Teaching Efficiency
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HIGHER EDUCATION PERSPECTIVES FOR AN EXCITING EDUCATIONAL EXPERIENCE – PART III: AN INDIAN CONTEXT

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Abstract. In a modern industrialized society science education plays an important role in the progress of the country and protection of the environment. The quality of higher education in India needs substantial improvement through vision and proper planning. It is necessary to introduce a series of major educational initiatives that have immense scope for value addition and enhancing learners' involvement in the educational activities to leave a lasting impression. An attempt has been made to indicate appropriate changes in the higher education system and arouse the interest of the young aspirants in science, in their educational journey. The current paper highlights the salient features of science higher education perspectives in an Indian context. The implementation of the modern educational practices will open up a new window to explore science in its true sense and perspective. The innovative educational schemes for development of science higher education and achieving excellence go a long way in making learning an enjoyable, exciting and memorable experience.

Keywords: E-resource, teaching tools, enhanced understanding, active participation, vibrant curriculum, educational significance, contemporary practices

Background information - topic of interest

The lack of proper higher education perspective can cause effective personal functional problems and higher education in science is, thus, of paramount importance to the quality of public life by proper mental make-up. The advancements in sciences are phenomenal and adopting them suitably in science education is a major challenge that requires more careful planning and precise thinking about educational processes and learning outcomes. We have to address the key issues related to science education, research in science education and the great bearing it has on social fabric in passing theoretical knowledge, practical skills and social values from one generation to the next. There is a need to understand that a knowledge society can be created on the basis of progressive education and we have to face the challenges of the current global practices, trends and needs as citizens of a fast-changing society. India has tremendous potential as an emerging nation to grow through an integrated education development plan, favorable

higher educational policy framework, speedy execution of positive policy changes, and establishment of better educational infrastructure, ethical work practices, environmental and social responsibilities and use of technology to transform education landscape. These basic aspects have the potential to not only change India's research profile radically but also to show its presence in the global educational space. At a national level, India has made a multitude of positive contributions in several sectors that involved hard work, dedication and commitment, despite the complexities of Indian society. The focus now should be to improve the higher education sector by spreading effective science education that has a significant influence on the progression of domestic development within the larger social and environmental sustainability context. It is important to put in place an educational system with inbuilt checks and balances and develop selected cities as educational hubs of India to become the epicenters of activity. Such initiatives will contribute significantly toward improvement in science education from a larger perspective and trigger a positive thought pattern to gain considerable momentum on the path of growth. It would be meaningful to think of the higher education perspective to serve as a catalyst to cause the change to connect the learner to eventually establish world peace more effectively (Fig. 1). The issues of quality of higher education need to

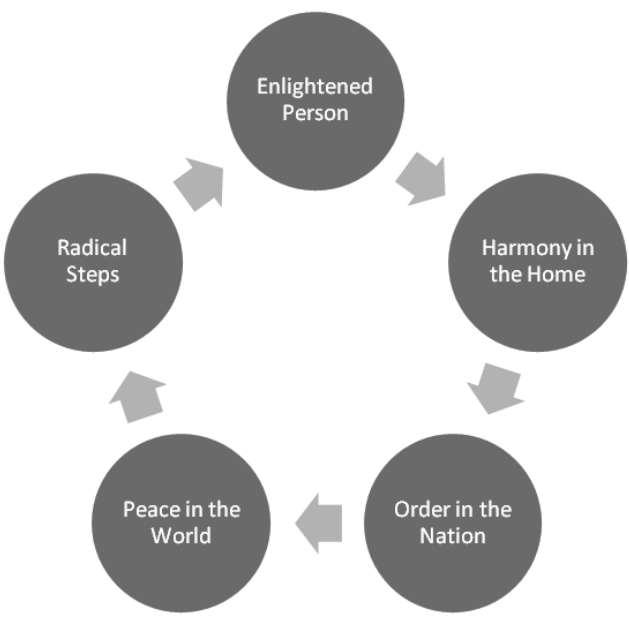

Fig. 1. Educational change effects from a radical idea to establish world peace

be considered urgently to figure among the best in the world and a radical transformation of modern higher education system has become necessary from a global perspective.

