concepts covered: Sub-atomic particle, chemical reaction initiation, orbital concepts of atom, J. J. Thomsons discovery. The electron (symbol: e^-) is subatomic particle discovered in 1897 by J.J. Thomson and his team of British physicists. It is produced in the process of photon collision. i.e $\gamma+\gamma\leftrightarrow e^{+}+e^{-}$. In quantum mechanics, the behaviour of an electron in an atom is described by an orbital, which is a probability distribution rather than an orbit. In the Fig. 2 the shading indicates the relative probability to "find" the electron.

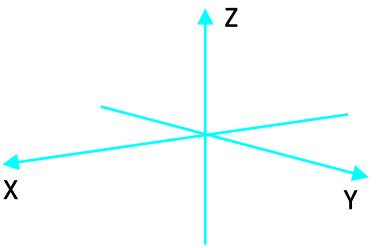

Fig. 2 : Orbitals $(\ell=0, m_\ell=0)$

Source: www.wikipedia.org/orbital

Example 6

Electric and magnetic fields oscillate me.
I am a wave and can travel anywhere.

Also my partner (radio wave) is group 2b Carcinogen.

I can make Radio, Telephone, TV, mobile live. Who am I?

Explanation: Electromagnetic radiation
Electromagnetic radiation, Radio communication, Telephone communication, Dual character (Wave and Particle nature). Electromagnetic radiation (EM radiation or EMR) is a form of energy emitted and absorbed by charged particles, which exhibit wave-like behaviour as they travel through space. EMR has both electric and magnetic field components, which stand in a fixed ratio of intensity to each other, and which oscillate in phases perpendicular to each other and perpendicular to the direction of energy and wave propagation. Louis de Broglie in 1924 that the scientific community realised that electrons also exhibited wave-particle duality so much so EMR also exhibit same duality.

Example 7

In modern industry, I am used as green solvent.

I have unique property of diffusion like gas through solids, can dissolve organic substances/ catalyst.

Being a fluid, I am used for chemical separation due to low toxicity and noninflammability.

I have no surface tension and has low viscosity.

Identify me (supercritical CO_2 fluid).

Example 8

People call me as universal solvent and polar solvents.

When heated at 374° C and 218 atm I can initiate synthetic reactions.

Under these conditions, I am categorised as cheap, clean and green solvents.

Who am I? (Super critical water)

Example 9

In the manufacturing of gold nano particles, I am used as a reaction starter.

I am highly toxic and burst into flames at room temperature.

Green chemists replace me with $NaBH_4$

This is how green chemists apply the principle of safer chemistry for accident prevention, i.e, to minimise the potential for chemical accidents including explosions and fire. Guess me!

Explanation: (Diborane B_2H_6)

Role of Teacher

According to Swami Vivekananda "True teacher is one who can throw his whole force into the tendency of the taught. Without real sympathy we can never teach well". Thus, in the process of riddling, the role of teacher is to organise information around conceptual clusters of problems, questions and different situations in order to engage the students interest. Primarily conceptual ideas are presented as broad concepts and then they are broken down into simplest forms. The learner reconstructs ideas into logical forms and finally derived conclusion, i.e., fixes the answer of it by herself/himself. Hence, the basic role of teacher is to engage students in an interactive way for the evolution of new ideas.

Conclusion

Teaching chemistry in schools and colleges aims at fulfillment of the goals of education, which covers a wide range of intended targets, i.e, the intellectual, personal and subject-society interface. Conceptual learning in chemistry needs to be approached in a relevant manner, but the teaching must also not lose sight of the fact that the attitudes, communication abilities and personal attributes amongst students (such as creativity, initiative, self-paced learning) need to be developed. This strongly calls for a paradigm shift in teaching-learning approach in chemistry. Chem-riddling is found to be an effective pedagogy for teaching chemistry at higher secondary and under-graduate level. It will not only encourage students' involvement, but will also result in a teaching approach that builds on prior constructs held by students, thus enhancing the relevance of chemistry in the eyes of students.

References

Banks, Richard C. 1996. *The Chemical Educator*. vol. 1, No. 2.

Biswal, B.N. 2012. No Mystery Only Chemistry, *Science Reporter*. vol.49, No.3.

Holbrook, J. 2005. *Chemical Education International*. vol.6, No.1.

Kaur, R. 2012. Constructivism: examining its applications in science education. *Edusearch*. vol.3, No.2.

Kaur, S. 2012. Effect of constructivism based teaching strategy on academic performance of students in chemistry at secondary level. *Edusearch*. vol.3, No.2.

Kind, Per M. 2011. *International Journal of Science Education*. vol. 33, No.18, pp. 2527–2558.

National Curriculum Framework. 2005. NCERT, New Delhi.

Rubab, S. 2012. Communicating science through thematic philately. Pre-proceedings of International conference on *Science Communication for Scientific Temper*. 10–12 January 2012, New Delhi.

Sharma, Mala D. 2004. *Resonance*. July–2004, pp74–76.

EXPERIENCE OF TEACHING ABOUT THE COMPONENTS OF THE AIR AT THE ELEMENTARY LEVEL

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While teaching in Class VIII of a rural Government Middle School during a field visit, the author found that students were confused between air and oxygen. This paper shows the attempt made to help the students realise that the air is a mixture of various gases. The major components of air are nitrogen, oxygen, carbon dioxide, water vapour and various other gases. These components have special characteristics. Although air is invisible, it is possible to show how each component of the air can be identified by performing activities.

Introduction

During a field visit, the author decided to go to a rural school in Haryana for a period of three months to transact the concepts given in the science textbooks, developed by NCERT in the light of National Curriculum Framework (NCF-2005). The author wanted to observe whether children are able to comprehend the concepts given in the textbooks, which would have actually given feedback about the textbooks and ultimately would have been helpful in revising these textbooks.

In a Government Middle School in Haryana, the author interacted with children of Upper Primary Stage, i.e., Classes VI–VIII. In the present paper the author wants to share one of her experiences while interacting with Class VIII students on the topic[16] Components of Air" (NCERT, 2006).

Interaction with Class VIII Students– A View

During the discussion I asked the students, "Do we inhale the air while breathing?"

Students: No, we inhale only oxygen and exhale carbon dioxide.

Me: From where do we get oxygen?

Students: The air

Me: Does this mean our noses have masks which filter oxygen from the air, which we breathe?

Students: (Laughing) "No madam".

I noticed that students are confused between the air and oxygen, because they were not realising that oxygen is one of the components of the air.

Here I was concerned about their understanding of the components of the air. However, components and composition of the air are usually covered in Class VI textbook.

Me: Do you know which components make up the air?

Students: (Saying with hesitation) Carbon dioxide and oxygen.

Me: You are right but along with carbon dioxide and oxygen, there are other gases also which the are present in the air. Let us find out.

I decided to discuss about the composition of the air and demonstrate the presence of various components of the air.

Next day I went to the class with the following materials:

Candles, beaker, copper sulphate, calcium hydroxide, testtube, straw, rubber cork with hole, match box, glass tumbler, water and ice.

Presence of Oxygen in the Air

I lighted two candles [Fig.1] and placed them on the table and asked the students "Which component of the air helps in burning?"

Students: The air

Me: (Reinforcing) but which component of the air?

Students: (Silence..... No answer).

[Here, it was important for me to tell them that it is oxygen present in the air which helps in burning].

Fig.1: Burning of candles

Me: What will happen to the burning candle if we do not supply air/oxygen? Let us find out.

Fig.2: Beaker Placed Over Burning Candle

Rahul (a student) placed a beaker over one of the burning candles [Fig. 2].

Sunder: Oh! It is still burning.

Puja: (A few seconds later) It got extinguished (Fig.3).

Fig.3: Candle got extinguished

Me: Why did it take a few seconds for a candle to extinguish?

Jaychand: May be some air was trapped inside the beaker.

Rahul: I think oxygen which was present in the air is over. That is why the candle got extinguished.

Me: Very good. So what have we understood from this activity.

Students: Oxygen is present in the air and it helps in burning.

Me: Good. So, you all will agree that this proves that oxygen is one of the components present in the air. Now, can you think is there anything else present inside the beaker?

Students: There is nothing inside the beaker except candle.

Here I deliberately did not want to talk about other components of the air. I wanted them to explore themselves, so I continued further.

Air Contains Carbon dioxide

Me: You have said earlier that the air contains carbon dioxide and we also exhale carbon dioxide. Let us prove it.

I took a little amount of lime water (which I prepared by dissolving calcium hydroxide in distilled water) in the test tube and set up the apparatus as shown in the Fig. 4.

Fig.4: Testtube Containing Lime Water

I asked children to exhale air into the test tube containing the lime water (Fig.5).

Fig.5: Exhaling Air in Lime Water

Students: Wow! It is turning milky (Fig.6).

Fig. 6 : Lime Water Turning Milky

Fig. 7: Testtube Containing Milky Lime Water

Me: Lime water turned milky (Fig.7). This shows the presence of carbon dioxide in exhaled air.

I also told students to leave freshly prepared lime water outside for few hours. Next day they were surprised to see that lime water turned milky. This shows presence of carbon dioxide in the air.

Presence of Water Vapour in the Air

I told children to take half a glass of water and clean it from outside with a piece of cloth. I asked them to add some pieces of ice into the water and told them to observe carefully.

Fig.8: Appearance of Water Droplets on Outer Surface of Glass Tumbler Containing Iced Water

Me: Can you see any changes on the outer surface of the glass tumbler?

Students: We can see some water droplets on the outer surface of glass tumbler (Fig.8).

Me: From where do water drops appear on the outer surface of glass tumbler?

Sunder: From the water contained in the glass tumbler.

Laxmi: May be from the air.

Me: Yes. The cold surface of the glass tumbler containing iced water cools the air around it and the water vapour of the air condenses on the surface of the glass tumbler.

I performed one more activity by involving children to prove that water vapour is present in the air.

I took copper sulphate crystals in a test tube (Fig.9) and heated it (Fig.10) and asked children to observe carefully.

Fig.9: Testtube Containing Copper Sulphate

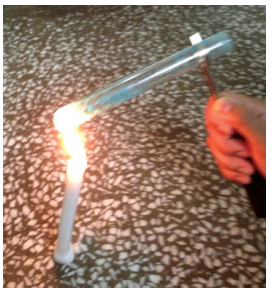

Fig.10: Heating Copper Sulphate

Students: Blue colour of copper sulphate is disappearing and it is turning white (Fig.11).

Me: Good. Can you observe anything else in the test tube?

Most of the students said "Nothing", except one student.

Fig.11: Disappearance of Blue Colour of Copper sulphate

Rahul: Yes, I can see some drops of water on the inner surface of the test tube (Fig.12)

Me: Where have these drops of water come from?

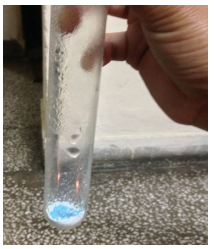

Fig. 12: Showing Presence of Water Drops

Students: Most of the students had blank looks.

Pooja: From the atmosphere

Students: Yes. Pooja is right.

They repeated what Pooja said "From the atmosphere"

Me: Can you think of any other answer?

Manju: May be the material that you have taken in the testtube contains water.

Me: Great. Water molecules are present in copper sulphate crystals. You will study about this in detail in higher classes. On heating copper sulphate, this water is removed which you could see in the test tube. On removing water, copper sulphate crystals turned white in colour.

Me: Is it possible for copper sulphate crystals to get the water back? Let us find out. Keep this copper sulphate in open for some time and observe.

Students: It is changing its colour and is retaining its original blue colour back.

Me: Can you give reason for what you have observed?

Students: May be it is getting its water back.

Me: Yes, but from where?

Laxmi: May be from the air.

Me: Well done. Copper sulphate has trapped water from the air. Since this is a rainy day, copper sulphate took less time to retain its colour. Otherwise it takes little longer.

This proves that the air contains water vapour.

After this discussion, I told one of the students to write all the components of the air which we have identified so far on the blackboard. To show students responses, I also drew a pie chart of air composition on the blackboard (Fig.3.13).

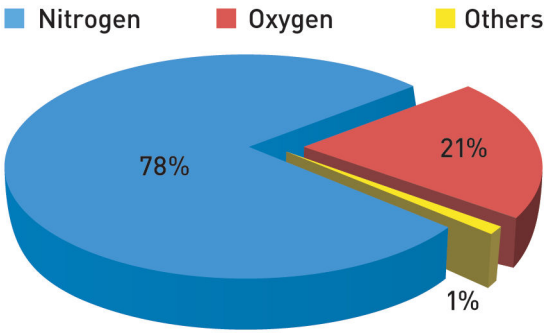

Fig.13 : Composition of the Air

Students: Madam you have shown in the Fig. 13 that the air contains nitrogen which we have not identified so far.

Me: Nitrogen and other gases, such as argon are non-reactive gases. Recall the activity "Burning of Candle", where oxygen gas was used in burning. However, nitrogen and other gases do not help in burning.

I showed them bloated packet of potato chips and asked them "Can you guess which gas is present in this packet?"

Students: The air. We mean oxygen

Me: It is filled with non-reactive gas such as nitrogen. It is a major component of air as you can see from the Fig. 3.13. If we fill this packet with air, the oxygen present in this air will make the oil rancid present in the chips and these will taste bad. To keep these chips fresh they are flushed with nonreactive gas, such as nitrogen.

After this discussion students did not give me time to ask and they concluded that major components of the air are nitrogen, oxygen, water vapour, carbon dioxide and other gases.

Pooja: Oh! Now I have understood that oxygen gas was used for burning candle and the other gases which were present inside the beaker could be nitrogen, carbon dioxide, water vapour, etc.

I could see the confidence on their faces and the joy of learning more and this journey on the path of education continued.

References

NCERT. 2005. *National Curriculum Framework*. NCERT, New Delhi.

___. 2006. *Science* for Class VI. NCERT, New Delhi.

AN INVESTIGATION INTO THE CONCEPTUAL UNDERSTANDING OF STUDENTS ABOUT THE CONTENT OF EVS AT THE PRIMARY LEVEL

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An investigation into the conceptual understanding of content of EVS at the Primary level has been carried out in 10 sample schools. Three schools were English medium and seven schools were Hindi medium from both rural and urban areas in Ajmer district of Rajasthan. Investigators observed the classroom transactions of the content of EVS of the sample schools and administered the research tools on students and teachers. Investigators also interviewed the subject teachers to seek specific information in relation to their academic and professional qualifications as well as classroom transaction. Analysis of the data was done through both qualitative and quantitative approaches indicates that there is a considerable difference in conceptual understanding of EVS between the two groups of students: those who were studying in Hindi-medium schools and those who were studying in English-medium schools.

Keywords: Conceptual Understanding of EVS.

Introduction

The objectives at the Primary stage are to nurture the curiosity of the child about the world to have the child engage in exploratory and hands-on activities for acquiring the basic cognitive and psychomotor skills through observation, classification, inference, etc., to emphasise design and fabrication, estimation and measurement as a prelude to the development of technological and quantitative skills at later stages; and to develop basic language skills: speaking, reading and writing not only for science but also through science. Science and social sciences should be integrated as 'environmental studies' with health as an important component and its teaching should be recast so that it enables children to examine and analyse everyday experiences. Concerns and issues pertaining to the environment should be emphasised in every subject and through a wide range of activities involving outdoor project work. Some of the information and understanding flowing from such projects could contribute to the elaboration of a publicly accessible, transparent database on India's environment, which would in turn become a most valuable educational resource (1-17). It is a long held debate in India whether the medium of education should be universally recognised English language or the regional language.

There are pros and cons of both the options. However, it is universally recognised that students learn better through their mother tongue as medium of instruction. Let us begin with some crucial questions related with medium of instruction. What is the impact of medium of instruction on conceptual understanding of content of EVS? Do students face problems in understanding concepts due to medium? What can be possible points which we should observe in class when teacher is teaching or what can be some of the possible statements that can be put in questionnaire for the teachers to fill? Keeping above in view, investigations into the conceptual understanding of students about the content of EVS at the Primary level have been carried out in 10 sample schools (three English-medium and seven Hindi-medium from both rural and urban areas) in Ajmer district of Rajasthan.

