IWSA NEWSLETTER

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Inauguration of the Rugnasahayak Course on 17th May 2014.
Chief Guest Dr. Kalyani Sen being felicitated by Ms. Shubangi Tirodkar, IWSA and Dr. Sudha Rao, President, IWSA.

BRNS sponsored lecture on 10th July 2014 at Rajiv Gandhi College, Vashi.
Dr. Kailas is seen at the Centre with the Principal Dr. Gurav.

BRNS sponsored lectures on 17th July 2014 at SIES College, Sion.
Dr. Shyamala Bharadwaj and Dr. D. Bahadur (extreme right) are seen with the Principal Dr. Mehta (dais).

Dr. Susan Eapen addressing the audience at the BRNS sponsored lectures at SIES College, Sion on 17th July 2014

BRANCHES

Roorkie 1979 • Hyderabad 1979 • Pune 1980 • Nagpur 1982 • Kolhapur 1982
Delhi 1987 • Kalpakkam 1987 • Baroda 1988 • Lucknow 1997• Amravati 2010

Celebration of Environment day on 7th June 2014

Nursery children enjoying the fresh air.

First Ranker Ms. Kajal Mhatre being felicitated by
Ms. Reeta Sonawat.

Farewell to Hostel Asst. Supervisor
Ms. Shanta Salvi (centre) on 31st July 2014.
Also in the picture are Ms. Elizabeth and Ms. Suman Walia.

Nursery/Creche Teachers Training Course Batch of 2014 with faculty on 21st June 2014.

FROM THE EDITOR'S DESK

This is a special issue on Science Education. Fortunately, eminent educationists in Science have contributed for this issue. Dr Chitra Natarajan, Dean, HBCSE, has written on Science Education. In earlier days, the traditional method was of 'chalk & talk classrooms' as she states. This used to be boring at times. Now the emphasis is on audio-visual presentations by teachers. Students learn easily as these are made interesting. Practicals are necessary for Science students and demonstrations are mostly replaced by hands-on experimentations. HBCSE has been encouraging 10th -12th standard students to conduct curiosity-based projects, which are directed by senior Scientists/teachers. More students are attracted every year to perform hands-on experiments at HBCSE. Their experience is reflected in Dr Chitra's article.

The article by Dr Sheela Donde, visiting faculty, IISER, Pune, on different perspectives of Science Education in India, elaborates on the recent efforts in improving the state of science in India and the most important issues that have to be addressed immediately. Based on her experience as college professor for 30 years, she has emphasized the necessity for educating teachers for special skills and knowledge of advanced technology. Various suggestions mentioned in the article need to be implemented by exploring funds from Public and private sectors.

IWSA has been contributing continuously towards improvisation of science education through its various programs for students as well as teachers. IWSA had organized a Refresher Course for Science teachers in Bio-Technology at national level, which was supported by the 3 National Science Academies. The aim of this course was also to educate teachers and to conduct hands-on experiments and demonstration of state-of-art equipment in research institutions. Considering the need to conduct research projects for 3-6 months as a part of the UG and PG science degree course, either in their own College or in Institute / Organization / Industry, the training imparted to the teachers and their exposure to the newer technology or modern Instruments, through this refresher course, will go a long way.

The important role of an inspired, committed and motivating teacher in promoting education in any field is never over emphasised. Late Dr Shardini Dahanukar had vast experience in Science Education as a professor of Pharmacology and later on as the Dean of Nair Hospital and Medical College. She not only taught the medical UG & PG students but also guided students for M Sc & PhD. Dr Urmila Thatte, who was her student and later on her colleague, has narrated the story of her close association with Dr Dahanukar as a teacher and as a collaborator. The article pulls your heart strings!

Another article is by Dr Amit Modi the founder and CEO of TechShiksha, an educational company to promote scientific learning of school students with the help of innovative science activities and give them sound knowledge to make them young engineers and innovators. He explains how children exercise their logic, aptitude and reasoning at every step while experimenting and how they develop interest in science projects.

I thank all the three writers for devoting their precious time in spite of their busy schedule.

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PRESIDENT'S MESSAGE

Sudha Rao
(President, IWSA)

With the arrival of the festive season, everybody is concerned about the impact it will have on the environment, by way of pollution - noise, garbage, sewage, filth, water, non biodegradable material used for idols and items used for decoration. Keeping the environment clean and free of pollution is a vital issue. Hence the main focus of several organizations - whether NGOs, Institutes, Universities or Academic Centres, is protection of the overall environment from pollution during all festivals and monitoring the ill effects that it may cause. I am happy that IWSA is also participating in this endeavour by conducting awareness lectures, eco friendly workshops, seminars - and this special issue of its newsletter on Science Education.

Our motto has always been to take science to the masses, popularize science and develop a scientific temper amongst women and children. Science education amongst children is mostly text book oriented. At the pre primary level, science is treated like an untouchable subject in their learning process. Their curiosity is at the peak in early childhood. If interest is created at this stage of life, their interest in science will be sustained throughout their life. Probably this is the reason why science subjects do not touch their hearts when they go to primary and secondary education.

It is only when children are taught science by relating it to their day to day life, environment and household activities, will the barrier in the learning process be overcome. This will encourage them to become scientists in the true sense. IWSA has a dream to have a spacious well equipped laboratory on our campus for children in the age group of 6 to 16 years, where they can come and try any experiment or conduct practicals for their projects - along with their parents and teachers.

In fact a small beginning has been made through the Science Nurture Program and the Sunday Science Club with TechShiksha, where children have the opportunity to observe, ask questions, do experiments, and explore. In this process, their teachers are around to guide them and to fulfill their curiosity. We hope that our programs will help in creating the tempo required to make children responsible citizens of our country.

My warm wishes and greetings for the festive season!

V. Sudha Rao
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UPCOMING EVENTS

The Special General Body Meeting for passing the amendments to Rules and Regulations of the Indian Women Scientists' Association (IWSA) will be held on Saturday, 23rd August 2014 at 12.00 noon

The Special General Body Meeting for passing the audited accounts for the year 2013-14 of the Indian Women Scientists' Association (IWSA) will be held on Saturday, 23rd August 2014 at 2.30 p.m.

Dr. Sharadini Dahanukar

(17th October 1945-- 4th August 2002)

Robert Frost had once said "There are two kinds of teachers: the kind that fill you with so much quail shot that you can't move, and the kind that just gives you a little prod behind and you jump to the skies". Dr. Sharadini Dahanukar was like the latter – she inspired her students to dream and realize their full potential.

I first knew her as my Pharmacology teacher in II M.B.B.S. – the subject is by definition a dry one and we used to sit through most lectures more out of compulsion than interest. Madam (Dr. Dahanukar) took her first lecture for us in the Main Lecture Theatre, I remember and I was mesmerized. There was clear logic in this subject I felt – it was not only about rote learning. I remember she had recited a Hindi quote in her first lecture "Pharmacology *tu badi bewafa, subah mein padhi, shyam tak safa*." Thereafter she went on to teach us Pharmacology in such a way that, believe me – I still remember some of her teachings. I was fortunate enough to have her as my tutorial teacher. And then there was no looking back for me – I loved the subject with a passion that made me take it up as a postgraduate course. Is it not said that a good teacher is one that inspires? My professional life is evidence of this inspiration of a teacher, dedicated to her art of teaching.