The science subjects are often seen as difficult mainly because of the way students learn the subject rather than the intrinsic nature of the science. We have to systematically inculcate positive attitude towards society in an individual's mind and encourage them to learn the subject beyond examination-centric view leading to the whole learning process and a simple shift in thinking attitude. Research has shown that we connect the next stage of learning to previous knowledge, experience and attitudes (Abraham, 2008; Reid, 2009) (Fig. 2). The essential point to note is that the limited attention span of current generation needs the almost instantaneous brand new narratives that help rekindle academic interest, to step out of their little cocoon and change attitudes towards science. The adoption of creative education using different high impact techniques is certainly better than the conventional top-down learning process using the petrol-pump concept. It is important to include contemporary course content, extrapolation of science to real life problems, proper practical component, strong industry-academia relationship, interdisciplinary subjects as electives, availability of online databases (Scopus, SciFinder and Science Direct), better exposure to research, to make the learning process interesting and enjoyable. The science education policy reforms plays a big role in advancing global environmental protection and sustainable development in addition to adopting green chemistry principles in industrial processes. More importantly, the effectiveness with which the new policy is implemented and translated into public goods that create social impacts is a primary concern. There should be strong system of transparency and social audit with a greater focus on policy outcomes and accountability outward to society. Key concerns in Indian higher education system in the broader context of the world around us include the adoption of the semester system, operational difficulties and major policy changes. We have to work towards educational change to provide a comfortable work environment and become responsible and truly engaged citizens to contribute to a progressive science graph and growth profile of India. Only an educational revolution can create a knowledge society by rapid metamorphosis and there is a need to empower active learners with domain knowledge, management and leadership skills, soft skills, stress management and industry relevant competencies, considering India's vast younger population base. The number of people in the working age category (21-59 years) forms 60 % of the country's population and to make best use of the opportunity it should facilitate higher education and skill development for those who need it. Hence, refocusing our efforts on science higher education in India would make a big impact to realize her dreams and steer the youngsters in the right direction with required energy and enthusiasm (Fig. 3). It makes sense to create high impact learning experiences by blending of technology and classroom teaching, learning style modifications and constant exposure to new ideas with the final output.

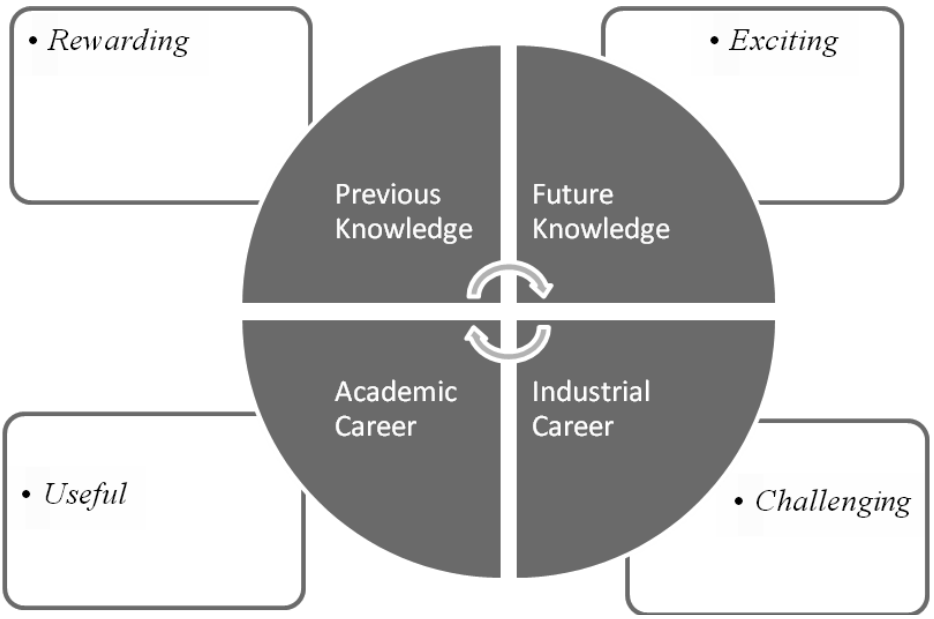

Fig. 2 The learning to pursue careers in the sciences and the connection to previous learning

Beyond the ordinary - power pack

There is a growing need for excitement in science education and a catch up with higher disciplinary knowledge, scientific wisdom and the complexities on a world scale by adopting a multi-pronged strategy. The exchange of novel ideas and experiences on education continue to influence people at personal and public levels initiating individual and collective self-expression. Some drastic steps are required to be taken on an emergent basis to ensure faith of people in higher education and induce a significant shift in teaching paradigm. The innovative and progressive measures may be related to realizing the gravity of the problem, enhancing the intrinsic value of the higher education and monitoring their final impact as a result of proper deliberations and taking stakeholders into confidence to bring marked improvement in personal and social lives. The learning of science subjects becomes more meaningful when the learner realizes their importance in many real-life situations. In view of the remarkable change in the attitudes of our youth, it is necessary to adopt new educational techniques and innovative teaching methods that help in learning science in an interesting manner. The undergraduate, postgraduate and PhD teaching programs in various disciplines for development of core skills and