Plan of the Study and Tool

The research study was planned to be conducted in two types of schools – one following English-medium and the other teaching academic courses in Hindi including regional language. This study was restricted to only 10 schools (three English-medium and seven Hindi-medium) of Ajmer district situated both in rural and urban areas. Research tools were designed (Yadav and Sharma, 2011) for assessment of conceptual understanding of students about the content of EVS in three workshops using following performance indicators:

List of Performance Indicators

Interpreting → Clarifying → Changing from one form of representation to another
→ Paraphrasing
→ Representing
→ Translating

Exemplifying → Illustrating → Specific examples
→ Instantiating

Classifying → Categorising → Determining something that belong to category
→ Subsuming

Summarising → Abstracting
→ Generalising

Inferring → Concluding → Drawing logical conclusion from information
→ Extrapolating
→ Interpolating
→ Predicting

Comparing → Contrasting → Detecting correspondence in two ideas
→ Mapping
→ Matching

Explaining → Constructing modules

Above indicators were used to prepare the questions of EVS subject by a team of experts of education and teachers at Primary level and passed through a process of refinement and validation. To do this, the questions were revised based on the reactions of the two Primary school teachers about face validity, clarity of language and suitability for the age level of concerned students. In order to optimise the reliability and validity of the test, the test was first given to a group of 30 Primary level students. After necessary revisions stemming from the item

analyses of the study, in terms of item difficulty and item discriminatory indexes, conceptual tests for Classes III - V were formed (Yadav and Sharma, 2011). Finally 7 to 10 questions were kept in the conceptual tests. During the process of structuring the tools, concepts in EVS for Classes III-V were first identified and the subject experts prepared the questions covering those concepts. Additionally, experts' opinions were taken into consideration and the questions were translated from English into Hindi which was necessary for the students of Hindi-medium schools. The tool of conceptual understanding test was tested on two focus groups, one from the school taught in Hindi and one from the school taught in English for trial/vetting purposes. After interviews with experts in the field and students about the comprehensibility and clarity of the questions, the questions were revised and finalised. Conceptual tests (tools) were administered to students of Classes III-V at three English-medium schools and seven Hindi-medium schools. All the responses given by the students were analysed and classified into three categories namely (i) Acceptable Response (AR), (ii) Unacceptable Response (UR), and (iii) No Response (NR) for the analysis purpose.

Sample and Size of the Sample

In order to administer the said tools ten Primary Schools—three English-medium and seven Hindi-medium —from both rural and urban areas were identified in Ajmer district of Rajasthan. The list of sample schools is given here:

1. Government Upper Primary School, Rural Hindi-medium (RHM)
2. Government Upper Primary School, Urban Hindi-medium (UHM)
3. Government Upper Primary School (UHM)
4. Private Public School (UHM)
5. Government Girls Upper Primary School (UHM)
6. Government Upper Primary School (RHM)
7. Government Upper Primary School (UHM)
8. Demonstration Multipurpose School Urban English-medium (UEM)
9. H.K.H. School (UEM)
10. Sacred Heart Public School (REM)

The research study was conducted in two types of schools – one following English-medium and the other teaching academic courses in Hindi-medium including regional language. Researchers have compared the methods of both types of teachers applied in the classroom, their experiences, the curriculum and the materials they used in the classroom. Present study was conducted in only ten schools (three English-medium and seven Hindi-medium) with 60 teachers and 625 students studying EVS in Classes III – V of Ajmer district of Rajasthan situated both in rural and urban areas.

Analysis of the Responses and Results

Qualification of Teachers

The qualifications of the teachers teaching EVS in sample schools were determined using tools given in the reference (Yadav and Sharma, 2011). In Hindi-medium schools, 83.3 per cent teachers are postgraduate, 14.3 per cent graduate and 2.4 per cent teachers are with qualification of 10+2 whereas in case of English-medium schools 38.9 per cent teachers are Postgraduate, 44.4 per cent are graduates and 16.7 per cent are having 10+2 qualification. These percentages reveal that teachers in the Hindi-medium schools have higher

qualification than that of English-medium school teachers. The professional qualifications of teachers of Hindi-medium and English-medium indicate that the percentage of untrained teachers in Hindi-medium schools is only 4.8 per cent whereas in English-medium it is 11.1 per cent. It also revealed that in Hindi-medium schools the percentage of B.Ed. degree holder teachers is 76.2 per cent and in English-medium 73.2 per cent.

Medium-wise Responses

Classified into three categories – Acceptable Response (AR), Unacceptable Response (UR) and No Response (NR) for the analysis purpose. Students' responses on the basis of medium of instruction were obtained by administering assessment tools for studying the students' conceptual understanding about the concepts of EVS in Classes III, IV and V of Hindi and English-medium schools. Graphical representation of AR, UR and NR is shown in Fig. 4. Examination of responses shows that out of 10 items pertaining to conceptual understanding of students studying in Classes III, IV and V, the performance of students of English-medium schools is better than students of Hindi-medium schools.

Class-wise Responses

Details of students' class-wise responses for class III, IV and V respectively are graphically shown in Fig. 2 (a), 2(b) and 2(c). On examination of class-wise responses of EVS, it was found that the conceptual understanding of the students of Class V is better in comparison with other Classes (III and IV).

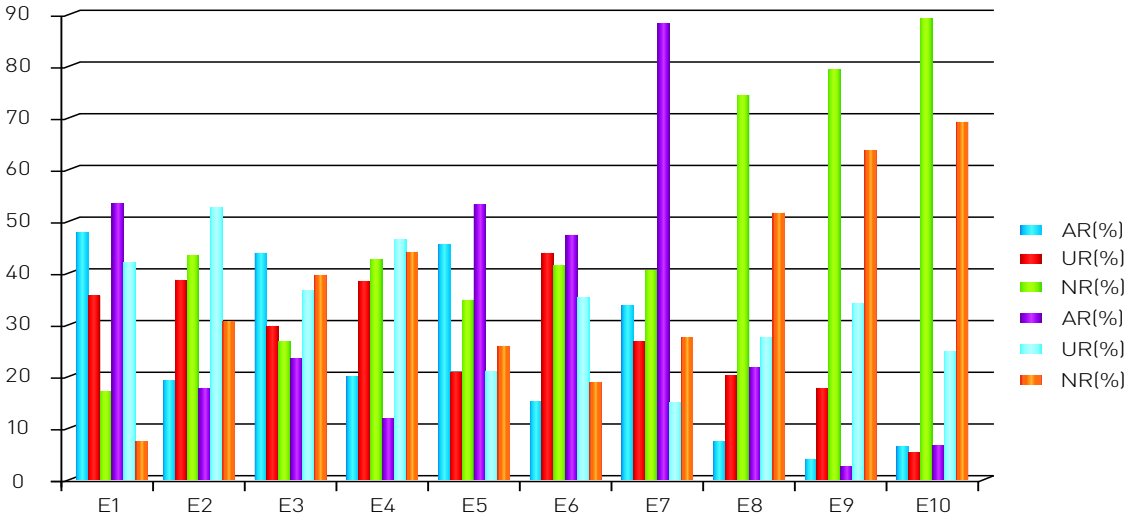

Fig.1: Students' Responses on the Basis of Medium of Instruction: EVS (Percentage of responses is given on Y-axis and number of item is given on X-axis).

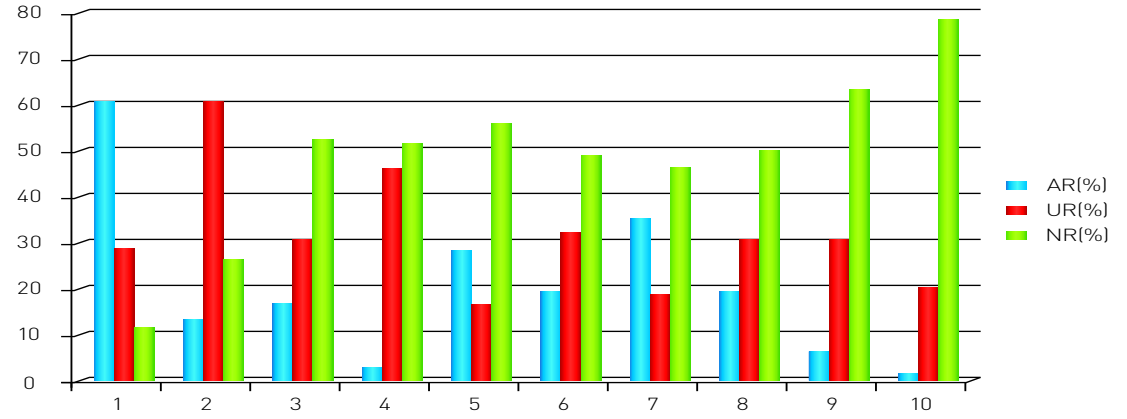

Fig. 2 (a): Class-wise Students' Responses of Conceptual Understanding of EVS (Class III)

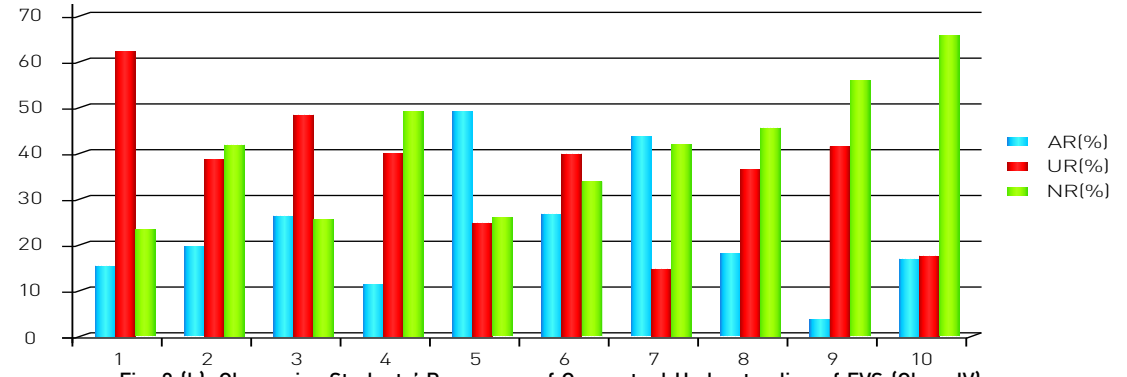

Fig. 2 (b): Class-wise Students' Responses of Conceptual Understanding of EVS (Class IV)

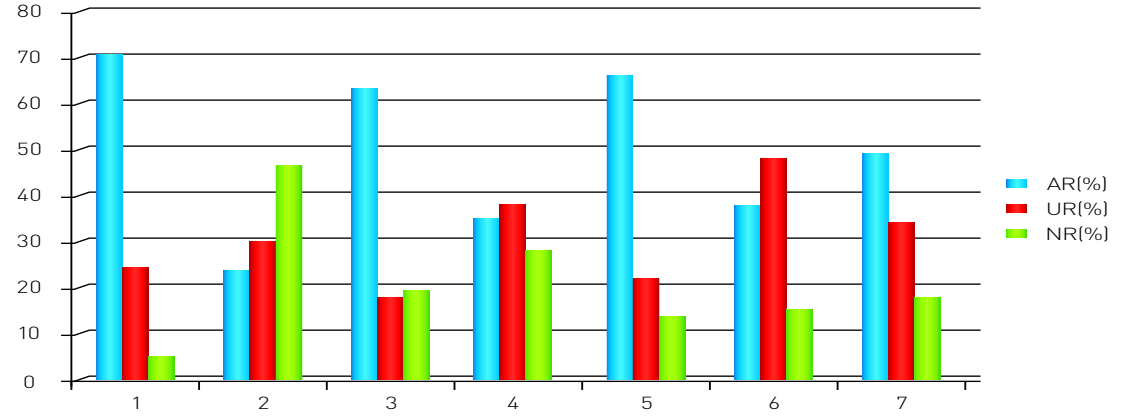

Fig.2(c): Class-wise Students' Responses of Conceptual Understanding of EVS (Class V)

Location-wise Responses

Students' responses were examined on the basis of location of schools (urban/rural). It is evident from Fig. 3 that the conceptual understanding of students in EVS of urban schools was better than that of rural schools.

School-wise Responses

Graphical representations of school-wise responses of students in EVS are shown in Fig. 4(a) – (j). In order to analyse the response we assumed that if students' response was equal or greater than 40 per cent, their conceptual understanding was considered as up to the mark. It is evident from Fig. 4(a) that the performance of the students of school No. 1 is satisfactory in EVS whereas in school No.2 performance of the students is not up to the mark as can be seen from the acceptable responses shown in Fig. 4(b). Analysis of the responses of students of school No.10 in EVS indicates that the performance of the students is sound whereas performance of students of schools No.8 and 9 is better. School No.8 and 9 are located in urban area whereas school No.10 is situated in rural area. School No. 8 only is Government school and the remaining two English-medium schools are private. Out of three English-medium schools, conceptual understanding of the students about the content of EVS is not up to the mark in school No. 10 where only one item was responded to correctly by 43.8 per cent students.

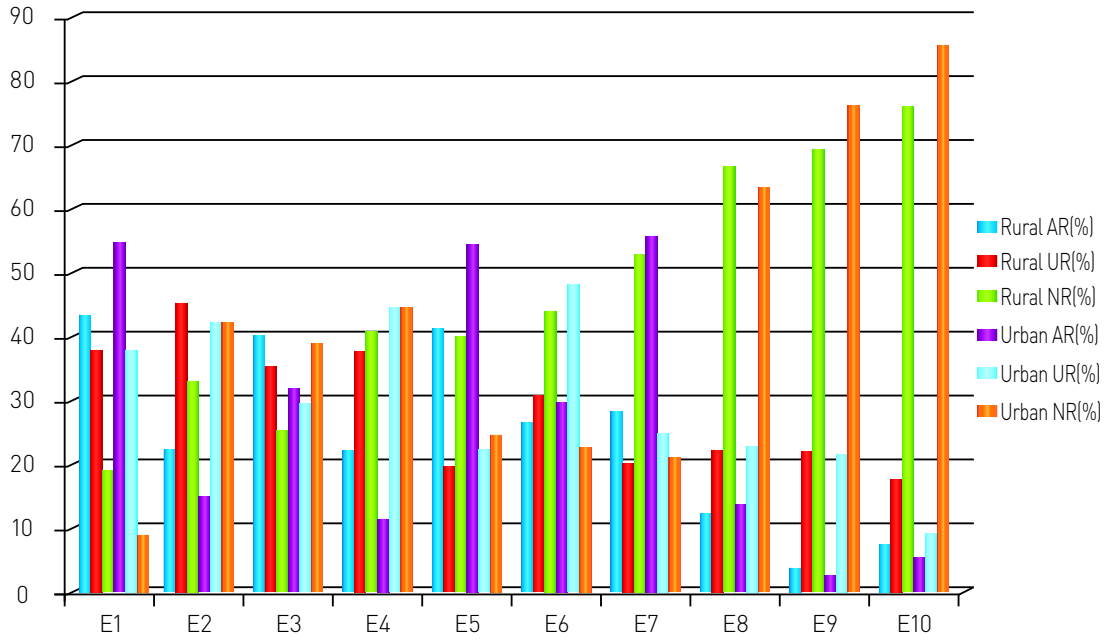

Fig. 3: Students' Responses on the Basis of Location of Schools: EVS

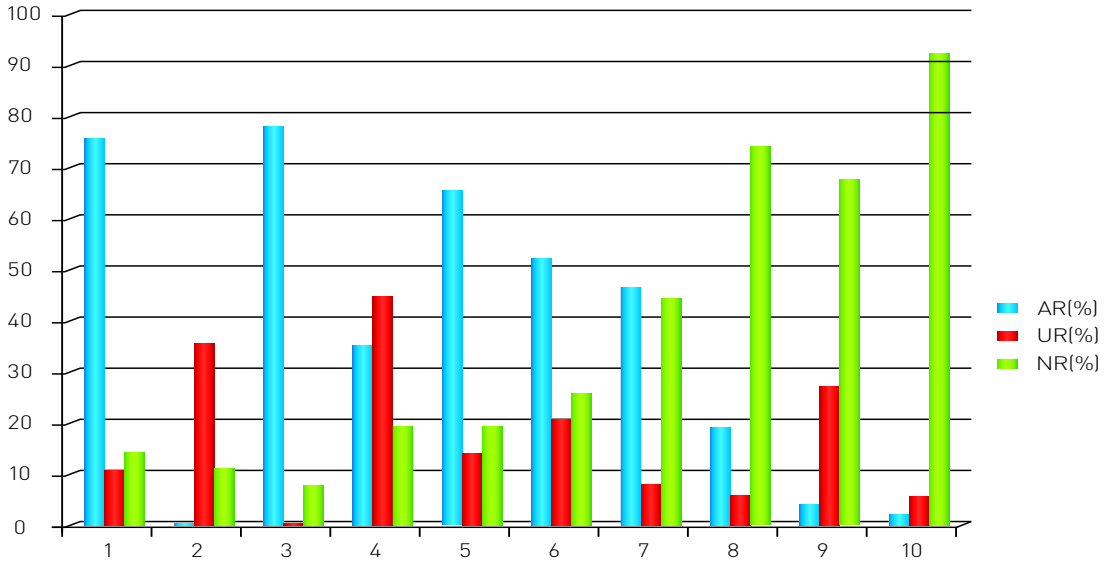

Fig. 4(a): School-wise Students' Responses for Conceptual Understanding of EVS: (School 1)

