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I, Ashok Srivastava, hereby declare that the particulars given above are true to the best of my knowledge and belief.

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EDITORIAL

The Year—2010, saw the publication of the UNESCO Science Report –2010. Though the report reviews globally the status of science, China and India stand out for their economic growth, development in science, technology and industry. The story of India is worth revisiting. We reproduce the article, 'The Rise of Innovation in India'. Several factors, like economic growth, innovations in service and manufacturing sectors, knowledge-intensive products and services and Foreign Direct Investment (FDI), have contributed to this rise. It is also remarkable to note that the number of foreign Research and Development (R and D) centres have increased from about 100 in 2003 to about 750 by the end of 2009. The article also talks about challenges that remain. This year was also celebrated as the International Year of Biodiversity. Second article in this issue is devoted to this theme. It discusses about biodiversity loss and need to create awareness for biodiversity conservation. One of the themes of the International Year of Biodiversity is education. The article, ' The Adventures of Patrimonito describes pictorially about a series of short, animated cartoons for schools developed by the UNESCO's World Heritage Education Programme . Patrimonito is a character representing a heritage guardian and means 'small heritage' in Spanish. In each adventure, Patrimonito comes to the rescue of a natural or cultural World Heritage site that is experiencing problems. This is followed by two research studies. One investigates the problem-solving ability of higher secondary students in physics, in relation to sex of students, locality and types of schools. The other paper talks about the effect of Programmed instruction on achievement of secondary school children in life sciences. The Central Board of Secondary Education (CBSE) has recently introduced the scheme of Continuous and Comprehensive Evaluation (CCE) at the secondary stage. This issue carries an article on formative assessment in science. It presents a scheme for development of tasks in science and explains it with examples. The importance of disaster management and the desirability of its inclusion in school curriculum is discussed in an article in this issue. In addition to regular features, we include an article on Thalassemia. It talks about the nature of this disorder, its types, signs and symptoms, clinical complications, treatment and medication.

Comments and suggestions from readers are welcome.

THE RISE OF INNOVATION IN INDIA*

Sunil Mani**

In recent years, there has been much discussion in expert circles and the popular press about the rise of innovation in India. In the following extract from the chapter on India in the UNESCO Science Report-2010, we explore the reasons behind this success story and the challenges that remain.

The rise of innovation in India has been precipitated by a number of factors. Firstly, India has emerged as the fifth largest economy in the world in Purchasing Power Parity (PPP) dollars, according to the World Bank. In relative terms, however, India's economy is just half the size of China's, which also happens to be growing at a faster rate: 8.7 per cent in 2009 after progressing by 10 per cent or more for six years in a row. India's real GDP growth slipped back to 7 per cent in 2007 and to less than 6 per cent in 2009, after climbing from 5 per cent in 2002 to a steady 9 per cent in 2005–2007, according to the International Monetary Fund (IMF).

Secondly, there are many instances of innovation in the services sector, especially as concerns health care. Currently, the services sector accounts for two-thirds of GDP in India. Both the services and manufacturing sectors have been performing very well .

In the manufacturing sector, for instance, the release of Tata's Nano brand in 2008 hailed the advent of 'the world's cheapest car', at US$2 ,200. The car was designed at Italy's Institute of Development in Automotive Engineering with component parts manufactured by an Indian subsidiary of Bosch, a German company. Approximately two-thirds of the technology for Bosch products used in the Nano car is sourced from India. The initial production target is for 2,50,000 units per year.

In the health sector, the MAC 400 machine produced by General Electric's John F. Welch Technology Centre in Bangalore records a patient's electrocardiogram. As it is portable, it can be used in rural areas to diagnose heart disease.

For a very long time, Indian policy-makers avoided using the explicit term of 'innovation' in policy documents dealing with technological activities.

* Reprinted from 'A World of Science', Vol. 8, No.4, October-December 2010

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The word 'innovation' appears in a policy document for the first time in 2008, in the draft National Innovation Act. This development reflects a broad sentiment in both policy and business circles that the country is becoming more innovative – at least certain industries.

A third factor is that the knowledge intensity of India's overall output has expanded. Currently, about 11 per cent of India's GDP comes from knowledge-intensive products and services. Also noteworthy is that growth in knowledge intensive production surpasses that of the economy overall.

The majority of new companies belong to knowledge intensive sectors and the number of knowledge intensive enterprises has mushroomed over the past seven years or so. This trend is corroborated by the technology content of all industrial proposals implemented since the first reforms to liberalise the economy got underway in 1991.

Once again, with the exception of the textile industry and a few others, the majority of new proposals emanate from technology-oriented industries in areas such as chemicals,energy, electrical equipments and so on.

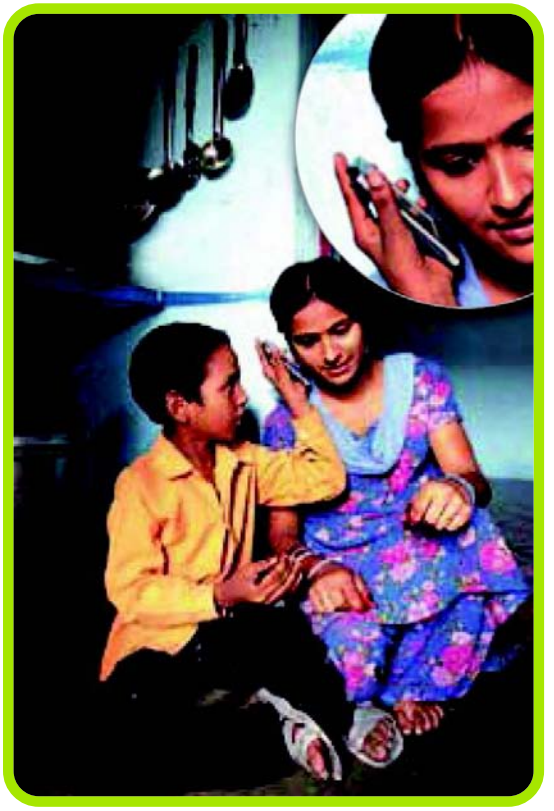
A fourth factor is that Foreign Direct Investment (FDI) from India has grown considerably, from just US$2 million in 1993 to about US $19 billion in 2009. This includes some high-profile technology-based acquisitions abroad by Indian companies. Examples are Tata Steel's takeover of British industry giant Corus, Bharat Forge's takeover of forging companies in Germany, the UK and USA, and Suzlon's takeover of wind turbine companies in Germany.

The growing number of foreign acquisitions of 'active targets' in technological jargon, has given Indian companies considerable access to the technological capacity of the acquired firms without their having to build this up assiduously from scratch. The same goes for mergers.
Before Tata Steel's purchase of Corus, Europe's second largest steel producer with annual revenue of around £12 billion, the Indian steelmaker did not hold a single American patent. The takeover brought it over 80 patents, as well as almost 1,000 research staffs.

In addition, the number of foreign research and development (R and D) centres have grown from fewer than 100 in 2003 to about 750 by the end of 2009. Most of these R and D centres relate to information and communication technologies and the automotive and pharmaceutical industries.

A fifth factor is that India has become more competitive in hightech areas. Although manufactured exports are still dominated by low-tech products, the share of high-tech products has doubled in the past 20 years to 17 per cent. India has become the world's largest exporter of Information Technology (IT) services since 2005 and exports of aerospace products have been increasing at a rate of 74 per cent per year, compared to 15 per cent for world exports of these products.
India is acknowledged to have considerable technological capability in the design and manufacture of spacecraft and is now an acknowledged global leader in remote sensing. According to Futron's 2009 ranking of ten entities in its Space Competitiveness Index, India ranks better than the Republic of Korea, Israel or Brazil.

However, the bulk of innovation in this area comes from the government sector rather than industry, a situation that is set to change. Aerospace exports from India have increased



manifold in recent years, even if exports tend to be confined to aircraft parts or components. With approximately 300 small and medium-sized enterprises active in this area, India is slowly emerging as one of the few developing countries to have a high-tech industry of the calibre of its aerospace industry.

A limited spillover of government research to civilian use

Government expenditure on R and D in India tends to focus on nuclear energy, defence, space, health and agriculture. The spillover of government research to civilian use is very limited, although in more recent times, conscious efforts have been made by the government to orient research more towards socio-economic goals. This is slowly beginning to produce results, especially in the area of space research with the development of environmental monitoring, satellite communications and so on.

The higher education sector in India is not a source of technology for industry. This may come as a surprise, as the Indian Institutes of Technology do collaborate with private industry. Unfortunately, however, cases of actual technology generation are few and far between, as much of R and D relates to basic research. Moreover, the institutes tend to be extremely teaching-intensive institutions. It is estimated that the entire higher education sector in India contributes no more than 5 per cent of GERD. It does act as an important reservoir of skilled personnel, however, for the other factors in India's national innovation system.

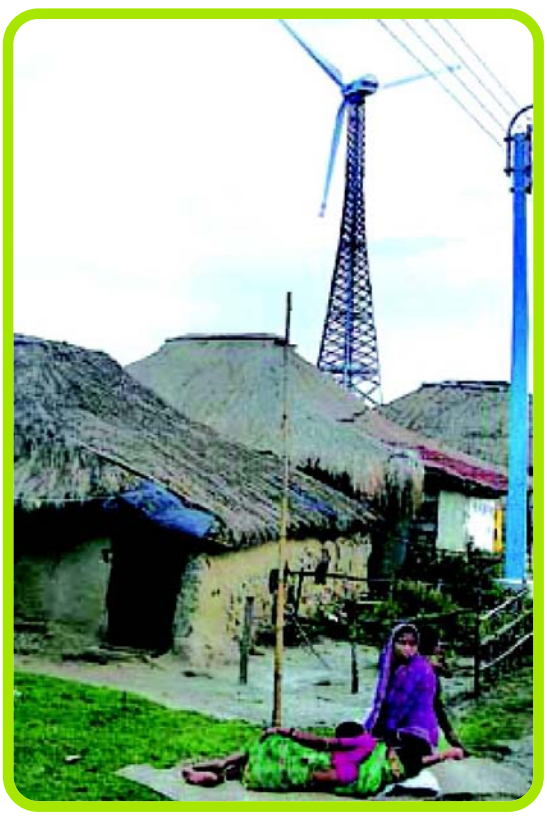
Currently, private companies spend approximately four times more than public enterprises on R and D and nearly three times more than government research institutes. In other words, private enterprises are moving towards the core of India's innovation system. Four industries account for the lion's share of investment in R and D, with the pharmaceutical and automotive industries topping the list. There is insufficient evidence to show that India's entire industrial sector has become more innovative since 1991 but India's pharmaceutical industry certainly has.

Remedying a shortage of trained personnel

Of late, industry has been complaining of serious shortages in technically trained personnel. A study by the Federation of Indian Chambers of

Commerce and Industry in 2007 revealed a 25 per cent shortage of skilled personnel in the engineering sector.

Two issues have an impact on the potential supply of scientists and engineers for domestic businesses, in particular. The first is the long-standing issue of the migration of highly skilled personnel from India to the West primarily. There is every indication that this brain-drain has accelerated in recent times. The second issue concerns the growing amount of FDI flowing into R and D. Foreign R and D centres are able to offer domestic researchers and R and D personnel better incentives than domestic businesses. As a result, India's small stock of scientists and engineers may be lured to foreign R and D centres.



The central government in particular has reacted vigorously. In higher education, it is seeking to arise the gross enrolment ratio from 11 per cent in 2007 to 21 per cent by 2017, one of the targets of the Eleventh Five-Year Plan (2007–2012).
One-quarter of the student body is currently enrolled in the fields related to Science and Technology (S and T), according to the UNESCO Institute for Statistics.
The government has opted to establish 30 new central universities from 2010 onwards, 14 of which will be 'innovation universities'. Each innovation university is expected to focus on one area of significance to India, such as urbanisation, environmental sustainability and public health. In parallel, the government is doubling the number of Indian Institutes of Technology to 16 and establishing 10 new National Institutes of Technology, three Indian Institutes of Science Education and Research and 20 Indian Institutes of Information Technology to improve engineering education.

This year, the government is also in the process of adopting a policy of permitting foreign universities to enter the higher education system in India by establishing their own campuses or via joint ventures with existing universities and institutes.

The impact of the Indian Patent Act

One important policy change in recent years has been the adoption of the Indian Patent Act, which took effect on 1 January 2005. This ordinance

sought to bring the country into compliance with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organisation. The most distinguishing feature of this policy change is the recognition of both product and process patents, as opposed to solely process patents in the earlier Act of 1970. In bringing India into compliance with TRIPS, the intention was to restrict innovation in the pharmaceutical industry in particular, where the lack of product patents had allowed firms to reverse-engineer known products at little cost. This 35-year learning period seems to have given the pharma firms the time they needed to acquire the skills crucial to inventing new chemical entities.

After the adoption of the Indian Patent Act, it was expected that R and D spending by the pharmaceutical industry would slump. This reasoning was based on the belief that much of Indian R and D in pharmaceuticals still consisted of reverse-engineering. By requiring recognition of both product and process patents, it was thought that the amended Act would reduce the space for reverse-engineering. It turns out private pharmaceutical companies in India have actually continued to register an increase in R and D investment of almost 35 per cent per year (See Figure).

In fact, some of the provisions in the Indian Patent Act have protected Indian pharma companies, even if the ordinance imposes a 20-year protection period for product patents. For example, there is a provision for granting compulsory licences for the export of medicines to countries that have insufficient or no-marketing capacity, to meet emergent public health situations, in accordance with the Doha Declaration on TRIPS and Public Health. This allows Indian companies to produce and export AIDS drugs to African and Southeast Asian countries. Another safeguard has been the introduction of a provision making patent rights for mailbox applications available only from the date of granting the patent rather than retrospectively from the date of publication. This provision has saved many Indian companies from being attacked for infringement of patent law by multinational companies that might otherwise have obtained patents for drugs already put on the market by Indian companies.

As for the impact of the Act on innovation in the agriculture, biotechnology and IT sectors, this aspect still needs to be analysed in depth.

The incredible feat of Indian pharma

Turnover by the Indian pharmaceuticals industry has grown from a modest US$300 million in 1980 to about US$19 billion in 2008. India now ranks third world-wide after the USA and Japan in terms of the volume of production, with a 10 per cent share of the world market. In terms of the value of production, it ranks 14th for a 1.5 per cent global share.

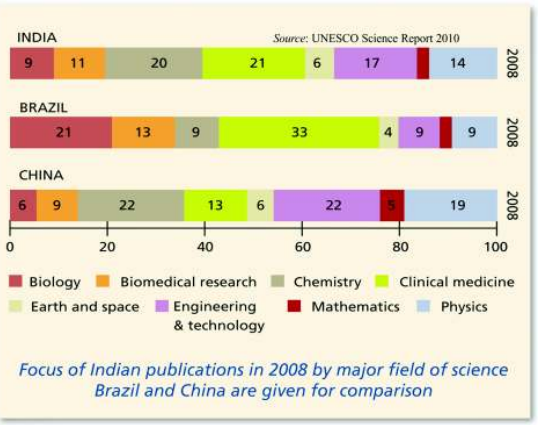
In all, there are about 5,000 foreign and Indian firms engaged in the manufacturing pharmaceuticals, which directly employ about 3,40,000 individuals. Much of industrial growth is fuelled by exports, which grew by 22 per cent on average between 2003 and 2008. The top five destinations in 2008 were, in descending order, the USA, Germany, Russia, United Kingdom and China.

The industry has four key characteristics:

- it is dominated by formulations, the process of combining different chemical substances to produce a drug, and employs over 400 active chemicals for use in drug manufacture, known as Active Pharmaceutical Ingredients;
- it is very active in the global market for generics, even supplying developed countries;
- it enables India to be self-sufficient in most drugs, as witnessed by a growing positive trade balance; and
- it is one of the most innovative industries in India, in terms of R and D and the number of patents granted, both in India and abroad.

One spin-off of India's innovative capability in pharmaceuticals is that it has become a popular destination for clinical trials, contract manufacturing and R and D outsourcing. These capabilities hold great promise for the Indian pharma industry, as an estimated US$103 billion of generic products are at risk of losing patents by 2012. Furthermore, the global market for contract manufacturing of prescription drugs is predicted to grow from US $26 billion to US $44 billion by 2015 or so. According to experts, the country has 'good' to 'high' skills in preclinical trials and Phase I clinical trials and 'very high' skills in Phase II and Phase III clinical trials.

A very recent trend observed in India's pharma industry is the wave of cross-border mergers and acquisitions in which Indian companies have taken over foreign ones and foreign firms have, in turn, taken over Indian companies. The pharma industry has become one of India's most globalised industries. One of the most high-profile takeovers concerns Ranbaxy, India's largest pharma company and the country's biggest producer of generic drugs. In 2008, Japanese pharma giant Daiichi Sankyo acquired a majority stake (35 per cent) in Ranbaxy, at a cost of up to US$4.6 billion.



Focus of Indian publications in 2008 by major field of science
Brazil and China are given for comparison

A sharp rise in publications

The most recent Thomson Reuters data confirm that India's strength truly lies in chemistry, pharmacology and toxicology (See Figure). The number of Indian articles recorded in the Science Citation Index have progressed rapidly, doubling between 2002 and 2008 to 36261. If this growth rate is maintained, India's publication record will be on par with most G8 nations within 7–8 years. India could even overtake them between 2015 and 2020.

Foreign companies dominate patents

India has improved its patenting record in the USA, with an acceleration over the past decade.

Most Indian patents are utility patents, namely, those for new inventions. However, most of these patents are in chemistry-related areas and most are being granted to foreign companies located in India, based on R and D projects they have carried out in India. This is a growing trend.

Similarly, the number of national patents granted by the India Patent Office has increased tremendously, even if over three-quarters are still granted to foreign entities. Once again, most of these patents concern chemistry and pharmaceutical-related areas. Thus, although the TRIPS compliance of the Indian Patents Act appears to have had a positive effect on patenting by Indian inventors, most of the patents granted to Indian inventors both in India and abroad are going to foreign companies.

India has certainly made great strides in space research, life sciences and especially in biopharmaceuticals and IT. Although domestic science continues to dominate, there is also a growing presence of foreign entities in India's technology system.

The main challenge will be to improve both the quality and quantity of S and T personnel. Fortunately, policymakers are seized of this problem and have taken energetic steps to remedy the situation, as we have seen. The future success of India's national innovation system will depend on how well they succeed.

INTERNATIONAL BIODIVERSITY YEAR – 2010
SAVING BIODIVERSITY FOR POSTERITY

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Biodiversity is pivotal to life on Earth. Various life forms e.g. animals, plants, micro-organisms (such as bacteria and viruses) etc., are responsible for throbing of life on our planet Earth. These various life forms may collectively be called biodiversity.

Walter G. Rosen was the first to use the term biodiversity in 1985 although some conservation scientists like Thomas Lovejoy had earlier advocated the use of the term 'biological diversity.' Much before that the term 'natural diversity' was also used. However, somehow the term biodiversity seems to have universal appeal and is, therefore, now widely accepted.

The importance of biodiversity

Biodiversity has direct or indirect role in fulfilling the needs and wants of life on Earth. It provides us with food, fibres, timber, energy, pharmaceuticals, raw materials and, of course, industrial chemicals. Besides, it also plays a significant role in purification of water and air, pollination, the absorption of carbon by trees, renewed oxygen supply, natural pest control, flood and erosion control, and the absorption and detoxification of human and industrial wastes.

Biodiversity also acts as a great source of beauty, wonder, joy and entertainment for many people. Aquariums, zoos etc., not only have entertainment value but they also educate the people especially young children about the animal world. They also act as source of income to the states owning them. Bird watching, wild life observations, pet keeping, gardening etc., not only provide joy and recreational pleasure but these activities have many physical and psychological benefits as well. Forests, mountains, water falls etc., are sources of perennial natural beauty filling us with profound pleasure and bliss. Biodiversity has given birth to the concept of ecotourism too which is a rich source of revenue for the states involved with it. Besides, biodiversity has also

scientific importance for human survival. Every species can help scientists unravel as how life evolved and functioned on this planet and how it will continue to evolve in future.

Thus, it is apparent that biodiversity has not only ecological and environmental importance but has social and cultural importance as well. However, industrialisation and consumerism that is in-built in our modern life style has posed great threat to biodiversity. As a result, the danger of extinction is looming large on many species of wild animals and plants. The conservation of biodiversity on Earth is, therefore, an absolute necessity. With this primarily in view, the United Nations in its 83rd plenary meeting held on 20 December 2006 declared the present year (2010) as the International Year of Biodiversity (IYB). Many activities are being carried out the world over on the eve of IYB. The main aim behind these activities is to create awareness in people so that they may be able to understand the importance of biodiversity, thus motivating them towards conservation of biodiversity.

Underlining the importance of biodiversity, the United Nations has given the following slogan for the International Year of Biodiversity (2010):

"Biodiversity is life"
"Biodiversity is our life"

The central idea hidden in the slogan is that biodiversity is the basic foundation of life and biodiversity is pivotal to our i.e., human life on Earth.