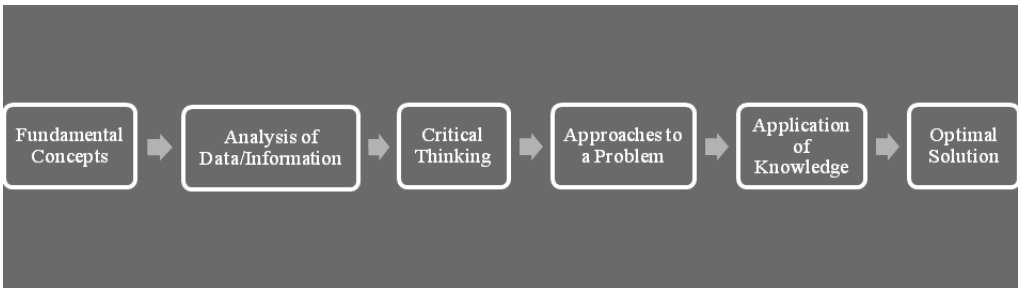

Fig. 3 Educational process that opens up mental faculties to take us from initial level of understanding to a deeper understanding of a subject leading to problem solving

the practice of teaching have to undergo radical change and teachers are expected to express explicitly the scientific ideas rightly to the current generation making them aware of responsibilities. In the Process Oriented Guided Inquiry Learning (POGIL) approach, the teacher is the facilitator who helps learners to explore and analyze data, invent an underlying concept and then apply their new knowledge to problem solving or new situations.[1)] Another effective strategy is the concept mapping technique where the central concept is mapped with network of interrelated important concepts to make the subject more relevant in the current global scenario and socio-scientific context. This will enable the learners to make interdisciplinary connections and acquire the necessary depth of knowledge in the subjects. Educating students with different but interrelated combination of courses should be visible through content as well as actions and reflect in learning outcomes.

Other classroom methods to enhance the experience include seminars, demonstrations, case study, role play or problem solving, computer assisted learning, audio-visual media show or experience theatre and student projects. The art of educating using V diagram correlates the topic taught in theory and laboratory experiment (Gowin & Alvarez, 2005). For instance, classroom teaching of potentiometric titration can be connected to experimental determination using V diagram leading to better understanding of the subject matter. Computational chemistry may play a pivotal role as a teaching tool in chemical education and as a research tool in different branches of chemistry. The important point here is that the present technology savvy generation absorbs the subject more effectively. The interactive way of instruction method, experiential learning and project based learning also should be emphasized and incorporated as an integral part of our education system. We still have a long way to go in terms of having high quality teachers who join the profession by choice, quality learners who are willing, optimistic

and enthusiastic, state of the art infrastructure to impart appropriate practical training required in industry and the proper academic environment in higher educational institutions. The last decade has seen the introduction of several useful innovations aimed at executing educational processes and an increase in the education-oriented papers and articles. Educational research studies have been published in several educational science journals providing different teaching ideas and different learner expectations. These articles help us to adopt pragmatic approach with proper educational outcomes and to arrive at facilitators' and learners' unique perspectives. Now there are more than sixty science/engineering/technology oriented educational journals and these assist in exploring the creative range inspired from inherent vibrancy, richness and depth of scientific acumen (Thimmappa, 2013a). The 23rd IUPAC International Conference on Chemistry Education will be held in Toronto, Canada in July 13-18 2014 with the theme "Developing Learning Communities in the Chemical Sciences".[2)]

In our previous papers we have covered in detail, power point presentations, open source articles, lateral learning materials, supplementary materials, problem based learning, multimedia solutions, miscellaneous methods, human resource development, learning beyond boundaries, inspiration by books, visual education, laboratory and life, policy matters, essential elements and miscellaneous perspectives (Thimmappa, 2013a; 2013b). In this paper, we have tried to capture some perspectives of higher education and find partial solutions to fundamental educational questions. The main focus of this paper is on worthwhile educational tasks from an evolutionary perspective to direct the dynamic energy of younger generation in the right direction while protecting the environment. It is about how to improve and integrate science educational aspects and protection of the environment to a great extent. This is not a comprehensive review and the target reader interested in serious science reading is directed to detailed literature to proceed gradually. We have outlined several perspectives and reforms in the higher educational sector under specific sections- background information, beyond the ordinary, content creation and contemporary concerns. The ideas expressed in this paper were developed as a result of teaching for many years, experience in listening to the common complaints from faculty and research scholars and educational research outputs of people. The purpose of the paper is to change the perception of the general reader through opening of eyes and increasing the level of awareness to have higher confidence levels. It is also aimed at academicians involved in improving higher education conditions in India to raise the bar. This article explores the possibilities, values and ideals, philosophy and operational methods of how higher education must change to make a big difference in learning outcomes. The paper emphasizes the role of narrative in provoking debate among the academic audience with a fresh perspective. The essence of the paper reflects the current condition of higher education in India and it sends out a very strong signal

to the academic community on the need for urgent serious introspection and a range of solutions for educational reforms. It also highlights the positive effects of higher education that can make a big difference in a person's life and propagates the importance of science education across the nation. The simple steps can power up teaching-learning interactions and can have even more positive outcomes eventually leading to a cutting edge scientific solution. The intention is to bring about a big difference in perspective to contribute to developing a truly vibrant higher educational system and new developments in different fields of basic and applied science. It is essential to support the younger generation across India to join global initiatives towards advancement for employers, entrepreneurs, executives and employees by pursuing higher education in science, engineering, medical and agricultural fields. The scope of the article is limited to the quality enhancement in science education, faculty development and educational policies that has immense educational significance which is in the larger interests of a healthy society.