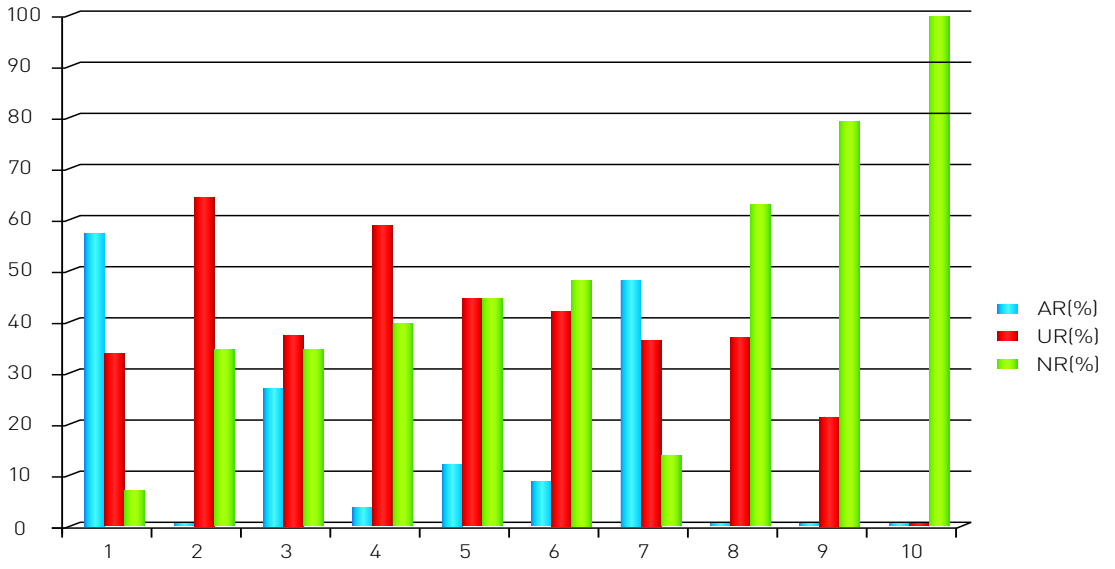

Fig. 4(b): School-wise Students' Responses for Conceptual Understanding of EVS: (School 2)

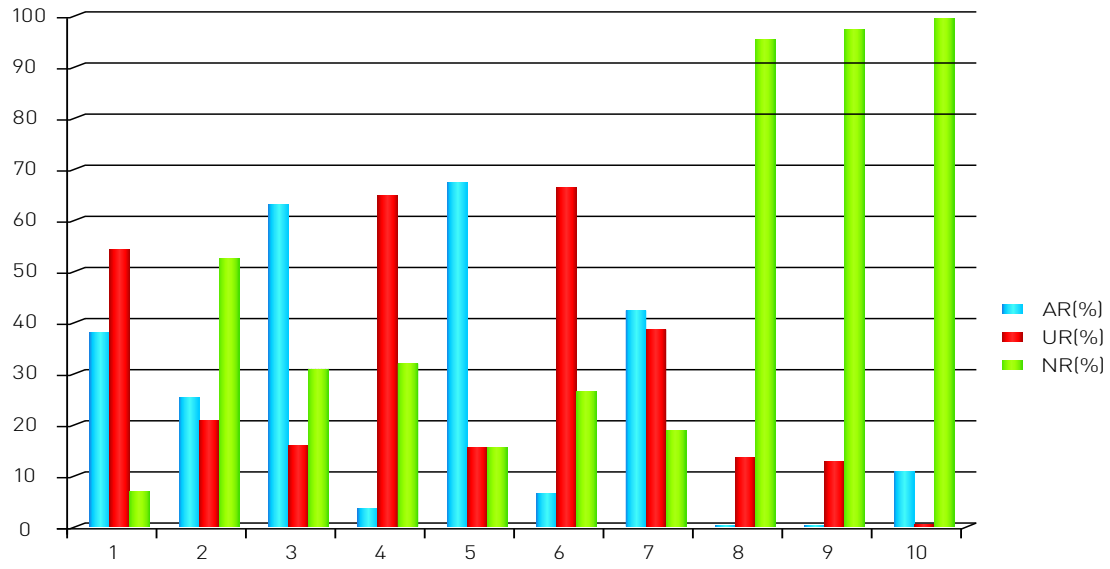

Fig. 4(c): School-wise Students' Responses for Conceptual Understanding of EVS: (School 3)

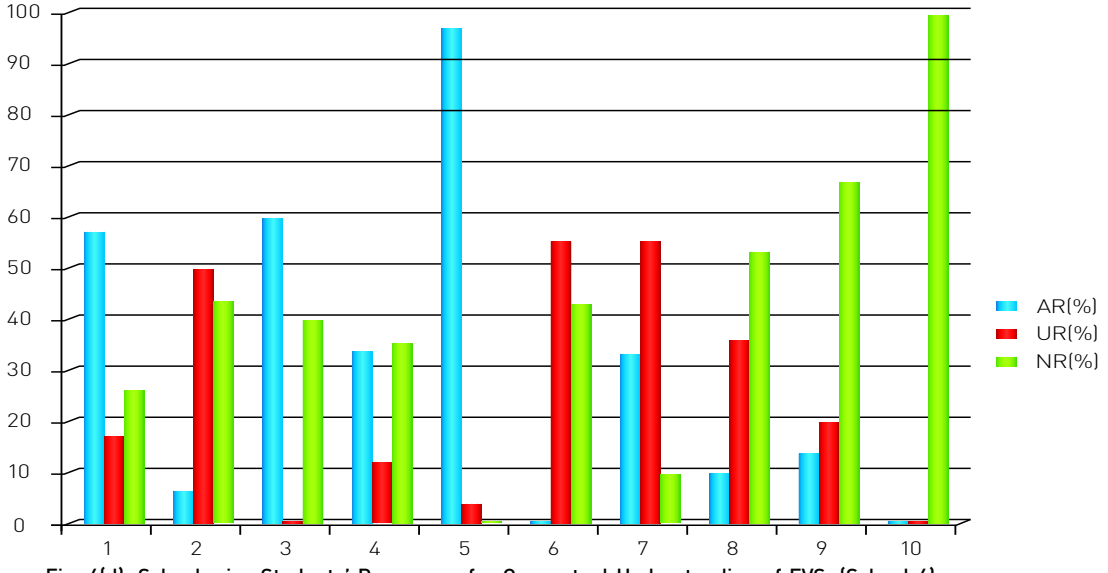

Fig. 4(d): School-wise Students' Responses for Conceptual Understanding of EVS: (School 4)

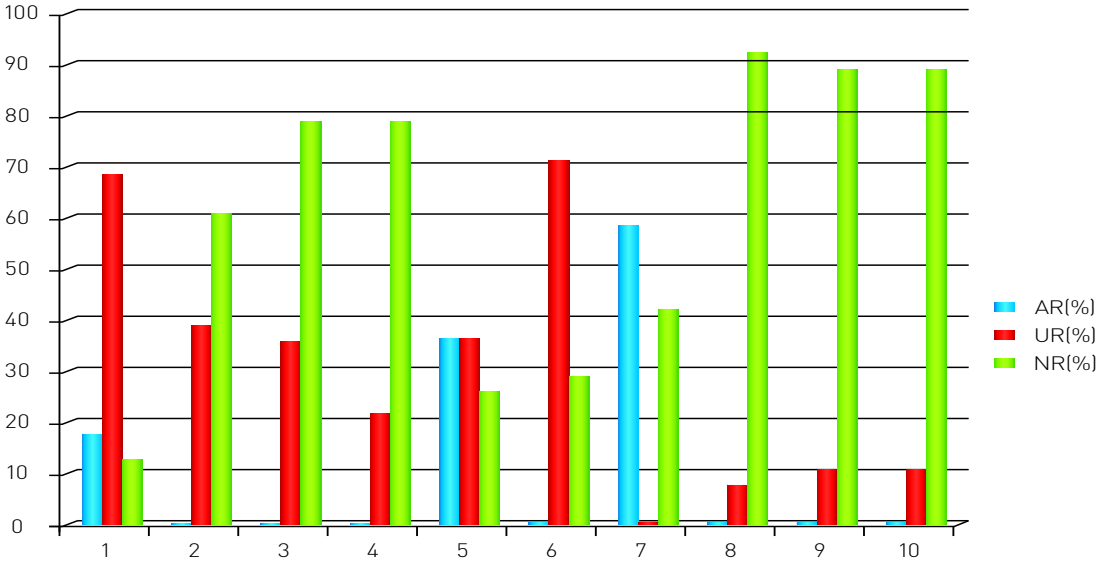

Fig. 4(e): School-wise Students' Responses for Conceptual Understanding of EVS: (School 5)

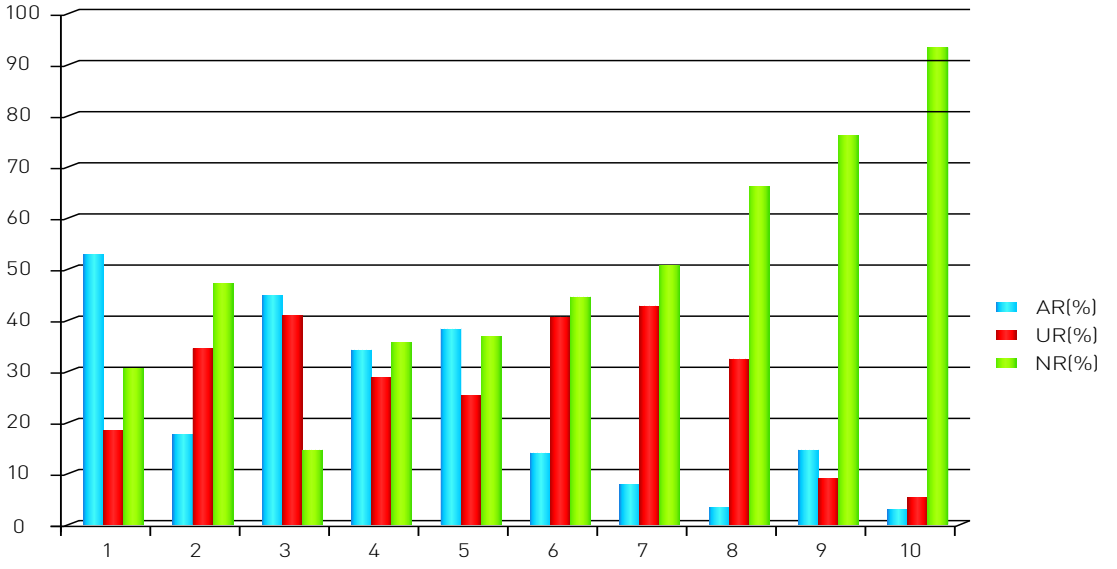

Fig. 4(f): School-wise Students' Responses for Conceptual Understanding of EVS: (School 6)

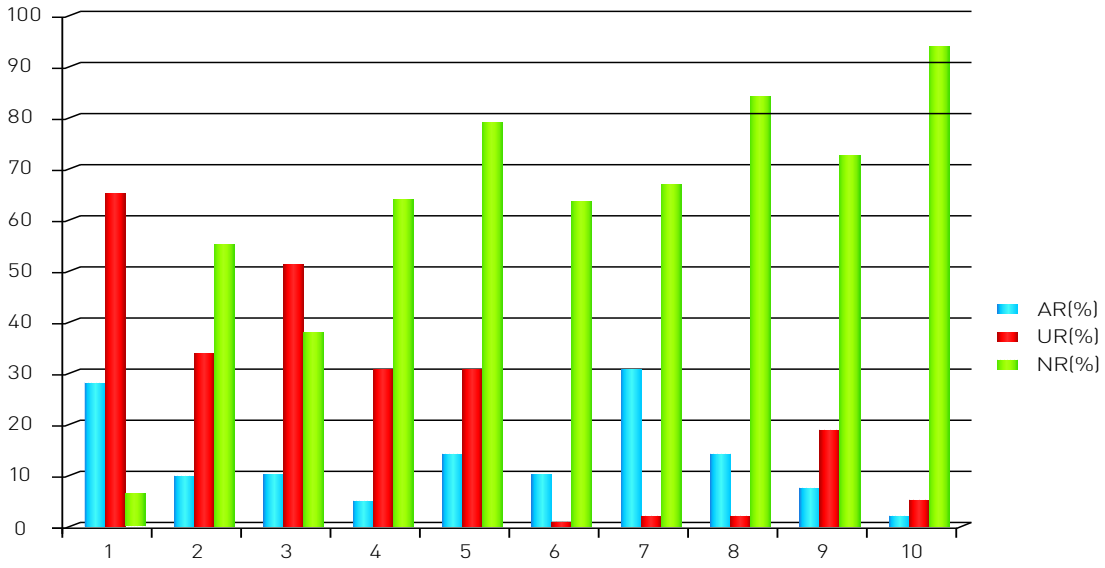

Fig. 4.4(g): School-wise students' responses for conceptual understanding of EVS: (School 7)

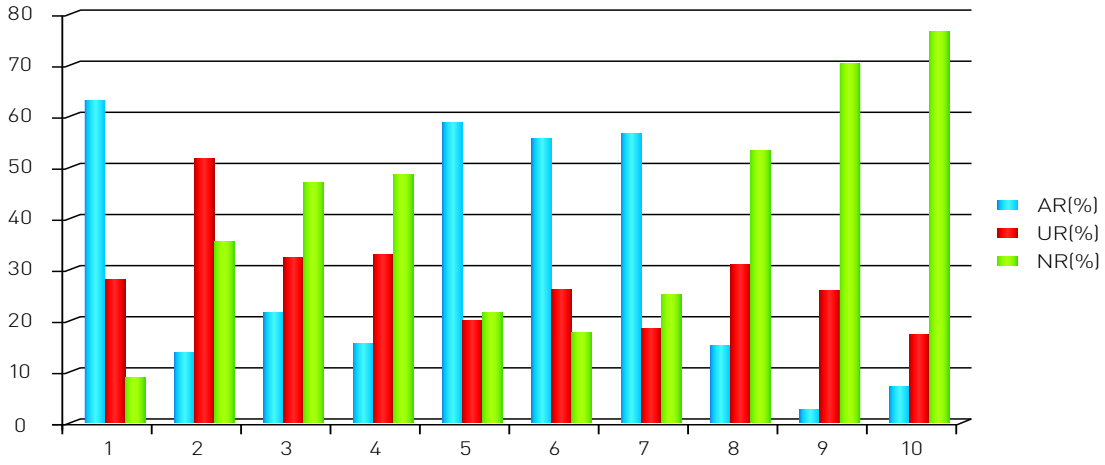

Fig. 4.4(h): School-wise students' responses for conceptual understanding of EVS: (School 8)

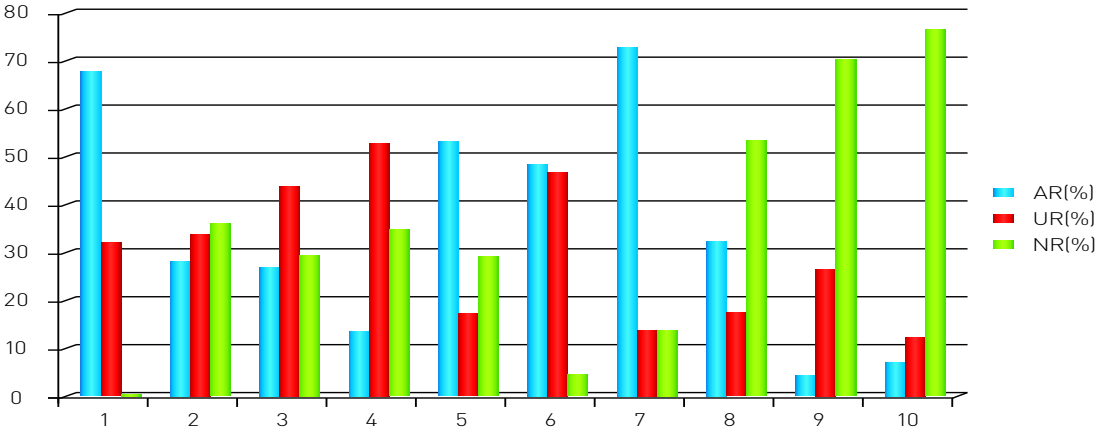

Fig. 4(i): School-wise Students' Responses for Conceptual Understanding of EVS: (School 9)

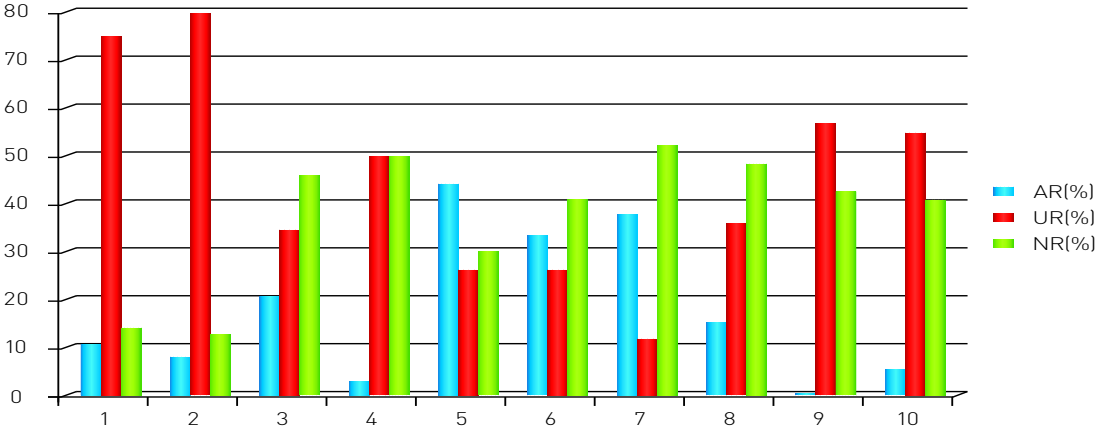

Fig. 4(j): School-wise Students' Responses for Conceptual Understanding of EVS: (School 10)

It has been found from the classroom observations that the Hindi-medium Government schools were lacking in infrastructure and physical facilities and the teachers by and large were using traditional teaching methods (photographs 2–5), whereas the English-medium private schools were found rich in infrastructure and the teachers were using latest computer-assisted techniques in classroom transaction as can be seen in the Photograph 1.