Madam was a multi-faceted personality. For her, it was not only about Pharmacology (at which she excelled) but she also took a deep interest in Ayurveda. I remember early on in my postgraduate life I was a harsh questioner. I could not accept her "teachings" – I asked questions incessantly and perhaps that was the most important thing she taught her students – to be curious, not hesitate to ask your seniors, question and question again, and then plan the study and conduct it. I remember each step of the research story that went behind our painstaking work on *Tinospora cordifolia*. At all steps Madam encouraged her students to grow. She was like the wind – invisible but forceful, gentle yet sometimes gusty, she could push you onto the road that you chose for yourself. A teacher is not only one who gives of herself but one who makes students realize their own talents.

She actually even taught her students "how to teach" – not with any technology – but simply showed us by example. She was so encouraging - I still remember that time when I was scheduled to take my first lecture for medical students (who I believe can be the harshest critics – falling asleep invariably in most pharmacology lectures) – I was understandably nervous. She actually had me rehearse in front of her in the Lecture theatre. Why would a teacher give so much of herself to her students? Only because she was a "driven" teacher.

She was a prolific writer and somewhere along the way she asked me to collaborate with her to write in English – translate or adapt some of her works. While writing these books I learned so much about communicating with people – she was an "all round" teacher – not restricting her teaching only to the facts in a Pharmacology text book, but teaching everything written and unwritten in the book of life.

She encouraged extra-curricular activities and her student following was immense. Yet, at the bottom of all this she continued to be a student herself.

Henry Adams said "A teacher affects eternity; he can never tell where his influence stops." In much the same way, through us, her students, this great teacher lives on – and her influence on the various areas she touched – pharmacology, Ayurveda, research, teaching, trees and flowers, will forever inspire newer students.

Dr. Urmila Thatte
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Reports from Head Quarters

Rugnasahayak Certificate Course - 2014

The first Rugnasahayak Certificate Course (Course Co-ordinator: Dr. Surekha Zingde, former Dy. Director, CRI-ACTREC) was conducted by IWSA in collaboration with MGM's Hospital in Navi Mumbai, between 17th May and 14th August 2014. The course was inaugurated on 17th May 2014 by Dr. Kalyani Sen, Medical Superintendent, MGM Hospital, at the IWSA Headquarters. Dr. Sen impressed upon the students the important role played by Rugnasahayaks in looking after the well being of the sick and the elderly, while also emphasizing how the course would provide them skills towards gainful employment. In all, eight participants enrolled this first course. In the month long initial training, they were taught different aspects of patient care by Mrs. Meera Achrekar, Asst. Nursing Superintendent, ACTREC and her nursing staff. They learnt about basic anatomy and physiology, infections and diseases, communication skills for dealing with elders and patients with Alzheimer's disease, and handling of medical equipment and small gadgets used by clinicians. These aspects were covered by doctors from BARC and members of IWSA. Information about nutrition, yoga, oral hygiene, etc was provided by volunteers. All the faculty members did an excellent job, and the students were overwhelmed by their sincerity and willingness to impart knowledge. From 2nd June to 2nd August 2014, the students were given hands on training as Nurse Aids under the guidance of Sister Savia Fernandez, MGM Hospital. In the final weeks of training, the students were exposed to other clinical settings. For more information about the course, you may contact the IWSA office on 022-27661806 or send an enquiry on email : iwsahq@gmail.com.

World Environment Day

IWSA celebrated World Environment Day on 7th June 2014 by planting a rose sapling at its Vashi campus by the hands of Day Care Children. On this occasion, Ms. Asha Khandkar, IWSA member, spoke about the importance of trees in our life.

Nursery/Creche Teacher's Training Course

IWSA has been conducting the Nursery Teachers Training Course (TOT) since several years. After completing the course, successful trainees find employment with IWSA Nursery School, Anchorwala, Don Bosco, Radhikabai Meghe, Sai Holy Faith, North Point, St. Mary, Kidzee, Vibgyor, Sanjjas Ashram BMC School, Neyal K.G. School, Tots 2 Teens, etc, on an average monthly salary of ~Rs. 10,000/-.

§ On 21st June 2014, a function was held at the IWSA headquarters, Vashi, Navi Mumbai to felicitate the top rankers of the 18th batch of TOT. This year's results were excellent - 100%, and the toppers were: Ms. Kajal Mhatre (1st Rank - 84.9%) and Ms. Sheetal Karande (2nd Rank - 82%).

§ On the same day, inauguration of the 19th batch of TOT took place. The Chief Guest at this function was Prof. Reeta Sonawat, Head, Human Development Department, SNDT Women's University, Mumbai. The Chief Guest praised the efforts of IWSA towards "Early Childhood Education". She appealed to the students to follow the 3D's - discipline, dedication and devotion, and not to treat this profession as a business.

BRNS Popular Science Lectures

IWSA, supported by BRNS-DAE, organized three popular science lectures over the past few months at various colleges in Mumbai and Navi Mumbai.

§ The first of these lectures was held on 10th July 2014 at the Rajiv Gandhi College of Arts, Commerce and Science, Vashi, Navi Mumbai. "Atomic Energy in National Development" by Dr. S. Kailas, former Director, Physics Group, BARC & Raja Ramana Fellow and Senior Scientist, University of Mumbai-Centre of Excellence in Basic Sciences. In his talk, Dr. Kailas spoke about the generation of atomic energy, and its use to meet the electricity needs of the country, stressing on its efficiency compared to hydro or coal generated electricity. He elaborated on the safety measures in place during construction of nuclear reactors, and allayed concerns about radiation from the reactors, informing all that the ambient radiation was well below acceptable limits, ensuring that there

was no hazard to society at large. He went on to discuss other applications of nuclear energy - for the diagnosis and treatment of cancer, to generate varieties/ strains of agriproducts with high yields or those that could be grown under drought and high salt conditions, and to irradiate foods/ spices and medical devices for sterilization and long term storage. He also touched upon the avenues open for higher education under DAE and the openings at the Training School. Nearly 150 students attended the lecture - which was well appreciated as apparent from the questions raised by the youngsters.