Content creation - close-up picture

Educational transformation is essentially about exploring processes and programs with a global perspective and taking progressive steps to ensure standard educational practices, adopting cutting-edge technology in the field of educational enhancements, preventing examination related malpractices and maintaining educationally motivated social values. Research in science education at higher level is required and this should be supplemented by seed funding and continuous support to promote insight-oriented education. Constantly improving quality through innovative vision, curriculum development, laboratory development and human resource development are appropriate steps in the right direction. It is necessary to enhance the academic rating of our higher educational institutions at national and international levels by educational processes, services and optimal use of resources. One way to offer real learning is through the live science engagement by designing innovative and impactful ways of meaningful teaching-learning interactions in educational institutions of higher learning. It is important to improve networking among higher educational institutions in the country and establish the required academic quality through constant interactions among them. It is also important to mentor and train the next generation of teachers, teaching researchers and researchers who can bring about transformation and education evolution through transformation via intense learning experiences (Fig. 4). It is the most important necessary preventive measure to avoid a future shortage of quality science teachers, domain education specialists, scientists and industrial workforce. As a great amount of training, skill and discipline is required, interactive lectures, workshops on educational themes, panel discussions, conferences on science education involving oral and poster presentations would provide a suitable platform for fruitful interactions. Similarly, the use of

e-materials and co-operative learning, educational fairs and tours, 'Science on Wheels' for science popularization (trains and mobile vans), PPT/PDF library, interactive science presentations, awareness camps and training, science cartoons (scientoons), use of e-resources (data bases, subject gateways, courseware), refresher courses, physical and computer models, science charts, supplementary display materials, worked examples, exposure visits, inspiring talks, awareness speeches and practice problems/sessions are certainly helpful to gain more knowledge.[3)] The electronic presentation of lectures must contain simple diagrams, relevant images in addition to optimum material coverage and slow mode of delivery to be effective. Progressive disclosure of the underlying concepts and proper explanation and elaboration should eventually lead the learners to treasure trove of constant inspiration and scientific knowledge. This is essential to stimulate their interest and advance their understanding, without overloading them. One could use a presentation programs such as Microsoft PowerPoint, Apple Keynote, Prezi, OpenOffice.org Impress to generate presentation content. Using simple but powerful anecdotes and parables from all over the world to demonstrate certain scientific concepts, principles, specific functional aspects, scientific evidences, comments and usefulness facilitates personal or professional development with an enthusiastic, nurturing and positive attitude. The exposure of students to scientific equipment expo displaying comprehensive range of modern instruments for preparation, characterization, testing, processing and measurements enables learners to broaden their horizon. The ball & stick models, computational models, space filled models of chemical structures help the learner to visualize the 3D shapes of molecules and provide a very accurate insight. The science can be taught in tune with Nature, though our intellectual understanding of nature is weak. It can be taught at descriptive, submicroscopic and symbolic levels without losing the larger perspective that would have direct and indirect impact on the learners (Fig. 5). It is better to give the learner an exposure to both constructive applications of nuclear reactions as power source as well as destructive applications of nuclear bomb, missiles and cluster bombs, chemical weapons of mass destruction. It makes educational sense to emphasize conceptual understanding at a deeper and more reflective level to have clarity of perception along with nobility of thought, interdisciplinary perspectives and long-term prospects.

The learner centered approach involving collaborative and cooperative learning, peer interactions and team work often lead to better understanding of the subject matter to scale the steep learning curve. The active learning modules, for example, using web based tutorial material, 3D molecular models in teaching science (e.g., 3D structures in stereochemistry), multimedia learning tools, computer assisted learning, student seminars, group discussions and debates, case studies, quiz program, games and puzzles, role playing, innovative science projects, problem based learning methods make the

learning more efficient. These active learning techniques involve linking of knowledge to special problems, integration of concepts, principles and reasons, and interpretation of factual information to make a positive impact on the learning process. Open educational resources like educational videos, online lectures, open access textbooks and collaborative learning are available freely on the internet for those interested in learning.[4)] Science and industry museums housing working models in different branches of science, specialized museums such as anatomy, ecology, oceanography, seismology, and aerospace engineering museum and science tableaus based on different themes related to satellites, sericulture, mining and agriculture as part of science fairs also contribute to improved retention and recall and higher confidence levels. It is in the interest of the active learners to pursue ambition, sharpen intellect and practice innovation to cause