Apart from this meaningful slogan, the logo released by the United Nations on the occasion of IYB has within boldly drawn digits 2010, sketches of iconographic elements symbolising biodiversity. These include fish, waves, a flamingo, an adult and child and a tree. A host of symbolic iconographic elements are included within this design to depict the scope of biodiversity, which includes marine, flora and fauna aspects. Together, they demonstrate how biodiversity is life and how we, as humans, are realising our place within this journey.

Identification of biological species

Thus, far about 1.8 million biological species have been identified on Earth. The insects outnumber all other species. So far we have been able to gather information about 0.8 million insects while it is estimated that there number may be between 10 million and 30 million insects on Earth. The scientists have estimated that the total number of all biological species on Earth may be about a hundred million.

The scientists are busy looking for new and hitherto unknown species of animals and plants. However, some of the present animal and plant species are getting extinct or rare, thus endangering biodiversity. The International Union for the Conservation of Nature and Natural Resources (IUCN) maintains a red data book in which the record of all endangered animal and plant species is kept.

Endangered species and threat of extinction

In 2007, the IUCN after making survey of around 13,88,137 species belonging to eight main biodiversity groups (mammals, birds, reptiles, amphibians, fish, insects, mollusks and plants) found that around 15,790 biological species are endangered.

Some species of animals and plants have already suffered extinction from the world. The dodo of Mauritius, the passenger pigeon of America and cheetah, once found in India in large number, are but a few well-known examples of such extinct species.

While talking of the extinction of animals, the dinosaurs automatically come to our mind. About 65 million years ago, probably due to an asteroid hitting the Earth, the dinosaurs got completely wiped out from Earth. However, before that four episodes of natural extinction had occurred which were caused by climate change. The first of these episodes was in Ordovician period about 448 million years ago while the second occurred in the Devonian period around 365 million years ago. The third and fourth extinction episodes took place around 286 and 210 million years ago, in Permian and Triassic periods, respectively.

Causes of biodiversity degradation

In this context, it needs to be clearly understood that in all the five episodes of extinction mentioned above, human activities did not play any role. However, the degradation or extinction of biodiversity which is happening today is attributable mainly to human activities. Over-exploitation of natural resources, hunting and poaching, pollution and global warming have all contributed to dwindling biodiversity causing potential threat to it.

Pollution and global warming on Earth are also a result of anthropogenic or human factor. The human activities have, therefore, contributed in a big way in causing threat to biodiversity. In this scenario, it becomes our duty to conserve biodiversity.

India has an age-old tradition of giving protection to animals and plants. Showing benevolence to animals has been at the very roots of Indian culture and philosophy. India has also the tradition of maintaining sacred groves. These are generally preserved by local communities on religious grounds. Sacred groves are found in the states of Rajasthan, Maharashtra, Karnataka, Kerala and Assam. Also, there has been a tradition of maintaining sacred rivers in our country.

The biodiversity of India

India is a land of rich biodiversity. It finds place amongst 17 megadiverse nations of the world. The total geographical area of our country is 32,87,263 square kilometres which is only about 2.4 per cent of the total global land area. In spite of this, 7-8 per cent of the total world biodiversity is found in India.

The survey of about 70 per cent of our geographical area from the point of view of identification of biodiversity has been carried out. On the basis of this survey we have been able to identify some 45,500 plant species and 91,000 animal species. Included amongst the animal species are 59,353 species of insects, 2,546 species of fish, 1,232 species of birds, 460 species of reptiles, 397 species of mammals and 240 species of amphibians. Amongst these ,some species are native to India. They are called endemic species.

There are two main centres of biodiversity in our country which are abundant in endemic species. They are called biodiversity hot spots. Twenty hot spots of the world have been reported so far. The Eastern Himalayas and Western Ghats are the two hot spots of biodiversity in India.

Need to create awareness for biodiversity conservation

On the occasion of International Biodiversity Year, we need to create awareness in people towards biodiversity conservation by reminding them of our strong cultural traditions of preserving animals and plants. We have to tell them that if today, sparrow is struggling for its existence it simply means that not all is well with our ecosystem. There is definitely something which is ailing it which, one never knows, might also affect us in future.

We are spending so much on Project Tiger and Project Elephant. After all, what is the necessity of preserving tigers and elephants? It has to be brought home to people that they are gorgeous animals and our country's pride. In this scenario, can we allow the tiger or elephant to vanish? Visitors throng in large numbers just to have a glimpse of the majestic big cat-tiger which is so beautiful and attractive.

The tiger population has become abysmally low. It is estimated that there are barely 1,411 tigers left in the country. Is it not our sacred duty to save tiger which is also our national animal? Why tiger alone? It is our duty to save all animals and plants on Earth because without them life on the planet is unthinkable. The co-existence of human beings with animals can only give us true happiness, inner contentment and prosperity to live with grace on this planet.

Certainly, the vast resourcefulness of Earth and its beauty lies in biodiversity. It is, therefore, our sacred and moral duty to conserve it for posterity.

THE ADVENTURES OF PATRIMONITO*

One of the themes of the International Year of Biodiversity is Education. UNESCO's World Heritage Education Programme has developed a series of short, animated cartoons for schools which depict the adventures of a character called Patrimonito, a heritage guardian whose name means 'small heritage' in Spanish.

Introduction

In this early scene from the film, poachers have come to the Virunga mountains to kill gorillas. One will be shot trying to protect its young then carried to a nearby village to be sold as bushmeat. Patrimonito will explain to the villagers why gorillas need protecting.

In each adventure, Patrimonito comes to the rescue of a natural or cultural World Heritage site that is experiencing problems. The character was created in 1995 by a group of Spanish-speaking pupils during a workshop at the First World Heritage Youth Forum in Bergen (Norway) and has since become an international mascot.

The cartoon series was launched in 2002 within a competition for secondary school pupils organised by UNESCO to celebrate the 30th anniversary of the World Heritage Convention. The winning storyboards have been professionally animated and are distributed to schools in CD-ROM format.

So far, eight 4-minute films have been made. There is no dialogue but music and short texts accompany each film in one or more of the six official languages of UNESCO: Arabic, Chinese, English, French, Russian and Spanish.

Five of these films follow the fortunes of cultural heritage:

- the historic centre of Havana (Cuba);

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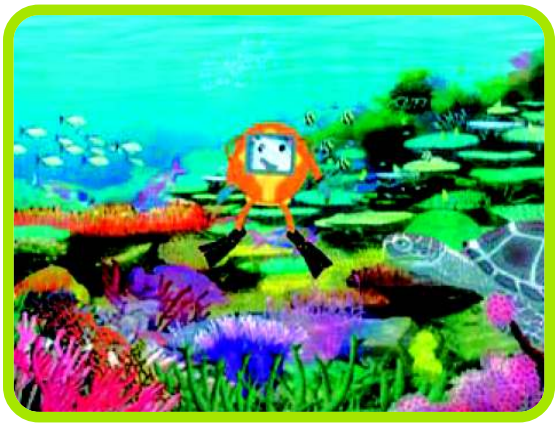

In this film, Patrimonito visits the Great Barrier Island in 1980 (left), where he meets dugongs, turtles, schools of many different kinds of fish and colourful corals. He then returns with a young friend 20 years later, only to find that warming sea temperatures from climate change have bleached the corals. In the second still (right), Patrimonito has grabbed an anchor before it can lodge in a coral on the seafloor and his young friend is picking up rubbish thrown overboard by the growing number of pleasure yachts in the area.

- the wooden church in Urnes (Norway);
- the 11 churches built out of the rockface in Lalibela (Ethiopia);
- historic monuments of Novgorod (Russian Federation); and
- the Old Town of Avila (Spain).

The remaining three focus on natural sites:

- the Sub-Antarctic Islands (New Zealand);
- the Virunga Mountains (Democratic Republic of Congo, Rwanda, Uganda) ; and
- the Great Barrier Reef (Australia).

In the cartoon overleaf, we follow the adventures of Patrimonito in the Sub-Antarctic islands, which have been over-run by a horde of little pigs.

Invasive little aliens: a Patrimonito adventure

One hundred fifty years ago, the seas and cliffs south of New Zealand in the sub-Antarctic islands teemed with seals, seagulls, penguins and a great diversity of other species. The islands were home to ten of the world's 24 albatross species.

One day in 1864, a sailing ship came into view. As the ship approached the islands, a storm brewed. The ship was tossed about by the high waves. With night falling, the captain accidentally ventured too close to the shore and the ship was thrown against the rocks.

The only survivors were two little pigs who managed to make it ashore on a barrel, a girl and a boy. The locals greeted them with curiosity rather than fear. It wasn't long, however, until the two little pigs were causing trouble. One day, a pig came racing around a corner so fast that he knocked a couple of penguins into the water! He then accidentally crushed the unprotected egg under his hoof.

The pigs were always hungry. When one of them saw a eagull sitting on a big, juicy egg, it would chase the seagull away then grab the egg and eat it. The pigs loved living on an island where they could find plenty to eat. Soon they were raising a family. They had a lot of piglets, who then had a lot of piglets of their own. Within a few years, there were hundreds of pigs on the island.

Life became a nightmare for the birds. With the pigs eating or destroying their eggs, they were unable to raise any chicks. The bird population began to dwindle. As the years went by, there were fewer and fewer birds in the seas and skies. By 2004, the situation had got so bad that Patrimonito decided to act.

He hopped in a dinghy and headed for the Sub-Antarctic Islands. The birds greeted him anxiously. The pigs kept breaking or eating their eggs, they said, and trampling the undergrowth. It was becoming impossible to raise a family. There was only one thing for it, Patrimonito realised.

The pigs would have to go! In a green meadow, Patrimonito sneaked up behind one of the pigs and threw a net over it. He was such a good pigcatcher that, within no time at all, he had captured all the pigs on the island. He piled them high in his dinghy and, with a cheery wave, he was off. At last, the birds could raise their chicks in peace.

The bird population started to climb again and, by 2255, the seas and skies were once more teeming with birds. This is a true story. The introduction of pigs into the Sub-Antarctic Islands endangered the existing animal and plant populations. That is why these pigs are called 'invasive alien species' and that is why they had to go!

For details and to view these films: http://whc.unesco.org/en/patrimonito

PAINFUL THALASSEMIA : A REVIEW

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Introduction

The term Thalassemia is a disorder, mainly prevalent among Mediterranean people, and was responsible for its naming. 'Thalassa' is a Greek word for the 'Sea', and 'Haema' is for 'blood'. It was first identified by Cooley and Lee (1925), hence named 'Cooley' s Anaemia'.Thalassemia is an inherited blood disorder, passed down through generations through genes. The disorder is a result of the failure of formation of haemoglobin in red blood cells and consequently is causing anaemia (Forget and Cohen, 2005). Normally, red blood cells survive for 120 days but inThalassemia, red blood cell survival is reduced.Thalassemia is actually an inherited autosomal co-dominant disorder. In this, the genetic defect results in reduced rate of synthesis of one of the globin chains that make up of haemoglobin. The most clinically relevant are alpha (á) and beta (â) thalassemias, which are caused by mutation in globin gene cluster. These defects include mutations usually have geographic and ethnic distribution.

The normal adult haemoglobin molecule is made up of two parts – 'heme' and 'globin'. 'Heme' is a porphyrin containing iron and 'Globin' is made up of four polypeptide chains of two types – Alpha (á) and Beta (â). Thus, each globin molecule is made up of two alpha and two beta chains. This haemoglobin is called haemoglobin A (Hb A) because this forms the major part of haemoglobin found in adults. In adults, there is another small fraction of haemoglobin called haemoglobin A_2 (HbA_2), the globin portion of which is made up of two á and two delta (ä) chains (Shah, A., 2004).

The â – globin chain of Hb A and ä-globin chain of HbA_2 differ only by ten amino acids in the sequence. Normally the concentration of HbA_2 is less than 3.5 per cent of the total Hb. During fetal life, the major portion of Hb is fetal haemoglobin (Hb F). The globin of which is made up of two á chains and two gamma (ã) chains. The concentration of HbF falls after birth and in adults

HbF is less than 2-3 per cent of total haemoglobin (Shah, A., 2004 and Sarnaik, 2005). In fact the type of haemoglobin varies during the foetal life and that of the adult. There is a genetic regulation that during the foetal life HbF is synthesised and among adults HbA replaces HbF.

The thalassemia syndromes are heterogenous group of inherited anemias characterised by defects in the synthesis of one or more of the globin chains (Weatherall and Clegg, 1981).

- Production of structurally normal, but decreased amounts of globin chains – the thalassemias (Sarnaik, 2005).
- Production of structurally abnormal globin chains – e.g. Hb S, Hb C, and Hb E (Sarnaik, 2005).
- Failure to switch globin chain synthesis (Sarnaik, 2005).

The thalassemias are classified according to the affected chain of the haemoglobin molecules. The á-globin chain is affected in á-thalassemia and in â-thalassemia, the production of â-globin is affected. The á-globin gene cluster is located very close to the telomere of the short arm of chromosome number 16 whereas â-globin gene cluster has locus on the distal end of the short arm of chromosome number 11 (Antonarakis *et al.*, 1982; Turn *et al.*, 1985; Wilkie *et al.*, 1991). Thus in a normal person with two copies of each chromosome, there are two loci encoding the â chain, and four loci encoding the á-chain. As â-globin chains are encoded by single gene on chromosome 11; á-globin chains are encoded by two closely linked genes on chromosome 16 (Low, 2005).

Types

The various types of thalassemia have specific names related to the severity of the disorder. Both alpha and beta thalassemias are of major thalassemia and minor thalassemia type. Thalassemia minor occurs if one receives the defective gene from either mother or father only. Thalassemia minor is asymptomatic and hence this condition is called as carrier. If an individual inherit the defective genes from both parents then thalassemia major develops.

Alpha Thalassemia

Alpha thalassemia involves the genes HBA_1 and HBA_2 inherited in a Mendelian recessive fashion. It is also connected to the deletion in the short arm (p) of the 16th chromosome (OMIM). This results in decreased á- globin production, therefore, fewer alpha globin chains are produced, resulting in an excess of â-chains in adults and excess of ã-chains in newborns. The excess of â-chains form unstable tetramers (HbH of â-chains) which have abnormal oxygen dissociation curves i.e., reduced capacity to carry oxygen.

Homozygote á°(alpha Zero) thalassemias, where there is lots of $ã_4$ chains but no á-globin at all (Hb Bart's), often results in still birth (Steensma et al., 2005).

- In á -thalassemia silent carrier, one of the four á loci is affected.
- In á -thalassemia minor, two of the four á loci are affected. It is also called á -thalassemia trait.
- When three loci are affected, the haemoglobin-H (HbH) disease occurs. This

disease rises from interaction of á + and á° determinants and patient have moderate anemia.

- á -thalassemia major develops when all four loci are affected. It is also called hydrops fetalis or Hb Bart's disease in which fetus cannot survive and mostly dead at birth (Low,2005; Higgs, 1993; and NHLBI, 2008).

Beta Thalassemia

â - thalassemia occurs when a defected gene affects the production of beta-globin chain of the haemoglobin protein, due to mutations in the HBB gene on chromosome 11, (OMIM) also inherited in an autosomal recessive fashion. The severity of the disease depends on the nature of the mutation. Mutations are characterised as $â^0$ (beta zero) if they prevent any formation of â chains; they are characterised as â+ (beta positive) if they allow some â chain formation to occur. In either case, there is a relative excess of á -chains, but these do not form tetramer. They bind to the red blood cell membranes, producing membranes damage, and at high concentrations they form toxic aggregates (NHLBI, 2008).

In â -thalassemia minor, only one â -globin allele bears a mutation. It is also called â -thalassemia trait. This is a mild microcytic anemia. In most cases â -thalassemia minor is asymptomatic, and many affected people are unaware of the disorder. The patient will have an increased fraction of HbA_2 (→2.5 per cent) and a decreased fraction of HbA (←97.5 per cent).

In â -thalassemia major, both of the â -chains are affected and results in severe microcytic, hypochromic anemia, which lead to death before age twenty if not treated properly and in time (Weatherall, 1967 and Thein, 1993).

â -Thalassemia Intermedia: It is a condition intermediate between the major and minor forms. Affected individuals can often have moderate type of anemia, and individuals can manage a normal life but may need occasional blood transfusions, for examples at times of illness or pregnancy, depending on the severity of the case (Low, 2005).

Delta Thalassemia

Similar to that of á and â (globin) chains being present in haemoglobin, about 3 per cent of adult haemoglobin is made up of alpha and delta (ä) chains. Just as with beta thalassemia, mutations can occur which affect the ability of this gene to produce delta-chains. A mutation that prevents formation of any delta chain, termed as delta zero (ä°) mutation (Low, 2005).

- When an individual inherits two delta zero mutations, no HbA_2 ($á_2ä_2$) can be formed.
- Individuals who inherit only one delta thalassemia mutation gene, will have a decreased HbA_2.

  Thalassemia can co-exist with some other haemoglobin opathies or haemoglobin variants (Debaun and Vichinsky, 2007). The most common of these are as follows:
- HbE/thalassemia; common in Combodia, Thailand and parts of India; clinically similar to â -thalassemia major or thalassemia intermedia (Fucharoen *et al.*, 2000).
- HbS/thalassemia; common in African and Mediterranean populations; clinically similar to sickle cell anemia.

- HbC/thalassemia; common in Mediterranean and African populations; HbC/â^{0}-thalassemia causes a moderately severe hemolytic anemia with splenomegaly; HbC/â$^{+}$ thalassemia produces a milder disease (Low, 2005; Angastiniotis and Modell, 1998).

Prevalence

Thalassemias are common autosomal recessive disorders especially in populations of Mediterranean, Middle Eastern and Far Eastern descent. Relatively high incidence is also observed in people of Asian Indian origin but the incidence is more limited in those of African descent (Cao *et al.,* 1997). In India the majority of â -thalassemia carriers were migrants from Pakistan and their pattern of mutations differed from the subjects of Punjab, Haryana and Uttar Pradesh (Verma *et al.*, 1997). Region-wise and Caste-wise analysis showed the highest prevalence of á -thalassemia among the Punjabi population originating from Northern region of India (Nadkarni *et al.*, 2008).

Signs and Symptoms

The most severe form of á -thalassemia major causes still at birth i.e., death of the unborn baby during last trimester of pregnancy. Children born with thalassemia major are normal at birth, but develop severe anemia during the first year of life. Other symptoms can include as follows:

Spleen enlargement

The spleen is an organ that helps your body to fight with infections and remove unwanted material. When a person has thalassemia, the spleen has to work very hard. As a result, the spleen becomes larger than normal.

Growth failure

The child becomes weak and lethargic with poor appetite, height, weight and the overall development is abnormal.

Bone deformities

Specially in case of bone marrow expansion, an attempt to compensate for excessive ineffective erythropoesis causes marked skeletal deformities with frontal bossing, cheek bone and jaw protrudes. Also distortion of ribs vertebrae and pathological fracture of long bones can be seen in thalassemic patients.

- Paleness and restlessness accompanied with symptoms of Jaundice
- Headache
- Fatigue
- Also the shortness of breath occurs.

Thalassemia minor is generally asymptomatic.

Clinical Complications

Heart and Liver Diseases

Cardiac complications remain the most important in determining the survival of â -thalassemia major patients (Brittenham *et al.*, 1994 and Piga *et al.*, 1997). Myocarditis, pulmonary hypertension can be related to iron overload in adult patients. Cardiac disease causes death in developed countries as a result of non-compliance to

desferoxamine from the third decade of life. With the emergence of advanced cardiac magnetic resonance imaging technique, the early diagnosis can be possible and survival of patients can be improved (Wonke, 2001).

- Blood of â – thalassemia patients remain chronic hyper-coaguable state with increase incidence of thromboembolic episodes. It is common in thalassemia intermedia patients. Patients had high plasma levels of markers of coagulation and fibrinolysis activation. Also their erythroid precursors had an enhanced capacity to generate thrombin (Cappellini *et al.*, 2000; Panigrahi and Agarwal, 2007).

Infections

Thalassemic patients have an increased risk of infections because of splenectomy, iron load and blood borne infections, particularly viral. Bacterial infection mainly *Yersinia enterocolitica* infection is suspected with other clincial symptoms (Adamkiewicz *et al.*, 1998). The blood borne viral infections, particularly Hepatitis B and C and more recently HIV have relatively high frequency in transfusion dependent â -thalassemia patients (Shad and McHutchinson, 2001).