- In this series, two lectures were held on 17th July 2014 at SIES College of Arts, Science and Commerce, Sion, Mumbai. Prof. Dhirendra Bahadur, Professor & Institute Chair, Metallurgical Engineering and Material Sciences, IIT – Bombay, Powai, Mumbai spoke about "Nanotechnology - a Chemist's Perspective". In his talk, Prof Bahadur informed the audience how the surface energy, reactivity and surface electrical, optical and magnetic properties of particles change when the size of particle reduces. Electron microscopy and scanning electron microscopy can be used for detection of nanoparticles. He explained the procedures for preparing nanoparticles and also their application in health care. In the second talk, Dr Shyamala Bharadwaj, Head, Fuel Cell Materials and Catalysis, Chemistry Division, BARC, Mumbai, spoke about "Hydrogen Energy". She spoke about the importance of hydrogen as an alternate and attractive energy carrier in the foreseeable future. Various research efforts aimed at the production of hydrogen from water splitting cycles were discussed along with an account of the research efforts towards hydrogen storage and utilization in fuel cells. Both these lectures were attended by about 110 students and the departmental faculty.

Farewell to Ms. Shanta Salvi

Ms. Shanta Salvi, Assistant Supervisor, IWSA Hostel, superannuated on 31st July 2014. At a function organized that day at the IWSA headquarters, Shanta – as she was affectionately called by IWSA members and hostel inmates, was given a warm farewell and presented a gratuity of Rs 1.2 lakh from the Staff Welfare Fund in appreciation of the 22 years of yeoman services to the Association. IWSA wishes her all the best for the years ahead.

Report from Kalpakkam Branch

Convener : T.Jayanthi
Secretary : Jemimah Ebenezer
Treasurer : Padma S. Kumar

1. Technical Talk on "One Hundred Years of X-Ray Diffraction".

IWSA, Kalpakkam Chapter celebrated the International Year of Crystallography 2014 by arranging a Technical Talk on the topic "One Hundred Years of X-Ray Diffraction". The lecture was delivered by a leading scientist belonging to Material Science Group Dr S. Kalavathi, CMPD. The technical talk was held on 18th July at CDO Lecture Hall, IGCAR. Smt. Shivakamy, Jt. secretary introduced the speaker.

Our eminent speaker elaborated on crystals, X-rays, on flurry of activities which ultimately lead to Crystallography and our understanding of the nature of matter. She further enlightened us on X-ray diffraction which was discovered exactly 100 years ago. In 1914, German scientist Max von Laue won the Nobel Prize for physics for his discovery on X-rays getting diffracted by simple crystals. The speaker has not only brought out the struggles of leading scientists in their works which ultimately lead to the discovery but also insisted on how they stood for the values of society. It was altogether an interesting and excellent technical talk that everyone in the audience got benefited. On behalf of IWSA, Smt. T. Jayanthi handed over a memento to Dr S. Kalavathi as a token of our respect and love for her.

2. AGM held at CDO Lecture Hall on 18th July 2014

Annual General body Meeting of IWSA Kalpakkam (K) branch has been conducted on 18th July 2014 at CDO Lecture Hall, IGCAR. Around 50 IWSA members have attended AGM. The program started with the welcome address from Convener Smt. T. Jayanthi. A talk on "One Hundred Years of X-Ray Diffraction" has been delivered by Dr. S. Kalavathi, EC member, IWSA-K. Smt. Jemimah Ebenezer Secretary, IWSA-K has presented the report on the activities of IWSA-K during the period 2013-14. It was proposed by Smt. Rajeswari, FChD and seconded by Smt. Manohari, HASD. Smt. Padma S. Kumar, Treasurer, IWSA-K has read the Auditors report on IWSA-K's accounts. It was proposed by Smt. Bindu Sankar, CD and seconded by Smt. Saritha P.Menon, EID. This was followed by a brief presentation and discussion on the plans of works for the year 2014-15 by Smt. T. Jayanthi, Convener. The session ended with vote of thanks by Smt. Bindu Sankar.

Science Education: teacher communities and research based practices

''First I thought very hard about the topic and got it clear in my own mind. Then I explained it to my students so that they would understand it with the same clarity I had. At least that was the theory. … And whenever I made any serious attempt to determine what my students are learning, it was clear that this approach just didn't work. … An occasional student here and there might have understood my beautifully clear and clever explanations, but the vast majority of students weren't getting them at all." Nobel Laureate American physicist Carl Wieman (Wieman, 2007, p 10)

This seems to echo the situation in a traditional science class of a competent teacher. The teacher comes prepared to teach a "lesson", which may be concepts, phenomena, procedures, etc. She lectures to a class of largely passive students, who are expected to do homework involving questions from the back of the lesson she has just taught. The answers are reproductions from the lesson and, if at all there is a problem to be solved, students are expected to use pre-taught recipes. This article briefly (a) argues how the teaching-learning of science can be made more effective, (b) addresses the mechanisms and support that teachers need to enable them to initiate effective classroom practices, and (c) highlights the role of educational research in validating and sustaining such practices.

A. How can we make teaching-learning of science more effective?

If the traditional methods such as the usual chalk and talk method in the classrooms are supplemented with relevant activities, projects, demonstrations, discussions and experiments - especially in science classes, students are more likely to be actively engaged in the teaching-learning process. It is widely accepted that becoming educated is not simply a matter of accumulating information; it involves the gradual induction of students into new perspectives on the world, the development of new problem-solving skills and new ways of using language for representing knowledge, and making sense of the experience.

As Uma Sudhir from Eklavya, Madhya Pradesh, who has been engaged in teacher development says, "One of the problems of science education in schools is that it is not contextualized and the role of the home and the knowledge students have already gained is not used as a resource. This goes against what we know about learning from cognitive science: that students learn by engaging with the new material to be learnt and connecting it to what they already know. The nature of science presented in classrooms is that of facts and information to be transmitted. The authority of the textbook is unchallenged and teachers themselves are used to instructions given to them in a top-down manner. This results in disempowerment of both students and teachers." (private communication).

Besides, activity based learning or inquiry based methods are absent in classrooms. One of the main problems is that teachers are either unaware of or are not confident about implementing these pedagogies in their classrooms. The pre-service and in-service training of teachers must equip them with the skills required to create learning situations and raise investigative questions. In rare instances where demonstrations replace experimentation, they are done without student participation or discussion. Teachers must encourage discussion, argumentation and student talk that may lead to theoretical development. They need to provide opportunities for students to develop experimental skills such as observation, designing of experiences or drawing conclusions.

A.1 Activities, demonstrations, experiments and investigatory projects

Learning science can be an outcome of different kinds of hands-on activities. Some may be simple exploratory activities or surveys, and one learns a wide variety of skills from these activities, such as collecting, recording, analysing and documenting data. Experiments and investigatory projects are necessary in two complementary ways. Firstly even when experiments are done in a lackadaisical manner wherein the outcomes are well-known, they are still useful in learning a particular set of skills – handling equipment or learning to process the data and present it by drawing graphs, diagrams, etc. Secondly, investigatory projects give students a chance to try out the method of science in order to find the answers to questions that puzzle them. Projects have the additional advantage of promoting learning across different disciplines.