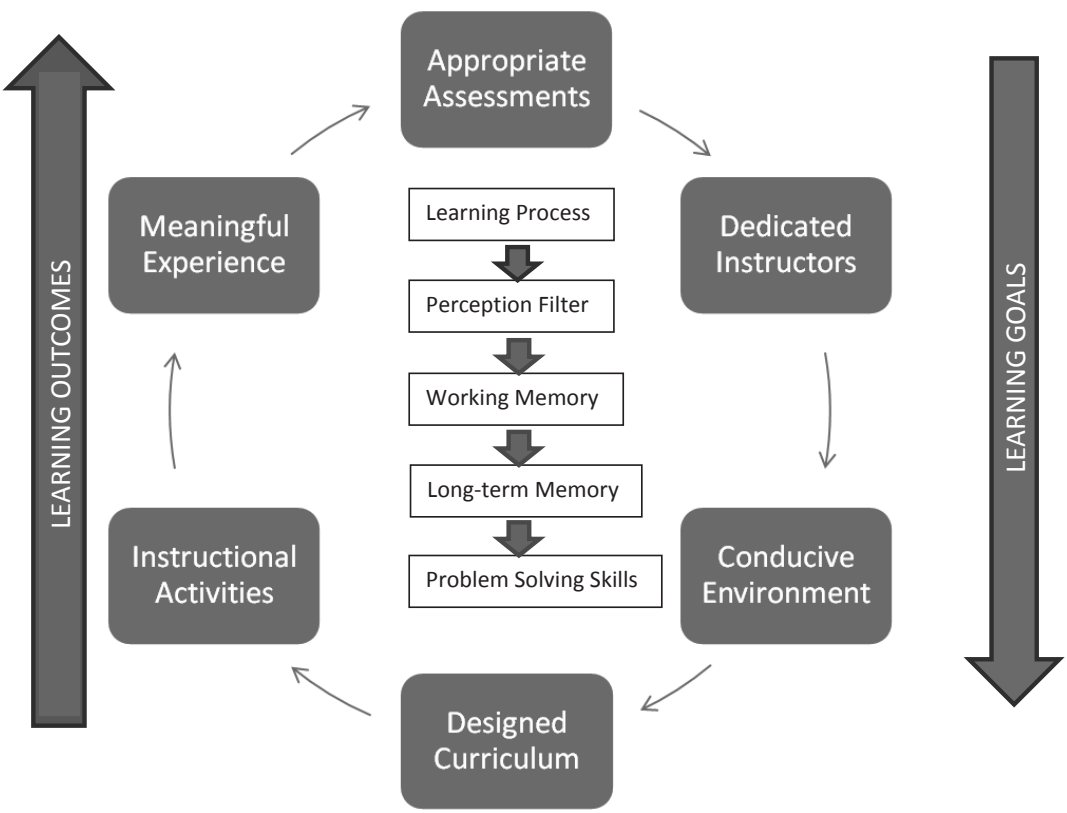

Fig. 4. A perspective diagram showing the factors influencing successful learning outcomes

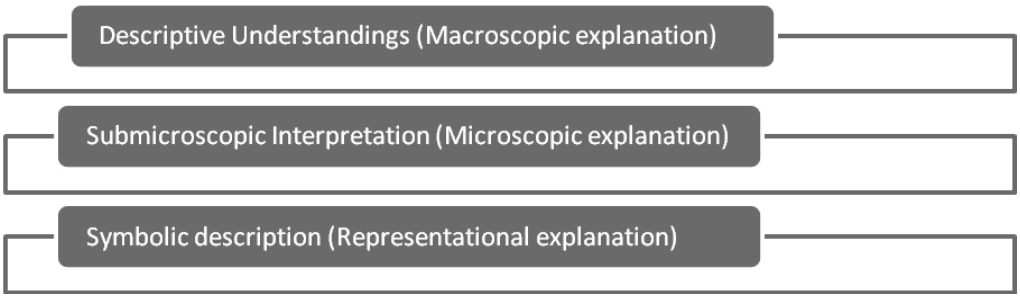

Fig. 5 Effective science communication at different levels for learners' intellectual development

changes in perception, develop innovative mindset and project management. It is also important to understand that the ability to comprehend the subject matter is one thing while the ability to express the ideas on paper is quite another. In addition to competence in their specialized field of work the students have to learn ethics in publishing, academic work and civil society at large. The perspective that artworks, drawings, paintings and photographs speak louder than words retain the vein of scientific objectivity and enquiry. It has the great potential to convey concepts with a potency and higher impact than expression by words and hence helps to broaden knowledge and deepen understanding. This will eventually lead to appropriate solutions to contemporary scientific problems of different branches and real-life problems with a human interest angle.