Endocrine dysfunctions

- Delayed Puberty and defective functions of gonads or failure of whole hypothalamic pituitary gonadal axis (Beshlawy *et al.*, 2007).
- Diabetes Mellitus is also relatively common complication in patients who have been inadequately iron chelated (Chern *et al.*, 2001; Dmochowski *et al.*, 1993; Ladis *et al.*, 1998).
- â - thalassemic patients also deals with fertility problems. Most of patients in their second and third decade of life apparently well feeling, are asking for help with fertility related problems (Skordis *et al.*, 1998).
- Osteoporosis represents an important cause of morbidity in adult patients with thalassemia major. The pathogenesis of osteoporosis in thalassemia major is multifactorial and includes bone marrow expansion, endocrine dysfunction and iron overload. In this, the diminished osteoblast function is accompanied by a comparable or even greater increase in osteoclast activity (Voskaridou and Terpos, 2004).

Psychological Problems

Due to growth failure and other complications, thalassemic patients oftenly seem to be emotionally disturbed. Also some of the patients reported with X-linked alpha thalassemia/mental retardation Syndrome (ATR-X). It is a syndromic form of X-linked mental retardation. The ATR-X syndrome accompanied by severe psychomotor retardation, minor facial anomalies, genital abnormalities and an unusual form of á-thalassemia (Gibbons *et al.*, 1995; Wada *et al.*, 2005; McPherson *et al.*, 1995). Depression regarding the future, Illness and finances can also be seen in thalassemic patients (Shaligram *et al.*, 2007).

Sociological Problems

Sociological problems also occur with psychological problems in thalassemic patients.

The problems like failure in adjustment with family and friends are occurred due to abnormal growth and body image especially during adolescence. Economic burden may be arise due to poor family conditions and low educational status. Thalassemic individuals have to deal with problems of fertility and reproducibility, so marital life, of Thalassemic individuals get miserable (Anastasopoulos, 1996; Palma *et al.*, 1998; Khurana *et al.*, 2006 and Ratip *et al.*, 2003).

Diagnosis

- At the diagnosis protocol includes spleen enlargement.
- Complete Blood Analysis—A complete blood analysis of the thalassemic individual should be done to check the following abnormalities which can occur in red blood cells:
- A. Red blood cells appear small and abnormally shaped when looked under microscope
- B. Haemoglobin level can be decreased
- C. A Complete Blood Count (CBC) reveals mild anemia.
- D. Platelet count can also be lower down.

Electrophoresis: A larger number of haemoglobins are identified by electrophoresis. System is very convenient, can be adopted for identification of other haemoglobin (Hb) variants like HbF, HbD, HbE, HbS etc. and for globin chain analysis. With this, the elevated level of HbA_2 can be detected (Sachdeva *et al.*, 2002).

Polymerase Chain Reaction (PCR): A reliable, single-tube multiplex PCR assay have developed for the 6 most frequently observed determinants of á -thalassemia. The assay allows simple, high throughout genetic counselling or screening for the common hematological disorders (Chong *et al.*, 2000).

High Performance Liquid Chromatography (HPLC): It is convenient , efficient, reproducible and cost-effective method for screening and diagnosis of thalassemia (Precisely HbA_2 and HbF) and other haemoglobinopathies like, HbF, HbA_2 HbD, HbE, Hbs and á -thalassemia. With the help of HPLC technique percentage of variants present in the blood can be detected very easily.A test called Mutational Analysis can help to detect á -thalassemia that cannot be detected with haemoglobin electrophoresis.

Treatment and Medication

Thalassemia minor do not require any specific treatment. In Thalassemia major, patients require treatment like regular 'Blood Transfusions' when the haemoglobin level lower down than 8 g. To maintain the Hb level above 10g is the mainstay of treatment. Since the deficiency in thalassemia is that of red cells, only packed red cells and not whole blood should be transfused. Blood transfusions are usually require in every 2-5 weeks, to maintain the pre-transfusion Hb level above 9-10.5g/dl. The decision to initiate life-long transfusion therapy should be based on a definitive diagnosis of severe thalassemia, taking into account the molecular defects, the severity of anemia on repeated measurement, the level of ineffective erythropoiesis and clinical criteria such as failure to thrive or bone changes. (Shah, A., 2007).

Splenectomy is indicated when hypersplenism sets in, as indicated by increase in the transfusion

requirements. Splenectomy may also be done if massive enlargement of the spleen produces intolerable discomfort. It increases the risk of serious infections and hence should be avoided till 6 years of age (Viens *et al.*, 1998).

Chelation Therapy: Iron overload is an inevitable and serious complication of long-term blood transfusion therapy which requires adequate treatment in order to prevent early death mainly from iron induced Cardiac disease. It has been clearly shown that optimal Chelation therapy extends complication-free survival (Brittenham *et al.*, 1994; Anderson *et al.*, 2002; Piga *et al.*, 2003).

Stem cell transplantation: It may be called as bone-marrow transplantation which can cure â -thalassemia major. In this, affected children can received a transplantation from a family donor or HLA identical sibling donor (Orofino *et al.*, 2003). Allogenic haematopoietic stem cell transplantation is the only cure for the patients with haemoglobinopathies. Results of transplants have steadily improved over the last few decades due to effective control of transplant-related complications and development of new preparative regimens (Gaziev and Lucarelli, 2003; Piga *et al.,* 1997; Lucarelli *et al.*, 2002).

Gene Therapy or Genetic Engineering: Gene therapy is being tried by replacing the defective gene with normal functional gene. The concept of introducing genes into human cells for therapeutic purposes developed nearly 50 years ago as diseases due to defects in specific genes were recognised. The Hb disorders, an early target for gene therapy, have proved particularly challenging. Although ongoing research is yielding new information that may ultimately lead to successful clinical trials (Nienhuis, 2008).

Prevention

The most important concern of the thalassemia eradication programme should be its prevention.

Programmes of prospective Carrier screening and genetic counselling of â -thalassemia among couples planning marriage, pre-conception, or during early pregnancy are ongoing in several at risk populations. Carrier detection is carried out by haematological analysis followed by mutation detection by DNA analysis. The pregnant women can be screened using the single tube osmotic fragility test and prenatal diagnosis can accomplished by mutation analysis on PCR amplified DNA from chorionic villi. These programmes have been very effective due to education programmes, because awareness generation is still a primary requisite to make women register early at antenatal clinics and bring their spouses for screening when required (Cao *et al.*, 2002; Colah *et al.*, 2008).

Conclusion

Management of â -thalassemia is very expensive, arduous and painful as frequent blood transfusions are required, with possible risk of blood transmitted infections. Iron overloading in liver, heart and endocrine glands results, leading to their dysfunction, requiring expensive chelating agents for its removal. It is, therefore, necessary to prevent the birth of affected children by prenatal diagnosis, to reduce the socio-economic pressure on the family and burden of the disease on community. So, screening, genetic counselling , awareness and prenatal diagnosis are essential to control this dreaded and painful genetic disorder.

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FORMATIVE ASSESSMENT IN SCIENCE: AN EXEMPLAR

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Evaluation is a systematic process for collecting, analysing and interpreting evidences of learners'. It needs to be integrated with the process of teaching and learning. Evaluation should facilitate all-round development of the child, for that, formative system of evaluation has to be encouraged.

Introduction

Education is concerned with the all-round development of the child i.e., physical, socio-cultural, intellectual etc. Therefore, there is a need to assess the child's development on all its aspects. At present, educational system does not assess the progress of the child as a whole but only his/her academic achievement in specific areas. Position paper developed by National Focus Group (NCERT-2005) on "Examination Reforms", strongly recommends Continuous and Comprehensive Evaluation (CCE) system in order to make evaluation comprehensive and regular, provide space for teacher for developing creative thinking, provide a tool for diagnosis and for equipping learners with great skills and at the same time to reduce stress on children. The CCE scheme is simple, flexible and implementable in any type of school from an elite one to a government school located whether in rural or tribal area. It can be applied to all school stages.

At any school stage, whether elementary, upper primary or secondary students are young and sensitive, therefore, no rigid system of evaluation should be imposed on them. Evaluation should be integrated with the process of their learning and growth. Currently, the evaluation of students' performance is, on the whole, summative. It is criticised because the record of the progress of students' performance is registered on a half-yearly/yearly basis. This summative evaluation results in superficial learning which students forget in the long run. It also contributes to some extent to students' lack of interest in school. To make evaluation more meaningful, a well designed, planned, systematic and formative system of evaluation have been introduced. Formative assessment of performance of a student's learning is a step-wise process of mastering competencies in scholastic and co-scholastic areas whereas summative assessment is terminal in nature after a particular class.

A designed and relevant tools for the formative assessment on the chapter namely "Is Matter Around us Pure," *Science Textbook*, NCERT for Class IX, 2006 is being presented here. The design is meant to be an exemplar rather than prescriptive. Steps followed to evolve this design are enumerated to give an idea to design and develop tools for any topic in science irrespective of the stage of education in which it is being taught.

Step-I

Content Analysis

While doing content analysis of the chapter, identify the concepts expected to be learnt. Content analysis of the chapter "Is Matter Around us Pure" reveals that the concepts to learn are:

- A mixture contains more than one substance.
- A mixture is said to be homogeneous if it has a uniform composition throughout and heterogeneous if it has non-uniform composition.
- A solution has a solvent and solute as its components. The component of the solution that dissolves the other component in it (usually the component present in larger amount) is called the solvent. The component of the solution that is dissolved in the solvent (usually present in lesser quantity) is called the solute.
- Properties of a solution.
- Expressing concentration of a solution-mass/mass percentage and mass/volume percentage.
- In a solution, the relative proportion of the solute and solvent can be varied, depending upon the amount of solute present in a solution, it can be called a dilute, concentrated or a saturated solution.
- Solubility and effect of temperature on solubility.
- Properties of a suspension.
- Properties of a colloidal solution.
- Methods of separating the components of a mixture and their application—evaporation, centrifugation, filtration, sublimation, chromatography, distillation, fractional distillation, crystallisation.
- Physical and chemical changes.
- Pure substances—Types (elements and compounds).
- Physical properties of metals and non-metals.
- Difference between a mixture and a compound.

Intended learning outcomes

1. The learner is able to distinguish between

- Homogeneous and heterogeneous mixture
- Saturated and unsaturated solution
- Solution, suspension and colloidal solution
- Physical and chemical change
- Pure substance and mixture

- Element and compound
- Mixture and compound
- Metal and non-metal on the basis of their physical properties.

2. The learner is able to apply the knowledge to understand the following

- Filtration can be used to separate components of only a suspension and not of solution or colloidal solution
- Properties of a compound are different from its constituent elements.
- Mixture shows the properties of all its components.

3. The learner is able to

- calculate the concentration of a solution
- calculate the solubility of a substance
- separate the components of different types of mixtures.

4. Learner is able to describe the

- process of purification of impure water before being supplied as drinking water to homes
- process of separation of various gases present in air
- tyndall effect

The learner is able to apply the knowledge and understanding of concepts to interpret data and solve problems based on experiments and activities.

Step-II

Construction of Tools and Methods of Assessment

Formative assessment can be done using one or more of the following methods –

(i) Pen and paper test

This may be done by devising

Multiple Choice Questions (MCQ's)

The given MCQ question is designed to assess the understanding of the difference between a homogenous and a heterogeneous mixture by the learner.

Examples

- Which of the following are homogenous in nature?

(i) Ice	(ii) Wood
(iii) Soil	(iv) Air
(a) (i) and (iv)	(b) (i) and (ii)
(c) (iii) and (iv)	(d) (ii) and (iv)

- Seema was given two mixtures 'X' and 'Y'. She observed that both the mixtures appeared to be homogenous. She also observed that mixture 'Y' scattered a beam of light passing through it, whereas mixture 'X' did not scatter light. So, she concluded that

(a) 'X' is a suspension	(b) 'X' is a colloid
'Y' is a colloid	'Y' is a solution

(c) 'X' is a solution
'Y' is a colloid

(d) 'X' is a colloid
'Y' is a suspension

The above given question is designed to assess the understanding of the properties of solution, suspension and colloids by the learner. In this question the child is analysing the data using two properties of the mixture, namely homogeneity and Tyndall effect.

(b) Very Short Answer Questions

Very short answer questions, usually have one word or one sentence answer.

Example

- Is rusting of iron a physical change or a chemical change?
- Salt can be recovered from its solution by evaporation. Suggest some other technique for the same.

The very short answer questions are designed to assess that the learner is able to distinguish between physical and chemical change. He/she is also able to separate the components of different types of mixtures.

(c) Short Answer Questions

Short answer questions usually have three/ four sentence answer.

Example

This question is designed to assess the skill of applying knowledge of different methods for separating components of a mixture.

- Rahul is given a mixture of iron fillings, copper turnings and copper powder. Guide him to separate the components of the mixture.

The answer to this question involves two steps. Each step should be evaluated, one for the name of the method involved and the other for writing the name of the components separated by that method.

The question given below will assess the capability of the learner to observe changes in his/her daily life and relate them to the knowledge acquired by him/her about physical and chemical changes.

- When it rains, puddles are formed. After 2-3 days, these puddles dry up on their own. Is this a physical or a chemical change? Justify your answer.

This question should be evaluated for both the parts separately.

Similarly, other different types of questions can be framed such as fill-in-the blanks, matching type, true or false, completion type (where incomplete figures are given or incomplete labeling is done, which has to be completed.), open-ended, activity-based questions, etc. While framing any type of question, it should indicate the limit and the scope of the answer in accordance with the estimated time and marks allotted to it. A question should be framed in a clear, precise manner with unambiguous language. It should be within the comprehension level of the child. Utmost care needs to be taken while framing questions, so that these may be used to test the real understanding of the concepts, which, in turn, would also help reduce student's anxiety. Open-ended questions and activity-based questions can be framed.

Open-ended questions will test the expression and the ability to formulate an argument using relevant facts. Activity-based questions increases the sense of observations among children and also help in better understanding of the concepts. All these types of questions can be given while doing formative assessment of a child.

(ii) Tasks based on activities/experiments

'Learning by doing' not only increase the sense of observation among children but also help in better understanding of the concepts.

The following task involves an activity based on the concept of physical and chemical changes. It is designed to assess the ability of the learner to perform the activity, observe and draw inference.

Example

- Take ten drops of soap solution in a test tube. Add two drops of red litmus solution to it. It turns blue. Then add vinegar to this solution drop-wise until the blue colour changes again. Now answer the following questions:

  What is the change in colour of the solution after adding vinegar?

  Has a physical or a chemical change occurred?

  Justify your answer.

Now the point arises on what basis one should evaluate this activity?

We should look at the answer to these questions and evaluate a child :

Is the child able to use right apparatus?

Is the child able to use the appropriate technique?

Can the child think logically and rationally?

Is the child able to achieve the desired results?

Is the child able to interpret and derive the conclusion?

Is he/she able to apply the theoretical knowledge in practical situation?

Other questions can be asked based on the particular activity/experiment which a child has performed.

(iii) Task based on project work/survey:

The advantage of giving a project is that it provides an opportunity to the child to explore and work with his/her own hands.

Example

This task involves a survey and assesses the ability of the learner to collect information and analyse it.

- Make a survey of your home and make a list of four pure substances and four mixtures which are frequently used in day-to-day life. Classify the pure substances as elements and compounds.
- Visit a nearby dairy and report about the processes used to separate cream from milk.
- Make a survey and write a report about the processes involved to get the supply of drinking water to your home from water works.

Project work generally involve collection and analysis of data. Project work can be school-based or home-based or both. These can be

open-ended or structured and can be both individual or group projects. A child can be evaluated on the basis of his/her data collection, observation and data interpretation. Projects related to child's immediate environment/culture/ community based should be encouraged.

(iv) Task based on group discussion

Activities and project work should be followed by a group discussion. In group discussion, each child should get a chance to speak. He/she should be assessed on the basis of the following points. Does he/she have :

- the content knowledge of the activity/project.
- the ability to putforth his/her views.
- proper communication skills i.e., speaking/ writing.
- respect to the peer group.
- proper body language while interacting.

Not only should the child who is discussing about his/her project/activity be assessed by the teacher, but the other children in the class can also be assessed by the teachers who are asking relevant questions to the child related to the project/activity. Activities/projects provide an opportunity to work in groups and help in developing a positive attitude towards group work, sharing and learning from each other. Group discussions can also be done on a particular topic or concept given in the chapter. Group work can also help the teacher to assess the ethical values among children.

(v) Task based on quiz and crossword puzzles

These may also be given while doing formative assessment. Oral or written quiz can be given in the class. Quiz not only helps in analysing the entire chapter but also keeps the learner mentally alert.

Example

- Melting of iron metal is a physical change. (Yes/No)
- Decaying of wood is a chemical change. (Yes/No)
- Ice and air are homogenous in nature. (Yes/No)
- Soil is homogenous in nature. (Yes/No)
- Rusting of an iron article is called corrosion. (Yes/No)
- Why particles of colloidal solution do not settle down when left undisturbed?
- Suggest a suitable method to separate a volatile and a non-volatile components.
- Is water an element or a compound?
- Name a lustrous non-metal.
- Name a non-metal which is known to form the largest number of compounds.

A teacher can quickly assess the child by giving a written/oral quiz to know whether he/she has understood the topic.

Puzzles can be given in the class to test the understanding of the concepts. This is one of the play-way methods to assess the child. It helps in reducing the stress among the children. This can be given as a group or as an individual activity.

Example

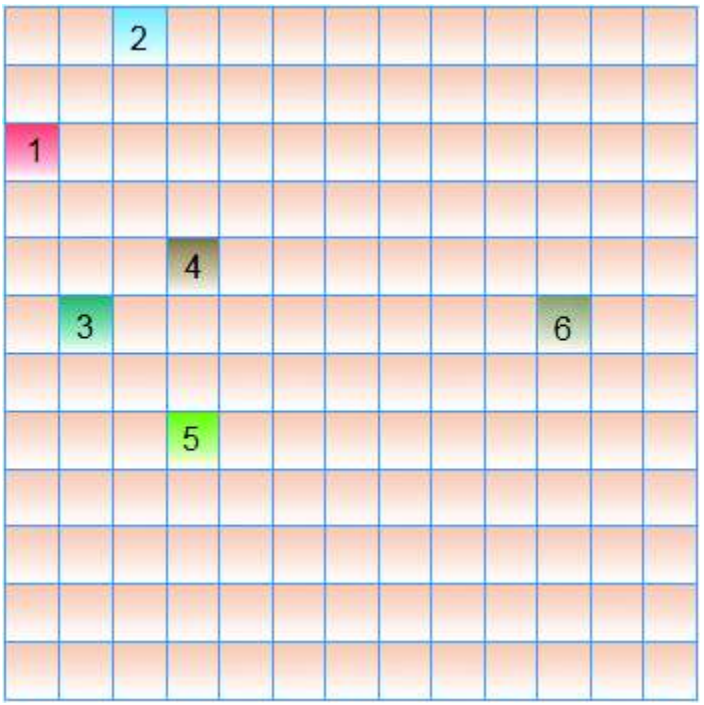
Complete the given crossword puzzle by using the given data.

Across

1. A metal which is commonly used for making ornaments and does not corrode even if left in water for several years.
3. An element which forms rust on exposure to moist air.
5. A very reactive non-metal stored under water.

Down

2. A white lustrous metal used for making ornaments and which tends to get tarnished black in the presence of moist air.
4. Both brass and bronze are alloys of the element.
6. The metal which exists in the liquid state at room temperature.



All the above mentioned tasks may be designed to test the knowledge, understanding and application of the concepts taught in the class. The methods used for assessing the performance of a child will depend upon the nature of the task. The given list of task is not exhaustive. More tasks can be designed to evaluate a child in a holistic way such as class work, home work, assignments etc.

Remedial measures

Continuous and comprehensive evaluation has many advantages. This evaluation mode will enable teachers to understand the areas/topics in which students are having difficulty and concentrate their efforts in those areas. The teachers will plan for remedial measures for students who are not working at the expected pace. The teacher can reteach the topic. He/she should encourage good work of the students to be demonstrated in the class. He/she needs to modify the strategies as per the needs of the students. The remedial help provided by the teacher to the students using one-to-one communication/interaction will motivate the children to attend the school regularly and thus making teaching-learning joyful. It will reduce anxiety and stress which often builds-up if children are assessed only once through an examination at the end of the year. It will help in developing the holistic personality of a child. Due to timely diagnosis of learning gaps and remedial interventions, a higher level of learning will be achieved among children. There will be shift from need for learning to love for learning and in the long run, it will reduce the drop-out of children from schools.

Conclusion

After going through this paper, it is expected that teachers will find the process of classroom assessment easier to do, more interesting and useful. It will be helpful for the teacher in promoting the student learning to the fullest extent. In order to have holistic development of the child, let us welcome and follow formative assessment honestly and make this shift a success.

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EFFECT OF PROGRAMMED INSTRUCTION ON ACHIEVEMENT OF SECONDARY SCHOOL CHILDREN IN LIFE SCIENCE

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Introduction

Science and Technology have created a phenomenal impact in shaping the lifestyle of human beings all over the world. Now-a-days all disciplines are becoming more scientific. Our method of observation becomes more symbolic, graphical and linguistic models in every discipline. Speaking on our dependence on science **Sandave (1963)** says:

Our Environment to a great extent is influenced by science. The clothing we wear, the houses in which we live, the agricultural method which produced our food and necessities, our automobiles, our telephones, our radios, the electrical appliances which are used in the home, all are based upon scientific information.