Demonstrations in science classrooms, when used suitably, can increase students' participation in class. The teacher needs to prime the students to discuss the demonstration that will follow, and need to also discuss the observations once it is completed. One such teaching strategy that can be used for experiments and demonstrations is termed 'Predict, Observe and Explain' (POE), developed by White and Gunstone (1992). Before the demonstration, students are asked to make some predictions about a phenomenon and these are followed by careful observation and explanation of the same.

This method helps the teacher to understand the students' existing theories or ideas, and helps the student to think critically and explain the results that may be different from their predictions. Thus demonstrations can be modified to exploit the students' arguments and serve as an important pedagogical tool. Demonstrations are essential for several reasons. There may be many experiments/ activities that students cannot perform on their own, because of expensive resources or their being too dangerous or complex for students. Demonstrations can also be used to improve students' skills of observation, recording and analysis. In his essay, Katz (2002) says, "an effective demonstration should promote good observation skills, stimulate thought, arouse curiosity, present aspects of complex concepts on a concrete level and, most important, be the basis for class discussion."

A.2 Classroom dialogues to support science learning

Classroom interaction can take the form of rote, recitation, instruction, discussion and dialogue. Research has indicated that Indian teachers make very limited use of dialogic methods; also teachers, rather than encouraging a dialogue, tend to mute students' voices in their classrooms as these may pose a threat to their knowledge and authority. In such a situation, students too tend to be afraid to give answers of which they are unsure, and may never present their experiences that conflict with what is being presented in science classes. Thus students may hold on to alternate views as there is no opportunity to express these.

In a science class, where there are diverse learners, a dialogic approach can help bring about different perspectives and voices. Dialogue does not mean a teacher framing closed-ended questions with the students competitively trying to answer the questions in monosyllabic answers. Dialogue implies that both students and teachers present their ideas and contribute to the teaching-learning process. Classroom interactions can be between teacher-student, teacher-group, teacher-class and vice versa as well. The teacher has an important role in guiding the conversation purposefully towards reasoning and inquiry, and active engagement in dialogue, argumentation and/or discussions helps students learning. This requires teachers to have a deeper knowledge of the subject under discussion

than they normally have, and the confidence gained through experience and the knowledge. They can be initiated into such ecologies of learning by participating in peer discussions with mentor support.

No matter how suitable the curricular materials are, the teacher plays a crucial role in enhancing the quality of science learning among students. Steps are urgently needed to strengthen the teaching-learning of science at all levels in the country. Given that almost 92% of those that go to school do not ultimately go to college, the most effective way to improve learning in science and mathematics is by addressing school teachers - over 6.5 million of them, through appropriate schemes. Addressing the problems also requires both an understanding of the roots of the problems, and provision of a support system to teachers to help them empower themselves and also their students.

B. What do science teachers need?

School teachers first get a degree in content, like higher secondary certificate to become elementary school teacher, or a graduation to teach higher levels. Then they acquire a professional degree in teaching, such as a diploma in education or a B.Ed., which is supposed to expose them to tools and methods of pedagogy. Current teacher preparation divorces teaching as an activity from what is being taught. According to HBCSE's *Working Paper on In-service Teacher Professional Development for Elementary Education*, the separation of pedagogy from content on the one hand, and from the social sciences on the other, has made teacher education irrelevant to the practice of teaching, and led to a diminished status of the teacher in the academic community. This is true at all levels of education. The arguments above highlight the importance of *pedagogical content knowledge* and competencies for all teachers at all levels, and also teacher educators. This knowledge would also be useful for those framing curricula and developing syllabi.

The Hoshangabad Science Teaching Programme (HSTP) has shown that it is possible for experiments relevant to the topics covered in middle-school science to be carried out in classrooms with easily available materials. By conducting experiments and discussing the observations, teachers and students begin to appreciate what it means to do Science. However, teachers can only initiate such activities when they feel assured of expert support in science and mathematics. Processes must be initiated that will encourage teachers to propose and carry out investigative projects of 2 to 3 months duration with their students, to work collaboratively with their peers, adequately supported through mentoring by experts.

Research in teacher professional development shows that beliefs and attitudes of teachers change only when they interact with their peers, and share and discuss their experiences. They also derive their self-esteem from the standing of the community they belong to. Processes need to be initiated to form and sustain communities of teachers who follow exemplary teaching practices and contribute to the development of professional competence. Suitable infrastructure and resources are essential to support teacher communities.

Several state institutions, like SCERT and DIETS, are involved in pre- and in-service teacher education programmes. Participation of these institutions in initiating the processes will help build their own capacity for science teacher education. Besides, the infrastructure and resources of the institutions can be optimally built up and utilised for consolidation, follow-up and documentation of the efforts.

Teachers often have to balance the different tasks assigned to them, which may be at times conflicting. They struggle to allocate time between the administrative demands of school systems, and their academic commitment to

students learning. Any effective process for building communities of teacher professionals must involve the educational bodies governing the schools, such as educational authorities of the state (UT) and the major national level School Boards, like CBSE.

B.1 Building a professional community: learning from peers

The professional development of teachers needs much improvement. There is an urgent need to bring teachers together for professional communication. We learn best along with a peer group, and must build networks of teachers who can learn from each other's experiences and support capacity building. Such networks can lobby for conditions necessary for successful teaching-learning. It can also introduce peer evaluation and collaborative working, which can go a long way towards developing teachers' esteem and improving the quality of work that they do.

B.2 Citizen science projects

Most science teachers gain content knowledge by reading about science - not by doing science. A citizen science project typically involves public participation in an ongoing scientific research. Unlike science-fair projects, citizen science projects have a longer duration, continuous engagement and collaboration that could sustain a network of teachers and scientists using social networking and the internet space for communication and collaboration. Support from experts is provided through interactions and collaborations between the teachers and researchers from colleges, universities and other academic institutions. Participating in ongoing academic work done by career scientists may boost the confidence and social standing of science teachers in society. In order to expand the base of science communication, it is essential to communicate about science and mathematics in local Indian languages, by creating a sustainable self-rewarding multi-lingual social network using multi-lingual digital platforms.

C. Role of educational research

Scientists build models and theories based on evidence. These are the practices of science. Their theories and models extend, refine, and revise scientific knowledge. Scientists operate on a variety of resources to investigate natural phenomena and build theories. Scientific ideas have evolved over time – nature of matter going from an ether continuum to atomicity, from light corpuscles to waves to duality, from alchemy to chemical reactions, and so on. What we can learn about science through a study of the history and philosophy of science - in terms of its characteristics as well as the dynamics of its evolution, has considerable implications for science education at all levels – from elementary to tertiary education.

Educational research establishes the connection between science and science learning, between content based pedagogies and effective learning, and the effect of teacher professional development on the knowledge and competencies of learners. How is educational research in the Indian context to be generated? How can teachers gain pedagogic content knowledge and become competent to create efficient teaching-learning situations? Effective science education can result if teachers engage in reflective teaching and research-based teaching-learning practices. That is, communities of teachers study their own practices of dealing with a topic in class. They discuss and document their practices, comparing them to current research on teaching-learning of that topic. That such practices are taking root is evident from several developments. The number of journals publishing articles on science education research has proliferated by an order of magnitude in the last couple of decades. Promotion of educational research and evidence-based classroom education is one of the major goals of internationally influential professional bodies like Royal Society of Chemistry (RSC, 2014) and American Chemical Society (ACS).