Photograph 1

The different methods used by the teachers in classroom for transacting the content of EVS in Government schools are shown in the following photographs (2–5):

Photograph 2

Photograph 3

Photograph 4

Photograph 5

Findings

On the basis of qualitative and quantitative analysis of data of ten primary schools (three English-medium and seven Hindi-medium) in Ajmer district of Rajasthan, the major findings are as follows:

- The medium of instruction in none of the schools was purely English or Hindi for transacting the content of EVS. When the teachers asked questions in English about the content of EVS to the students, only a few students replied in English only, that too in broken English. When students faced problem in replying in English about the content of EVS, the teachers used Hindi (including local dialect) and as a result, students were able to answer the questions in Hindi.
- When the teachers used English in some of the rural English-medium schools, students were found passive and showed no sign of enthusiasm and eagerness towards learning the content of EVS. But the same students showed keen interest and great

enthusiasm and took active part in learning when the teachers interacted in Hindi. The teachers used English only when the texts were read out from the books. All other teaching-learning interaction in EVS took place mostly in Hindi. When the teachers had to write something on the blackboard, they used English in English-medium schools and Hindi in Hindi-medium schools, respectively.

- From the analysis of students' response of conceptual understanding of EVS on the basis of medium of instruction it was found that the performance of students of English-medium schools was better than that of Hindi-medium schools. Analysis of responses revealed that conceptual understanding of students in EVS of urban schools was found better than that of the students of schools situated in rural areas. The maximum percentage of teachers in Hindi and English-medium schools who encouraged students' participation for classroom interaction and contributed in creating conducive learning environment is 69 per cent and 89 per cent, respectively.
- Academic qualifications of Hindi-medium school teachers were found higher than that of their English-medium counterparts. In regard to professional qualifications of teachers of Hindi and English-medium schools, data revealed that the percentage of untrained teachers in Hindi-medium schools was only 9.8 per cent whereas in case of English-medium schools the percentage of untrained teachers was 11.8 per cent. Analysis also revealed that the percentage of B.Ed. degree holder teachers was 76.2 per cent in Hindi-medium school and in English-medium School it was 73.2 per cent. Hindi-medium school teachers possessed more teaching experience in terms of years than that of English-medium school teachers. However, teachers were unexposed to the in-service programmes.
- The number of students was found less in Hindi-medium schools and the teachers were also not in sufficient number to engage the classes. It was also noted that there was no use of ICT in the classroom of Hindi-medium schools. However, some of the English-medium schools do have.

Discussion and Implications

The present study was conducted in only ten schools (three English-medium and seven Hindi-medium) of Ajmer district of Rajasthan situated both in rural and urban areas. The study was carried out with 60 teachers and 625 students studying EVS in Classes III – V. Therefore, results of the study can not be generalised to other parts of the country. However, on the basis of findings after the analysis of data pertaining to the study, the following recommendations are made:

- It was found from the analysis of the responses of conceptual understanding test of EVS that the performance of students of Hindi-medium schools was not up to the mark as compared to that of students of English-medium schools. Reason for this performance may be related with the lack of infrastructure in Government Hindi-medium schools. It was also observed that in English-medium schools there were sufficient number of teachers, but in Government Hindi-medium schools, there was shortage of teachers. Lack of sufficient number of teachers may be one of the reasons

for students not performing well in subject content of EVS. So, it is suggested that sufficient number of teachers should be made available in government schools.

- Although the Hindi-medium schools teachers are more qualified and experienced than their English-medium counterparts, however, students' performance in their schools is not as good as that of English-medium students. It may be because of teachers' frequent involvement in other assigned duties and responsibilities, which may adversely affect the performance of the teachers as well as students in conceptualisation of the content of EVS. Hence, it is suggested that these additional responsibilities may be minimised so that teachers can devote more time in teaching-learning activities related with EVS in schools.
- It was found that there were teachers who were unexposed to in-service training programmes for refreshing their subject both in content and pedagogy. Therefore, teachers may be provided opportunity to participate in in-service training programmes for refreshing their subject knowledge at least once in a year. Emphasis may be given to the activity-based teaching-learning process by involving students in it.

Interaction with the students while transacting the subject content of EVS needs to be encouraged. Teachers are expected to link classroom experiences with experiences outside the classroom situations during content transaction. The infrastructural challenge involved in making available computer hardware and software and connectivity to every school should be ensured for making teaching of EVS interesting and meaningful to the students.

Conclusion

On the basis of findings of the study it may be concluded that together with other factors such as the teachers' ability and their methods, mother tongue as medium of instruction plays a vital role in students' full participation in classroom teaching-learning process and conceptual understanding of the subject content of EVS.

Acknowledgement

Authors sincerely acknowledge their gratitude to Professor J. K. Sood and Dr A.S.Raizada for their contributions in the development of research tools pertaining to the present research study. Authors are also thankful to the Headmasters/ Principals for their help rendered during the tools administration and interactions with students and teachers in their schools.

References

Bark, M. 2004. *Research in Science and Technology Education*. 22, 171.

Borghi, L *et al*. 2005. *Physics Education*. 40 (3), 267.

CARVALHO P. S. AND A. S. SOUSA. 2005. *Physics Education*. vol. 40, No. 3, p.257.

CUMMINS, J. 2000. Bilingual Children's Mother Tongue: Why is it Important for Education?

JAIN, H.C. *et al*. 2003. Research Project Report. R.I.E., NCERT, Ajmer.

MEHROTRA. R. N. 1986. Medium of Instruction: a Case for Modern Indian Languages in School Education in India: Present Status and Future Needs. NCERT, New Delhi

National Curriculum Framework. 2005. NCERT, New Delhi.

SHARMA, S.V. *et al*. 2003. *School Science*. vol. XLI, 36.

__ et al 2004. *School Science. vol.* XLI, 14.

__ *et al*. 2005. *Physics Education*. p.179.

__ 2005. *Research Project Report*. R.I.E., NCERT, Ajmer.

__ 2006. *Research Project Report*. R.I.E., NCERT, Ajmer.

__ 2007. *Research Project Report*. R.I.E., NCERT, Ajmer.

__ *et al*. 2007. *Physics Education* (UK). vol. 42, No. 5, p.516.

__ 2011. *IAPT Bulletin*.168–175.

WATSON, J.R. 2004. *Int. J. Science Education*. vol. 26, p.57.

YADAV, S. *et al*. 2011. *Research Project Report*. R.I.E., NCERT, Ajmer.

PROJECTILE MOTION OF A CRICKET BALL FROM BOWLING TO OVER BOUNDARY IN CRICKET

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In a cricket game, bowler bowls at the batsman who hits the ball powerfully and hits an over boundary. In this process, first considered projectile motion of the ball from the bowler to the pitch where the ball strikes affecting an elastic impact with the grounds followed by its second projectile motion until being batted by the batsman causing the second impact but between the ball and the bat. The third projectile motion arises from the batsman to a spot outside the field resulting in score of an over boundary, So that in course of projectile motion of the cricket ball vis-a-vis its impact with the pitch and the bat a minimum velocity of hitting the ball with the bat by the batsman for over boundary is determined. Thereafter the maximum range in the horizontal direction of the ball due to a given velocity of hitting it, escaping a catch by a fieldsman, is also computed. All along the air resistance is neglected. The effects of spinning of the ball are neglected.

Introduction

Khillare (2006) dealt with the projectile motion of a cricket ball bowled by a player upto the pitch or upto the batsman in case of full-toss ball and thereafter with direct/oblique impact between the ball and the bat. In order to determine the velocity of the ball immediately after its impact with the bat, he considers that this velocity is in the direction normal to the bat surface, whereas from a realistic point of view, the batsman has all options to strike the ball in different directions which tends to affect the velocity of the ball. In his paper, Khillare (2006) has shown that the bowler throws the ball upward making an angle with the horizon to determine its range upto the pitch or batsman, which is far from a realistic situation. In fact the bowler throws the ball downwards making an angle with the horizon aiming at its reaching the pitch/batsman in so much as this leads to far greater velocity of approach of the ball towards the batsman who is then exposed to greater chances of misplaying/commiting mistakes causing bowled-out, caught-out or L.B.W. In Khillare's treatment, the cricket ball bowled by a player attains the greatest height and afterwards goes down to reach the pitch/batsman in a longer time. In contrast while watching a cricket match, the bowler is mostly observed to throw the ball downwards at a certain angle — horizon, i.e., not allowing it to attain the maximum height but for it to reach to the pitch or batsman in faster time. In the second phase, he considers the elastic impact of the ball with the pitch, taking into account the coefficient of elasticity between the ball and the ground. In the third, fourth and

fifth phases the motion of the ball from the pitch to the batsman at a certain range, elastic collision between the bat and the ball, and motion of the ball lifted by the batsman in air, ultimately scoring an overboundary have been discussed.

Motion of Cricket Ball from Bowler to the Pitch

Let the bowler deliver the ball from height h_1 measured from the ground downwards with velocity "u" an angle "α" to the horizontal and pitch "t" at a distance x_1 from himself in time t_1, g being the acceleration due to gravity neglecting the air resistance and considering its motion in the vertical and horizontal direction, as illustrated in Fig. 1.

$$h_1 = u \sin\alpha . t_1 + \frac{1}{2} g t_1^2 \quad (1)$$

$$x_1 = u \cos\alpha . t_1 \quad (2)$$

Had the ball been thrown upwards by the bowler at that angle keeping all other parameters the same, the ball would reach pitch in time t_1' covering the horizontal distance .

$$-h_1 = u \sin\alpha . t'_1 - \frac{1}{2} g t_1^2 \quad (3)$$

$$x'_1 = u \cos\alpha . t_1' \quad (4)$$

Comparison between equations (1) and (3) corroborates that $t_1' > t_1$ and consequently with a chance of yielding a full toss ball.

Eliminating t_1 between (1) and (2) one gets

$$h_1 = x_1 \tan\alpha + \frac{1}{2} g \frac{x_1^2}{u^2} \sec^2\alpha \quad (5)$$

Bounce of the Ball from the Pitch

Let the ball strike the pitch with velocity v_1 at angle to the level ground. Then according to textbook' the relation between the initial and final velocities in the vertical direction is given by

$$v_1^2 \sin^2\beta = u^2 \sin^2\alpha + 2gh_1 \quad (6)$$

While the horizontal component of the velocity remain constant

$$v_1 \cos\beta = u \cos\alpha \quad (7)$$

Considering an elastic collision[2] of the ball with the pitch having the coefficient e_1 of elasticity between them, by Newton's experimental law of collision, one can write

$$v_2 \sin\gamma = e_1 v_1 \sin\beta \quad (8)$$

Where v_2 is the velocity of the ball after rebound the pitch at an angle γ to the horizontal. This is illustrated also in Fig. 1. After all the horizontal component of the ball velocity remaining constant because of no gravitational force and no impulsive action in that direction, we can rewrite

$$u \cos\alpha = v_1 \cos\beta = v_2 \cos\gamma \quad (9)$$

Thereafter if the cricket ball attain a height h_2 from the pitch (to be stricker by the batsman) and thus travels a horizontal distance x_2 along the pitch in time t_2, then

$$h_2 = v_2 \sin\gamma t_2 - \frac{1}{2} g t_2^2 \quad (10)$$

$$x_2 = v_2 \cos\gamma t_2$$

Or, because of (9), it becomes

$$x_2 = u \cos\alpha . t_2 \quad (11)$$

Eliminating t_2 between (10) and (11) one gets

$$h_2 = \frac{x_2 v_2 \sin\gamma}{u\cos\alpha} - \frac{1}{2} g \frac{x_2^2}{u^2}\sec^2\alpha \qquad (12)$$

Further by use of (6) and (8), one gets for (12) :

$$h_2 = \frac{x_2 e_1 \sqrt{u^2\sin^2\alpha + 2gh_1}}{u\cos\alpha} - \frac{1}{2} g \frac{x_2^2}{u^2}\sec^2\alpha \qquad (13)$$

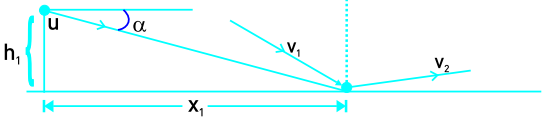

Fig. 1: The Ball Delivered by the Bowler is Bounced from the Pitch and Approaches the Batsman.

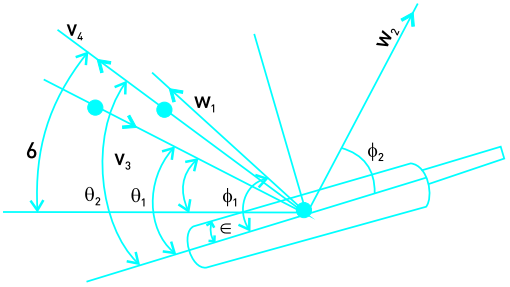

Fig. 2: The incoming Ball is Batted and Levels the Bat.

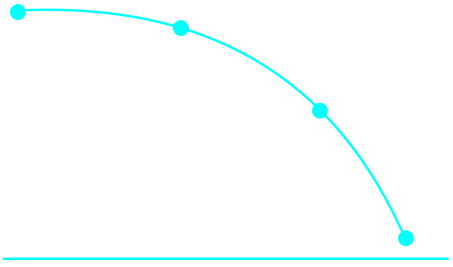

Fig. 3: The Ball Smashed by the Batsman Soars into the air Resulting in a Six.

If v_3 be the velocity of the ball and δ the angle of its inclination to the horizon after attaining the height h_2 from the pitch,

$$v_3^2 \sin\delta = v_2^2 \sin^2\gamma - 2gh2 \qquad (14)$$

$$v_3 \cos\delta = v_2 \cos\gamma = v_1 \cos\beta = u\cos\alpha \qquad (15)$$

Employing (8) in (14), one gets

$$v_3^2 \sin^2\delta = e_1^2(u^2\sin^2\alpha + 2gh_1) - 2gh_2 \qquad (16)$$

Impact Between the Bat and the Ball

Let the batsman strike the ball moving with velocity v_3 inclined at angle δ to the horizontal as above obviously resulting in an oblique elastic impact between the bat and the ball such that just before the impact the velocity of the bat is w_1 making and angle ϕ_1 to the plane surface of the bat at the point of contact between the bat and the ball is angle $(90-\phi_1)$ to the normal to the surface at the point of contact and the velocity of the approaching ball is v_3 whose direction makes an angle θ_1 in the same way with the plane surface of the bat, entailing

$$\theta_1 = \in + \delta \qquad (16\text{-}1)$$

Where $\in$ is the inclination of the bat surface with the horizontal.