Science in its various forms and shapes helps us to understand ourselves and the environment around us. However, this task to understand ourselves and the environment is not so simple as it appears otherwise. To facilitate and serve the purpose in a better way, attempts are made to divide the subject matter and knowledge of the science into some distinctive branches. The study of physical science helps us to understand the material aspect of life and helps us to harness the physical forces and material world for the benefit and progress of man; the life science or the biological science help us to understand the life in all its aspects. We study of our plant kingdom and life of animals—terrestrial, aerial and aquatic. Such knowledge helps us to understand our own life and utilise this knowledge for healthy living in healthy environment.

As the child of today is more advanced and ahead of his father and forefathers in scientific advancement, proper care should be taken to see that the child develops in a systematic way to fit herself/himself to the modern world. Today each child must gain some fundamental knowledge of

science to develop acquisitiveness about varieties of things in a better way. He needs to be well informed about the developments taking place in the field of science. For this, it has become necessary to recognise and improve teaching and learning of science right from the school stage.

Aims of life science education at secondary level

The advantages that can be drawn by the study that subject generally become the aims for its study. The following are aims of teaching Life science at the lower secondary stage:

- To provide the students deep insight (more than the previous classes) with the facts and principles of life science.
- To develop their ability to perform experiments more skillfully and to help them to have better insight about the applications of science.
- To provide appropriate opportunities for the development of the inventive and creative faculties of the students
- To provide essential base for the higher specialised studies in the areas and fields of life science and technology.
- To equip the students with all the basic scientific knowledge and skills of life science which are helpful in day-to-day life.
- To help them in adopting and learning some useful scientific activities as hobbies and leisure hours purposeful activities.
- To create in them proper attitude and faith regarding the values and contribution of Life science.

Instructional materials in life science education

Effective instruction in life science can be attributed to the meaningful organisation of women/men, material, method and machine employed in the instructional situation. With the invention and use of modern scientific gadgets like computer, television, overhead projector etc., learning has been simplified and made faster and productive. In addition to this, innovative techniques like programmed instructional materials, interactive video and various forms of print materials have minimised the teacher's effort and increased self-instructional habit among the learners.

In this context there is a need for production of self-instructional modules for dealing with large amount of subject contents. There is lack of adequate materials in life science education programmes. Chalk and talk method is still prevalent in majority of schools. Use of modern instructional techniques among teachers for teaching life science has not reached its expectations. This is because the educational authorities have not been successful in equipping the teachers with the modern technology for developing self-instructional materials to meet the needs of large number of learners. With this end in view, the researcher makes an attempt to bring out an innovative programmed learning materials for students' uses. This may help in providing support for fulfilling the objectives for which textbooks are in uses.

Programmed instruction

Programmed instruction or programmed learning is one of the important innovations in the teaching-learning process. Programmed instruction is a carefully specified, systematically planned, empirically established, skillfully arranged and effectively controlled self-instructional technique for providing individualised instruction or learning experiences to the learner. It is an application of the principles of behavioural sciences and technology in the field of education. Following are some characteristics of programmed instruction:

- The programmed instruction is a process of constructing sequences of instructional material in a way that the rate and depth of learning are maximised, understanding is fostered and the motivation of the student is enhanced.
- The subject matter of the programme is presented by breaking into small steps in a logical sequence. The small steps stress the gradual nature of the increase in complexity and the smoothness of the transition from one item to the next, information grows in depth, changes occur in quality and quantity.
- In programmed learning situation, the learner progresses at its own pace.
- Programmed learning provides for constant evaluation through the record of learner's responses. The quality of the programme can be improved through checking the number of errors at each step and the learner's programme can be evaluated by looking into various types of responses produced by the learners.
- Programmed learning is based strictly on the behaviouristic principles of psychology. A fair amount of stress is laid on the examination and development of understanding through the handling of various cases in learning process.

Principles of programmed instruction

The principles on which programmed learning is based were discovered in psychological laboratories, which were discussed below:

- **Principles of small steps:** It is experimentally verified that a dullest student can learn as effectively as the brightest student, if the subject matter is presented to them in suitable small steps. The steps are so small that the students can easily go through it and give answers without any mistake. Thus the students will be able to go through the task or steps and sequentially learn all the steps.
- **Principle of active responding:** The second psychological principle is that the students learn better and faster when they are actively participating in the teaching-learning process. Programmed materials provide opportunity to every learner to respond at every small step.
- **Principle of reinforcement:** The third principle from the psychological laboratory is that the students learn best when they can confirm their answer immediately. It is one type of reinforcement to work on the programme or to learn. A student who must wait two weeks for the test results probably

will not learn as well as a student whose test is scored immediately.

- **Principle of self-pacing:** The programmed instruction is based on the basic assumption that learning take place effectively if the learner is allowed to learn at his own pace. Therefore, a good programme of the material always takes care of the principle of self-pacing. A learner moves from one frame to another according to his own speed of learning.

- **Principle of student evaluation or student testing:** Continuous evaluation of the student and learning process leads to better teaching-learning. In the programmed instruction, the learner has to leave the record of his responses because he is required to write a response for each frame on response sheet. This detailed record helps in revising the programme.

Types of programmed instruction

Among various programming, linear and branching programmings are most important. They are discussed below:

- **Linear programming:** B.F. Skinner of Harvard University and his associates are the originators of the linear type of programming. This is also known as the Skinnerian programming or Extrinsic programming and based on the principle that the learner's original response should be gradually attained or shaped until he meets some standard or acceptable performance. In this programming the best way to teach students is to break the subject matter into meaningful segments of information and write small steps in such a way that only the correct responses are likely to occur. Students learn better when they are successful. The student should be provided immediate knowledge of the result of his performance. He should actively participate in the learning process by constructing responses. In short, linear programming is based on the theory of the stimulus response reinforcement sequence of operant conditioning.

- **Branching programming:** Branching programming was developed by Norman A. Crowder (1954), an American technician. This is also known as Intrinsic programming. The programming is developed to overcome the limitation as reflected under linear programming. In this type, the learner has several branches before him. The responses to the item determine which of several units he will be directed to attempt. The branching type of programme is found useful in learning problem-solving and various types of analytical abilities.

Need of linear programming

Linear programming is used for solving the following problems of education:

- The individual difference is the major problem of education. Every learner does not get opportunity to proceed according to his own abilities and rate of learning.

- In teaching and learning, main emphasis is given to presentation rather than doing. The students learn better by doing.

- There is no provision for diagnosing the weakness and difficulties of the learners, so that remedial instruction or teaching may be organised to remove learner's difficulties.
- The available textbooks do not provide any reinforcement to learners' behaviours or activities.
- Teaching strategies, textbooks, teaching aids do not provide any opportunity to check his responses immediately so that he could know how successfully he is learning.

In classroom teaching, a teacher tries to pace with the average students and he ignores the bright and poor students of the class. These problems of teaching-learning can be solved effectively by the use of programmed learning strategy. It incorporates the psychological principles of learning.

Role of the teacher in programmed instruction

The teacher occupies a significant position in the teaching-learning process. He is the pivot around which all the educational programme rotate. In this connection, George Temlison has rightly remarked that:

You can do without the ministry, you can do without the civil service. But if there are no teachers the world would be backing the barbarism in two generations.

The role of the teacher in the selection of programmed learning may be stated as under:

- Teacher as an advisor in helping students in the selection of programmed learning material.
- Teacher as a discussion leader for focusing the attention of the learners on important points.
- Teacher as a guide to clarify doubts and elaborate on various points asked by the learner.
- Teacher as an evaluator of the learning outcomes.
- Teacher as a consultant to the various agencies engaged in production of programmed material.

Programmed instruction in India

The concept of programmed instruction was introduced in India in December 1963 with the organisation of three days seminar on programmed instruction at Central Pedagogical Institute, Allahabad. In this seminars 25 educators of training colleges of the country participated. After that, several seminars were organised on programmed instruction in the training colleges of Punjab, Gujarat and Maharashtra. In 1965, NCERT organised a workshop at Psychological Foundation Department for a week to train 25 lecturers of training colleges. In 1966, NCERT organised a workshop on programmed instruction and 40 teachers of sciences, mathematics, statistics, geography, family planning and defence persons were participated. They had prepared programmed instruction material in their discipline. Most of programmed materials were designed on science and mathematics. Council had organised second workshop at Chandigarh. Some persons working in this area formed Indian Association of Programmed Learning (IAPL) during 1966. An annual conference is organised every year as a

new aspect of IAPL and Journal of Educational Technology is published by this organisation. Central Advanced Studies of Education (CASE) Baroda, Meerut University and H.P.University have also introduced a course on programmed instruction at B.Ed, M.Ed and M.Phil (Education) levels. By doing this, they are providing knowledge and skill of programmed instruction strategy. In these Universities, number of programmed instruction materials have been designed and evaluated on different school subjects.

Programmed instruction is still in its infancy in India. As regards to its classroom use, it may be observed that it is almost nil.NCERT has also done some work in this field. Inspite of all these efforts, it may be stated that the application of programmed instruction has not yet made an appreciable impact on our classroom teaching. Our methods of teaching still remain traditional, by and large.

Reveiw of related studies

Leslie and Angell (1964) made a comparative experimental study of programmed instruction and traditional classroom instruction. He found that the results obtained by programmed instruction were in no way inferior to those obtained by traditional methods of teaching. Fieldman (1965) conducted several studies using programmed instructional material and the textbooks used in traditional classroom. He found that his results were inclusive, because some studies showed no significant differences. Chibbar (1973) made a comparative experimental study of programmed instruction and traditional classroom instruction for teaching biology and found no significance between the two methods. Pandey, Abha Km.(1974) conducted an experimental study, which involved the application of two teaching methods. He found no significant difference between the methods. Das Rabindra (1984) conducted his Ph.D. study on "The development and tryout of self-instructional material on health education for high school student with special reference to communicable diseases" his main findings are (a) the self-instructional materials succeeded in enhancing the learning capacities of the student when self-administered by the students as well as administered under the supervision of the teacher, (b) The self-learning techniques were found superior to the other modes of learning, (c) A very proportion of students showed a favourable attitude towards the prepared self-instructional material. Chaudhury, M. (1985) made a study on preparation and evaluation of programmed learning material in geography for the secondary level. His main findings are (a) Students gained significantly in the knowledge of the subject by reading the programme, (b) The mean gains for the different institutions varied to a fair extent but all these gains were highly significant. Mehta, J.M.(1985) conducted a study on the construction of different types of programme in mathematics and the relative efficiency. He found that (a) The different types of learning programme were equally efficient compared to ordinary method, (b) The linearly prepared programme was found efficient, (c) The effect of learning through different programmes upon high achievers and low achievers was equal. Desai, R.M.(1986) conducted a

study on the effectiveness of programmed learning strategy in teaching of physics in the eleventh grade. He found that (a) Pupils took active interest in reading and teaching through programmed material. He found that (b) programmed learning material approach easy and interesting as each pupil had an opportunity to learn at his own speed and capacity.
(c) The programmed learning approach proved better than the lecture method in the study of physics. Kalacherry, K.A . (1987) conducted an experimental study on the preparation and tryout of programmed instructional material on the syllabus of chemistry prescribed for Class VIII in Maharashtra state. He found that,
(a) About 83 per cent learners were able to response correctly to 83 per cent of the frame,
(b) The value of measure of density for the whole programme was found to be 0.36. It was found that a few students who scored usually below 50 per cent in the traditional system, scored above 85 per cent through the use of programmed material. Debi, M. K. (1989) worked on Development and testing the effectiveness of PLM in the syllabus of principles of Education in B.T. course of Gauwhati University. He found that students taught through PLM performed better than students taught through traditional method. Ambli, S. (1992) studies the step, size, extrinsic, intrinsic reinforcement and overt-covert response transformation in reading materials and their interactions on learners' performance. The researcher found that step size was of significance only in the girls' sample with small step materials; girls learnt better but the response mode found to have significant impact both on boys and girls. Sahu, A.R. (2001) conducted his M.Phill study on Development of programmed Text in science for students of Class VII. He found that students taught through PLM performed better than students taught through traditional method.

Rationale of the study

As the world is progressing rapidly, the students' need to be given more knowledge in quick time, now-a-days classroom teaching is very much inadequate in India as it is evident everyday from newspapers, magazines etc. Very often parents also complain that nothing is taught in the school. This type of problem is due to the prevailing traditional method of teaching. In traditional teaching and learning, main emphasis is given for presentation rather than doing. But the students learn better by doing. Self-instructional material can solve this purpose the best. Considering above fact in mind, researcher wants to prepare a linear programmed instructional material in which the subject matter of the programme is presented by breaking into small steps in a logical sequence. The small steps stress the gradual nature of the increase in complexity and smoothness of the transition from one item to the next. Therefore, information grows in depth changes occur in quality and quantity and the individual may get mastery over as many subjects as he likes. So, the researcher is interested to develop a programmed instruction in life science for secondary school children to find out its effect on their achievement.

Objective of the study

- To develop a Programmed Instructional Material in life science for secondary school children.
- To study the effect of Programmed Instruction on achievement in life science.
- To compare the achievement in life science through programmed instruction and traditional approach.
- To analyse the effect of programmed instruction on achievement in life science with reference to sex.
- To study the interaction effect of the method of teaching and sex on achievement in life science.

Hypothesis

- There will be significant difference in the achievement in life science through programmed instruction and traditional approach.
- There will be no significant difference in the achievement in life science through programmed instruction and traditional approach.
- There will be significant difference between achievement in life science of boys and girls learning through programmed instruction.
- There will be no significant difference between achievement in life science of boys and girls learning through programmed instruction.
- There will be significant interaction effect of the method of teaching and sex on achievement of life science.
- There will be no significant interaction effect of the method of teaching and sex on achievement of life science.

Scope and delimitation of the study

As the present study is a pilot project, the study has been delimited to the following aspects:

- The programmed instructional material developed by the researcher is only meant for the children of Cuttack district only.
- Further due to the paucity of time and money, only one topic "The diseases due to over intake of food" will be taken for programmed instruction.
- The programmed material developed by the researcher will be linear in nature.
- The sample of the study consists of eighty students from two schools i.e., one for control group and another for experimental group.

Overview of the design

The design chosen in the present study was pre-test-post-test equivalent groups design. There were two groups, one control group and one experimental group. In this design, experimental and control groups were generally kept as identical as possible with the exception that experimental group exposed to the experimental treatment. Pre-test and post-test were proposed to be administered to both the groups.

Where,

O1 = Pre-test for control group.

O3 = Pre-test for experimental group.

T1 = Teaching through traditional method.

T2 = Treatment for experimental group i.e., teaching through programmed instruction.

Table 1: Design of the Study

Control Group			Experimental Group		
O1	T1	O2	O3	T2	O4

O2 = Post-test for control group.

O4 = Post-test for experimental group.

Sampling

Eighty number of Class IX students of Cuttack district had participated in this study. They were samples from two high schools and were assumed to be equal in all respect. The details of participants are listed below:

Table 2: Sample of the Study

Name of the Group	Control Group		Experimental Group	
Sex	Boys	Girls	Boys	Girls
No. of participants	20	20	20	20

Tools and techniques

- Programmed Instructional Material on the topic 'The diseases due to over intake of food' in Life Science for Class IX.
- Achievement test.

Procedure of the study

To assess the previous knowledge of the student in the topic 'the diseases due to over intake of food' , the pre-test was administered both on control group and experimental group. Then, their scores were recorded separately. After that, the topic 'The diseases due to over intake of food' was taught to the control group through traditional method. This topic was taught in three periods taking three consecutive days. Then, the prepared programmed instructional material on the same topic was given to the experimental group. It also took three periods in three consecutive days. When the subjects were provided with programmed instructional material, the teacher physically present in the class to clarify the doubts arose by the students. After teaching of the same topic to control group and experimental group with two different methods, a post-test was administered to both the groups. Then, their post-test scores were recorded separately. Then the pre-test and post-test performances of the subjects and also the post-test performances of the control group and experimental groups were fed to statistical treatment i.e., ANOVA to find out the effect of programmed instruction.

Results of the study

In the present study all the scores had been collected from 80 students of Class IX. Among these 80 students, 40 students constitute one group known as control group, it contains 20 boys and 20 girls and other 40 students constitute another group known as experimental group, it also contains 20 boys and 20 girls. All the pre-test and post-test scores of both control group and experimental groups were analysed and their mean and standard deviation were calculated. These are given in table 3. From

Table 3: Mean and Standard Deviation of Pre-test and Post-test Scores of both Control and Experimental Group

Name of Test		Pre-test			Post-test		
Name of Groups		Control Group	Exptl. Group	Combined	Control Group	Exptl. Group	Combined
Girls	M	2.5	12.8	12.65	22.4	31.45	26.92
	SD	3.05	2.67	3.19	5.95	4.05	6.81
	M	10.3	10.35	10.32	21.25	28.95	25.1
Boys	SD	2.78	2.67	2.72	3.86	3.58	6.36
	M	11.4	11.57	—	21.82	30.2	—
Combined	(B+G)	SD	3.12	3.25	—	5.05	4.03

Table 3, it is observed that pre-test mean score of control group and experimental groups are 11.4 and 11.57, respectively. It clearly indicates that the scores of both the groups are equal. It is also clearly observed that the standard deviation of pre-test mean score of control group and experimental groups are 3.12 and 3.25, respectively. It also indicates that there are similar scores in both the groups. Table 3 also indicates that the mean score of girls are slightly greater than the mean score of boys.

From the same table, it is clearly observed that during post-test the mean scores obtained for both the groups were higher than the corresponding pre-test mean score i.e., pre-test and post-test mean scores of control group are 11.4 and 21.82, respectively. It indicates that the traditional method had some effect on the achievement of life science. But, the pre-test and post-test mean scores of experimental group are 11.57 and 30.2, respectively, it indicates that the programmed instructional approach had some more positive effect on the achievement of life science than traditional method. The post-test mean score of control group and experimental groups are 21.82 and 30.2, respectively. This clearly indicates that programmed instruction was more effective than traditional approach on the achievement of life science.

Besides this the 2×2 (Equal cell) ANOVA techniques were used for testing the hypothesis. The summary of variance is given in Table 4.

- **Difference in the achievement through programmed instruction and traditional approach**

In terms of independent variable methods of teaching, there exists significance difference, F=66.95 (df=1, 76), where the tabulated value is 7.01 at 0.01 in the achievement of students as shown in Table 4. Students taught through programmed instruction performed significantly better than students taught through traditional approach. In Table 3 instructional material indicates higher mean marks than students taught through traditional approach as their mean scores are 30.2 and 21.82, respectively. The result is in accordance with the first hypothesis that there will be significance difference in the achievement in life science through programmed instruction and traditional approach.

Table 4: Summary of Analysis of Variable (ANOVA)

Sources of Variance	df	SS	MS	F	Significant/ not Significant
Method	1	1402.81	1402.81	66.95	.01
Sex	1	66.61	66.61	3.18	NS
Interaction	1	9.11	9.11	0.434	NS
Within	76	1592.45	20.45	-	-

Findings of present study have been in conformity with a substantial body of literature provided by other researchers. Leslie and Angell (1964) had reported programmed instructions were in no way inferior to those obtained by traditional methods of teaching. Debi, M.K.(1985) also reported that students taught through programmed learning material performed better than the students taught through traditional method. Similarly a number of findings of Fieldman (1965), Das Rabindra (1984), Mehta, J.M. (1985) had reported that programmed instructional approach is more effective than traditional approach in classroom situation.

So, the hypothesis, there is significant difference in the achievement in life science through programmed instructional material and traditional approach is accepted and the null hypothesis, there is no significant difference in the achievement in life science through programmed instructional material and traditional approach is rejected.

- **Difference among achievement of boys and girls**

In terms of independent variables sex, there exist no significant difference, F=3.18 (df=1, 76) in the achievement of boys and girls as shown in Table 4. From Table 3 girls have secured higher marks than the boys as their mean scores are 26.92 and 25.1, respectively. But this mean difference between girls and boys is negligible. The result is in accordance with the second hypothesis that there will be no significance difference exists in the achievement of life science between the boys and girls learning through programmed instructional material.

In this connection several studies had been conducted. Mehta, S.J. (1972) found in his study that the achievement of girls to be superior than boys in experimental as well as in control group. In contrary, Singh, B.P. (1972) reported that achievement of boys was higher than that of girls through the programmed learning performance.

Further, a study conducted by Ambli, S. (1992) found that there exists significance only in the girls sample. With small step materials girls learnt better but the response made was found to be significant impact both on boys and girls.

Thus, regarding the sex variables, no final conclusion can be drawn because results of the studies are inconsistent with regard to sex variable.