The Carl Wieman Science Education Initiative (CWSEI) advocates a scientific approach to science education in university departments (CWSEI, 2013). Physics education seems to have taken a historically leading role in educational research. Learning chemistry has come to be viewed as building the ability to reason across the three aspects of chemistry: (a) macro aspects which may be visible and tangible, (b) micro aspects like atoms and molecules, and (c) kinetics, and the representational aspects of symbols, notations and equations. Several laboratory modules have been developed based on research-based practices (MIT, 2013). Biological knowledge also requires an understanding of the relationship between different levels of organization, viz., the macro, micro and molecular levels. Besides, the structural and functional linkages of biological concepts are not well integrated (Duncan & Reiser, 2007; Marbach-Ad, 2001). Simple model systems like fruit flies, snails and earthworms, and experiments are studied to understand complex mechanisms. Recent biology education research has focused on the use of Multiple External Representations (MERs) for learning about a concept. Building physical models is considered to bolster the transition of learners from abstract to concrete knowledge about 3-dimensional entities (Tsui & Treagust, 2003; Srivastava & Ramadas, 2013). Gesture and analogy are used to connect external representations with learners' internal representations.

C.1 Science Education Research at HBCSE

From HBCSE's inception, research in science education has formed a significant aspect of its developmental programmes from school to undergraduate levels. Early research interests at the Centre included language and science, knowledge frameworks of children and their alternative conceptions in specific topics of physics, chemistry and biology, career aspirations of underprivileged students, mathematical modelling of educational processes, instructional strategies in physics laboratory experiments, etc. The Diagnosing Learning in Primary Science project studied the tribal and urban children's ideas on plants, living and non-living, and the role of experiments in science (Chunawala et al., 1996; Natarajan et al., 1996; Ramadas et al., 1996). The Centre's research in Science, Technology and Mathematics Education (STME) is informed by current perspectives in cognitive science, developmental psychology, history and philosophy of science, and socio-cultural aspects of science and education.

Effective teaching-learning of a topic in science must take into account students' existing (prior) ideas in that topic. Research at HBCSE includes students' spontaneous ideas on light, heat, matter, motion, life and human body. Other studies include students' mathematical understanding in several areas as well as concept mapping. An area of physics education research addresses the relation between demonstrations, experimental problems, procedural understanding of experiments, and conceptual understanding. A concept inventory is a set of carefully crafted multiple choice questions aimed at probing misconceptions and deficient understanding, and eliciting ill suited reasoning patterns. Concept inventories have been developed at HBCSE on topics like friction on rolling bodies, and rotational kinematics.

Sociocultural aspects in STME have been addressed through: attitudinal studies, classroom interactions, collaborative learning, inclusive education, diversity in science education, learner-centred practices, affective outcomes, student engagement, socio-scientific argumentation, ethical and moral issues, and out-of-school learning. Study of gender and other socio-cultural factors and contexts as they relate to education has been an ongoing research activity at the Centre. Research on graduate and post-graduate students' argumentation and justification patterns on socio-scientific issues shows that this can be a context for

developing understanding about the nature of science. Participation in an international collaborative project, 'Science Education and Diversity', provided a framework for understanding the relationship between culture and science education within classroom settings, and a basis for designing flexible and diverse approaches to science education that are sensitive to diversity.

Studies on visuospatial thinking and reasoning at HBCSE address science topics that involve significant visual content and where spatial relationships predominate, such as human physiology, elementary astronomy, and DNA structures (Ramadas, 2009; Padalkar & Ramadas, 2011; Vinisha & Ramadas, 2013). The studies influence diagrammatic conventions in teaching-learning, linking of text with diagrams, mental rotations, perspective-taking, and use of body gestures to connect models with diagrams. The ability to read, analyse and make graphs is an essential interdisciplinary skill for science education. A research study provides students with opportunities to engage with graphs in meaningful ways. Details on past and ongoing research at HBCSE are available on its website (HBCSE, 2014).

The Collaborative Undergraduate Biology Education (CUBE, 2013) project, initiated at HBCSE, is aimed at engaging teachers and students in biology research using model systems through a potentially nationwide network of collaborative groups, including students, teachers, subject experts and education specialists. The groups are connected locally in real space and time, and virtually across the country.

D. In Summary

Learning environments must be rich in opportunities for engaging students in higher order mental processing – explaining, arguing and justifying. Groups of teachers, supported by subject specialists and education specialists, can plan such classroom situations through research-based practices. One of the objectives of HBCSE, with an active research group of about 20 academics - about the same number of scientific staff, and an equal number of graduate students working on educational research, seeks to seed research-based teaching-learning practices in Indian classrooms. The Centre supports to the best of its ability endeavours for building of communities of teachers and educators who engage in innovative and research based practices to vitalise education in general, and school science, technology and mathematics education.

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Science Education: different perspectives

Over the past several years, a large number of articles on Science Education in India have been written by national and international bodies, forums, organisations and individuals. Several government bodies, NGOs and private organisations have contributed either positively or negatively towards achieving the current state of science education in our country. The notion of "building the scientific temper" in our country was proposed by Late Pandit Jawaharlal Nehru in the 1950's. Our National Policy on Education, 1986 states, "*the wealth and prosperity of a nation depend on the effective utilisation of its human and material resources through industrialisation (investment capital). The use of human material for industrialisation demands its education in science, and training in technical skills.*"

However it is only recently, over the past 8-10 years, that the Government of India has put in serious efforts towards improving the state of science in the country, and the fruit of its efforts have been acknowledged in the UNESCO Report 2010, as follows: *"A bipolar world in which science and technology (S&T) were dominated by the Triad made up of the European Union, Japan and the USA is gradually giving way to a multipolar world, with an increasing number of public and private research hubs spreading across North and South. Earlier and more recent newcomers to the S&T arena, including the Republic of Korea, Brazil, China or India, are creating a more competitive global environment by developing their capacities in the industrial, scientific and technological spheres."* Governments worldwide have realized the crucial importance of science for socio-economic development. Those developing countries that have progressed fastest in recent years are the ones that have adopted policies to promote science, technology and innovation. The urgency to design new policies for the growth and sustenance of the science, technology and industry sectors in India is all the more demanding since, by 2050, India will have one of world's largest young

population - 25% of the world's graduate students! In order to maintain a sustained availability of trained and skilled personnel in the fields of science and technology, who can compete and excel in the global scenario, the need for restructuring/ reforming our education system is apparent.

- **Government policies and governance** : A positive political will and commitment of the Government, and the planning, formulation and implementation of Government policies for the growth and sustenance of high quality science education in the country are both extremely important for the success of the National Education Policy that is idealistic in its objectives and realistic in its approach. Scholars, philosophers, scientists, educationists, psychologists, sociologists, economists and industrialists should all contribute positively towards the formulation of these Policies.