It is desirable to include science education (lectures and seminars) as a significant part of international science fairs. The young talent should be nurtured through Science Olympiad Activities (SOA) and Science Project Exhibition (SPE) initiatives incorporating teaching tools, science working models, innovative demonstrations, games and puzzles relevant to science. Once they study certain basic coursework and the advanced courses in the relevant subject specializations, they should be exposed to research methodologies by a mentor. Then they will be better equipped to take up a research project and direct their energy to carry out research in various current topics in sciences (Fig. 6). Innovation in Science Pursuit for Inspired Research (INSPIRE) is a national program implemented by department of science and technology to study science and pursue career in research on basic and applied sciences.[5)] It is also important to institute an award for professional accomplishments (authors, reviewers, reporters) and creation of education research oriented jobs, establishment of training facilities that match the global standards to pursue professional and creative interests. It is imperative for the academies to honor persons in appreciation of their distinguished educational work and achievement or outstanding social service. The Indian media should highlight the scientific advancements, break-

through research outputs, outstanding products and higher educational reforms through television, radio stations and print media. Recruitment of dynamic young professionals from outside the state or country and discouraging inbreeding is certainly a step in the right direction. The adoption of interdisciplinary approach and perspectives in teaching and research i.e., nanoscience, biological mathematics, research methodology and/or cognitive science could lead to the development of effective problem solving skills. We see in India a number of instances where compartmental attitude is reflected by the individual departments or faculty members is detrimental to research. Starting a smaller scientific circle to share our thoughts, experiences, memories, resources, information and knowledge brings back multifold benefits to the scientific community. The corporates should be actively involved in implementing several useful educational core projects and integrated technology solutions as a part of Corporate Social Responsibility (CSR). This collaborative process should be an integral part of society and massive public-private partnership (PPP) projects should be initiated. A typical example is the Mission-10X initiative by Wipro as a part of learning enhancement training to increase the employability of engineering graduates in this diverse, multicultural, multi-religious and multilingual country.[6] The government should encourage them to continue with community service by simplifying the rules. As part of classroom dynamics the use of clickers to foster discussion and keep every student actively engaged in class is becoming popular (Martyn, 2007). If an instructor poses questions in the middle of the lecture asking the students to click their answers, the system immediately displays a graphic representation of their answers on the screen. The right messages via internet can motivate and guide the youth encouraging them to actively participate in developmental activities or processes of the nation and eventually become global citizens with universal appeal. They should command their own space in different fields of human activities in terms of international standing on a global scale and further intense community exploration of the infinite potential of the human spirit by developing a broad range of cognitive skills.

Contemporary concerns - solution in sight

The quantum of information available on websites is increasing at a rapid rate but its effective use in meaningful learning by the young learner to become a storehouse of knowledge is often lacking. They may have the theoretical knowledge but may not know how to apply this knowledge, or how to communicate effectively. It is in the interest of the institute to post good resource materials developed in house on their intranet portals, with periodic revision to update the material. It is necessary to remove the inherent drawbacks of educational institutes by recruiting honest people and maintaining a high level of transparency and accountability. The basic goal here is to cleanse the society by taking all appropriate steps and to develop rational thinking. This could also be instilled

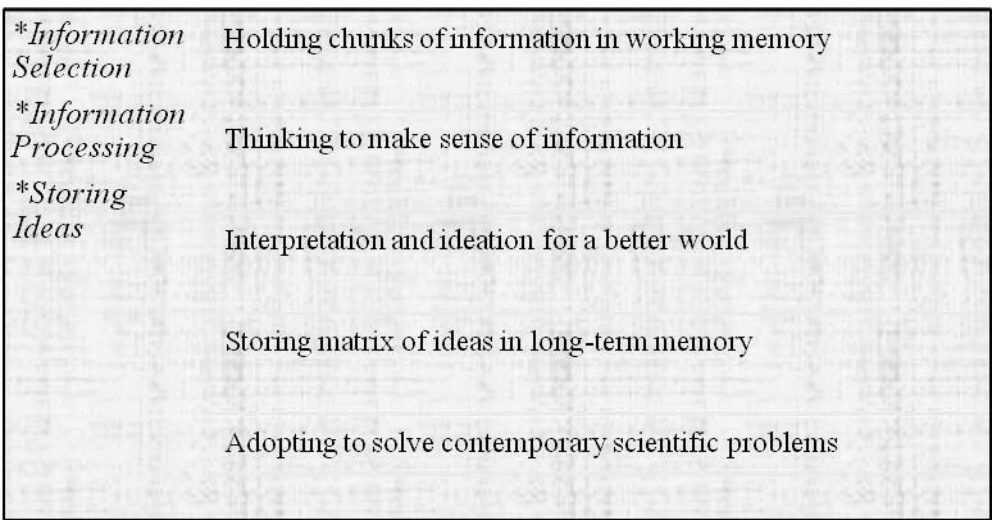

Fig. 6 Diagrammatic representation of information processing using working and long-term memories

by including corruption courses in the higher educational curriculum. The academic institutions should take the path of long-term prosperity and introduce 'Corruption and its Control', 'Research Methodology' 'English language and communication skills' as compulsory courses in addition to compulsory core courses in programs, and certain interdisciplinary courses such as 'Green Chemistry', 'Chemical Biology' as open electives in an effort towards vibrant curriculum. The responsible behavior training and awareness generating programs across the nation should be initiated to address corruption in all forms, empowering people to take forward the dream of a corruption free India. The existence of that attribute of a good teacher could have a tremendous impact on the practice of education and learners to become active participants involving in schemes in building a stronger workforce for sustainable future. We have to ensure that in a multiple author paper each author has substantial intellectual contribution to the papers' content- conception of the work, analysis or interpretation of data, drafting and critical revision and responsible for accuracy and integrity of any part of the work. The introduction of workshops with different specific themes, based on current scientific issues every year or conducting science model competitions is expected to get good response from many young enthusiastic learners. Conducting national workshops on perspectives on science education and their relevance to technology[7] and national symposium on chemistry and humanity[8] in different locations within the country as well as setting up