- **Interaction effect of the method of teaching and sex on achievement**

There is no significant interaction effect of methods of teaching and sex. The obtained value, F=0.434 (df=1, 76) indicates interaction effect is insignificant as shown in Table 4. From Table 3, students taught through traditional approach exceed very marginally in their achievement as the achievement scores of student, changes from the boys to the girls. Again from Table 3, it is clearly observed that students taught through programmed instruction exceed marginally from boys to the girls. It is evident that methods of teaching and sexes have no influence upon each other. Figure 1 shows the illustration of sex and methods of teaching effect on achievement.

Fig.1 Illustrates sex and methods of teaching effect on achievement, several studies had been

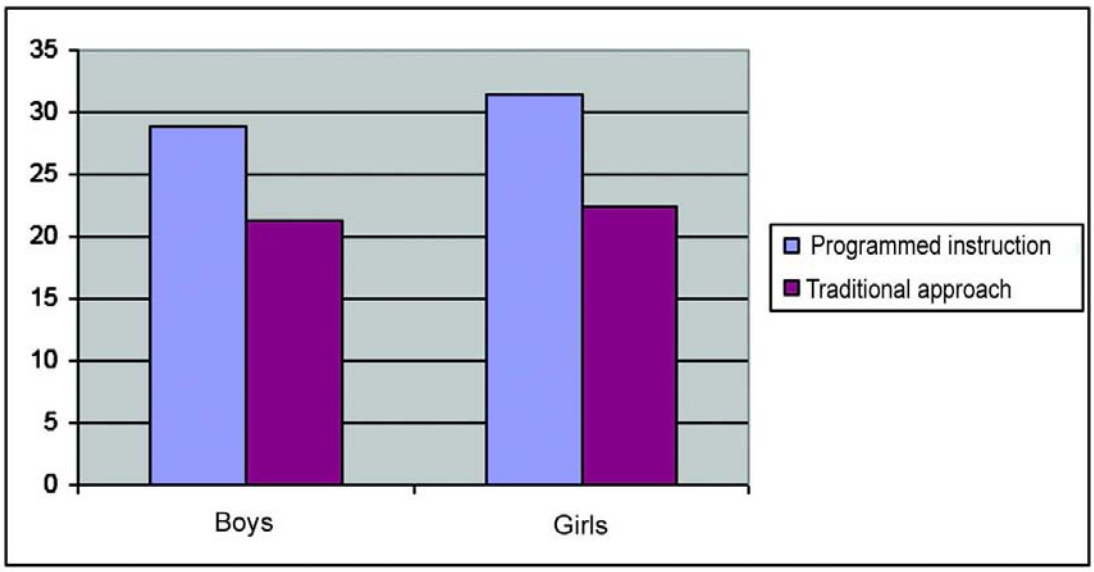

Fig.1 : Difference of achievement among boys and girls

conducted in this direction. Kkrumbottz, J.D. and Weilsman, R.G. (1964) had conducted a study in this direction and found that interaction effect was not significant.

Educational implications

The present study offers a number of implications.

- At elementary level, there is an urgent need to prepare textbooks on linear model. Because, generally there single teacher required to teach all subjects. This strategy will be very helpful to them. It may raise the academic standard of primary education.
- At secondary level, the major feature is the diversified curriculum; the teacher may be assigned a subject other than his interest. The diversity of interest and curriculum necessitates the application of self-instructional strategies. It may be used on remedial teaching. The classroom teaching may be followed by this strategy.
- The implication of programmed instructional approach in correspondence education is beyond imagination. Because it is now necessary to realise that the self-instruction could be made possible if the correspondence lessons are programmed. Again, a large number of school teachers feel frustrated when new courses are introduced in the curriculum, the programmed learning text will equip them with new content and new method of teaching. Further till now,

fifteen Universities have been introduced correspondence education at graduate level and post graduate level. In this context programmed lessons should be brought at par of the regular students and by doing so standard of higher education can be maintained by them.

- The implication of programmed instructional material for language teacher is also beyond consideration. With the present methods of teaching language the task seems to be insurmountable. The programmed material for language learning will be presented in a book format for which it will achieve the objectives of language teaching.
- It may also be noted that science and mathematics are growing rapidly that is becoming harder and harder for school teachers to keep pace with the change. In this regard, the programmed instructional material should develop on new topics which will be helpful to equip themselves with latest content and they will be able to keep pace with time.
- Implication of programmed instructional material in medical and health education is also unbelievable. To cope with the rapid advancement in the field of medical education programmed instructional material may be used by the doctors and medical colleges.
- The strategy of programmed instructional material will also be helpful to solve the problems like, population growth, information growth, demand for higher education and further education, teacher shortage, demand of competent teachers and existing limitations and resources.

Besides all these, there is no significance difference existing between boys and girls in learning programmed instructional material, so programmed instructional material can widely used in the above area irrespective of sex, which is an important variable in learning situation.

Thus, the results of the present study expected to throw light in the field of education and accordingly inspire teachers, educationists and other researchers to build up bright academic accomplishment.

Suggestions for future research

The present investigation identified several ways of possible exploration and numbers of important findings have been reported in the present study.

However, in view of inevitable limitations and constraint of this study following directions are suggested for future research:

- Development of programmed text in branching style and tests its efficacy over traditional approach.
- Development of programmed text in any subjects other than life science and tests its efficacy over traditional approach.
- The present study has been tried out in limited area and sample. So it is recommended to try out in large sample and in different areas of the state for its validation.

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A STUDY OF PROBLEM-SOLVING ABILITY IN PHYSICS AMONG INTERMEDIATE LEVEL STUDENTS

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This study attempts to assess the problem-solving ability in physics among intermediate level students in relation to their sex, locality and type of school. To execute the present study, 500 students studying physics in Class XII from 30 schools of Rohilkhand region were selected on basis of multi stage random sampling technique. The present study was conducted through survey method. The data were analysed by mean, S.D. and 't' test. The findings indicate that sex and type of school both influenced the physics problem-solving ability of the students. Students of privately-managed and girl students have better physics problem-solving ability than their respective counterparts. However, locality does not reflect the significance effect over physics problem-solving ability of the students.

With the advancement in science and technological fields, the life of the individual is becoming more and more complex confronted with a variety of problem each and everyday. In order to lead a comfortable life, a person must have the capability to solve these problems in his/her own unique manner keeping in view his/her personal life settings and style. This capability is much more acquired rather than being by innate. So, it is the responsibility of education system to develop problem-solving ability in the students so that they may solve their problems independently for better adjustment. Discipline of science presents a better scope for this purpose.

Science should not be seen as a sterile academic discipline but should be taught at all stages in a way, which emphasises practical, investigative and problem-solving approach. At present, basic science is taught as a part of environmental studies at primary level. From upper primary level to secondary level, it is taught as a part of general science. In the hierarchy of types of learning, problem-solving learning is at the top. So, it is quite necessary that in the schools, subjects should be taught in the way that ensures highest level of learning. In physics, it becomes much more important because problem-solving ability in this subject is directly linked with our social progress.

Development of this ability is also associated with stages of cognitive development. According to Piaget, after the expiry of formal operation stage (about 15 years), the child may reach full intellectual potential to discover problems through mental manipulation of symbols by adopting a logical and systematic procedure. It implies that students at senior secondary level are matured enough to display problem-solving ability.

At senior secondary level, science is an optional subject. The students who opt for physics at this level are very different in their problem-solving ability. Some students are quick and efficient problem-solvers, while some students fail to solve even simple problems. This raises the question as why some students are poor problem-solvers and others are efficient, when the learning experiences provided to them are almost the same? The difference obviously lies within the problem-solver. Therefore, it would be interesting to understand the nature of difference between the successful and unsuccessful problem-solvers.

Review of the evidence in this aspect shows that very few researchers have tried to explore the impact of various individual characteristics of learners on their problem-solving ability, specially in physics subject. The studies conducted by Ajwani (1979) and Naga Lakshmi (1996) showed that there was no significant sex differences in relation to problem-solving ability. Mishra (1986) found in his study that public school students performed on the combinatorial grouping problem irrespective of school, place and sex. Kazemi (1996) also found that boys and girls did not differ significantly on achievement in solving mathematical word problems. However, Kiran (1983) , Dharchingpui (1989) and Anthony (1991) found in their studies that significant sex difference in problem-solving ability existed. Mealings (1961), Anthony (1991) and Roberts (2006) found in their studies that age of the child did not significantly affect problem-solving ability. But Ajwani (1979) and Shrestha (1982) found that problem-solving ability of the subjects increased with an increase in age. Studies conducted by Sumathy (1994) and Naga Lakshmi (1996) found that rural and urban students differ significantly to each other in problem-solving ability in physical science and mathematics respectively. Thus, findings in this area are quite contradictory and necessitate for further studies. With this view point, present study has been undertaken.

Objective

To assess the problem-solving ability in physics among intermediate level students in relation to their sex, locality and type of school.

Hypotheses

Following hypotheses have been framed to fulfil the objective of the study–

(1) There is no significant difference between boy and girl students in respect to their problem-solving ability in physics.

(2) Urban and rural students do not differ significantly in their problem-solving ability in physics.

(3) No significant difference exists between the students of privately-managed and government-managed schools in respect to their problem-solving ability in physics.

Methodology

Study has been carried out through survey method.

Sample

A sample of 500 students studying physics in Class XII was selected on the basis of multistage random sampling technique taking into consideration proper representation to both the sexes (Boys and Girls), locality (Urban and Rural) and type of schools (Privately-managed and Government-managed). At the first stage, four districts were selected randomly out of eight districts of Rohilkhand region. Then, out of various senior secondary schools located in these districts, thirty senior secondary schools in which science was offered at XII level were selected randomly giving proper representation to locality.

Tool

A test for measuring problem-solving ability in physics was developed by the investigators. The test was validated and revised at three stages— individual testing, small group testing and field testing. The initial draft of the test consisted of 150 problem-solving items. The final form of test consisted of 74 items. The reliability of the test was calculated by test –retest method and was found to be 0.73. It was validated for its content only.

Statistical Techniques

't' test has been used for analysing the data. Table 1 shows the performance of boys, girls as well as total students on physics problem-solving ability. The mean score of total students is 42.25. The maximum possible score on Physics Problem-solving Ability Test is 74. This shows that the average performance of intermediate level students is approximately 60 per cent on the constructed test. The value of standard deviation (13.09) indicates that scores of students are within the normal range of deviations.

Results and Discussions

Table1 : Difference in the Mean Scores in Physics Problem Solving Ability of Boy and Girl Students

Groups	N	M	S.D.	't'
Boys	300	41.23	12.82	2.14*
Girls	200	43.78	13.38	
Total	500	42.25	13.09	

*Significant at 0.05 level

Table 1 also reveals that there is a significant difference in physics problem-solving ability of boy and girl students at 0.05 level of significance (t=2.14). Thus, sex of the students affects the physics problem-solving ability. Mean score on physics problem-solving ability of girls (M=43.78) is higher as compared to the mean score of boys (M=41.23), meaning thereby that girls are better in physics problem-solving ability than boys.

Similar findings were found by Kiran (1983), Dharchingpui (1989) and Anthony (1991). They explored that students have significant difference on problem-solving ability in relation to sex. But this finding is somewhat contradictory to some of the previously reported ones. Ajwani (1979) observed no

significant sex difference in subject ability to solve problems. Naga Lakshmi (1996) observed in her study that there was no significant difference between the performance of boys and girls regarding problem-solving ability in mathematics.

Finding of the present study is quite interesting and contradicts the general viewpoint that mathematics and physics are the subjects in which boys can do better than the girls. The reason for the obtained difference in physics problem-solving ability of girls and boys may be that girls are more serious in their studies, to see the things more critically and to devote more time in understanding each and every thing as compared to boys who are probably not so serious.

It is also possible that at this stage of age, cognitive development of girls is faster than the boys resulting in better development of problem-solving ability.

Table 2 : Difference in the Mean scores in Physics Problem-solving Ability of Rural and Urban Students

Groups	N	M	S.D.	't'
Rural	100	40.17	11.97	1.78
Urban	400	42.77	13.32	

Table 2 shows that 't' value among students of rural and urban areas for differences in physics problem-solving ability is not found significant at any level of confidence. Thus, this table indicates that both groups are similar on physics problem-solving ability. The mean scores of rural and urban students are 40.17 and 42.77, respectively.The result is contradictory to the study conducted in India by Sumathy (1994) who found significant difference on problem-solving ability in physical sciences between the rural and urban students.Urban students were at a higher level than rural students on problem-solving ability. Naga Lakshmi (1996) also found in her study a significant difference in the problem-solving ability in mathematics students of rural and urban areas in favour of the latter groups. The present study infers that locality does not effect the problem-solving ability among intermediate level students showing that students of rural locality have come at par to urban students in this respect.

Table 3 : Difference in the Mean scores in Physics Problem-solving Ability of Students belonging to Privately-managed and Government-managed Schools

Groups	N	M	S.D.	't'
Privately-managed	400	43.26	13.47	3.48**
Government-managed	100	38.22	10.58	

**Significant at 0.01 level

The close scrutiny of Table 3 indicates that the students studying in privately-managed and government-managed schools have a significant difference at 0.01 level of confidence in respect to physics problem-solving ability. The mean value of physics problem-solving ability of privately-managed schools students (M=43.26) is higher than the mean value of government-managed schools students (M=38.22). So, it may be concluded that students of privately-managed schools are better in physics problem-solving ability than those of government-managed schools. This is perhaps due to the reason that the privately-managed schools are more equipped in many aspects than government-managed schools. The buildings, the libraries, the

laboratories, the teaching staff, the educational atmosphere, the competitive spirit among the students, the amenities provided to students to pursue education, the opportunities of exposure through science fairs, exhibitions, workshops, debates, symposium, etc., the student participation in teaching-learning process, use of audio-visual aids etc., are better in privately-managed schools than in government-managed schools. Probably these factors contribute in the development of problem-solving ability among the students.

There may be one more reason behind this finding. The quality of teaching is better in private schools. The teachers have to show more sincerity and more interest in teaching in private schools because of the fear of losing their job or immediately being questioned by the management about the quality of their teaching. Thus, the standard of teaching is better in privately-managed schools than government-managed schools, which might play a role in the development of problem-solving ability in physics among the students.

Thus, it can be concluded on the basis of the present work that type of school effects physics problem-solving ability of the students and environment of private schools is more suitable in this respect than that of government schools.

Conclusions and Suggestions

The conclusions and respective suggestions based on the findings are as follows:

1. Sexwise, there are differences in problem-solving ability in physics of intermediate level students. Girls are better in physics problem-solving ability than the boys. So, this study suggests that boys are required to show more seriousness in their studies, to see the things more critically and to devote more time in understanding each and every concept. Parents and teachers are suggested to take this finding in cognizance and facilitate the boys in developing problem-solving ability through providing proper home/school environment.

2. Locality does not affect the problem-solving ability in physics among intermediate level students showing that rural students are at par to urban students in this respect.

3. On problem-solving ability in physics type of school is a determining factor for students. Students studying in privately-managed schools are superior in problem-solving ability in physics than the students studying in government-managed schools. In view of this finding of present study, teachers serving in government schools are suggested to do more sincere efforts in this direction. It is desirable for them to make changes in their planning suitably so that more activities like brain-storming, group discussions, project methods, debates, symposium, etc., may be organised for the development of problem-solving ability among their students.

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DISASTER MANAGEMENT AS A COMPONENT IN SCHOOL CURRICULUM

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Disaster is a sudden adverse or unfortunate extreme event resulting in loss of lives and properties. Disaster management is preparing for reacting and recovering from disasters. In India, it has been introduced at school level and preparing children to combat and sensitise about disasters, will prove a fruitful and blessing for millions of lives saved by them

Introduction

Mother earth has hidden manifold mysteries, wonders and secrets in her lap. The man has been endeavouring to unravel these mystics since ages. The unrevealed mysteries become the causative agents of the disasters and catastrophes resulting in innumerable loss of precious lives and properties. Abiding by the need to combat disasters, governments and scientists have directed their resources in this direction. Substantial scientific and material progress has been made but the human toll and economic losses due to calamities have remained recurrent events. It was in this background that the United Nations General Assembly in 1989, declared the decade 1990-2000 as the International Decade for Natural Disaster Reduction with the objective to reduce loss of lives and properties and restrict socio-economic damage through concerted international action, especially in developing countries.

Disasters

The term disaster has been interpreted in lots of ways by various individuals and organisations. According to Haddow and Bullock, "Disaster is a sudden adverse or unfortunate extreme event which causes great damage to human beings as well as flora and fauna". Balaji, Sankar and Karthi defined disaster as a serious disruption of the functioning of a society, causing widespread human, material or environmental losses, caused by hazards, which exceed the ability of affected society (community) to cope using only its own resources.

Disasters occur swiftly, instantly and erratically. This extreme event either natural or man-induced

exceed the bearable scale within or beyond certain time limits, make regulation difficult, result in appalling losses of property and earnings and paralyses the life.

Disaster management

Disaster management is the discipline of dealing with and avoiding menaces. It is a discipline that involves preparing for disaster before it happens, disaster reaction as well as supporting, and rejuvenating society after disasters have occurred. It is a continuous process by which all individuals, groups and communities manage hazards in an effort to circumvent or recuperate the impact of disasters resulting from the hazards.

The process of disaster management involves four phases: mitigation, preparedness, response and recovery.

Mitigation

Mitigation efforts are long-term measures that attempt to prevent hazards from developing into disasters altogether or to reduce the effects of disasters when they occur.

Preparedness

The plans of action are developed when the disaster strikes. Common preparedness measures include

- The communication plans with easily understandable terminology
- Development and practice of multi-agency coordination
- Proper maintenance and training of emergency services
- Development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans
- Stockpiling, inventory and maintenance of supplies and equipment.

Response

The response phase includes the recruitment of the essential emergency services and first responders in the disaster area. It includes a first wave of core emergency services, such as firefighters, police and ambulance crews supported by a number of secondary emergency services, such as specialist rescue teams.

Recovery

In recovery phase the affected area is restored to its previous state. Recovery efforts are primarily concerned with actions that involve rebuilding destroyed property, re-employment and the repair of other essential infrastructure.

Disaster management occupies an important place in every country's policy framework as it is the poor and the under-privileged who are worst affected on account of calamities/disasters.

Disaster management in India

India has been susceptible to natural disasters on account of its unique geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have been intermittent phenomena.

About 60 per cent of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; about 8 per cent of the total area is prone to cyclones and 68 per cent of the area is susceptible to drought. In the decade 1990-2000, an average of about 4344 people lost their lives and about 30 million people were affected by disasters every year. The loss in terms of private, community and public assets has been astronomical. The super cyclone in Orissa in October 1999, the Bhuj earthquake in Gujarat in January 2001 and Tsunami in 2004 underscored the need to adopt multi-disciplinary and multi-sectoral approach and incorporation of risk reduction in the developmental plans and strategies.

Prevention is better than cure, is an old saying which is very appropriate in the perspective of disaster management. Every year massive amount of resources is used by our Government as well as Aid agencies in relief and rehabilitation measures. It is now apparent that mitigation and outlay in disaster preparedness can save thousand of lives, imperative economic possessions and livelihoods and reduce the cost of overall disaster relief.

The government of India has shifted its focus from traditional response and recovery approach to strategic risk management and reduction and from a government-centered approach to decentralised community participation. The new approach adopted by the Government of India proceeds from the conviction that mitigation has to be multi-disciplinary spanning across all sectors of development. The new policy also emanates from the belief that investments in mitigation are much more cost effective than expenditure on relief and rehabilitation.

Disaster Awareness in School Curriculum

The educational system is the hub of younger blood on whose shoulders lay the responsibility of making a nation a safe place to live in. On these lines, the Ministry of Home Affairs, India launched a set of nation-wide disaster risk mitigation initiatives in its Tenth Five Year Plan to empower the younger generation to combat disasters. One of the important initiatives recommended to the education boards and institutions is the inclusion of disaster management in the curriculum of school and professional education.

In lieu of this, disaster management as a frontline curriculum in Social Sciences has been introduced at the school level by The Central Board of Secondary Education (CBSE) for Classes VIII, IX, X and XI. The State Governments have been advised to take similar steps vis-à-vis their school boards. Several States Governments like Tamilnadu, Sikkim, Delhi, Gujarat, Bihar, Maharashtra, Punjab and Orissa have introduced the disaster management in schools from Class VIII onwards. Now Ministry is working with the Council of Board of School Education (COBSE) to facilitate inclusion of disaster management in public education in all 39 School Boards in the country.

The curriculum of disaster management introduced in the schools emphasises on structural and non-structural measures that one needs to take to combat disasters. The course content for various classes includes:

- Class VIII: Preparedness measures for earthquakes, cyclones, floods, droughts and man-made disasters.