- **Funding** for Primary, Secondary and Tertiary Education has increased. Overall, in our nation, the Education Sector received an allocation of Rs. 68,728 crore for 2014-15, up by 11.1% from last year. The school sector received an increase of 9.9% and higher education went up by 14.98%, with the largest share going to technical education. However the allocation for teacher education is not clear. Involvement of the private sector in funding teacher education should be explored.

- **Infrastructure**: Along with making education free and compulsory at the school level (introduction of the RTE Act in 2009) and increasing the number of schools/ colleges/ universities/ research institutions, improving the related infrastructural facilities such as classrooms, toilets, drinking water, facilities for sports and extracurricular activities, well equipped libraries and laboratories, computers for online and offline education, internet with appropriate bandwidth etc. are of utmost importance. Public-private partnerships should be established to get the infrastructure into place.

- **Trained manpower** : The availability of good, trained, skilled science and mathematics educators is one of the pillars of high quality education. Teacher education should be given prime importance, if any paradigm shift has to be brought about in improving the scientific temper in our country. A National Policy with a strong focus on Teacher Education at the primary, secondary and higher education levels is highly essential.

It would not be possible for me to discuss all the issues related to science education in this article, and hence I would like to focus on four issues: Training for teachers at all levels, STEM education, Open education movement, and Non-formal science education.

Teacher training

Recognizing the need for high quality science teachers, the Ministry of Human Resource Development (MHRD) should establish **Indian Institutions for Science Teacher Education and Research (IISTER)**, on the lines of the IITs, IIMs, and IISERs. Several such Institutions should be set up, at least one per state, to cater to the high demand and extremely scarce supply of qualified teachers. The requirement for high quality teachers in India is perhaps as high as the need for high quality scientists, technologists or managers. Teachers should be given the same status, recognition, privileges and salaries as researchers, in order to attract the best talent into this profession. Recognizing the urgent need for high quality teachers, the Gujarat Government established the Indian Institute of Teacher Education (IITE) in 2010, which offers a four-year integrated course on Teacher Education. The National Institute of Technical Teachers Training and Research (NITTTR), Chennai was established as an autonomous Institute by the Ministry of Human Resource Development, Government of India in 1964, to improve the quality of Technical and

Vocational Education and Training (TVET) system in India and in the southern region in particular.

● To improve the quality of teachers, strict criteria need to be put into place for their selection and training. One year training in Science Teaching to students after completing M.Sc. or Ph.D. in any of the Science streams would produce Science teachers/ educators with M.S.Ed. or Ph.D.Ed. degrees, who would have the professional expertise and teaching skills for innovative teaching. Science Education Institutions like the IISERs, NISER, IISc, HBCSE, etc. could contribute significantly towards producing science teachers/ educators. HBCSE has a Ph.D. program in Science Education which is becoming increasingly popular.

● Tenure track merit-based appointments; regular teacher evaluation by students, peers and autonomous bodies; merit-based promotions, and reward and recognition incentives should be put in place and implemented rigorously.

Continuous Professional Development Frame work for teachers at all levels should be formulated, funded and implemented. Training of teachers and teaching educators should involve training not only at the level of initiation (in terms of a minimum educational qualification requirement), but also necessitate a continuous professional development in terms of subject content, teaching skills and teaching pedagogies. Training in soft skills such as communication skills, counseling skills, interpersonal skills, computer skills, as well as information retrieval and effective delivery skills should be a part of this training. Training in the use of technology for imparting education should be mandatory.

● Importance of ICT (Information and Communication Technology) in teacher education: To circumvent the problem of delivering high quality teachers in a short span of 5 years, MHRD should resort to Open and Distance Learning (ODL). The Commonwealth of Learning provides support to teacher education institutions to design and deliver quality teacher education through ODL and facilitates the development and use of Open Education Resources (OERs). The National Council of Teacher Education (NCTE) is now launching a new project for integrating technology in education – Integration of Technology in Teacher Education) project in collaboration with Intel® Teach Program. As per the latest reports, currently 523,000 school teacher positions are vacant in India. In Delhi, the proportion of unqualified teachers is 0.08%. In Arunachal Pradesh (a state with minimal teacher training capacity), the unqualified teacher percentage is 71.21%. In Bihar, 45% of existing teachers are unqualified. Similar statistics apply to states such as Orissa, Uttar Pradesh and West Bengal (The Bordia Report 2010).

● Teachers/ Teacher educators should be involved in the development of course material, and the use of technology in development of Open Educational Resources should be encouraged. Collaboration with partner institutions in implementing this should be promoted. Hands-on experimentation, concept based inquiry driven curriculum, as well as critical thinking, analysis and evaluation should be emphasized. Text books/ educational software should be designed and developed for improving the understanding of science concepts, both by teachers and students. Thought provoking exercises and assessment techniques in schools, research based projects in high school and undergraduate colleges, basic and applied research projects with industry internships, and incubation cell facilities for developing innovative ideas for entrepreneurship training in universities would help in this direction. Howard Hughes Medical Institute [www.hhmi.org] also emphasizes similar initiatives.

● The ambitious National Program on Technology Enhanced Learning (NPTEL) funded by MHRD - a joint venture by IISc and IITs, expects to offer e learning in Engineering, Sciences, Humanities and Management, through web and video courses [www.nptel.iitm.ac.in]. So far, NPTEL has developed over 1230 courses in video and web formats, across various disciplines: Engineering, Basic Sciences, Humanities and Social Sciences and Mathematics, using more than 1200 subject experts.

STEM education

● Introduction of a strong STEM (Science, Technology, Engineering and Mathematics) education policy, with an emphasis on interdisciplinary, borderless curricular framework, from primary school to college level, should be made mandatory. To provide STEM education in schools, a National Council or Centres of Excellence should be established to train and produce STEM Educators. Science research and education institutions like IISERs should tie up with the IITs, NITs and various

engineering and technology qualifications earned by students in universities and increase their employability in industry.

● The Maker movement is an excellent example of the use of technology for science education in STEM, to translate innovative ideas into products. It works on the "invent to learn" concept, uses technology to make, repair or customize the things we need bringing engineering, design and computer science to the masses. New tools and technology, such as 3D printing, robotics, microprocessors, wearable computing, e-textiles, "smart" materials and programming languages are being invented and affordable versions of these inventions, tools and ideas are shared with teachers so that they can be implemented in the K-12 classes.

● Another example of STEM education is a research intensive UG program (4-year B.Sc.) initiated at IISc with a strong foundation in Mathematics, Physics, Chemistry, Biology, Engineering, Material Science and Liberal Arts, which allows easier migration between science and engineering streams. Due to the STEM based program, the 2012 global employment ranking of IISc rose from 134 to 35. According to the US Department of Commerce report, employability of STEM educated persons in the US was three times higher as compared to their non-STEM counterparts, over the past decade. In Finland, integration of Science, Technology and Industry policies has transformed the country from a forest based economy to a high technology based economy.