So much so that let v_4 be the velocity of the ball immediately after the impact between the ball and the bat i.e. the velocity with which the ball leaves the bat, say, at an angle θ_2 to the bat surface and w_2 the velocity of the bat inclined at an angle ϕ_2 to the bat surface at the point of contract after the impact owing to the batsman's striking the ball with the bat. This is depicted in Fig. 2. Since the components of velocities perpendicular to the line of impact, i.e., along the line of intersection between the plane surface of the bat, and the plane containing the bat—normal at the point of contact of the bat with the ball at the instant of

strike by the batsman and the direction of approach velocity of the ball before the impact remain unaltered before and after the impact because of no impulsive action along that line, we get

$$v_4 \cos\theta_2 = v_3 \cos\theta_1 \quad (17)$$

$$w_1 \cos\phi_1 = w_2 \cos\phi_2 \quad (18)$$

By the principle of conservation of momentum (Loney, 1969) along the line of impact i.e. normal to the surface of the bat of mass M striking the ball of mass m, one can write

$$mv_4 \sin\theta_2 + Mw_2 \sin\phi_2 = -mv_3 \sin\theta_1 + Mw_1 \sin\phi_1 \quad (19)$$

$$v_4 \sin\theta_2 - w_2 \sin\phi_2 = -e_2(-v_3 \sin\theta_1 - w_1 \sin\phi_1) \quad (20)$$

Which is due to Newtons experimental law (Loney, 1969) of collision, e_2 being the coefficient of elasticity between the ball and the bat. Combining (19) and (20),

$$V_4 \sin\theta_2 = \frac{M(1+e_2)w_1 \sin\theta_1 - (m - Me_2)v_3 \sin\theta_1}{M+m} \quad (21)$$

$$w_2 \sin\phi_2 = \frac{(M - e_2 m)w_1 \sin\phi_1 - m(1+e_2)v_3 \sin\theta_1}{M+m} \quad (22)$$

Dividing (21) by (17), we obtain the direction of the velocity of the ball heading towards over boundary which of course solely depend upon the batsman's prowess and strength of hitting the ball corroborated by the v_4 and θ_2 as above, escaping a fieldsman's catch and passing over the boundary line. However, squaring and adding (21) and (17) is obtained the velocity v_4 acquired by the ball after being striken by the batsman in an attempt to credit an over boundary.

$$V_4 = \left[\left\{\frac{M(1+e_2)w_1 \sin\theta_1 - (m - Me_2)v_3 \sin\theta_1}{M+m}\right\}^2 + v_3^2 \cos^2\theta_1\right]^{1/2} \quad (23)$$

But the ball leaves the bat for an overboundary at an angle σ to the horizon given by

$$\sigma = \theta_2 - E \quad (24)$$

Conditions for over Boundary

If the ball, after being hit by the batsman as above, strikes the ground beyond the boundary line covering a horizontal range R from him in time t_3 then

$$-h_2 = v_4(\sin\sigma)t_3 - \frac{1}{2}gt_3^2 \quad (25)$$

$$R = v_4(\cos\sigma)t_3 > R_0 \quad (26)$$

$$t_3 = \left[v_4 \sin\sigma + \sqrt{v_4^2 \sin^2\sigma + 2gh}\right]/g \quad (27)$$

Where R_0 is the distance of the boundary line from the batsman smashing the ball for an over-boundary. Relation (23) suggests that the more is the speed of the bat hitting the ball, the more is the velocity of the ball leaving the bat, however this velocity of the ball also depends on the angle ϕ_1 of posing the bat and contributes to its lifting in the air for safely crossing the boundary evading any scope of "catch" by any fieldsman.

Maximum Range of the Cricket Ball with given Velocity of the Ball Leaving the Bat

Now we can find the maximum range of the ball proceeding for an over boundary with respect to an optimum inclination of the velocity of ball acquired immediately after being hit by the batsman. This can be obtained by eliminating t_3 between (26) and (27) and thereafter applying differential calculus for maxima/minima.

$$-h_2 = R\tan\sigma - \frac{1}{2}gR^2(\sec^2\sigma)/v_4^2 \quad (28)$$

Differentiating (28) with respect to and setting

$$\frac{dR}{d\sigma} = 0 \quad (29)$$

for maxima/minima of R, one gets

$$R_{\max} = \frac{v_4^2}{g\tan\sigma_{opt}} \quad (30)$$

Eliminating R_{max} between (28) and (30), we get

$$-h_2 = \frac{v_4^2}{g} - \frac{v_4^2}{2g}\frac{(1+\tan^2\sigma)}{\tan^2\sigma}$$

Or, $\tan^2\sigma = \frac{2gh_2}{v_4^2} + 1$ (31)

Employing which in (30) we find the maximum range

$$R_{max} = \frac{v_4^2}{g\sqrt{1+\frac{2gh_2}{v_4^2}}} \quad (32)$$

It can also be shown that $\left(\frac{d^2R}{d\sigma^2}\right)_{\sigma opt} < 0$ as the condition for maximum range.

The minimum velocity with which the ball can be relieved of the bat due to strike by the batsman for a given horizontal range R can be obtained by use of $\frac{d(v_4^2)}{d\sigma} = o$ from (28):

$$\left(v_4^2\right)_{min} = g\left(\sqrt{h_2^2 + R^2} - h_2\right) \quad (33)$$

$$\left(\tan\sigma_{opt}\right) = \left[-h_2 + \sqrt{h_2^2 + R^2}\right] / R \quad (34)$$

σ_{Opt} is the optimum angle of projection of the just batted ball to obtain the maximum range R_{max} with given initial velocity v_4 or the minimum velocity $(V_4)_{min}$ with given range R.

Numerical Example

In this section it is discussed with the help of a table how the batsman elegantly hits the ball for overboundaries. The cricket ground is of oval, i.e., elliptic shape with approximate distance 72 metre to 82 metre between the boundary line and the pitch, i.e., position of the batsman. So employing (27) and (32) is prepared Table 1 with given data mostly effecting a six. The average velocity of just batted ball varies from 90km/hr to 120km/hr for a sixer in a cricket match. The acceleration due to gravity = g= 10 metre/sec^2

Table 1

Velocity of the batted ball (metre/ sec.)	Exit Velocity of the batted ball (km/hr)	Inclination of the exit velocity with the horizontal (degree)	Height of the ball in contact with the bat (metre)	Time of the flight of the ball on striking the ground (second)	Horizontal distance covered by the ball (metre)	Distance of the boundary line from the batsman in the plane of the flight of the ball (metre)	The greatest height attained by the ball (metre)	Over boundary Yes or No
30	108	60°	1.00	5.22	78.165	75.12	34.75	Yes
28	1008	30°	1.00	2.87	69.616	72.52	10.80	No
30	108	30°	1.20	3.08	80.018	78.14	34.95	Yes
25	90	45°	1.50	3.621	64.010	70.15	17.125	No
30	108	45°	1.25	4.303	91.278	80.25	23.75	Yes
27	972	45°	1.25	4.025	76.845	74.35	19.475	Yes
28	100.8	60°	1.00	4.895	68.430	81.15	30.40	No
30	108	Sin-3/5	1.00	3.655	87.720	80.38	17.20	Yes
30	108	Sin-14/5	1.00	4.842	87.156	79.52	29.80	Yes
27	972	60°	1.00	4.719	63.714	73.25	28.34	No

Table 5.1 spells out that a batsman can strike a six by lifting the batted ball high after imparting it higher velocity. Nevertheless the batsman can drive the ball with comparatively lesser high speed followed by attaining lesser height in lesser time to get it over boundary. Otherwise the batted ball falls short of the boundary line to be caught by a fieldsman or rolls on the ground to the boundary line for a four.

References

KHILLARE, S.R. 2006. Mathematics for better cricket. *Bulletin of Marathwada Mathematical Society*. vol. No. 2, pp.49–56

LONEY, S.L. 1969. *The Element of Statics and Dynamics Part II*. Book Palace. pp. 125–144.

SCIENCE TEACHERS AT THE UPPER PRIMARY LEVEL IN DIRECT CONVERSATION WITH TEXTBOOK DEVELOPER DURING VIDEO-CONFERENCING: AN EXPERIENCE

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Introduction

In education system, there has to be congruence among policy statement, curriculum, syllabus and content in textbooks .The introduction of changes needs comprehensive planning, but as no planning is perfect, introduction of changes needs not wait too long. Similarly, it is found that curriculum misses some policy initiatives, syllabus misses some aspects of curriculum and textbooks misses some aspects of syllabus. Hence, periodic reviews should be undertaken to identify gaps and missing links. In the sequence of curriculum revision, this was the fourth revision of curriculum which made available National Curriculum Framework–2005 (NCF–2005) in our hands.The NCF–2005 has significantly altered the perspective on subject content in the light of constructivist approach to teaching-learning, by giving emphasis on the development of critical thinking and self-reflection abilities among students. The major thrust is given on enhancing comprehension of children in the classroom and integration of evaluation within the teaching-learning process. The foundation of success of any planning is not laid only through the involvement of educational planners, teachers, experts, representatives of the government and non-government organisations, but the voice of layperson is equally important. Hence, the process of further revision of curriculum was open to everybody for the inclusion of their views as well as of their feedback about the current scenario. After revision of curriculum, the syllabi in different areas were developed with the spirit to make an attempt to eradicate the problem of loaded bags.

As a continuous effort, the new textbooks have been developed by the team consisting of teachers, subject experts, representatives from various government and non-governmental organisations. The NCF–2005 has provided the necessary guidelines and directions for organising the content in different subjects at the various stages of school education.

After development of textbooks the major thrust was to reduce the distance between textbook developers and textbook users. Hence, while the textbooks were being prepared, it was realised in different forums that there is a need for orientation of teachers in the use of new textbooks considering the approach and

organisation in terms of content, style, exercises and illustrations, etc., in conformity with the thinking of NCF–2005.

The practice that has been followed for seveval years is to initiate the chain reaction by preparing the Key Resource Persons who further train other teachers, and the process goes on. But with time, it has been found that the quality of training dilutes at successive levels.Hence, it was appreciated that the orientation of teachers be organised by involving maximum possible number of teachers across the country and with an opportunity to these teachers to interact directly with the resource persons/experts and textbook writers so that they can be motivated to participate at all stages of the innovations and could gain confidence with a sense of self achievement.

Technology helped us to find out the solution so that the balance between quality and quantity could be taken into consideration. The use of videoconferencing, one of the modes of virtual academy, was adopted for the nation-wide orientation programme for the teachers of Kendriya Vidyalaya Sangathan, Navodaya Vidayalaya Samiti and independent schools affiliated to the Central Board of Secondary Education, on the use of new textbooks developed by NCERT, based on NCF–2005.The objectives of the programme were:

- to orient the teachers with new approach to education articulated in NCF –2005;
- to make them aware about the organisation of content and the use of the new textbooks; and
- to obtain feedback of teachers for continual and possible future improvements in school education.

The use of videoconferencing in the programme provided opportunity to about 40,000 teachers across the country for being in direct conversation with experts and textbooks writers. The discussion and consultations with focus on expeditious communication with teachers on NCF–2005, syllabi and the new textbooks led to the conclusion that videoconferencing could be an appropriate mechanism for the purpose. The programme was organised phase wise in coherence with the development of textbooks for each stage. The programme for the teachers of upper primary level was organised in three phases linked to three stages of textbooks development for various subjects.

The use of videoconferencing mode for the organisation of orientation of science teachers in three phases enabled about 3,650 teachers [VI -1291;VII-1307 andVIII-1052] to interact with experts / textbook writers through 30 learning centres located in different States, e.g., Andhra Pradesh, Karnataka, Tamil Nadu ,Kerala, Chhattisgarh, Himachal Pradesh, Madhya Pradesh, Rajasthan, Odisha, Gujarat, Haryana , Uttarakhand, Maharashtra, Uttar Pradesh, Assam, J & K, Meghalaya, Goa and Union Territory of Chandigarh.

The activities during each day consisted of:

- three presentations by the experts (30 minutes each) from teaching end, i.e., Central Institute of Technology (CIET) studio;
- three group-works by the teachers after each presentation in the supervision of master trainers at learning centres (30 minutes each); and
- three live interactions of teachers with the experts (60 minutes each).

Table 1

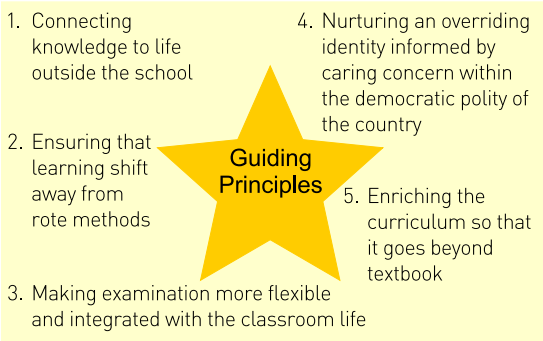
Types of Questions, Queries, Observations and Suggestions Made by the Science Teachers during Live Interaction

Class	Syllabus/ Curriculum	Textbook Content	Evaluation	Teaching Methodology	Non-availability of Books in Time	Infrastructure & Other Support Facilities	Time Management	Total
VI	11	20	14	11	05	02	02	65
VII	7	75	5	25	7	0	1	120
VIII	10	20	5	11	6	07	05	64
Total	**28**	**115**	**24**	**47**	**18**	**09**	**08**	**249**

The three presentations made by experts on each day were concerned with:

- Salient features of the new textbooks (*content, style, exercises and Illustrations, etc.*), reflection of NCF–2005 in new textbooks, interconnection/continuum across subjects and levels (classes) of education and Guidelines for using Textbooks;
- Teaching strategies for selected topics in the subject areas; and
- Evaluation strategies to be adopted by the teachers at different levels.

The main purpose of writing this paper is to: disseminate important information to a larger number of teachers who could not be included in the videoconferencing; to use the compiled information for enriching future programmes; and to make available the feedback of teachers on NCF–2005, new syllabi, textbooks and other related aspects to policy planners and other stake holders in school education. The group of teachers in Science subjects have provided their views, observations and feedback and also put forward their questions/queries. During live



interaction a total of about 249 questions/queries, observations and suggestions were made by the teachers (Table 1).

What NCF–2005 Says about Science Education?

The NCF– 2005 addresses the problem of curriculum load on children and it elaborates on the insight of "Learning without Burden". It recommends a major change in design of syllabi and textbooks and also a change in social ethos. To make teaching a means of harnessing the child's creative nature, NCF–2005 also recommends a fundamental change in the matter

of organising school curriculum and in the system of examination. It will enable teachers, administrators and other agencies to develop and employ innovative, local, need-based programmes. The NCF–2005 proposes five guiding principles for Curriculum Development (CD) which are as follows:

NCF–2005 makes us realise to make education more relevant to the present-day and future needs. It recommends to alleviate the stress which children are coping with and also suggests the softening of subject boundaries so that children can get taste of integrated knowledge and joy of understanding. It views that resource must be developed to enable children to express themselves, handle objects, explore their natural and social milieu and to grow up healthy children's classroom experiences that permit them to construct knowledge.

NCF– 2005 envisages that good science education is true to child, true to life and true to science. Science is a dynamic, expanding body of knowledge covering every new domain of experience. Broadly speaking, scientific method involves several interconnected steps, i.e., observation, looking for regularities and pattern, making hypothesis, devising qualitative or mathematical model, deducing their consequences, verification of theories through observation and controlled experiment and arriving at principles, theories and laws governing the natural world . This leads to the basic criteria for validity of science syllabus which emphasise that:

(i) The contents, process, language and pedagogical practices of curriculum are to be as per the cognitive level of child;

(ii) Curriculum must convey significant and correct scientific information.

(iii) Simplification of content is necessary for adapting the curriculum to the cognitive level of the learner;

(iv) Curriculum should engage the learner in acquiring the methods and processes that lead to generalisation and validation of scientific knowledge;

(v) Science curriculum should be informed by historical perspective, enabling learner to appreciate how the concept of science evolve over time;

(vi) Science should be placed in wider context of learner's environment, local and global, enabling her/him to appreciate the issues at the interface of science, technology and society; and

(vii) It should promote the value of honesty, objectivity, co-operation and freedom from fear and prejudice and inculcates in the learner a concern for life and preservation of environment (NCF – 2005).

The focus of NCF–2005 for science education in terms of validity vague was kept in view to design the syllabus of science for different stages. It was felt that to bring any changes in the desired direction, changes are required at syllabus level also. The most challenging task while designing the syllabus with this spirit was its presentation, because syllabus is a direct mode of communication between NCF and textbook writers .The challenge was to make the syllabus an enabling document for the creation of textbook that will be interesting and challenging without being loaded with factual information. This ultimately needs change in pedagogy.
The syllabus was organised in such a manner that instead of merely listing the topic it was presented in columns, concepts.

This way of presentation was followed up to secondary level .The most unusual feature of syllabus is that it starts with questions rather than concepts.

This paper specifically talks about changes at upper primary level. Seven themes were identified at the upper primary stage. This is the stage where children have just completed primary schooling and there is a need for continuity within the thematic areas covered at primary level.

Science at the Upper Primary Level

At the upper primary stage, the child should be engaged in learning principles of science through familiar experiences, working with hands to design simple technological units and modules (e.g., designing and making a working model of a windmill to lift weights), and continuing to learn more on environment and health through activities and surveys. Scientific concepts are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary school science. Group activity, discussions with peers and teachers, surveys, organisation of data and their display through exhibitions, etc., in schools and neighbourhood are to be an important component of pedagogy.