of Foundation for Educational Research, Advocacy and Learning (FEARL) could act as catalysts in the educational transformation, catalyzing growth and environment. It should be involved in promoting science and a research culture among each of the emerging generation. Participation in such a forum will help gain distinct knowledge about the current state of affairs, share experts' perspectives and provide the edge to look at the roadmap of science development. The establishment of a National Level Academy of Science Education (NLASE), a State Level Higher Education Council (SLHEC) and a University Level Academic Council (ULAC) for directing and preparing a road map for higher educational institutions with short-term and long-term perspectives is essential. The setting up of a Higher Education Task Force (HETF) with proper legislative power and executive action is absolutely essential. It can focus on two key aspects of spreading the necessary awareness about the importance of higher education. It is the first step towards real transformation and it can encourage people to learn science on a large scale, creating winds of change and a sense of national interest. This body could concentrate its effort on changes in educational practices, develop an action plan, restructuring science courses, enhance industry interactions and establish a new educational discipline and ecological thinking. It is also useful to conserve national flavor of the country in certain bioscience fields while adding color to the world science literature in this era of increased inclination of people towards globalization.

It is important to note that initiatives to establish research units on innovative projects, setting up of different schools of Physics, Chemistry, Engineering, Mathematics, Management in partnership with central universities and leading companies help promote further growth. We need at present urgent attention to policy changes that can encourage the extent of higher education benefits to the younger people in the near future to make landmark achievements. The advantage of this aggressive approach is that we have the ability to become successful and the learners have to engage a little bit more seriously and give enough attention to studies or classroom lectures. It is reasonable to expect the positive effects of better reading habits on our mental health and energy as it will stimulate the mind in subtle and unique ways and leave an indelible imprint on our mind. The essential features of the semester system with continuous assessment, grading and credit systems, substantially reduced course content and enhanced learner-teacher interactions are beneficial when compared with the traditional annual system practiced in some universities in India. It is better to introduce the semester system in the higher education sector throughout the country and make the learners actively take part in educational activities. As a part of the initiatives for educating the young people and creating awareness for higher education in science, the science reading practice by the parents and teachers would have a positive impact on the learners as they learn by example and will be encouraged to adopt and nurture the habit of reading science books.

The universities and institutes should offer a warm reading ambience, ample seating arrangements and attractive landscaping to create a right atmosphere to grasp the subject. The optimal use of government and private healthcare and engineering infrastructure for science education should be encouraged. The scientific evaluation of the impact of higher education on learning outcomes in India should be carried out by an independent agency with sufficient background in the field. Though the statistical information reported in several studies may not reflect the actual status because of poor documentation and reporting it provides a rough estimate. The reasons for poor performance of research scholars in areas of poor mental activity, stress and unhealthy work culture should be analyzed and addressed based on guidance and balanced approach. The government must actively try to refine our higher education system and promote certain less popular branches of science as they can act as vehicles of new knowledge. The reputation of higher education as a means to liberation is growing stronger as concerns about safety, sustainability, scalability and pollution, healthcare and spiritual development have become key issues in the recent past. The creation of an Indian Special Interest Group (ISIG) for accreditation scheme to ensure standards in science education, and Science and Technology Parks of India (STPI) can serve as platforms for shifting paradigms, for changing rules or for looking at things differently. The establishment of a national level Center for Science Educational Counseling (CSEC) and setting up of an Educational Content Complaint Council (ECCC) or Science Standard Council of India (SSCI) to look into the various aspects of the educationally objectionable materials and to get a more accurate picture of ground realities at the organizational level is also essential. These bodies can have a chairperson and a maximum of ten members across the country and the stakeholders can report objectionable materials on their websites. Immediate corrective action must follow. Thus the higher education sector provides an interesting playground for the development of a wide range of new courses, programs, products and processes, and continues its upward trajectory to face the various challenges ahead.