● Homi Bhabha National Institute (HBNI) which is a deemed University set up in 2005 under DAE, and is the brain child of Dr. Anil Kakodkar, has proven to be another success story. It runs a unique Ph.D. program where a student has two supervisors - one having strength in basic research and the other having strength in technology development. The aim of this program and HBNI itself is to develop strong epistemic bridges between science, engineering and technology. HBNI has formal links with IIT-Bombay, IIT-Madras, IIT-Kanpur, Institute of Chemical Technology, Tata Institute of Fundamental Research, Indian Statistical Institute, Jadavpur University, etc. These Ph.D. students if trained in teaching skills would make excellent STEM educators.

Open Education Movement and its implications in Higher Education Institutes

Since 2000, the concept of openness in education - whereby knowledge at the university level should be accessible to all, free of cost, across geographic, social or economic boundaries - has been evolving rapidly. From the development of Open Education Resources (OERs), to online courses and platforms, to Massive Open Online Courses (MOOCs) in 2008, the Open Education Movement appears to have caught on. In contrast to traditional university online courses, MOOCs have two key features: open access - anyone can participate in an online course for free, and scalability - courses are designed to support an indefinite number of participants (Wikipedia, 2012). However, some MOOCs are massive but not open, while some are open but not massive. Various online platforms again differ in what they cover: edX offer [https://www.edX.org/] only Harvard and MIT courses, Coursera [https://www.coursera.org/] focuses on providing a platform that any university can use, while UDACITY [https://www.udacity.com/] only offers its own curriculum with specialised areas. Other open education initiatives such as Udemy [https://www.udemy.com/], P2PU [https://p2pu.org/en/], Khan Academy [https://www.khanacademy.org/] and Open University's Futurelearn have been around for a while and provide opportunities for anyone to learn with experts, peers and others outside the traditional universities. The scale and open nature of MOOCs provides a space for experimentation with online teaching and learning. These new approaches for higher education have generated significant interest from governments, institutions and commercial organisations worldwide; however their contribution to developing research and scholarship, ability of critical thinking and discernment, capacity for reflection will only be seen in the next decade.

With globalization of higher education, and the use of technology for open access teaching and learning, higher education is going through a paradigm shift. With information in any discipline now being available through the internet, various ICT platforms, open and distance learning platforms, MOOCs, etc., teachers now have to perform the role of knowledge facilitators, inspirational motivators, mentors, agents for developing research skills such as inquiry based concept building, interdisciplinary analysis and critical thinking, reflection and application.

Thus teachers have to be trained in strategies and methodologies for developing and promoting such higher cognitive skills in students. Accordingly, teacher training institutions need to take inputs from philosophers, thinkers, intellectuals, educationists, researchers and technologists for developing appropriate teacher training programs for teachers from schools, colleges and universities. Participation in such teacher training programs should be made mandatory for all teachers in a phased manner, with the use of ICT technology wherever possible, for its quality controlled, faster, and wider reach.

Non formal science education

Science education is not limited to "formal settings" like classrooms. Another completely different aspect of Science Education is "non-formal education", which can be undertaken outside the classroom by anyone - a child, an adult, an illiterate person who has never attended school or an uninitiated person not interested in doing science. Increase in outside-the-classroom learning, through visits to science museums, science centres, planetaria, exploratoria, science exhibitions, science clubs, science fairs, quiz competitions, summer training camps, mobile labs, public libraries, should be emphasized by involving Corporates, NGOs, NRIs, Institutions and the Government.

Science writing and communication should be taught at the high school level. Science that is done in research laboratories has to be communicated to the lay public, in order to arouse their interest in science, and produce new scientists in the next generation.

Science popularization through popular science books and educational videos should be taken up as a National Mission. The book "De-mystifying the Brain," written with the support of the National Mission on Education through Information and Communication Technology (NME-ICT) program launched by the Ministry of Human Resources Development, is the first instance of a book on popular science being included in the agenda of NME-ICT, as part of the National Education Policy. Science popularization through such a popular science resource material will go a long way in creating a solid foundation for Science Education in India.

Citizen Science Groups should be encouraged. Giving a lay person the opportunity to contribute to the development of science can be very inspiring. The Zooniverse web portal [www.zooniverse.org] lets anybody catalog heavenly objects from NASA images, or record citizen data on space, biology and the humanities. Seasonwatch [www.seasonwatch.in] and migrantwatch [www.migrantwatch.in] are two web portals initiated by NCBS, Bangalore for citizen group participation in observing changes in seasons and migratory bird patterns, respectively.

In conclusion, I would like to re-emphasize on the few points that I started out with - teacher training, STEM education, Open education movement, and non-formal science education, as important pillars that can contribute to strengthening the status of Science Education in our country.

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Sunday Science Club

"We learn 10% of what we read, 20% of what we hear, 30% of what we see, 50% of what we see and hear, 70% of what we discuss, and 80% of what we experience."

A famous Chinese proverb

Everybody likes to build projects, conduct experiments and explore science. To encourage activity based learning, and curiosity building attitude among children, we started TechShiksha Sunday Science Club in association with the Indian Women Scientists' Association (IWSA). This initiative organizes weekend sessions with children from 5th to 8th standard, where the children themselves build projects related to science. This gives them an opportunity to explore science practically, develop a scientific temper and also develop logical thinking. Some of the projects that children built are shown in the accompanying box.

TECHSHIKSHA PROJECTS	
Build Newton's F1 racing car.	Learn about Newton's laws.
Build a potential energy car.	Learn about potential and kinetic energy.
Build a Da Vinci catapult.	Learn about levers and classes of levers.
Build a hydraulic arm.	Learn about Pascal's laws.
Build a CAM mechanism toy.	Learn about machines.
Build a Curiosity Mars Rover.	Learn about NASA's expedition.
Build gear based toys.	Learn about types of gears.
Have fun making levitating pencil.	
Telegraph.	
Simple DC motor.	
Electric bell.	
Build a glider.	Learn about aeromodelling.
Build a balloon helicopter.	Learn about how helicopters fly.
Build a parachute.	Learn about forces acting on a flying object.
Build Galileo's telescope.	Have fun observing the sky.

According to TechShiksha, education is not about getting information but also developing the potential to analyse this information. This analysis can be achieved through a problem solving approach and activity based learning. TechShiksha started its research on how science can be made more interesting through activity based learning and problem solving approach.

When we do something, all our senses concentrate towards a single task. Therefore, it helps us in increased attention, greater understanding and better analysis. Research also shows that doing something independently makes us think logically and take decisions at every step. Imagine that you are building a clay toy. You will think twice while moulding the toy. To verify this, we designed a very simple experiment. We organized an activity with six groups each comprising of two children in the age group of 10 - 12 years, who did not know anything about the centre of gravity. We gave them the task of building a castle using playing cards. Some of the playing cards given to them were made of hard and heavier paper, while the others were normal cards. To our surprise, every group placed the heavier cardboard cards at the lower layer of the castle. This showed that children, although unaware of the theoretical knowledge, exercised their logic, aptitude and reasoning at every step of the activity. They made decisions at every step and built their castle.