During the interactive sessions a lot of observations, queries, suggestions and comments were made by the teachers on the new textbooks, related to their content, style, exercises and Illustrations etc.; reflection of NCF–2005 in new books; interconnection/continuum across subjects and levels (classes) and guidelines for using textbooks; and teaching strategies for selected topics and evaluation strategies to be adopted by the teachers at different levels. The details on few of them are explained as here:

1. We find a lot of repetition of the content in textbooks. In spite of repeating the things some more things could be added to remove the dilution of the syllabus.

The repetition of the content and dilution of syllabus are two different aspects. It was perceived during curriculum development and syllabus designing that cognitive vague should be given space and the syllabus should not be loaded with mere factual information. At the one side we discuss about learning without burden; on the other side we don't want to dilute the syllabus. Here we will have to focus on the objectives of science education. Does it mean to throw the information towards learner or to develop some fundamental skills and approach that are basically needed to learn science? If we analyse the initiatives to be taken, then it would be convincing that the syllabus is diluted from content point of view but from the view point of development of scientific temperament/attitude it needs a lot of effort. And that is the change that we really need in our system.

Group activities, discussion with the peer and teachers, surveys, organisation of data and their display through exhibition, etc., in school and neighbourhood should be important component of pedagogy. Because in hands-on way of learning science the ultimate aim is to help children become autonomous learners.

2. This is not a new thing to talk about activities in science teaching. We know its merits but it also carries some limitations like time constraints. During teaching-learning

process attention towards individual is also a matter of concern. We have to complete the syllabus within stipulated time which is too small to allow the activities in a classroom.

Definitely this is a matter of great concern. We should focus preferably on the issue. But should we stop ourselves to solve this problem just because of this time constraint? Or will we have to wait for a change that will bring change in our time schedule. Will you recommend longer school hours for teaching? No, you will not agree on this. Other school activities can't also be ignored just because of this. It has been felt that for transacting curriculum in the right spirit, teachers have to have triple combination of competencies, commitment and will power to perform.

Hopefully, we have got the solution of our problem. There is no question mark in front of our competencies but the matter of serious concern is our willingness to accept the challenges and commitment for the task. Beside this ideological parameter there is one more aspect of the problem. Somehow the term activity-based teaching misleads us.

In the textbook, if hundreds of activities are suggested then do we suppose to perform all the activities in classroom? We will have to think over it .There is some objective to perform an activity during science teaching-learning and that is to inculcate scientific attitude and scientific temperament among students. Once student starts taking interest in understanding the concept through this approach, rest of the things will happen themselves. And this will be the time when we will become the observer and facilitator rather than a teacher who is worried about syllabus completion. Ultimately, we will find that most of the things are going on without taking so much time that has scared us in the beginning to take a step forward in this direction.

During activities, individual attention doesn't come as a hindrance as activities provide an opportunity to work together and child can learn more within a peer group rather than as individual. Diverse thinking always brings out something innovative and creative and provides an opportunity to everyone along with motivation to learn from each other and hence the outcome will definitely be above our expectation. We all are aware that learning of concept is not the only outcome of this process, it also inculcate social values and sense of socialisation. Don't you think, in this way we can bring beautiful combination of science and humanities?

3. Students want to perform activities. But at upper primary level resources are also limited. How do we manage the things?

We are worried about availability of resources; this is a good indication to bring change. It reflects that we really want to take initiative but some hindrances stop us to move ahead. In the present scenario, we all are aware that there are no separate laboratories to work for students at upper primary level. But at this level, it is not expected from a child to handle typical kind of apparatus or instruments. The formal experimentation needs laboratory facilitation. So why do we panic about those kinds of facilities? And this is not a big problem for a competent and willing teacher. Although during writing the textbook, this kind of challenge was kept in mind and as far as possible those materials were suggested in the textbooks which are easily available. But even if the problem arises then we have solution in our hand in the form of low-cost teaching- learning material and in terms of substitution for a particular substance . Here we would like to share an experience of a teacher who is working in a government school. A small

science kit was made by collecting materials which are needed to perform activities with the help of students. All the materials in the kit are either improvised or low-cost materials. For example, for heating purpose a candle and an improvised sprit lamp/mustered oil lamp is kept, a rough balance was prepared with the help of sofa spring, etc.

4. What is CCE? We appreciate the book as it follows activity-based approach. Should we evaluate activities also?

As we know that at the upper primary stage the emphasis is on the process skills which enable children to know how to learn by themselves so that they can carry on learning beyond school boundaries. For this, there should be continuous and periodic assessment, with much less weight to the annual examination. Periodic and continuous assessment tells us about the learning progress of students and gives us direction for inputs for further improvement. Direct grading system should be adopted to show the progress of a child. The report card should show these grades for various components of assessment, but there should be no pass/fail grade and no detention. Merit ordering of students should be strongly discouraged.

The periodic tests should have both a written and an experimental component, with the practising teachers setting the question papers. Introducing open-book examination is one way to ensure moving away from mere information seeking questions in examinations. The examinations should assess the child's practical and problem-solving skills, ability to analyse data; application of knowledge learnt; understanding of concepts; understanding, reading and making graphical representations; and solving simple numerical exercises.

The parameter can be found to evaluate learner. At the end of each chapter, some activity-based questions are there.To answer such kind of questions, learner will have to perform the activity. This is also one of the ways to evaluate performance of students during activities. We all know that where we perform an activity or experiment, we note down our observations simultaneously and this practice is followed to learn systematic approach and to imbibe scientific attitude and values. This is the basis of evaluation during activities. At this stage, worksheets can also be prepared and used for students. There is no end to queries and questions until we wish to overcome them. Things cannot be changed overnight but changes can be initiated in a moment.

References

National Curriculum Framework.2005. NCERT, New Delhi. Available on www.ncert.nic.in/rightside/links/pdf/framework/english/nf2005.pdf

Syllabus—Elementary Level. 2006. NCERT, New Delhi (Volume-I). Available on http://www.ncert.nic.in/rightside/links/pdf/syllabus/vol1/preliams.pdf

PRELIMINARY STUDY ON ENVIRONMENTAL AWARENESS OF STUDENTS WITH THE IMPLEMENTATION OF ENVIRONMENTAL EDUCATION IN SCHOOLS IN INDIA

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Environmental education (EE) in India is implemented by infusing various environmental concerns through different subject areas in all stages of school education. In addition, there is a separate project-based syllabus compulsory for all students at the higher secondary stage. In spite of these efforts, it was felt that students in general had different notions about what constitutes 'environment'. Correct understanding of term environment is inevitable to achieving the objectives of EE. Besides, EE also envisages students to be familiar with the local environmental problems and provide the necessary skill to address such problems. Hence this study was undertaken as a preliminary research to find out students' basic understanding about the environment, their local environmental problems and their outlook towards such problems. The study revealed some basic issues for example, in their understanding about the term 'environment' and in their inability to connect their school curriculum and the environment outside their classroom.

Introduction

Environmental Education (EE) is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments, and skills to work individually and collectively towards solutions of current problems and the prevention of new ones (UNESCO, 1976). It is a life-long process; interdisciplinary and holistic in nature and application; an approach to education as a whole, rather than a subject; and about the interrelationship and interconnectedness between human and natural systems (UNESCO, 1978).

The first guiding principle of the Tbilisi Declaration (which still remains the guiding document for initiating actions in the area of EE, even today) says that Environmental education should consider the environment in its totality — natural and built, technological and social (economic, political, technological, cultural,historical, moral, aesthetical).

To sum up, EE is aimed at bringing about awareness, knowledge, attitudes, motivations, commitments, skills leading to new patterns of

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behaviour for solutions of current environmental problems and the prevention of new ones by considering the environment in totality.

EE is implemented in India for Classes I and II by infusing environmental concerns through the teaching of Languages and Mathematics, as Environmental Studies from Classes III to V, as infusion approach from Classes VI to X and at the Higher Secondary stage by adopting infusion approach as well as a project-based syllabus compulsory for all students irrespective of their stream (Position Paper of the Focus Group on Habitat and Learning, National Curriculum Framework 2005).

Proper understanding of the notion of human environment is essential for the attainment of the objectives of environmental education (EE), i.e. a better comprehension of environmental complexity and more efficient individual and collective action in coping with environmental problems (UNESCO-UNEP, 1986). This study was undertaken as a preliminary research to find out students' basic understanding about the environment with the implementation of EE in schools throughout the country.

For the study, some components of the above-mentioned elements of EE were considered such as students' understanding about the term environment itself and their awareness and understanding about local environmental concerns. To this end, a set of questions about the environment were prepared for students so as to obtain impromptu response which would reflect their understandings about environment and its related problems with honesty and sincerity.

METHODOLOGY

Data was collected through structured interview from students who represented their states/UTs at the Jawaharlal Nehru National Science, Mathematics and Environment Exhibition for Children held in Gangtok, Sikkim in November 2013. Data also include information collected randomly from students who visited the exhibition.

Results and Discussions

A total of 68 students who had come from as many as 23 States and Union Territories of India were interviewed for the study (Annexure I). Most of the students were in their high school and higher secondary school. The results of the study are provided below.

I. Students' understanding of the environment

As mentioned earlier, the environment needs to be understood in totality. EE includes a human component in the exploration of environmental problems and solutions which implies that the environment includes not only plants and animals but also buildings, highways, and ocean tankers (Disinger & Monroe,1994; Stapp et al., 1969). Some would call these human created environments as 'technological environments' (UNESCO-UNEP, 1986). In order to find out how much students have an understanding of the environment, students were asked to name any five components of the environment. The study revealed that barring one student (98.5%) all included the biophysical environment as they have studied in Science or Ecology chapters such as biotic and abiotic factors. However it was surprising that only 14.7% students mentioned buildings, houses, devices, etc., in their list,

which were otherwise thought to be very obvious examples. More surprising was the fact that only 33.8% mentioned people or human beings as a component of the environment (Fig.1). Another interesting observation of the study was that though students are very familiar with the term 'environment', many of them (35.3%) find it difficult to name just five components (Fig. 2). This indicates that the effectiveness of inclusion of chapters on environment related concerns is still doubtful. Similar observations were made with regard to chapters on conservation (Disinger, 1983).

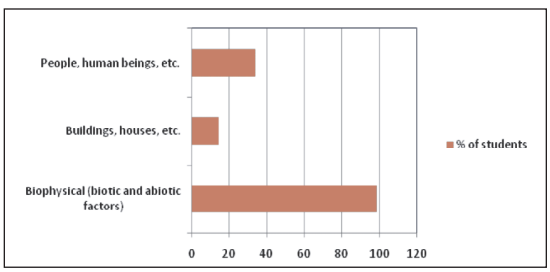

Fig. 1. General conception/idea of students about the environment

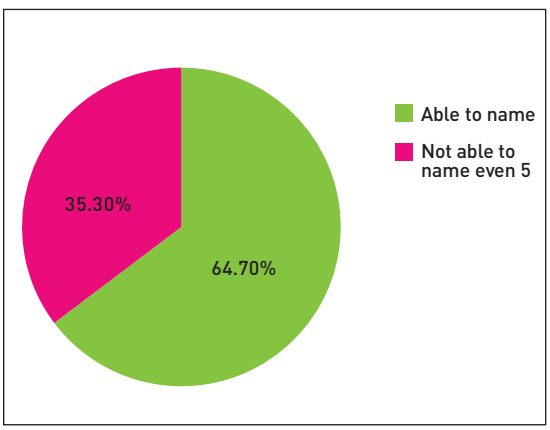

Fig. 2. Whether students were able to name any five components of the environment with ease

II. Students' understanding of environmental problems

Understanding of human habitat has to be locale specific, in the context of a global vision (Focus group paper on Habitat and Learning, 2006). And the first guiding principle of the National Curriculum Framework 2005 is 'connecting knowledge to life outside the school'. Keeping these in view, an attempt was made to find out how far students connect to their local environmental problems. For this, they were asked to name two environmental problems facing them. It was found that 23 students (33.8%) mentioned global warming or ozone layer depletion while 52 students (76.5%) mentioned problems related to pollution. While 25 students (36.8%) mentioned problems related to resources, it was interesting to find that nine (13.2%) students mentioned population related problems (Fig. 3). Though more than half of the students mentioned pollution-related problems, the number is quite lower than the expected as this problem is invariably faced by every student in their daily lives. The fact that a good number of students mentioned ozone layer depletion reveals a sort of disconnect with their daily life and more of a bookish knowledge. Students being aware about population-related problem are quite encouraging since it reveals that students are able to connect between biophysical environment and social environment.

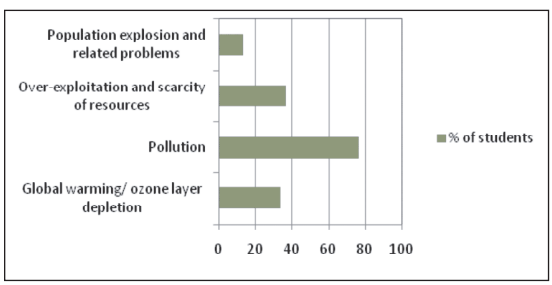

Fig. 3. Two most common environmental problems mentioned by students

An attempt was also made to find out if the students knew the reasons for the environmental problems they had mentioned. It was found that almost 80% of them knew the reasons while there were a few students who were not sure of the reasons or who did not respond (Fig.4).

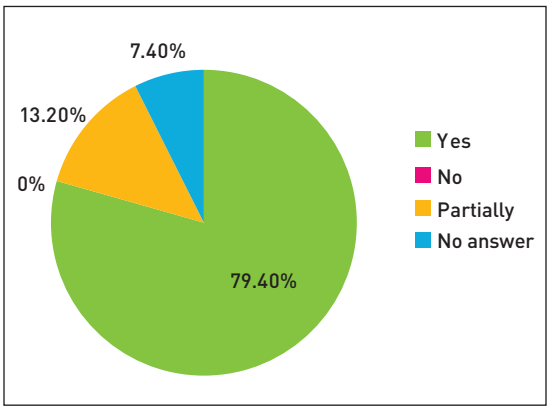

Fig. 4. Whether students actually know the cause of the problems they talked about.

III. Students' knowledge of impact of human activities on the environment

In order to find out students' knowledge of the impact of human activities on the environment, the reasons cited by students for environmental problems were analysed. It was found that 48 students (70.6%) mentioned industrialization and related problems, 32 students (47.1%) and 14 students (20.6%) mentioned improper disposal of waste as the reasons for environmental problems (Fig. 5).

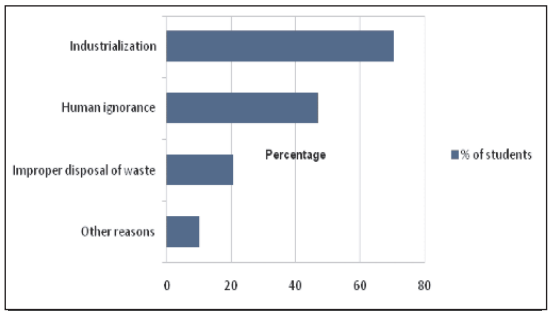

Fig. 5. Human activities mentioned by students to be the cause of environmental problems

Solutions to solve environmental problems

Knowledge of action strategies is a critical component for an individual to act on a particular environmental problem (Hungerford and Volk, 1990). An attempt was therefore made through this study to find out the solutions that students think which could solve environmental problems. It was found that 61 students (89.7%) mentioned education and awareness to be a good way to solve environmental problems. While 35 students (51.5%) mentioned judicious use of resources, 12 students (17.6%) mentioned various other solutions, such as use of solar rickshaw, biodiesel, reuse plastics, etc., and seven students (10.3%) mentioned enactment of laws would solve environmental problems (Fig. 6).

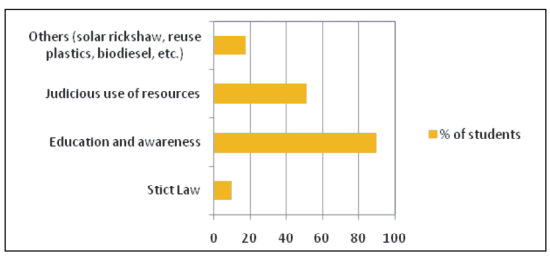

Fig. 6. Solutions for environmental problems suggested by students

Students in general did not mention the action strategies which they could actually take up. This could be due to their lack of awareness about the action strategies or it could be because they were not asked specifically about the actions that they could take up. Whatever the reason, it suggests that students do not consider themselves to be effective advocates to curb environmental problems.