- Class IX: Mitigation measures which include
  - Understanding the key terms and concepts
  - Components of disaster management
  - Prevention of specific hazards
  - Community planning in disasters.
- Class X
  - The role of government and other agencies in disaster management
  - Role of Science and technology in Disaster management
  - Initiating the concept of volunteerism among the children.
- Class XI (Sociology): include emergencies, gender and disaster management, role of community and local level institutions in disaster management
- Class XI (Geography): includes introduction to the key concepts, floods, cyclones, earthquakes, tsunami and landslides.

To make disaster management more effective, the subject has been allotted 8 marks for written examination and 20 marks for project work. The curriculum also intends to provide joyful experience for the students in the journey of Disaster Management by generous use of:

- Case studies
- Projects
- Success stories
- Anecdotes
- Regular participation in mock drills
- Minimum emphasis on learning of concepts

and community participation in the form of painting, debate, essay competitions, skits and exhibitions.

A teacher is an acknowledged guide in the process of learning. To ensure effective curriculum transaction, the Board has taken up extensive training programmes for the teachers in a phased manner across the country. In each of the training programmes, focus has been laid on the causes, preparedness and mitigation measures for various hazards.

The schools are encouraged to get their teachers and students and other ministerial staff trained on first aid, search and rescue etc., by various Governmental and Non-Governmental agencies.

Road ahead...

It is said that accidents do not happen but they are caused. Advance planning, effective implementation strategies, development of right attitude for safety, co-ordination and co-operation with agencies working in this area are important for ensuring safety in schools.

Introduction of disaster management has been a revolutionary step but still India has a long way to go. The curriculum enacted for the schools has covered almost all the conjectural aspects but the realistic approach has not been given due to weight age. The subject should be introduced on operational level to cover the maximum population.

To kindle the awareness of disaster management among students, teachers and community, the mock drill sessions should be given appropriate

prominence with emphasis on practical training for first aid, safety and rescue measures. Hazard specific mock drills should carry out every month.

The training modules should be prepared to sensitise and prepare the teachers for disseminating the existent depiction of disasters to students and make them prepared to face them. The community should be made a part of mock drills and rallies to sensitise them on this contemporary issue.

The print and electronic media should be mobilised to create awareness about the disasters and the means to alleviate them. Each child should teach at least a single member of the community in relation to ways of managing unseen natural and man-made disasters.

Conclusion

Disasters can happen anywhere, anytime and to anyone so it is imperative to make everyone around you aware of the disaster that is the only effective way in condensing the loss of lives and assets. The student community is the paramount resource in bringing this awareness among the people. Hence preparing them to combat and sensitise about disasters will prove a fruitful and blessing for millions of lives saved by them.

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SCIENCE NEWS

Rise in Oxygen Drove Evolution of Animal Life 550 Million Years Ago

Researchers funded by the Biotechnology and Biological Sciences Research Council (BBSRC) at the University of Oxford have uncovered a clue that may help to explain why the earliest evidence of complex multicellular animal life appears around 550 million years ago, when atmospheric oxygen levels on the planet rose sharply from 3 per cent to their modern day level of 21 per cent.

The team, led by Professor Chris Schofield, has found that humans share a method of sensing oxygen with the world's simplest known living animal — Trichoplax adhaerens — suggesting the method has been around since the first animal emerged around 550 million years ago.

Professor Schofield said "It's absolutely necessary for any multicellular organism to have a sufficient supply of oxygen to almost every cell and so the atmospheric rise in oxygen made it possible for multicellular organisms to exist.

"But there was still a very different physiological challenge for these organisms than for the more evolutionarily ancient single-celled organisms such as bacteria. Being multicelluar means oxygen has to get to cells not on the surface of the organism. We think this is what drove the ancesters of Trichoplax adhaerens to develop a system to sense a lack of oxygen in any cell and then do something about it."

The oxygen sensing process enables animals to survive better at low oxygen levels or 'hypoxia'. In humans this system responds to hypoxia, such as is caused by high altitudes or physical exertion, and is very important for the prevention of stroke and heart attacks as well as some types of cancer.

Trichoplax adhaerens is a tiny seawater organism that lacks any organs and has only five types of cells, giving it the appearance of an amoeba. By analysing how Trichoplax reacts to a lack of oxygen, Oxford researcher Dr Christoph Loenarz found that it uses the same mechanism as humans—in fact, when the key enzyme from

Trichoplax was put it in a human cell, it worked just as well as the human enzyme usually would.

They also looked at the genomes of several other species and found that this mechanism is present in multi-cellular animals, but not in the single-celled organisms that were the precursors of animals, suggesting that the mechanism evolved at the same time as the earliest multicellular animals.

Defects in the most important human oxygen sensing enzyme can cause polycythemia — an increase in red blood cells. This latest work could also open up new approaches to develop therapies for this disorder.

Professor Douglas Kell, Chief Executive, BBSRC said "Understanding how animals — and ultimately humans — evolved is essential to our ability to pick apart the workings of our cells. Knowledge of normal biological processes underpins new developments that can improve quality of life for everyone. The more skilful we become in studying the evolution of some of our most essential cell biology, the better our chances of ensuring long term health and well being to match the increase in average lifespan in the UK and beyond."

(Source: Science Daily Online)

More than 100 New Species Described by California Academy of Sciences in 2010

Global biodiversity surveys over the past few years have provided increasing evidence that our planet is in the midst of its sixth mass extinction. Plants, animals, and microorganisms are disappearing thousands of times more rapidly than they have for more than 65 million years, and for the first time in Earth's history, human activity is the predominant force behind this mass extinction. As governments and conservation organisations around the world attempt to stem this tide of disappearing species, they face a number of formidable challenges, but perhaps the greatest among them is this — we have only documented and described an estimated 10 per cent of the species on Earth, and it's hard to save a species when you don't know that it exists.

In an effort to help address this critical need for data about the diversity and distribution of life on our planet, scientists from the California Academy of Sciences have spent the past year exploring some of the most diverse — and often most threatened — habitats on Earth, searching for new species and creating comprehensive biodiversity maps. In 2010, these scientists have added 113 new relatives to our family tree, including 83 arthropods, 20 fishes, four corals, two sea slugs, two plants, one reptile, and one fossil mammal. The new species were described by a dozen scientists from the California Academy of Sciences along with several dozen international collaborators.

Proving that science still requires a spirit of adventure and exploration, the scientists made their finds over five continents (the Americas, Africa, Asia, and Australia) and three oceans (Atlantic, Pacific, and Indian), hiked through rainforests and dove inside submersibles, and looked everywhere from their own backyards (San Mateo County, California) to the other side of the world (the Seychelles). Their results, published in 27 different scientific papers, come during a year of heightened international interest in the

conservation of life on Earth. The United Nations designated 2010 as the "International Year of Biodiversity" and held a Biodiversity Summit in Nagoya, Japan this October, in which 18,000 participants representing more than 150 countries adopted strategic goals to combat ongoing biodiversity loss compounded by climate change.

"Species loss has been accelerating in the last 150 years due to human activity, with extinction rates estimated to be thousands of times greater than average," says Dr David Mindell, Dean of Science and Research Collections at the Academy. "Scientific exploration and discovery of new species are essential to characterising our planet's ecosystems before they disappear forever. Preserving biodiversity means healthy ecosystems, and healthy ecosystems are crucial to human health and economic well-being."

A recent example of this intimate connection appeared in the December 2nd issue of *Nature*, in which a team of U.S. and British scientists found that the transmission of infectious diseases, such as West Nile fever and Lyme disease, increased in environments where the diversity of wildlife was low. While the exact mechanisms behind this correlation remain unknown, the study illuminated a real danger to humans that results from biodiversity loss.

Below are a few highlights among the 113 species described by Academy scientists this year.

Galapagos Legacy

The Academy sent its first scientific expedition to the Galapagos Islands in 1905 and has since organised dozens of return trips. As a result, the Academy is now home to the world's most comprehensive collection of scientific specimens from these famous islands. Most Academy field work in the Galapagos today focuses on the marine environment, where dozens of new species have been discovered in the last decade. In 2010, scientist John McCosker and his colleagues described a new species of scorpionfish (*Scorpaenodes rubrivinctus*), which was collected by submersible along the islands' steep volcanic slopes 200-400 meters underwater. Submersibles allow scientists to explore a vast part of the Galapagos that was not accessible to Charles Darwin or the first Academy scientists.

Old Spiders, New Family

Although discovering new species is a common occurrence at the Academy, describing a new family of animals is rare. Arachnologists Jeremy Miller, Anthea Carmichael, Charles Griswold, and their colleagues did just that this year, describing a new spider family called Penestomidae. These spiders have been known for 100 years, but they were initially placed in the velvet spider family, Eresidae. Only with the modern techniques of DNA sequencing and scanning electron microscopy did Miller et al. conclude that the penestomids belong in a family of their own. The scientists also added five new species, all from South Africa: *Penestomus egazini*, *P. kruger*, *P. montanus*, *P. prendinii*, and *P. zulu*.

A Wasp Opus 30 Years in the Making

Future entomologists working on the Australian wasp genus *Sericophorus* will have a much easier time identifying species, thanks to a 234-page paper by curator Wojciech Pulawski. A Danish scientist named Ole Lomholdt actually initiated this massive study in the early 1980s. However,

following his untimely death in 1999, Pulawski picked up the mantle and finished this 30-year labour of love. Pulawski conducted additional field work in Australia, studied more than 1,000 specimens, described 30 species unknown to Lomholdt, generated photographs, added distribution maps, and analysed the wasps' evolutionary relationships. The result is the most comprehensive overview of *Sericophorus* ever published, including a key to 100 species.

California Hotspot

Besides hosting a diverse population of people, California is also home to one of the most diverse collections of plant and animal species on the planet. This rich diversity has earned California a title as one of the world's 34 biodiversity hotspots. Four species on this year's list were collected in the Golden State: two sea slugs (*Okenia felis* from Monterey County and *Flabellina goddardi* from Santa Barbara County); a cave-dwelling spider from the Mother Lode region of California (*Archoleptoneta gertschi*); and a sharp-tailed snake from the Coast Ranges and Klamath Mountains in the north (*Contia longicaudae*).

Gigantic Extinct Otter

Ten years ago, anthropology curator Zeray Alemseged initiated the Dikika Research Project to explore the fossil-rich Awash Valley in Ethiopia. While the project has yielded several important discoveries related to early human evolution (including the oldest evidence of tool use and meat-eating in hominins, reported this year in *Nature*), the non-human discoveries provide equally important information about the valley's ancient environment. This year, Alemseged and his colleagues report the only new mammal species on the Academy's list: a gigantic otter (*Enhydriodon dikikae*) from approximately 4 million years ago. Described from part of a skull and lower jaw, *E. dikikae* was more imposing than the cuddly otters familiar to us today. With an estimated skull length of 25 cm and a body weight of 100 kg, the extinct otter was roughly twice the size of a modern sea otter. Its ancient diet is ambiguous, but a battery of robust teeth suggests shellfish, catfish, juvenile crocodiles, turtles, and ostrich eggs as possibilities.

(Source: Science Daily online)

The Birth of Time: Quantum Loops Describe the Evolution of the Universe

What was the Big Bang and what happened before it? Scientists from the Faculty of Physics, University of Warsaw have attempted to answer the question. Within the framework of loop quantum gravity they have put forward a new theoretical model, which might prove useful for validating hypotheses about events prior to the Big Bang. This achievement is one of the few models describing the full Einstein's theory and not merely its greatly simplified version.

Physicists from the Faculty of Physics, University of Warsaw have put forward — on the pages of *Physical Review D* — a new theoretical model of quantum gravity describing the emergence of space-time from the structures of quantum theory. It is not only one of the few models describing the full general theory of relativity advanced by Einstein, but it is also completely mathematically consistent. "The solutions applied allow to trace the evolution of the Universe in a

more physically acceptable manner than in the case of previous cosmological models," explains Prof. Jerzy Lewandowski from the Faculty of Physics, University of Warsaw (FUW).

While the general theory of relativity is applied to describe the Universe on a cosmological scale, quantum mechanics is applied to describe reality on an atomic scale. Both theories were developed in the early 20th century. Their validity has since been confirmed by highly sophisticated experiments and observations. The problem lies in the fact that the theories are mutually exclusive.

According to the general theory of relativity, reality is always uniquely determined (as in classical mechanics). However, time and space play an active role in the events and are themselves subject to Einstein's equations. According to quantum physics, on the other hand, one may only gain a rough understanding of nature. A prediction can only be made with a probability; its precision being limited by inherent properties. But the laws of the prevailing quantum theories do not apply to time and space. Such contradictions are irrelevant under standard conditions — galaxies are not subject to quantum phenomena and quantum gravity plays a minor role in the world of atoms and particles. Nonetheless, gravity and quantum effects need to merge under conditions close to the Big Bang.

Traditional cosmological models describe the evolution of the Universe within the framework of the general theory of relativity itself. The equations at the core of the theory suggest that the Universe is a dynamic, constantly expanding creation. When theorists attempt to discover what the Universe was like in times gone by, they reach the stage where density and temperature in the model become infinite — in other words, they lose their physical sense. Thus, the infinities may only be indicative of the weaknesses of the former theory and the moment of the Big Bang does not have to signify the birth of the Universe.

In order to gain at least some knowledge of quantum gravity, scientists construct simplified quantum models, known as quantum cosmological models, in which space-time and matter are expressed in a single value or a few values alone. For example, the model developed by Ashtekar, Bojowald, Lewandowski, Paw³owski and Singh predicts that quantum gravity prevents the increase of matter energy density from exceeding a certain critical value (of the order of the Planck density). Consequently, there must have been a contracting universe prior to the Big Bang. When matter density had reached the critical value, there followed a rapid expansion — the Big Bang, known as the Big Bounce. However, the model is a highly simplified toy model.

The real answer to the mystery of the Big Bang lies in a unified quantum theory of matter and gravity. One attempt at developing such a theory is Loop Quantum Gravity (LQG). The theory holds that space is weaved from one-dimensional threads. "It is just like in the case of a fabric — although it is seemingly smooth from a distance, it becomes evident at close quarters that it consists of a network of fibres," describes Wojciech Kamiñski, MSc from FUW. Such space would constitute a fine fabric — an area of a square centimetre would consists of 10^{66} threads.

Physicists Marcin Domaga³a, Wojciech Kamiñski and Jerzy Lewandowski, together with Kristina Giesel from the University of Louisiana (guest), developed their model within the framework of

loop quantum gravity. The starting points for the model are two fields, one of which is a gravitational field. "Thanks to the general theory of relativity we know that gravity is the very geometry of space-time. We may, therefore, say that our point of departure is three-dimensional space," explains Marcin Domaga³a, Ph.D .(FUW).

The second starting point is a scalar field — a mathematical object in which a particular value is attributed to every point in space. In the proposed model, scalar fields are interpreted as the simplest form of matter. Scalar fields have been known in physics for years, they are applied, among others, to describe temperature and pressure distribution in space. "We have opted for a scalar field as it is the typical feature of contemporary cosmological models and our aim is to develop a model that would constitute another step forward in quantum gravity research," observes Professor Lewandowski.

In the model developed by physicists from Warsaw, time emerges as the relation between the gravitational field (space) and the scalar field — a moment in time is given by the value of the scalar field. "We pose the question about the shape of space at a given value of the scalar field and Einstein's quantum equations provide the answer," explains Professor Lewandowski. Thus, the phenomenon of the passage of time emerges as the property of the state of the gravitational and scalar fields and the appearance of such a state corresponds to the birth of the well-known space-time. "It is worthy of note that time is nonexistent at the beginning of the model. Nothing happens. Action and dynamics appear as the interrelation between the fields when we begin to pose questions about how one object relates to another," explains Professor Lewandowski.

Professor Jerzy Lewandowski standing by The Kitchen, 1948 by Picasso at the Museum of Modern Art in Manhattan. The lines in the painting are fairly similar to graphs showing the evolution of quantum states of the gravitational field in loop quantum gravity.

Physicist from FUW have made it possible to provide a more accurate description of the evolution of the Universe. Whereas models based on the general theory of relativity are simplified and assume the gravitational field at every point of the Universe to be identical or subject to minor changes, the gravitational field in the proposed model may differ at different points in space.

The proposed theoretical construction is the first such highly advanced model characterised by internal mathematical consistency. It comes as the natural continuation of research into quantisation of gravity, where each new theory is derived from classical theories. To that end, physicists apply certain algorithms, known as quantisations. "Unfortunately for physicists, the algorithms are far from precise. For example, it may follow from an algorithm that a Hilbert space needs to be constructed, but no details are provided," explains Marcin Domaga³a, M.Sc. "We have succeeded in performing a full quantisation and obtained one of the possible models."

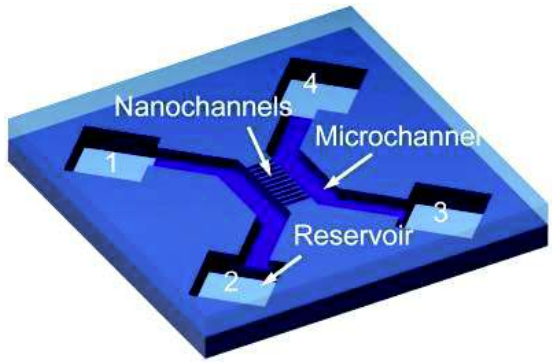
There is still a long way to go, according to Professor Lewandowski: "We have developed a certain theoretical machinery. We may begin to ply it with questions and it will provide the answers." Theorists from FUW intend, among others, to inquire whether the Big Bounce actually occurs in their model. "In the future, we will try to include in the model further fields of the Standard Model of elementary particles. We are curious ourselves to find out what will happen," says Professor Lewandowski.

(Source: Science Daily Online)

Nanotechnology: Tiny Channels Carry Big Information

They say it's the little things that count, and that certainly holds true for the channels in transmembrane proteins, which are small enough to allow ions or molecules of a certain size to pass through, while keeping out larger objects. Artificial fluidic nanochannels that mimic the capabilities of transmembrane proteins are highly prized for a number of advanced technologies. However, it has been difficult to make individual artificial channels of this size — until now.

Researchers with the U.S. Department of Energy (DOE)'s Lawrence Berkeley National Laboratory (Berkeley Lab) have been able to fabricate nanochannels that are only two nanometers (2-nm) in size, using standard semiconductor manufacturing processes. Already they've used these nanochannels to discover that fluid mechanics for passages this small are significantly different not only from bulk-sized channels, but even from channels that are merely 10 nanometers in size.



Schematic of a 2-nm nanochannel device, with two microchannels, ten nanochannels and four reservoirs. (Credit: Image courtesy of Chuanhua Duan)

"We were able to study ion transport in our 2-nm nanochannels by measuring the time and concentration dependence of the ionic conductance," says Arun Majumdar, Director of DOE's Advanced Research Projects Agency — Energy (ARPA-E), who led this research while still a scientist at Berkeley Lab. "We observed a much higher rate of proton and ionic mobility in our confined hydrated channels — up to a fourfold increase over that in larger nanochannels (10-to-100 nm). This enhanced proton transport could explain the high throughput of protons in transmembrane channels."

Majumdar is the co-author with Chuanhua Duan, a member of Majumdar's research group at the University of California (UC) Berkeley, of a paper on this work, which was published in the journal *Nature Nanotechnlogy*. The paper is titled "Anomalous ion transport in 2-nm hydrophilic nanochannels."

In their paper, Majumdar and Duan describe a technique in which high-precision ion etching is combined with anodic bonding to fabricate channels of a specific size and geometry on a

silicon-on-glass die. To prevent the channel from collapsing under the strong electrostatic forces of the anodic bonding process, a thick (500 nm) oxide layer was deposited onto the glass substrate.

"This deposition step and the following bonding step guaranteed successful channel sealing without collapsing," says Duan. "We also had to choose the right temperature, voltage and time period to ensure perfect bonding. I compare the process to cooking a steak, you need to choose the right seasoning as well as the right time and temperature. The deposition of the oxide layer was the right seasoning for us."

The nanometer-sized channels in transmembrane proteins are critical to controlling the flow of ions and molecules across the external and internal walls of a biological cell, which, in turn, are critical to many of the biological processes that sustain the cell. Like their biological counterparts, fluidic nanochannels could play critical roles in the future of fuel cells and batteries.

"Enhanced ion transport improves the power density and practical energy density of fuel cells and batteries," Duan says. "Although the theoretical energy density in fuel cells and batteries is determined by the active electrochemical materials, the practical energy density is always much lower because of internal energy loss and the usage of inactive components. Enhanced ion transport could reduce internal resistance in fuel cells and batteries, which would reduce the internal energy loss and increase the practical energy density."

The findings by Duan and Majumdar indicate that ion transport could be significantly enhanced in 2-nm hydrophilic nanostructures because of their geometrical confinements and high surface-charge densities. As an example, Duan cites the separator, the component placed between the between the cathode and the anode in batteries and fuel cells to prevent physical contact of the electrodes while enabling free ionic transport.

"Current separators are mostly microporous layers consisting of either a polymeric membrane or non-woven fabric mat," Duan says. "An inorganic membrane embedded with an array of 2-nm hydrophilic nanochannels could be used to replace current separators and improve practical power and energy density."