TechShiksha Sunday Science Club has received a very warm response. Its innovative projects, interesting sessions and workshops have excited children and developed in them a lot of interest in Science subjects. It has organized interesting sessions on Rocket Science, Robotics, Wireless Robots, Hot Air Balloons, Da Vinci Machines, Steam Engine, Motors, Generators, Telescopes, etc. TechShiksha is also going to organise an Electronics Club where children will learn about different electronics components, and build circuits. The idea is to create a Maker's revolution. Technology is moving very fast. We should not only be able to understand new technology but should also be able to play with it and apply it for a better cause. This is how we can create more inventors and makers.

We have lots of makers in and around our society. Their enthusiasm, interest, knowledge, and passion to build, should be channelized for the betterment of society. This would help many inventors, and lead to many new inventions. In order to support this, TechShiksha is working on a very new concept called TechShiksha MakerShala, which would be a Lab and Workshop setup that could be used by any Science enthusiast in the city who wants to build something. This would also provide a great space to connect with like minded people and start collaborative science and technology projects in the future.

TechShiksha - in collaboration with IWSA, has also made "Science Kits" which you can buy or gift to your friends. For details, please visit our website [www.techshiksha.com].

Let us all work together to nurture a child's curiosity into scientific exploration, and help develop 'out of the box' thinking.

Amit Modi
Founder and CEO of TechShiksha
web.techshiksha@gmail.com

SCIENCE ACADEMIES' REFRESHER COURSE ON FOUNDATION OF PHYSICS

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Organized by
Indian Women Scientists' Association, Mumbai

Please note the EXTENDED last date for APPLICATION

The year 2014 has been declared as the **International Year of Crystallography** (**IYCr2014**) by the United Nations. To celebrate this event, the Indian Women Scientists' Association (IWSA) at Vashi, Navi Mumbai, is organizing a **Refresher Course** for college level Physics Teachers, sponsored by the three national science academies of the country.

The two week Course would cover some of the interesting topics in this area as well as other topical subjects relevant to graduate and post graduate courses, suc h as: Electricity and Magnetism, Thermodynamics and Materials Science, Lasers and Optics, Plasma Physics, Nanoscience and Technology and Physics Teaching. Experiments are also planned on some of the topics. An excellent pool of resource persons for lectures and experiments have been drawn from the UM-DAE Centre for Excellence in Basic Sciences (CBS), University of Mumbai, Bhabha Atomic Research Centre (BARC), and Homi Bhabha Centre for Science Education (HBCSE). The Course Director is Dr S. Kailas (CBS and RRF & Former Director, Physics Group, BARC).The Course is scheduled prior to the Indian Science Congress which would be held at University of Mumbai. According to the UGC Notification (No.F.3-1/2009 dated 30 July 2010) teachers attending Refresher Courses of two-week duration are entitled to be considered for promotion.

Applications are invited from teachers with experience in teaching undergraduate and post-graduate courses in Physics. Teachers who wish to participate in the Refresher Course may apply through proper channel with the following details: name, date of birth, gender, e-mail, official and residential addresses, telephone numbers, academic qualifications, courses taught, affiliation, positions held and tenure. It is also essential to submit a brief statement (between 250 and 500 words) as to why they think the Course will help to improve their classroom teaching of Physics. **Applications should be submitted ONLINE by clicking the following link :**

http://web-japps.ias.ac.in:8080/Refreshcourse/RCFP.jsp

A print copy of the application must also be sent by speed post forwarded by the head of the institution. It shall reach the Course Coordinator before 20th SEPTEMBER, 2014. Selected candidates will be informed by **7th OCTOBER, 2014.** Outstation candidates will be provided local hospitality and round trip bus/train (three- tier AC) fare by the shortest route.

Course Director: Dr S. Kailas , Senior Scientist, DAE-Centre for Excellence in Basic Sciences, Mumbai
Course Coordinator: Dr Lalitha Dhareshwar, Raja Ramanna Fellow, BARC, Mobile No.: 09324960210
Course Secretary: Dr. Devaki Ramanathan Mobile No.:9867373859.

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION

Tata Institute of Fundamental Research

V.N. Purav Marg, Mankhurd , Mumbai 400 088.

A Profile

Homi Bhabha Centre for Science Education is a National Centre of the Tata Institute of Fundamental Research devoted to science, technology and mathematics education. The broad goals of the Centre are to improve the quality of science and mathematics education from the school to undergraduate college stages of education. The Centre carries out a wide range of activities towards its goals.

Research in Science, Technology & Mathematics Education

* Ph.D. programme in Science Education: Includes pre-Ph.D. Courses;
* Conference epiSTEME: series of biennial international conferences held since 2004.

Curriculum, Laboratory and Materials Development

* Innovative curricular and co-curricular materials and laboratories in school science and mathematics informed by research and field experience of the Centre;
* Contributions to policy and curricular effort at State and National level;
* Educational resources in the print and electronic media, and in English, Hindi and Marathi.

Teacher Orientation and Science Popularisation

Teacher development programs aim to enhance content and pedagogical techniques, introduce inquiry and experimentation, and relate science and mathematics to life. Exhibitions on '*History of Science'* and '*Gender and Science'* and its portable laboratory "Yes you can do it!" attract a large number of visitors every year.

Olympiads

HBCSE is the nodal Centre of the country for Olympiads in mathematics, physics, chemistry, biology, astronomy and junior science. The programme involves several stages of selection and training culminating in student teams contesting in International Olympiads in these subjects. Special Olympiad laboratories in physics, chemistry and biology have been developed for the purpose. HBCSE hosted the International Olympiads in Chemistry (2001), Astronomy (2006), Biology (2008), Junior Science (2013) and 2010 Asian Science Camp. HBCSE will host the International Physics Olympiad at Mumbai in 2015, where 90 countries are expected to participate.

National Initiative on Undergraduate Science (NIUS)

A natural sequel to the Olympiad programme at the Centre, the program mobilizes some of the best scientists and teachers from the country to nurture undergraduate students for research careers in the sciences.

Visiting Positions

The Centre offers visiting positions of varying durations to practising teachers and researchers for engaging in R&D in science, technology and mathematics **education**.

For more details visit our website: www.hbcse.tifr.res.in

Activities of Kalpakkam Branch

Dr. Kalavati, Scientist, Material Science Group, presenting the data.

Smt. T. Jayanthi, Kalpakkam Branch Convener, offering memento to Dr. Kalavati.

Smt. Jemimah Ebenezer Secretary, presenting the report of the activities of IWSA-Kalpakkam to the members.

Happy kids of the IWSA run Indirabai Padhye Nursery School

BOOK POST

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