Conclusion

The study can be concluded with the following observations:

1. Though students are familiar with the 'biotic' (plants and animals) and 'abiotic' (soil, water, air, light, temperature) components as they have been taught in different textbooks, students seem not to be very clear with the term 'environment' in totality. This is evident from the fact that houses, buildings, flyovers, vehicles, furniture or human beings did not figure in the response of many students. Unless students are able to consider the environment in its totality – natural and built, technological and social (economic, political, cultural-historical, moral, aesthetic), they will not be able to deal with environmental problems effectively.
2. Lack of understanding of the term environment is also evident from the fact that a good number of students found it difficult to name even five components of the environment.
3. Many students are not able to relate with the immediate environmental problems that they face in their daily lives, which becomes apparent from their bookish answers about the environmental problems, such as ozone layer depletion. As a result, they will not be able to contribute in solving their local environmental problems. It is essential to understand our habitat (immediate environment) so as to be able to take good care of it.
4. Students seem to lack adequate knowledge as to how they themselves can be active participants in solving environmental problems.
5. The study indicates that serious efforts need to be made in the teaching-learning of environment and its related concerns so as to bridge the gap between school curriculum and the environment outside classroom. This will serve as the first step in our efforts to achieve the goals of EE.

Annexure I

S.No.	State	No. of Students
1.	Andaman & Nicobar Islands	1
2.	Andhra Pradesh	3
3.	Bihar	2
4.	Dadra and Nagar Haveli	3

5.	Daman and Diu	1
6.	Delhi	2
7.	Goa	1
8.	Gujarat	4
9.	Haryana	1
10.	Himachal Pradesh	1
11.	Karnataka	3
12.	Kerala	2
13.	Maharashtra	6
14.	Manipur	2
15.	Meghalaya	1
16.	Odisha	3
17.	Punjab	4
18.	Rajasthan	4
19.	Sikkim	17
20.	Tamil Nadu	2
21.	Uttarakhand	3
22.	Uttar Pradesh	1
23.	West Bengal	1
Total		68

References

Disinger, J.F. 1983. Environmental Education's Definitional Problem. *Information Bulletin* No. 2. Columbus, OH: ERIC/SMEAC.

Disinger, J.F. and Martha C. Monroe. 1994. Defining Environmental Education EE Toolbox Environmental Education Toolbox Workshop Resource Manual.

Hungerford H.R. and T. Volk.1990. Changing learner behavior through environmental education. *Journal of Environmental Education*, vol. 21, No. 3, pp.8–21.

National Curriculum Framework – 2005. NCERT, New Delhi.

Position Paper of the National Focus Group on Habitat and Learning. 2006. NCERT, New Delhi.

UNESCO-UNEP International Environmental Education Programme. 1986. The balance of lifekind: an introduction to the notion of human environment. *Environmental Education Series* 18.

UNESCO. 1976. The Belgrade Charter. A Global Framework for Environmental Education. International Workshop on *Environmental Education*. Belgrade, Yugoslavia, 1975

___. 1978. The Tbilisi Declaration. Intergovernmental conference on *Environmental Education*: 1977.

William B. Stapp et al. 1969. The concept of environmental education. *The Journal of Environmental Education*. vol. 1, pp.30-31.

SCIENCE NEWS

Major Hurdle Cleared to Diabetes Transplants

Researchers at Washington University School of Medicine in St. Louis have identified a way to trigger reproduction in the laboratory of clusters of human cells that make insulin, potentially removing a significant obstacle to transplanting the cells as a treatment for patients with type 1 diabetes.

Efforts to make this treatment possible have been limited by a dearth of insulin-producing beta cells that can be removed from donors after death, and by the stubborn refusal of human beta cells to proliferate in the laboratory after harvesting.

The new technique uses a cell conditioning solution originally developed to trigger reproduction of cells from the lining of the intestine.

"Until now, there didn't seem to be a way to reliably make the limited supply of human beta cells proliferate in the laboratory and remain functional," said Michael McDaniel, Ph.D. professor of pathology and immunology. "We have not only found a technique to make the cells willing to multiply, we've done it in a way that preserves their ability to make insulin."

The findings are now available online in *PLOS One*.

The current method for harvesting human islets, which are comprised primarily of the insulin-producing beta cells, makes it necessary to find two or three donors to extract enough cells to produce an adequate supply of insulin to treat a single patient with diabetes.

The idea for the new technique came from an on-campus gathering to share research results. Lead author Haytham Aly, Ph.D., a postdoctoral research scholar, reported on his work with beta cells and was approached by Thaddeus Stappenbeck, M.D., Ph.D., associate professor

of pathology and immunology, who studies autoimmune problems in the gut. Stappenbeck had developed a medium that causes cells from the intestine's lining to proliferate in test tubes.

"He said, why don't you try it, and he gave us some samples," Aly said. "We put the solution in our freezer for a month or so, and when we finally gave it a try, we were amazed at the results: human beta cells in Dr. Stappenbeck's solution reproduced at a rate that was 20 times higher than beta cells in a solution that contained the sugar glucose."

The ability to produce large quantities of human beta cells in the laboratory gives the researchers hope that they could one day be transplanted into patients with type 1 diabetes.

The advantage of Stappenbeck's solution may be that it is designed to activate multiple growth signaling pathways in cells, according to the researchers. Earlier attempts to make beta cells proliferate focussed on one or two growth pathways. The solution also activates genes that help prevent beta cells from dying.

Because pancreatic cancers are among the most deadly tumors, the scientists checked to make sure the proliferating beta cells weren't becoming more like cancer cells. They found that none of the factors known to contribute to pancreatic cancer were active in the laboratory-grown beta cells.

"This is an important concern to keep in mind if we are to expand human beta cells in culture with this medium and subsequently transplant them into patients," said Aly.

If the new availability of laboratory-grown beta cells makes it possible to treat patients with transplants from one donor instead of multiple donors, McDaniel noted, that might reduce the risk of immune system rejection of the transplants.

"Another benefit in using this novel growth medium to expand isolated human beta cells is that the cells remain healthier and have reduced levels of cell damage or death," Aly said. "That may also reduce the chances of immune system rejection."

Study of Oceans' Past Raises Worries About their Future

The ocean the Titanic sailed through just over 100 years ago was very different from the one we swim in today. Global warming is increasing ocean temperatures and harming marine food webs. Nitrogen run-off from fertilisers is causing coastal dead zones. A McGill-led international research team has now completed the first global study of changes that occurred in a crucial component of ocean chemistry, the nitrogen cycle, at the end of the last ice age. The results of their study confirm that oceans are good at balancing the nitrogen cycle on a global scale. But the data also shows that it is a slow process that may take many centuries, or even millennia, raising worries about the effects of the scale and speed of current changes in the ocean.

"For the first time we can quantify how oceans responded to slow, natural climate warming as the world emerged from the last ice age," says Prof. Eric Galbraith from McGill University's Department of Earth and Oceanic Sciences, who led the study. "And what is clear is that there is a strong climate sensitivity in the ocean nitrogen cycle."

The nitrogen cycle is a key component of the global ocean metabolism. Like the proteins that are essential to human health, nitrogen is crucial to the health of oceans. And just as proteins are carried by the blood and circulate through the body, the nitrogen in the ocean is kept in balance by marine bacteria through a complicated cycle that keeps the ocean healthy. The phytoplankton (microscopic organisms at the base of the food chain) 'fix' nitrogen in the shallow, sunlit waters of the ocean, and then as they die and sink, nitrogen is eliminated (a process known as 'denitrification') in dark, oxygen-poor pockets of the ocean depths.

Using sediment gathered from the ocean floor in different areas of the world, the researchers were able to confirm that as the ice sheets started melting and the climate warmed up at the end of the last ice age, 18,000 years ago, the marine nitrogen cycle started to accelerate. The ocean had stabilized itself in its new, warmer state, in which the overall nitrogen cycle was running faster, by about 8,000 years ago. Given the current dramatic rate of change in the ocean nitrogen cycle the researchers are not sure how long it will take for marine ecosystems to adapt.

"We are changing the planet in ways we are not even aware of," says Galbraith. "You wouldn't think that putting carbon dioxide into the atmosphere would change the amount of nitrogen available to fish in the ocean, but it clearly does. It is important to realise just how interconnected everything is."

This research was funded by the Canadian Institute for Advanced Research (CIFAR) through the Earth System Evolution Program

New Catalyst Neutralises Gases Responsible for Climate Change

New technology, developed by the Research Group in Carbon Materials and Environmental prevents nitrous oxide decomposing it into nontoxic products. The catalytic system is active, efficient and stable over time and can purify gases emitted by industries related to the production of fertilisers, plastics and coal burning plants to produce electricity or vehicles.

Nitrous oxide is a gaseous compound harmful to the environment which is related to the destruction of the ozone layer and the global warming. "Deleting all nitrous oxide emitted to the atmosphere due to human activities would be equivalent to reducing all emissions of greenhouse gases agreed in the Kyoto Protocol," Agustín Bueno López, researcher in the Carbon Materials and Environment Group explains.

The most promising method among those proposed for the removal of nitrous oxide consists of decomposing it into oxygen and molecular nitrogen which are the main components of air and therefore, they have no adverse effects on health or the environment. The main drawback is that temperatures above 625 °C are required so that this breakdown can take place spontaneously, and this temperature is much higher than that of polluted gas streams.

"However, nitrous oxide can be decomposed at lower temperatures using a suitable catalyst, but it usually comes along with other gases that inhibit the catalysts that were available heretofore, preventing its implementation on a full scale" Agustín Bueno explains.

Aiming to overcome the limitations, the present invention provides a novel catalyst system capable of working in the presence of inhibitors such as oxygen, other oxides of nitrogen and water vapour at temperatures below 450 °C, so it can be used in most of the sources emitting this pollutant gas.

"The catalytic decomposition is carried out by placing the catalyst in a fixed bed reactor through which the gas stream to be purified passes. The composition and temperature of the gas stream varies from source to source, and this is taken into account when implementing the catalyst," Agustín Bueno states.

The technology has been successfully tested in a real plant production of nitric acid and in the exhaust pipe of a state-of-the-art diesel engine, and the tests performed in the laboratory show that it can be applied to various chemical production plants, processes involving oxidation with ammonia, combustion processes of fossil fuels (coal, biomass, waste, etc.). and vehicle emissions (gasoline engines, diesel engines, etc.) among others.

Nanoparticle Opens the Door to Clean-Energy Alternatives

Cheaper clean-energy technologies could be made possible thanks to a new discovery. Led by Raymond Schaak, a professor of chemistry at Penn State University, research team members have found that an important chemical reaction that generates hydrogen from water is effectively triggered — or catalysed — by a nanoparticle composed of nickel and phosphorus, two inexpensive elements that are abundant on Earth.

The results of the research will be published in the *Journal of the American Chemical Society*.

Schaak explained that the purpose of the nickel phosphide nanoparticle is to help produce hydrogen from water, which is a process that is important for many energy-production technologies, including fuel cells and solar cells. "Water is an ideal fuel, because it is cheap and abundant, but we need to be able to extract hydrogen from it," Schaak said. Hydrogen has a high energy density and is a great energy carrier, Schaak explained, but it requires energy to produce. To make its production practical, scientists have been hunting for a way to trigger the required chemical reactions with an inexpensive catalyst. Schaak noted that this feat is accomplished very well by platinum but, because platinum is expensive and relatively rare, he and his team have been searching for alternative materials. "There were some predictions that nickel phosphide might be a good candidate, and we had already been working with nickel phosphide nanoparticles for several years," Schaak said. "It turns out that nanoparticles of nickel phosphide are indeed active for producing hydrogen and are comparable to the best known alternatives to platinum."

To create the nickel phosphide nanoparticles, team members began with metal salts that are commercially available. They then dissolved these salts in solvents, added other chemical ingredients, and heated the solution to allow the nanoparticles to form. The researchers were able create a nanoparticle that was quasi-spherical — not a perfect sphere, but spherical with many flat, exposed edges. "The small size

of the nanoparticles creates a high surface area, and the exposed edges means that a large number of sites are available to catalyse the chemical reaction that produces hydrogen," Schaak explained.

The next step was for team members at the California Institute of Technology to test the nanoparticles' performance in catalyzing the necessary chemical reactions. Led by Nathan S. Lewis, the George L. Argyros Professor of Chemistry at the California Institute of Technology, the researchers performed these tests by placing the nanoparticles onto a sheet of titanium foil and immersing that sheet in a solution of sulphuric acid. Next, the researchers applied a voltage and measured the current produced. They found that, not only were the chemical reactions happening as they had hoped, they also were happening with a high degree of efficacy.

"Nanoparticle technology has already started to open the door to cheaper and cleaner energy that is also efficient and useful," Schaak said. "The goal now is to further improve the performance of these nanoparticles and to understand what makes them function the way they do. Also, our team members believe that our success with nickel phosphide can pave the way toward the discovery of other new catalysts that also are composed of Earth-abundant materials. Insights from this discovery may lead to even better catalysts in the future."

In addition to Schaak and Lewis, other researchers who contributed to this study include Eric J. Popczun, Carlos G. Read, Adam J. Biacchi, and Alex M. Wiltrout from Penn State; and James R. McKone from the California Institute of Technology.

The research was funded by the U.S. National Science Foundation and the U.S. Department of Energy. The team has filed a patent application.

Martian Clay Contains Chemical Implicated in the Origin of Life, Astrobiologists Find

Researchers from the University of Hawaii at Manoa NASA Astrobiology Institute (UHNAI) have discovered high concentrations of boron in a Martian meteorite. When present in its oxidised form (borate), boron may have played a key role in the formation of RNA, one of the building blocks for life.

The work was published in *PLOS One*.

The Antarctic Search for Meteorites team found the Martian meteorite used in this study in Antarctica during its 2009–10 field season. The minerals it contains, as well as its chemical composition, clearly show that it is of Martian origin.

Using the ion microprobe in the W. M. Keck Cosmochemistry Laboratory at UH, the team was able to analyse veins of Martian clay in the meteorite. After ruling out contamination from Earth, they determined boron abundances in these clays are over 10 times higher than in any previously measured meteorite.

"Borates may have been important for the origin of life on Earth because they can stabilise ribose, a crucial component of RNA. In early life

RNA is thought to have been the informational precursor to DNA," said James Stephenson, a UHNAI postdoctoral fellow.

RNA may have been the first molecule to store information and pass it on to the next generation, a mechanism crucial for evolution. Although life has now evolved a sophisticated mechanism to synthesise RNA, the first RNA molecules must have been made without such help. One of the most difficult steps in making RNA nonbiologically is the formation of the RNA sugar component, ribose. Previous laboratory tests have shown that without borate the chemicals available on the early Earth fail to build ribose. However, in the presence of borate, ribose is spontaneously produced and stabilised.

This work was born from the uniquely interdisciplinary environment of UHNAI. The lead authors on the paper, Stephenson, an evolutionary biologist, and Lydia Hallis, a cosmochemist who is also a UHNAI postdoctoral fellow, first came up with the idea over an after-work beer. "Given that boron has been implicated in the emergence of life, I had assumed that it was well characterised in meteorites," said Stephenson. "Discussing this with Dr. Hallis, I found out that it was barely studied. I was shocked and excited. She then informed me that both the samples and the specialised machinery needed to analyse them were available at UH."

On our planet, borate-enriched salt, sediment and clay deposits are relatively common, but such deposits had never previously been found on an extraterrestrial body. This new research suggests that when life was getting started on Earth, borate could also have been concentrated in deposits on Mars.

The significance goes beyond an interest in the red planet, as Hallis explains: "Earth and Mars used to have much more in common than they do today. Over time, Mars has lost a lot of its atmosphere and surface water, but ancient meteorites preserve delicate clays from wetter periods in Mars' history. The Martian clay we studied is thought to be up to 700 million years old. The recycling of the Earth's crust via plate tectonics has left no evidence of clays this old on our planet; hence Martian clays could provide essential information regarding environmental conditions on the early Earth."

The presence of ancient borate-enriched clays on Mars implies that these clays may also have been present on the early Earth. Borate-enriched clays such as the ones studied here may have represented chemical havens in which one of life's key molecular building blocks could form.

UHNAI is a research center that links the biological, chemical, geological, and astronomical sciences to better understand the origin, history, distribution, and role of water as it relates to life in the universe.

A Microphone That Listens With Light: Microphones Have Hyper-Acute Hearing and a Sense of Direction

A sensor developed by scientists at SINTEF's MiNaLab will help to make microphones hypersensitive: "Think of traditional videoconference equipment. Several people are

sitting around the table, but the microphone has been placed where its sound reception is less than optimal. With technology of this sort, a microphone will be able to "see" where the sound comes from, pick up the voice of the person speaking, and filter out other sources of noise in the room," explains ICT researcher Matthieu Lacolle, who emphasises that acoustics scientists at SINTEF have also contributed to this innovative solution.

Small but tightly packed

The microphone is packed full of microelectronics. What makes it really special, however, is an optical position sensor that is no more than a millimetre in diameter.