The 2-nm nanochannels also hold promise for biological applications because they have the potential to be used to directly control and manipulate physiological solutions. Current nanofluidic devices utilise channels that are 10-to-100 nm in size to separate and manipulate biomolecules. Because of problems with electrostatic interactions, these larger channels can function with artificial solutions but not with natural physiological solutions.

The next step for the researchers will be to study the transport of ions and molecules in hydrophilic nanotubes that are even smaller than 2-nm. Ion transport is expected to be even further enhanced by the smaller geometry and stronger hydration force.

"I am developing an inorganic membrane with embedded sub-2 nm hydrophilic nanotube array that will be used to study ion transport in both aqueous and organic electrolytes,' Duan says. "It will also be developed as a new type of separator for lithium-ion batteries."

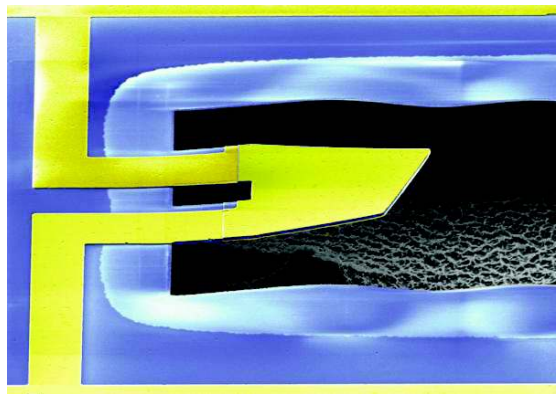
This work was supported by DOE's Office of Science, plus the Center for Scalable and Integrated Nanomanufacturing, and the Center of Integrated Nanomechanical Systems at UC Berkeley.

(Source: Science Daily Online)

Science's Breakthrough of the Year: The First Quantum Machine

Until this year, all human-made objects have moved according to the laws of classical mechanics. Back in March, however, a group of researchers designed a gadget that moves in ways that can only be described by quantum mechanics — the set of rules that governs the behavior of tiny things like molecules, atoms, and subatomic particles. In recognition of the conceptual ground their experiment breaks, the ingenuity behind it and its many potential applications, Science has called this discovery the most significant scientific advance of 2010.

Physicists Andrew Cleland and John Martinis from the University of California at Santa Barbara and their colleagues designed the machine — a tiny metal paddle of semiconductor, visible to the naked eye — and coaxed it into dancing with a quantum groove. First, they cooled the paddle until it reached its "ground state," or the lowest energy state permitted by the laws of quantum mechanics (a goal long-sought by physicists). Then they raised the widget's energy by a single quantum to produce a purely quantum-mechanical state of motion. They even managed to put the gadget in both states at once, so that it literally vibrated a little and a lot at the same time — a bizarre phenomenon allowed by the weird rules of quantum mechanics.



Science's Breakthrough of the Year goes to the first mechanical, vibrating device, which is as long as a hair is wide. The device is the first to reach the quantum ground state, a feat achieved by physicists at the University of California, Santa Barbara. (Credit: Aaron D. O'Connell and Andrew N. Cleland/University of California, Santa Barbara)

Science and its publisher, AAAS, the nonprofit science society, have recognised this first quantum machine as the 2010 Breakthrough of the Year. They have also compiled nine other important scientific accomplishments from this past year into a top ten list, appearing in a special news feature in the journal's 17 December 2010 issue. Additionally, Science news writers and editors have chosen to spotlight 10 "Insights of the Decade" that have transformed the landscape of science in the 21st Century.

"This year's Breakthrough of the Year represents the first time that scientists have demonstrated quantum effects in the motion of a human-made object," said Adrian Cho, a news writer for *Science*. "On a conceptual level that's cool because it extends quantum mechanics into a whole new realm. On a practical level, it opens up a variety of possibilities ranging from new experiments that meld quantum control over light, electrical

currents and motion to, perhaps someday, tests of the bounds of quantum mechanics and our sense of reality."

The quantum machine proves that the principles of quantum mechanics can apply to the motion of macroscopic objects, as well as atomic and subatomic particles. It provides the key first step toward gaining complete control over an object's vibrations at the quantum level. Such control over the motion of an engineered device should allow scientists to manipulate those minuscule movements, much as they now control electrical currents and particles of light. In turn, that capability may lead to new devices to control the quantum states of light, ultra-sensitive force detectors and, ultimately, investigations into the bounds of quantum mechanics and our sense of reality. (This last grand goal might be achieved by trying to put a macroscopic object in a state in which it's literally in two slightly different places at the same time — an experiment that might reveal precisely why something as big as a human can't be in two places at the same time.)

"Mind you, physicists still haven't achieved a two-places-at-once state with a tiny object like this one," said Cho. "But now that they have reached the simplest state of quantum motion, it seems a whole lot more obtainable — more like a matter of 'when' than 'if.'"

Atomic Weights of 10 Elements on Periodic Table About to Make an Historic Change

For the first time in history, a change will be made to the atomic weights of some elements listed on the Periodic table of the chemical elements posted on walls of chemistry classrooms and on the inside covers of chemistry textbooks worldwide.

The new table, outlined in a report released this month, will express atomic weights of 10 elements — hydrogen, lithium, boron, carbon,

Michael Wieser is a scientist from the University of Calgary who is helping to update periodic table. (Credit: Riley Brandt/University of Calgary)

nitrogen, oxygen, silicon, sulfur, chlorine and thallium — in a new manner that will reflect more accurately how these elements are found in nature.

"For more than a century and a half, many were taught to use standard atomic weights — a single value — found on the inside cover of chemistry textbooks and on the periodic table of the elements. As technology improved, we have discovered that the numbers on our chart are not as static as we have previously believed," says Dr. Michael Wieser, an associate professor at the University of Calgary, who serves as secretary of the International Union of *Pure and Applied Chemistry*'s (IUPAC) Commission on Isotopic

Abundances and Atomic Weights. This organisation oversees the evaluation and dissemination of atomic-weight values.

Modern analytical techniques can measure the atomic weight of many elements precisely, and these small variations in an element's atomic weight are important in research and industry. For example, precise measurements of the abundances of isotopes of carbon can be used to determine purity and source of food, such as vanilla and honey. Isotopic measurements of nitrogen, chlorine and other elements are used for tracing pollutants in streams and groundwater. In sports doping investigations, performance-enhancing testosterone can be identified in the human body because the atomic weight of carbon in natural human testosterone is higher than that in pharmaceutical testosterone.

The atomic weights of these 10 elements now will be expressed as intervals, having upper and lower bounds, reflected to more accurately convey this variation in atomic weight. The changes to be made to the Table of Standard Atomic Weights have been published in *Pure and Applied Chemistry* and a companion article in *Chemistry International*.

For example, sulfur is commonly known to have a standard atomic weight of 32.065. However, its actual atomic weight can be anywhere between 32.059 and 32.076, depending on where the element is found. "In other words, knowing the atomic weight can be used to decode the origins and the history of a particular element in nature," says Wieser who co-authored the report.

Elements with only one stable isotope do not exhibit variations in their atomic weights. For example, the standard atomic weights for fluorine, aluminum, sodium and gold are constant, and their values are known to better than six decimal places.

"Though this change offers significant benefits in the understanding of chemistry, one can imagine the challenge now to educators and students who will have to select a single value out of an interval when doing chemistry calculations," says Dr Fabienne Meyers, associate director of IUPAC.

"We hope that chemists and educators will take this challenge as a unique opportunity to encourage the interest of young people in chemistry and generate enthusiasm for the creative future of chemistry."

The University of Calgary has and continues to contribute substantially in the study of atomic weight variations. Professor H. Roy Krouse created the Stable Isotope Laboratory in the Department of Physics and Astronomy in 1971. Early work by Krouse established the wide natural range in the atomic weight of significant elements including carbon and sulfur. Currently, researchers at the University of Calgary in physics, environmental science, chemistry and geoscience are exploiting variations in atomic weights to elucidate the origins of meteorites, to determine sources of pollutants to air and water, and to study the fate of injected carbon dioxide in geological media.

This fundamental change in the presentation of the atomic weights is based upon work between 1985 and 2010 supported by IUPAC, the University of Calgary and other contributing Commission members and institutions.

The year 2011 has been designated as the International Year of Chemistry. The IYC is an official United Nations International Year, proclaimed at the UN as a result of the initiative of IUPAC and UNESCO. IUPAC will feature the change in the standard atomic weights table as part of associated IYC activities.

(Source: Science Daily online)

Antimatter Atoms Stored for the First Time

Atoms of antimatter have been trapped and stored for the first time by the ALPHA collaboration, an international team of scientists working at CERN, the European Organisation for Nuclear Research near Geneva, Switzerland. Scientists from the U.S. Department of Energy's Lawrence Berkeley National Laboratory and the University of California at Berkeley have made key contributions to the ongoing international effort.

ALPHA stored atoms of antihydrogen, consisting of a single negatively charged antiproton orbited by a single positively charged anti-electron (positron). While the number of trapped anti-atoms is far too small to fuel the Starship Enterprise's matter-antimatter reactor, this advance brings closer the day when scientists will be able to make precision tests of the fundamental symmetries of nature. Measurements of anti-atoms may reveal how the physics of antimatter differs from that of the ordinary matter that dominates the world we know today.

Large quantities of antihydrogen atoms were first made at CERN eight years ago by two other teams. Although they made antimatter they couldn't store it, because the anti-atoms touched the ordinary-matter walls of the experiments within millionths of a second after forming and were instantly annihilated — completely destroyed by conversion to energy and other particles.

"Trapping antihydrogen proved to be much more difficult than creating antihydrogen," says ALPHA team member Joel Fajans, a scientist in Berkeley Lab's Accelerator and Fusion Research Division (AFRD) and a professor of physics at UC Berkeley. "ALPHA routinely makes thousands of antihydrogen atoms in a single second, but most are too 'hot'" — too energetic — "to be held in the trap. We have to be lucky to catch one."

The ALPHA collaboration succeeded by using a specially designed magnetic bottle called a Minimum Magnetic Field Trap. The main component is an octupole (eight-magnetic-pole) magnet whose fields keep anti-atoms away from the walls of the trap and thus prevent them from annihilating. Fajans and his colleagues in AFRD and at UC proposed, designed, and tested the octupole magnet, which was fabricated at Brookhaven. ALPHA team member Jonathan Wurtele of AFRD, also a professor of physics at UC Berkeley, led a team of Berkeley Lab staff members and visiting scientists who used computer simulations to verify the advantages of the octupole trap.

In a forthcoming issue of *Nature* now online, the ALPHA team reports the results of 335 experimental trials, each lasting one second, during which the anti-atoms were created and stored. The trials were repeated at intervals never shorter than 15 minutes. To form antihydrogen

during these sessions, antiprotons were mixed with positrons inside the trap. As soon as the trap's magnet was "quenched," any trapped anti-atoms were released, and their subsequent annihilation was recorded by silicon detectors. In this way the researchers recorded 38 antihydrogen atoms, which had been held in the trap for almost two-tenths of a second.

"Proof that we trapped antihydrogen rests on establishing that our signal is not due to a background," says Fajans. While many more than 38 antihydrogen atoms are likely to have been captured during the 335 trials, the researchers were careful to confirm that each candidate event was in fact an anti-atom annihilation and was not the passage of a cosmic ray or, more difficult to rule out, the annihilation of a bare antiproton.

To discriminate among real events and background, the ALPHA team used computer simulations based on theoretical calculations to show how background events would be distributed in the detector versus how real antihydrogen annihilations would appear. Fajans and Francis Robicheaux of Auburn University contributed simulations of how mirror-trapped antiprotons (those confined by magnet coils around the ends of the octupole magnet) might mimic anti-atom annihilations, and how actual antihydrogen would behave in the trap.

(Source: Science Daily Online)

New Device Detects Insects in Stored Wheat

A laboratory milling device for improving stored grain management has been developed by Agricultural Research Service (ARS) scientists and an industry cooperator.

The system, called the "insect-o-graph," can detect internal insects in wheat that are not visible to the eye or that cannot be detected by usual grading methods. The device, built by National Manufacturing, Inc. (NMI), of Lincoln, Neb., was based on ARS-developed technology.

ARS engineers Tom Pearson and Dan Brabec, in the Engineering and Wind Erosion Research Unit of the agency's Center for Grain and Animal Health Research at Manhattan, Kan., developed the device, which uses electrical conductance signals to monitor wheat as it's milled. If a seed containing an insect is crushed, an electrical spike occurs. The software counts the number of insects in a kilogram sample. This system can detect low levels of infestations such as 5 to 10 infested seeds out of 30,000 good seeds.

Tracking insect infestations in stored grain is important to ensure grain quality because insect colonies can multiply rapidly over weeks or months, and consume and damage grain as the colonies grow. Insect damage reduces the grain's value, and the grain also requires additional cleaning to remove the insects and damaged kernels.

Grain companies inspect grain as it comes into their facilities and before storage. Before unloading a truck or railcar of grain, a few minutes are taken to sample the load and inspect the grain. The insect-o-graph can estimate the number of live insects hidden in a one-kilogram grain sample in about one minute.

The device was developed under a formal Cooperative Research and Development

Agreement (CRADA) with NMI, and in collaboration with the food manufacturing company General Mills, as part of efforts by ARS to transfer its technology from the laboratory to the marketplace for the benefit of consumers.

A paper describing this work was accepted for publication in the *Journal of Stored Product Research* in 2010 and will be published soon.

(Source: Science Daily Online)

Everything Evaporates, but How?

Evaporation is a common phenomenon in nature. For the last 130 years, it has seemed that its mechanism was understood well. However, computer simulations carried out by scientists from the Institute of Physical Chemistry of the Polish Academy of Sciences proved that the existing theoretical models were based on false assumptions. Thanks to the simulations, it was possible to learn the mechanisms of evaporation of drops into vacuum or into an environment filled with the vapour of a liquid under examination. However, the mechanism that plays a key role in the case of evaporation into a mixture of gases, for instance into air, is still unknown.

Evaporation takes place all the time in our environment. The phenomenon plays an important role in the formation of Earth's ecosystem and the life functions of many organisms — including humans, who like many other animals use it to stabilise their body temperature.

"The first scientific publication concerning the mechanism of evaporation was written by a famous physicist James Clerk Maxwell. We showed that it contained an error that has been repeated for the last 130 years," says Prof. Robert Ho^{3}yst from the Institute of Physical Chemistry of the Polish Academy of Sciences (IPC PAS) in Warsaw. The computer simulations that have just been completed allowed some of the puzzles connected with the evaporation of a liquid into vacuum or its own vapour to be solved. Currently, in cooperation with the Institute of Physics of the PAS, scientists from the IPC PAS are preparing a series of experiments that will allow them to verify the correctness of the model in the case of the evaporation of drops of water into air.

As much as 71 per cent of Earth is covered by oceans and seas which evaporate continuously. Since the heat of evaporation of water is very high, the evaporation determines Earth's climate. What is more, the content of water vapour — the main greenhouse gas — in the atmosphere changes as a result of evaporation. Its concentration in air may reach as much as four per cent, that is the value over one hundred times higher than that of the infamous carbon dioxide. According to various estimates, if there was no water vapour in air, the temperature on Earth would fall by 20-30 degrees.

Although evaporation is so common and it plays a big role in the environment, little attention has been given to the phenomenon. "Our studies also originated accidentally, as it often happens in science," says Prof. Ho^{3}yst. "Several years ago, in the Institute of Physical Chemistry of the PAS, it was necessary to test a new program for calculations relating to fluid dynamics. We decided to check the simulator using a popular problem. We chose evaporation because we thought that since the phenomenon was so

common and the subject was known for over one hundred years, everybody knew well what happened during the process. However, after we had made calculations using the existing formulas, it turned out that many things simply did not add up."

Polish scientists developed their own theoretical model of the phenomenon and then carried out computer simulations illustrating the process of evaporation of nanodrops into their own vapour or vacuum. The starting point was a drop of liquid closed in a vessel, and in equilibrium with its vapour. In some computer simulations the walls were heated, in some others the vapour was removed, and in the others not only was the vapour removed but the temperature of the system was maintained constant.

During evaporation the most interesting events take place on the border of a liquid and a vapour. The thickness of this interface is more or less equal to the diameter of an atom. The simulation of evaporation in a relatively small cube with faces one meter long would require the calculation of dozens of milliards of points along each of the three dimensional axes. The total number of points would increase to billion of trillions, which exceeds calculation abilities of modern and future computers. In order to deal with this obstacle, scientists from the Institute of Physical Chemistry of the PAS analysed the system of a size of only 1 cm, in which a drop of a diameter of approx. 70 micrometers evaporated. In addition, thanks to the use of symmetry, it was possible to reduce the theoretical description from three-dimensional to one-dimensional. The results of simulation agreed perfectly with the available measurement data.

"Maxwell assumed that evaporation took place at constant temperature. It is so, if we look at the initial state, that is a liquid, and the final state, that is a vapour. It is true that their temperatures are equal. But during the evaporation process itself, the nature acts in a completely different way," explains Ph.D. Marek Litniewski from IPC PAS.

The existing description assumed that the heat transfer in the system was stable and the rate of evaporation was limited by the efficiency of the process during which the particles break away from the surface of drops, i.e. diffusion. However, the simulation carried out in the IPC PAS showed that during the evaporation into vacuum or the liquid's own vapour the system gained mechanical equilibrium very quickly. Particles break away from the surface of a liquid and their mechanical recoil allows the equalisation of the pressure inside the drop. If the rate of evaporation on the surface achieved the maximum value and the system was still unable to equalise the pressures, spaces with new surfaces would open inside the drop and it would start to boil. However, it was observed that the mechanical equilibration of pressure can be insufficient and the temperature on the surface of the liquid decreases: the drop aims at maintaining the pressure equilibrium at the cost of its internal energy. This observation suggests that the factor that is crucial during evaporation is not the diffusion of particles into the environment but the heat transfer and the equality of pressures.

The studies will continue, this time from the point of view of the analysis of evaporation into the mixture of gases, in particular into air. The experimental part will be carried out by scientists from the Institute of Physics of the PAS (IP PAS),

headed by Assoc. Prof. Krystyna Kolwas. Physicists from the IP PAS have already observed the evaporation of microdrops of a liquid into the liquid's own vapour or vacuum. Drops of micrometric sizes were used in the experiments. Since their surface was electrically charged, the drops could be caught by the electric field, lighted by a laser and, while recording changes in interference patterns, it could be observed how their size changed during the evaporation.

Currently, thanks to a new measurement chamber with precisely controlled pressure and chemical composition of the atmosphere, a series of experiments on evaporation into air can be conducted, and consequently, it will be possible to determine which factor has a decisive influence on evaporation in the situation where pressures are equalised from the beginning. The results of the experiments along with computer simulations will allow creating a comprehensive picture of the process of evaporation of water drops in the conditions maximally similar to those that exist in nature.

The deeper understanding of physical mechanisms responsible for evaporation will affect many areas of human activity. Better climate models will allow more precise forecast of weather changes in a short and long time perspective, and more efficient devices for cooling processors and lasers will be developed. Since in engines the evaporation of fuel microdrops injected into a combustion chamber must precede the ignition, the knowledge of evaporation will allow increasing car efficiency in future.

"Our research shows that old formulas are still worth being examined," sums up Prof. Ho^{3}yst.

(Source: Science Daily Online)

Researchers Find Mathematical Patterns to Forecast Earthquakes

Researchers from the Universidad Pablo de Olavide (UPO) and the Universidad de Sevilla (US) have found patterns of behaviour that occur before an earthquake on the Iberian peninsula. The team used clustering techniques to forecast medium-large seismic movements when certain circumstances coincide.

"Using mathematical techniques, we have found patterns when medium-large earthquakes happen, that is, earthquakes greater than 4.4 on the Richter scale," said Francisco Martínez Álvarez, co-author of the study and a senior lecturer at the UPO.

The research, which will be published this month by the journal *Expert Systems with Applications*, is based on the data compiled by the Instituto Geográfico Nacional on 4,017 earthquakes between 3 and 7 on the Richter scale that occurred on the Iberian Peninsula and in the surrounding waters between 1978 and 2007.

The scientists applied clustering techniques to the data, which allowed them to find similarities between them and discover patterns that will help to forecast earthquakes.

The team concentrated on the two seismogenic regions with the most data (The Alboran Sea and the Western Azores-Gibraltar fault region) analysing three attributes: the magnitude of the seismic movement, the time elapsed since the last earthquake and the change in a parameter called the b-value from one earthquake and the other. The b-value reflects the tectonics of the region under analysis.

A high b-value means earthquakes are predominantly small in size and, therefore, the land has a low level of resistance. In contrast, a low value indicates that there are a relatively similar number of large and small seismic movements, which implies the land is more resistant.