The reason for giving a position sensor such an important role is that a microphone is completely dependent on a membrane, which picks up the pressure waves produced by the sound.

"In principle, a microphone acts like a drum. You have a membrane that vibrates when it is impacted by a sound — which is just a series of pressure waves. And then you have a reference surface in the background. The distance between these two surfaces registers the sound. We do this by measuring light waves from a microscopically small laser, so we can say that the sensor in microphones actually sees the sound," explains Lacolle.

The sensor can measure incredibly small movements, and thus also extremely quiet sounds. If we make the membrane light enough, and let it oscillate freely in the air, the microphone also becomes directionally sensitive. "That also tells us where the sound is coming from," says Lacolle, adding that the membrane is only 100 nanometres thick, almost 1,000 times thinner than a human hair.

Coloured by light

The technology that makes the microphone so sensitive is based on a combination of two optical phenomena; interference and diffraction, both of which are due to the wave character of light.

"If we hold up a CD to the light, we see the play of colours where it reflects the light. This happens because light consists of a spectrum of wavelengths that the naked eye perceives as colours, and these wavelengths are diffracted in different directions, explains Lacolle.

Another phenomenon that can be utilised to measure sound is interference, which occurs when a number of waves are superimposed on each other. You can observe this when you stand in a harbour where incoming waves are reflected by a pier and are superimposed on top of the waves that follow them into the harbour. Complex, apparently chaotic wave patterns can occur, but so do standing waves, which don't appear to move at all," says the SINTEF researcher.

What the SINTEF scientists did was to exploit optical diffraction and interference to measure membrane movements of less than the diameter of an atom by using the optimal sensor.

We have created very special grooved microstructures on the reference surface, which lies directly underneath the microphone

membrane. When the laser illuminates these microstructures, we can read off the direction in which the light is reflected by means of photodetectors, which transform the light into electrical signals."

Laboratory mass-production

The microphone thus consists of several elements: an ultrathin membrane, tiny grooved microstructures, a miniaturised laser and a number of photodetectors. Everything is integrated into a tiny circuit that is mass-produced on a silicon wafer on which all the structures are etched, using special equipment within a clean room.

Dust-free production

In MiNaLab's clean room, production takes place in a highly controlled environment. The production process is extremely sensitive; even a tiny grain of dust can destroy a whole production series, because it can affect the tiny microstructures.

"That's why our laboratory is equipped with vibration damping and air filters that take out particles as small as 100 nanometres," explains Lacolle.

Noise monitoring

The Norwegian company Norsonic supplies various types of noise-measurement equipment, and intends to use the new microphone to measure both sound pressure and acoustic power.

"The microphone is the very heart of the equipment that we supply. What is unique about this technology is that it can give us an extremely sensitive microphone that is capable of registering sound waves far beyond the range that microphones in this price class can do today. This lets us compete in a market that is currently occupied by very expensive equipment. Our version is also much smaller, which is an advantage in itself, because the physical size of the microphone actually affects the sound field that it is measuring," says senior scientist Ole Herman Bjor in Norsonic.

How the microphone works

In simple terms, we can say that the new microphone operates as follows:

- First, sound pressure is transformed into movements of the membrane.
- These movements are read optically via the light-sensitive detector.
- The light intensity is measured by a sensor which in turn transforms it into an electronic signal that is capable of reproducing the sound.

Other potential applications for the sensor include:

- Geophones for seismic shooting
- Photoacoustic gas sensors
- Accelerometers
- Vibration sensors
- Gyroscopes
- Pressure sensors
- High-temperature versions of the above-mentioned sensors
- Sensors for highly irradiated sites (nuclear power stations, x-ray equipment) or with electromagnetic radiation (sensors in motors or magnetic resonance equipment).

Cheetah-Cub: A Robot That Runs Like a Cat

Thanks to its legs, whose design faithfully reproduces feline morphology, EPFL's four-legged 'cheetah-cub robot' has the same advantages as its model: it is small, light and fast. Still in its experimental stage, the robot will serve as a platform for research in locomotion and biomechanics.

Even though it doesn't have a head, you can still tell what kind of animal it is: the robot is definitely modeled upon a cat. Developed by EPFL's Biorobotics Laboratory (Biorob), the 'cheetah-cub robot,' a small-size quadruped prototype robot, is described in an article appearing in the International *Journal of Robotics Research*. The purpose of the platform is to encourage research in biomechanics; its particularity is the design of its legs, which make it very fast and stable. Robots developed from this concept could eventually be used in search and rescue missions or for exploration.

This robot is the fastest in its category, namely in normalized speed for small quadruped robots under 30kg. During tests, it demonstrated its ability to run nearly seven times its body length in one second. Although not as agile as a real cat, it still has excellent auto-stabilisation characteristics when running at full speed or over a course that included disturbances, such as small steps. In addition, the robot is extremely light, compact, and robust and can be easily assembled from materials that are inexpensive and readily available.

Faithful reproduction

The machine's strengths all reside in the design of its legs. The researchers developed a new model with this robot, one that is based on the meticulous observation and faithful reproduction of the feline leg. The number of segments — three on each leg — and their proportions are the same as they are on a cat. Springs are used to reproduce tendons, and actuators — small motors that convert energy into movement — are used to replace the muscles.

"This morphology gives the robot the mechanical properties from which cats benefit, that's to say a marked running ability and elasticity in the right spots, to ensure stability," explains Alexander Sprowitz, a Biorob scientist. "The robot is thus naturally more autonomous."

Sized for a search

According to Biorob director Auke Ijspeert, this invention is the logical follow-up of research the lab has done into locomotion that included a salamander robot and a lamprey robot. "It's still in the experimental stages, but the long-term goal of the cheetah-cub robot is to be able to develop fast, agile, ground-hugging machines for use in exploration, for example for search and rescue in natural disaster situations. Studying and using the principles of the animal kingdom to develop new solutions for use in robots is the essence of our research."

Surgeons Implant Bioengineered Vein: Kidney Dialysis Patient First in U.S. to Receive Lab-Grown Blood Vessel

In a first-of-its-kind operation in the United States, a team of doctors at Duke University

Hospital helped create a bioengineered blood vessel and implanted it into the arm of a patient with end-stage kidney disease.

The procedure, the first U.S. clinical trial to test the safety and effectiveness of the bioengineered blood vessel, is a milestone in the field of tissue engineering. The new vein is an off-the-shelf, human cell-based product with no biological properties that would cause organ rejection.

Using technology developed at Duke and at a spin-off company it started called Humacyte, the vein is engineered by cultivating donated human cells on a tubular scaffold to form a vessel. The vessel is then cleansed of the qualities that might trigger an immune response. In pre-clinical tests, the veins have performed better than other synthetic and animal-based implants.

"This is a pioneering event in medicine," said Jeffrey H. Lawson, M.D., Ph.D., a vascular surgeon and vascular biologist at Duke Medicine who helped develop the technology and performed the implantation. "It's exciting to see something you've worked on for so long become a reality. We talk about translational technology — developing ideas from the laboratory to clinical practice — and this only happens where there is the multidisciplinary support and collaboration to cultivate it."

Clinical trials to test the new veins began in Poland in December with the first human implantations. The U.S. Food and Drug Administration recently approved a phase 1 trial involving 20 kidney dialysis patients in the United States, followed by a safety review. Duke researchers enrolled the first U.S. patient and serve as study leaders.

The initial trial focusses on implanting the vessels in an easily accessible site in the arms of kidney hemodialysis patients. More than 3,20,000 people in the United States require hemodialysis, which often necessitates a graft to connect an artery to a vein to speed blood flow during treatments. Current options have drawbacks. Synthetic vascular grafts are prone to clotting, leading to frequent hospitalizations, and harvesting veins from the patient's own body involves a separate procedure, with the risk of infection and other complications.

If the bioengineered veins prove beneficial for hemodialysis patients, the researchers ultimately aim to develop a readily available and durable graft for heart bypass surgeries, which are performed on nearly 4,00,000 people in the United States a year, and to treat blocked blood vessels in the limbs.
"We hope this sets the groundwork for how these things can be grown, how they can incorporate into the host, and how they can avoid being rejected immunologically," Lawson said. "A blood vessel is really an organ — it's complex tissue. We start with this, and one day we may be able to engineer a liver or a kidney or an eye."

The bioengineered vein is the product of a 15-year collaboration between Lawson and Laura Niklason, M.D., Ph.D., co-founder of Humacyte and a former faculty member at Duke who is now at Yale. Lawson and Niklason teamed up in the late 1990s after discovering they shared an interest in engineering blood vessels.

Building on work Niklason began as a bioengineering post-doctoral student, the duo worked to perfect the technology in animal

models and eventually moved to develop veins for human implantation.

"The bioengineered blood vessel technology is a new paradigm in tissue engineering," said Niklason, professor and vice chair of anesthesia, professor of biomedical engineering, Yale University, and founder of Humacyte. "This technology is a key step for patients with end-stage renal disease and can potentially avoid surgical interventions and hospitalisations. The fact that these vessels contain no living cells enables simple storage onsite at hospitals, making them the first off-the-shelf engineered grafts that have transitioned into clinical evaluation."

Overcoming setbacks and frustrations, the researchers notched numerous advancements, starting with the biodegradable mesh as the scaffolding for the veins. The mesh, easily manipulated into any shape, is formed into a blood vessel of varying lengths and widths.

When seeded with smooth muscle cells, the mesh gradually dissolves as the cells grow in a special medium of amino acids, vitamins and other nutrients. One key improvement, which strengthens the bioengineered tissue, is a pulsing force introduced during the growth process, in which the nutrients are pumped through the tube in a heartbeat rhythm to build the physical properties that are similar to native blood vessels.

After a couple of months, a life-like vein results.

Originally, the researchers sought to develop veins using a person's own cells to seed the scaffolding, reducing the risk that the patient's body would reject the implanted tissue. But growing personalised veins took too much time and ruled out mass production, so the researchers changed tack to develop a universal product.

Using donated human tissue to grow on the tubular matrix, they wash the resulting vein in a special solution to rinse out the cellular properties, leaving a collagen structure that does not trigger an immune response.

"At the end of the process, we have a non-living, immunologically silent graft that can be stored on the shelf and used in patients whenever they need it," Niklason said. "Unlike other synthetic replacements made of Teflon or Dacron, which tend to be stiff, our blood vessels mechanically match the arteries and veins they are being sewn to. We think this is an advantage."

When implanted in animals, the vein grafts actually adopt the cellular properties of a blood vessel. They don't just elude rejection; they become indistinguishable from living tissue as cells grow into the implant.

"They are functionally alive," Lawson said. "We won't know until we test it if it works this way in humans, but we know from the animal models that the blood travels through the blood vessels and they have the natural properties that keep the blood cells healthy."

Lawson's first patient, a 62-year-old man from Danville, Va., who has required kidney dialysis for years, received the bioengineered vein graft in a two-hour procedure on 5 June 2013.

Survival of the Galapagos Sea Lion

Immune systems of endangered Galapagos sea lions are in overdrive because of harmful activity by people, reveal scientists from the Zoological Society of London (ZSL).

The study shows that Galapagos sea lions (*Zalophus wollebaeki*) are more prone to starvation because of exposure to human influences like pets and pollution. These can impair the level of their immunity, making them less able to hunt and more likely to go hungry when food is scarce.

This research is published in *PLOS One*.

Conservationists spent more than 18 months on the Islands of San Cristobal, which is inhabited by humans, and Santa Fe, where there are no humans, dogs, cats, mice or rats. They tagged 60 Galapagos sea lions from each island and monitored their behaviour and physiology.

ZSL's Institute of Zoology Director, Professor Tim Blackburn says, "We are increasingly aware of the threats of infectious diseases to wildlife around the world, from amphibians in the tropics to the birds in British gardens. It is worrying that we are now potentially seeing such threats to sea lions in the supposedly pristine wilderness of the Galapagos Islands."

ZSL's Dr. Paddy Brock, author on the paper, says, "A tell-tale sign of an unhealthy sea lion is a thinner than normal layer of blubber, which is what we saw in the sea lions on San Cristobal. This was all the more notable as we didn't notice these patterns in sea lions on Santa Fe, where they live without the presence of people or pets.

"The immune systems of San Cristobel sea lions were more active, perhaps indicating a threat of infectious disease, which could mean human activity is increasing the chance of potentially dangerous diseases emerging in the Galapagos sea lion," Dr Brock added.

Despite laws designed to protect the unique wildlife found on the Galapagos, pets are regularly imported to the islands, which increases the risk of new diseases arriving and spreading to local species. In addition, dumping of sewage into the bay on San Cristobal where the sea lions live may be increasing their exposure to germs and bacteria associated with humans.

ZSL, together with collaborators, will continue to address the threats faced by the Galapagos sea lion by carrying out further research into the methods driving the described patterns, such as the role that genetics plays in shaping them.

What Do Memories Look Like?

Oscar Wilde called memory "the diary that we all carry about with us." Now a team of scientists has developed a way to see where and how that diary is written.

Led by Don Arnold and Richard Roberts of USC, the team engineered microscopic probes that light up synapses in a living neuron in real time by attaching fluorescent markers onto synaptic proteins — all without affecting the neuron's ability to function.

The fluorescent markers allow scientists to see live excitatory and inhibitory synapses for the first time and, importantly, how they change as new memories are formed.

The synapses appear as bright spots along dendrites (the branches of a neuron that transmit electrochemical signals). As the brain processes new information, those bright spots change, visually indicating how synaptic structures in the brain have been altered by the new data.

"When you make a memory or learn something, there's a physical change in the brain. It turns out that the thing that gets changed is the distribution of synaptic connections," said Arnold, associate professor of molecular and computational biology at the USC Dornsife College of Letters, Arts and Sciences, and co-corresponding author of an article about the research that appears in *Neuron* on 19 June.

The probes behave like antibodies, but they bind more tightly and are optimised to work inside the cell — something that ordinary antibodies can't do. To make these probes, the team used a technique known as 'mRNA display,' which was developed by Roberts and Nobel laureate Jack Szostak.

"Using mRNA display, we can search through more than a trillion different potential proteins simultaneously to find the one protein that binds the target the best," said Roberts, co-corresponding author of the article and professor of chemistry and chemical engineering with joint appointments at USC Dornsife and the USC Viterbi School of Engineering.

Arnold and Roberts' probes (called 'FingRs') are attached to green fluorescent protein (GFP), a protein isolated from jellyfish that fluoresces bright green when exposed to blue light. Because FingRs are proteins, the genes encoding them can be put into brain cells in living animals, causing the cells themselves to manufacture the probes.

The design of FingRs also includes a regulation system that cuts off the amount of FingR-GFP that is generated after 100 per cent of the target protein is labeled, effectively eliminating background fluorescence — generating a sharper, clearer picture.

These probes can be put in the brains of living mice and then imaged through cranial windows using two-photon microscopy.

The new research could offer crucial insight for scientists responding to President Barack Obama's Brain Research Through Advancing Innovative Neurotechnologies (BRAIN) Initiative, which was announced in April 2014.

Modeled after the Human Genome Project, the objective of the $100 million initiative is to fast-track research that maps out exactly how the brain works and "better understand how we think, learn and remember," according to the BRAIN Initiative website.

The research was supported by funding from National Institutes of Health (grant numbers GM-083898, MH-086381, GM-083898 and GM-060416).

Source : Science Daily Online

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WEB WATCH

In this section, we present websites and a brief introduction about them. Inclusion of a site does not imply that *School Science* endorses the content of the site. Sites have been suggested on the basis of their possible utility to school systems.

- serc.carleton.edu
  This website is also called Earth Exploration Toolbook. It features a bunch of online Earth system science activity. The website has many chapters and each chapter helps the user to explore many aspects of the earth system. The aim of this website is to motivate the users' confidence and skill so that they can carry on their own investigation of the earth system.
- mathworld.wolfram.com
  This educational website is dedicated to Mathematics. It is founded by Wolfram Research. The website features new mathematical discoveries contributed by various researchers. It also contains many innovative interactive elements, such as Mathworld classroom and many other interactive entries.
- nineplanets.org
  The website gives an outline of the solar system—its history, mythology and scientific knowledge and discoveries. It has features such as What's New and Express Tour. It discusses in great length regarding the planets and the natural satellites and it also contains their images. This website will clear many doubts pertaining to solar system.
- www.tolweb.org
  The full title of this website is *The Tree of Life Web Project*. It contains information about biodiversity. The aim of this website is to make the users and readers aware of the various species and organisms, living or extinct. It contains pictures and images of various species and organisms.

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To Our Contributors

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Primary Teacher A Quarterly Journal for Primary Teachers	₹65.00	₹260.00
प्राथमिक शिक्षक (त्रैमासिक) (Prathmik Shikshak) A Quarterly Journal in Hindi for Primary Teachers	₹65.00	₹260.00

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