"We have discovered the strong relationship between earthquakes and the parameter b-value, recording accuracy rates of more than 80 per cent," Antonio Morales Esteban, another of the co-authors of the study and a senior lecturer at the US highlighted. "After the calculations had been performed, providing the circumstances and sequences we have determined to be forerunners occur, we obtain a significant success probability."

The technique summarises the forecasts in two factors: sensitivity (probability of an earthquake occurring after the patterns detected occur) and specificity (probability of an earthquake not occurring when no patterns have occurred).

The results reflect a sensitivity of 90 per cent and specificity of 82.56 per cent for the Alboran Sea region and 79.31 per cent and 90.38 per cent respectively for the seismogenic region of the Western Azores-Gibraltar Fault.

That is, there is a high probability of an earthquake in these regions immediately after the patterns discovered occur (high sensitivity) and, moreover, on most of such occasions, they only occur after the patterns discovered (high specificity).

At present the team is analysing the same data using their own algorithms based on "association rules," other mathematical techniques used to discover common events or those which fulfil specific conditions within a set of events.

"The results are promising, although I doubt we will ever be able to say that we are capable of forecasting an earthquake 100 per cent accurately," Martínez Álvarez conceded.

(Source: Science Daily online)

Dogs have Bigger Brains than Cats because they are more Sociable, Research Finds

Over millions of years dogs have developed bigger brains than cats because highly social species of mammals need more brain power than solitary animals, according to a study by Oxford University.

For the first time researchers have attempted to chart the evolutionary history of the brain across different groups of mammals over 60 million years. They have discovered that there are huge variations in how the brains of different groups of mammals have evolved over that time. They also suggest that there is a link between the sociality of mammals and the size of their brains relative to body size, according to a study published in the *PNAS* journal.

The research team analysed available data on the brain size and body size of more than 500 species of living and fossilised mammals. It found that the brains of monkeys grew the most over time, followed by horses, dolphins, camels and dogs. The study shows that groups of mammals with relatively bigger brains tend to live in stable social groups. The brains of more solitary mammals,

such as cats, deer and rhino, grew much more slowly during the same period.

Previous research which has looked at why certain groups of living mammals have bigger brains has relied on studies of distantly-related living mammals. It was widely believed that the growth rate of the brain relative to body size followed a general trend across all groups of mammals. However, this study by Dr Susanne Shultz and Professor Robin Dunbar, from Oxford University's Institute of Cognitive and Evolutionary Anthropology (ICEA), overturns this view. They find that there is wide variation in patterns of brain growth across different groups of mammals and they have discovered that not all mammal groups have larger brains, suggesting that social animals needed to think more.

Lead author Dr Susanne Shultz, a Royal Society Dorothy Hodgkin Fellow at ICEA, said: 'This study overturns the long-held belief that brain size has increased across all mammals. Instead, groups of highly social species have undergone much more rapid increases than more solitary species. This suggests that the cooperation and coordination needed for group living can be challenging and over time some mammals have evolved larger brains to be able to cope with the demands of socialising.'

Co-author and Director of ICEA Professor Robin Dunbar said: 'For the first time, it has been possible to provide a genuine evolutionary time depth to the study of brain evolution. It is interesting to see that even animals that have contact with humans, like cats, have much smaller brains than dogs and horses because of their lack of sociality.'

The research team used available data of the measurements of brain size and body size of each group of living mammals and compared them with similar data for the fossilised remains of mammals of the same lineage. They examined the growth rates of the brain size relative to body size to see if there were any changes in the proportions over time. The growth rates of each mammal group were compared with other mammal groups to see what patterns emerged.

(Source: Science Daily Online)

The Puzzle of Biological Diversity

Biologists have long thought that interactions between plants and pollinating insects hasten evolutionary changes and promote biological diversity. However, new findings show that some interactions between plants and pollinators are less likely to increase diversity than previously thought, and in some instances, reduce it.

Findings, published in the *Journal of Evolutionary Biology*, show that local populations of one of the most distinctive plants in the Mojave Desert, the Joshua tree, are not as biologically diverse as would be expected. Joshua trees cannot produce seeds without specialised moths pollinating the tree's flowers. Previous research has shown that biological diversity exists among species of Joshua trees and their pollinating moths: Moths with longer ovipositors, the part of the moth used to lay eggs, favor trees with large flowers, while smaller moth species favor smaller flowers. Thus, biologists would expect the moths would adapt this trait to local flower populations and vice versa in order to reproduce. Yet using a combination of mathematical modeling and field studies,

researchers observed little biological diversity among populations and thus no evidence that local populations of moths adapt to local populations of Joshua trees.

"We had previously observed two species of moths and have shown that the larger moth species uses large flowers and the smaller moth species uses smaller flowers. However, once we account for this difference, there no evidence that moths have adapted to flowers," said William Godsoe, the study's lead author and postdoctoral researcher at the National Institute for Mathematical and Biological Synthesis.

The observation is consistent with recent work from biologists at the University of Idaho who, using a mathematical model, determined that in some cases interactions in nature don't increase diversity but instead reduce it. In a study published in *The American Naturalist*, University of Idaho biologists Jeremy Yoder and Scott Nuismer developed a mathematical model to compare how different interactions in nature affect biological diversity.

"The interactions we stimulated all change the evolution of the interacting species," said Yoder, who also co-authored the study on Joshua trees. "But different interactions can have very different effects — some increase diversity, some don't increase diversity at all, and some can even reduce diversity."

The Joshua tree study is a collaboration of theory and field work. "The patterns we're finding in the Joshua tree and moth data are exactly what we expect from the theory. Coevolution between Joshua tree and its pollinators acts to reduce the variation within species, which creates stronger contrasts between moth species and Joshua tree varieties," Yoder explained.

(Source: Science Daily Online)

Age Estimation from Blood has Immediate Forensic Application

Scientists have devised a method that would allow them to estimate the age of crime suspects or missing persons from blood collected at the scene of a crime.

In principle, the new profiling method could be put to immediate practical use by law enforcement, according to the researchers who report their findings in the November 23 issue of *Current Biology*. They have already begun the required validation of the test, which is designed to assure that quality standards are met.

"We demonstrate that human age can be estimated from blood with reasonable accuracy using a simple, robust, and sensitive test assay," said Manfred Kayser of the Erasmus MC University Medical Center Rotterdam in the Netherlands. "Our method is applicable in situations where only bloodstains are available, which covers a large proportion of crime cases."

The method will be especially useful in forensic cases in which age information is important to provide investigative leads for finding unknown persons, Kayser added. Existing methods for age estimation have limited use for crime scene investigation because they depend on the availability of teeth, bones, or other identifiable body parts having physical features that allow age estimation by conventional methods.

Other proposed genetic or biochemical methods to estimate age from blood samples have suffered from low accuracy and technical problems, Kayser said. The new method takes advantage of a fundamental characteristic of immune cells known as T cells.

T cells play a key role in recognising foreign invaders, an ability that depends on a diversity of T cell receptors, each matching specific molecules (antigens) derived from bacteria, viruses, parasites, or aberrant cells such as tumor cells. That diversity of receptors is achieved through a specific rearrangement of the T cells' DNA, a process that produces small circular DNA molecules as a by-product. The number of those circular DNA molecules (known as signal joint TCR excision circles, or sj TRECs for short) declines at a constant rate with age.

"With our test assay, we quantify the amount of sjTRECs in the total DNA extracted from a small blood sample and use a reference gene not affected by age to compensate for the total amount of DNA in the sample," Kayser explained.

The approach allows accurate estimation of age, give or take nine years, the researchers report, suggesting that it would be highly accurate in placing unknown persons into generational categories spanning about 20 years.

Kayser said that the test currently has the highest accuracy of any test designed to estimate a phenotypic human trait from DNA information. Notably, its prediction accuracies are comparable to or better than those recently demonstrated for predicting brown versus blue eye color from DNA, a test that has already been put to forensic use.

These new tests are harbingers of what's to come as researchers uncover new methods designed to reconstruct the appearance of unknown persons from biological crime scene samples or remains. The hope is that such methods will ultimately mean more crimes solved, the researchers say.

"Conventional DNA profiling applied in forensics can only identify persons already known to the investigating bodies, because the approach is completely comparative," Kayser said. "Hence, every forensic lab is confronted with cases where the DNA profile obtained from the evidence material does not match that of any known suspect tested, nor anybody in the criminal DNA database, and such cases therefore cannot be solved so far. In such cases, it is expected that appearance information estimated from evidence material will help in finding unknown persons."

(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

- **International year of Biodiversity**
  www.unep.org/iyb

  This is the official website of the International year of Biodiversity, run by the United Nations Environment Programme. It provides a variety of multimedia resources and external links covering biodiversity basics, news and initiatives.

- **Nature collection of biodiversity articles**
  www.nature.com/nature/supplements/ collections/biodiversity

  The research journal *Nature has brought out a collection of* previously published articles related to the ecological and economic importance of biodiversity. Some of these article are freely available. These are scholarly article based on researches and intends to enhance the understanding of the issue.

- **National Biodiversity Authority, India**
  www.nbaindia.org

  The National Biodiversity Authority was established in 2003 by the Government of India to regulate, conserve and sustainable use of bioresources of India through the Biological Diversity Act, 2002. The website describes about its activities and resources available through it.

- **The Indian Biodiversity Portal**
  Indiabiodiversity.org

  The Indian Biodiversity Portal (IBP) is a knowledge initiative to tap and spread the vast

array of knowledge on all aspects of Indian biodiversity. It is a public participatory effort embedded in civil society and endorsed by the National Knowledge Commission of India.

- **UNESCO Science Report 2010**
  www.unesco.org/science/psd

  It is edited by Susan Schneegans and developed by the Division for Science Policy and Sustainable Development, UNESCO. It presents a global overview of the main developments in scientific research, innovation and higher education since 2005. The report contains chapters describing the situation in regions of America, the Caribbean, the European Union, Southeast Europe, the Arab states, sub-Saharan Africa, Central Asia, South and Southeast Asia and Oceania. In additions, chapters are also devoted to Brazil, Canada, China, Cuba, India, Iran, Japan, Republic of Korea, Russian Federation, Turkey and the USA.

- **Teachers' Manual on Formative Assessment on Science (Class IX)**
  cbse.nic.in/cce/cce-manual/CBSE-FA_Class IX

  This link of Central Board of Secondary Education (CBSE) website presents Teachers' Manual on Formative Assessment on Science (Class IX). It can be freely downloaded. This manual provides in a systematic way, examples of formative assessment tasks related to topics in Class IX Science. The tasks are of different types such as Role plays, Crossword puzzle, Flow charts, Field trips, Class work/Home work assignments, Group work, Surveys, Project work, Worksheets, Games and Multiple Choice Questions. The tasks included are varied and cater to the different multiple intelligences.

- **Understanding Food Additives**
  www:understandingfoodadditives.org

  This website has been through collaboration between the Food Additives and Ingredient Association (FAIA) and the Chemical Industry Education Centre of the UK. What are food addictives and why there are characterised by E numbers ? Are they safe? Can they cause allergies? Answers to many such questions can be found on this website. It has a link for teachers also.

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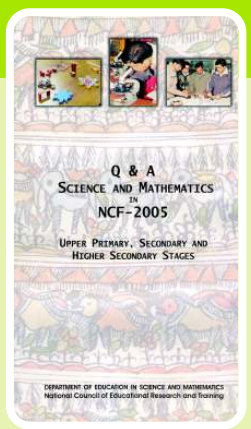
Book Reviews

Title	***Q and A: Science and Mathematics in NCF-2005***
Author	**Development Team**
Publisher	**National Council of Educational Research and Training**
Year	**March 2010**
Price	**₹ 65.00**



The book with the title *'Q and A: Science and Mathematics in NCF-2005'* is an attempt to fulfil the answers to the different queries of teachers concerning to the *National Curriculum framework-2005*. It explains in detail the various aspect of NCF 2005 with special reference to teaching of Science and Mathematics at upper primary, secondary and higher secondary stages.

The book re-emphasises guidelines and some of the ideas of NCF-2005. It is written in the dialogue form valuing teachers' queries and narration. It comprises three chapters and two annexures. The first chapter is about the major concerns and perspectives of NCF-2005; second chapter is related to criteria of an ideal science curriculum and shift in focus from mathematics content learning to mathematical learning environment, and third discusses about the difficulties faced by teachers in the implementation of the guidelines, examination reforms and issues related with the NCF-2005. Meaning of some key terms and phrases used in NCF-2005 are given in annexure one. This is very helpful and handy for the teachers. The key feature of the book is its format in which the complete text is printed in question-answer form. It makes it conveniently readable for the teachers who are hard pressed for time. The various questions raised by the teachers are taken positively. The answers given to them are easy to understand and convincing. The methodology used in the book to present the matter is appreciable. Teacher's real experiences of teaching-learning process discussed in annexure two are exemplary in nature. The concept of π is discussed in very interesting way for the everlasting learning. One of my colleagues Shri Sher Singh (TGT Mathematics) implemented this concept in his class observed that students' responses were amasing after knowing how the value of π is derived. The activities undertaken by

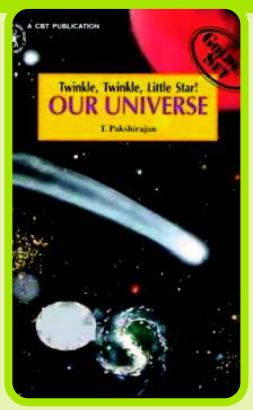
a teacher to teach the concept of Electricity and Magnetism is remarkable. In a similar way, an example quoted by a teacher to teach the different parts of plant make us feel the importance of innovation in the teaching methodology.

The book gradually takes the reader to the depth of the objectives of NCF-2005 and makes one realise the importance of activity-based teaching-learning process. It enables one to understand the new approach of education where students are at the centre of teaching-learning. It motivates and encourages the teachers to take the teaching-learning process beyond the boundaries of a particular subject. It makes emphasis on the interdisciplinary approach of teaching. It is written in lucid way and is prolific in nature.

I feel that this book will be an asset for one's personal library as well as the school library. It conveys essence of NCF-2005 in the context of science and mathematics in a simple manner. The teachers, educators and others will find it undoubtedly useful.

Sanjay Kumar Yadav
PGT
Kendriya Vidyalaya
Itarana, Alwar

Title	***Our Universe***
Author	**T. Pakshirajan**
Publisher	**Children's Book Troust**
Trust	**Nehru House,**
	4, Bahadur Shah Zafar Marg
	New Delhi
Pages	**107**
Price	**₹ 80.00**



A famous nursery rhyme "Twinkle, twinkle, little star!' is a beautiful expression of the excitement of a little child who looks at the night sky studded with innumerable stars. But, when the child grows up and wants to know about the stars he finds that they are neither 'twinkling' nor are they 'little.' In fact, they shine steadily and are massive in size. It is the light coming from them which after getting refracted from the atmospheric layers actually make them twinkle.

In the night sky, besides stars one observes the Moon and some planets with the naked eyes. However, there are heavenly bodies like asteroids, meteors, comets and myriad other objects invisible to the naked eyes. They all whirl round in the vast, black emptiness which we call 'outer space.' This space, and all the things in it, make the magnificent universe.

There are millions of galaxies in the universe. The galaxy we live in is called the Milky way.

Generally, the galaxies have a tendency to cluster together in groups of tens to many thousands owing to their mutual attracting influence. These groups are scattered all over the universe. Our own galaxy, the Milky Way, belongs to the cluster called the Local Group which consists of twenty-odd galaxies. The biggest and the most prominent member of this group is the Andromeda galaxy. This is 50 per cent larger than ours and lies 22,00,000 light years away from the Earth. As is well known, the distance travelled by light in one year is known as a light year in astronomy, which is around 100 trillion (10^{12}) kilometres. The Large and Small Magellanic Clouds are the two other galaxies in the Local Group. First described by the famous navigator Ferdinand Magellan, they both are situated at a distance of 1,80,000 light years from the Earth. Then there are other 'super clusters' of galaxies, which are collection of 40 to 50 galaxies. Most of the galaxies including our Milky Way galaxy are spiral-shaped. However,

there are some, which are spherical, elliptical or even irregular.

When one thinks of the universe, several questions leap to one's mind viz. When did the universe actually come into existence? How vast is it? When and how were the Sun, Moon and the planets formed? Why are there so many objects of different shapes and sizes in space? Why are all of them in motion? The book under review attempts to examine these and many more questions and tries to unfold the mysteries of the universe. After General introduction it moves on to describe the solar system and its planets in detail. The natural satellites or moons of the planets are described too.

The book introduces to the readers the world of asteroids, comets and meteors. It also includes discussion about nebulae, novae, supernovae pulsars, quasars and black holes.

The book has been written in simple language and lucid style. It encourages the young readers to take up astronomy as a career to unravel a few more mysteries and add a new dimension to human knowledge of the universe. The book, which is hard bound, is reasonably priced. It will prove to be of interest to students and teachers alike. Every school can be recommended to have a copy of this book.

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To Our Contributors

School Science is a journal published quarterly by the National Council of Educational Research and Training, New Delhi. It aims at bringing within easy reach of teachers and students the recent developments in science and mathametics and their teaching, and serves as a useful forum for the exchange of readers' views and experiences in science and mathametics education and science projects.

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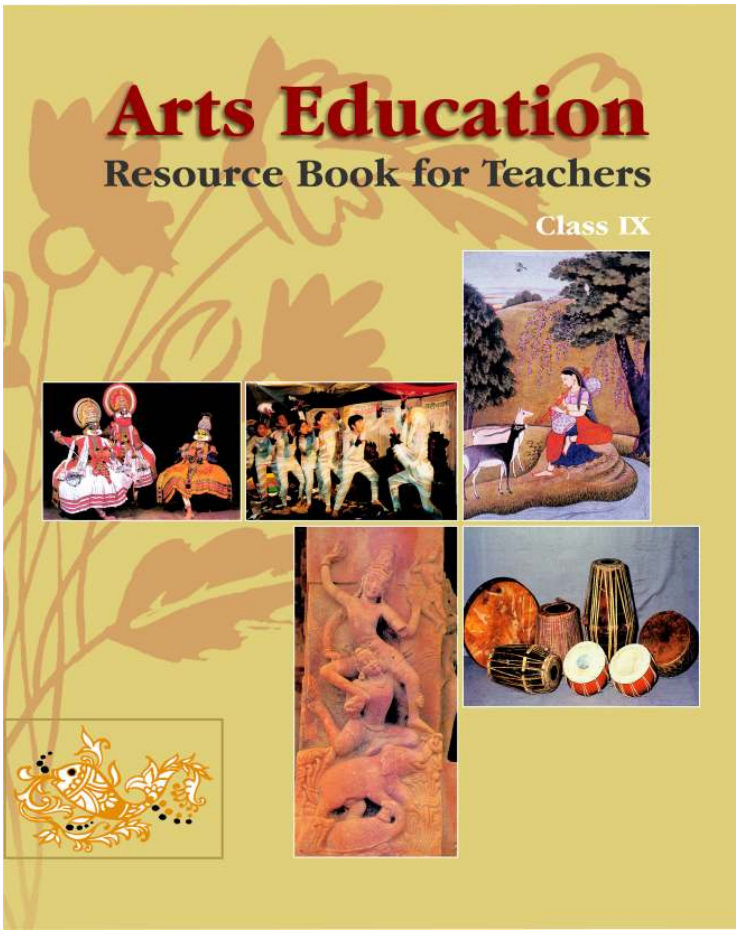

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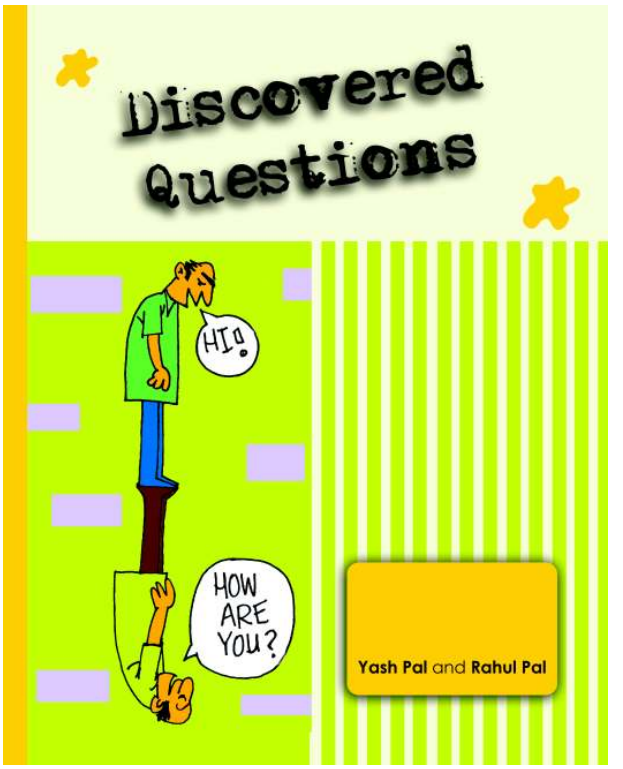

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