It is essential to create increased awareness about long-term prospects of science, motivate and engage the learners in the stream and infuse scientific temper in them (Reid, 2000; Johnstone, 1999; Hoffstein & Lunetta, 1982; 2004). If many teachers contribute their time, energy and resources voluntarily we can create a wave of transformation to take Indian higher education to the next level. The potential of the small seed to become a big tree through transformation is realized by providing a suitable environment. The active engagement of the learner in the learning process leads to effective learning and the inclusion of some current popular topics in the teaching content, such as nanoscience, photochemistry and light emitting diode (LED) display systems with their importance in a wide range of actual applications, is significant as it contributes to the students enjoy learning. The use of green chemistry in industrial processes, use of ionic liquids/water/

supercritical fluids, and waste minimization should be a part of the science teaching and learning. Because of the increased sensitivity to environmental concerns in the recent past, it is important to develop the ability to identify, analyze and solve practical problems to protect our only planet. In this context, a life cycle analysis of finished products from creation till degradation after usage should be a part of learning process. In addition to conforming to world-class environmental standards, it is the responsibility of each educated citizen to participate in conserving the biodiversity and precious resources of the planet. Spreading awareness about ecologically sustainable development and preventive techniques will definitely play an important role in controlling the widespread environmental degradation. Conducting eco-awareness workshops and field demonstration of environment friendly practices such as rainwater harvesting, and taking print out of e-mails only when necessary, will eventually contribute to better sustainable practices contributing less to pollution with superior ecofriendly solutions. It makes particular sense to set up water recycling plants in cities and towns and encourage individuals and industry to use recycled water to non-potable purposes, as it is a unique asset gifted by nature. The advantages of changing conventional processes and adopting green ones to develop green industry in place to make less energy-intensive and more ecofriendly are numerous. The inclusion of application-led vocational courses in applied science or special courses/specialized subjects for the highly gifted learners as an integral part of the program helps in proper development of talent. The higher educational institution should reach out to its learners through unique educational programs with topical courses in their curriculum. The EDUSAT program, a satellite based distance learning program on different science topics also provides insight through audiovisual aids. Conducting educational meetings and workshops with parents and alumni helps to provide a platform to education enthusiasts across the country to plan and organize educational movements to create opportunities for better education. It is a struggle to systematically unite people to fight for higher educational transformation and to retain scientific relevance. The modern web platform helps in facilitating conversations and sharing data in the public domain. The social activists should take up the educational issues that have the long-term significance and launch agitations. The nationwide public movement is expected to trigger major educational reforms by creating an educational wave in the country. They must organize and manage all their strength to be able to confidently move towards concrete higher educational goals in our long science journey and explore more possibilities to move concerned persons immensely towards realistic projections. The creation of better opportunities is one of the key objectives of educational change and opens the doors to an enlightened life to address various social and healthcare challenges that ensures very high quality life for the citizens. We have to work out some educational packages to attract students from across the world and extend bilateral relationships with other

countries. It is better to set up a working group/task force to implement educational reforms immediately and then convene a meeting to discuss the matter.

The celebration of 'World Education Day' every year reminds the educationists to take actions to promote higher education cause to current and future generations. The transformation of India into a major global center of science and technology, emerging as a preferred destination of education in the field remains to be seen. The perspectives presented signal a broad picture of exciting prospects for radical change and rapid growth of India. It is essential to provide people the opportunity to participate in debate on educational reforms, to influence the concerned on internet platforms, and induce certain cooperative educational movements and future growth. In the broad perspective, identifying and addressing the factors that lead to a lack of interest in younger generation is a much more effective way of proactive and optimal management for necessary change. The higher education movement contributing to the growth process should consider all aspects of improvement on the road to educational reforms such as; educational programs and courseware, concrete actions in quality of education, faculty and placement, long-term educational policies, rules and regulations, monitoring of performances, large-scale higher education, educational techniques, well trained and equipped workforce, introduction of new universities, thought leadership, new educational hubs, infrastructure and stat-of-the-art industrial cities. This is indeed a development of significant importance with inputs from parents and teachers, healthy teaching-learning practices and enabling policy framework without losing the whole perspective. All aspects of science higher education require much closer scrutiny to make considerable progress to generate highly skilled workforce.

It is time to begin a new educational journal that captures the current status, and highlights a multitude of factors that retard growth, power of advanced technology and future prospects in educational goals and reforms, educational research and practices and educational content development. It is worthwhile to conduct a survey and record the intricate details of the ordinary and extraordinary experiences of teachers and students in balanced technical reports to complement and supplement the changes in educational activities and to work out the concrete steps starting from sketch to finish. A document with explanation of the intricacies of the higher education world would have a strong impact on the future prospects of educational change that are substantial. In the light of these major concerns, higher education reforms should become the dominant topic of discussion in print and television media. There is a need of a revolution which changes the thinking pattern of the people, policy planners and education experts to have a globalized impact.

The problems faced by the teaching community such as lower salaries, lack of proper working conditions, absence of housing facilities, lack of financial incentives for chil-

dren's education, lack of proper transportation facilities, heavy workload, peer pressure to deliver immediate results, lack of proper healthcare schemes, subtle social pressure and other financial constraints for any constructive educational activities, should be addressed on an urgent basis. Necessary steps must be taken to attract the best talent to the teaching and research profession. Academic and research track record should be the main criteria in the appropriate faculty selection process and greater transparency, greater accountability and greater participation in all educational activities should be ensured. Further training and education should be encouraged on a priority basis. Sincere, passionate and qualified educators with excellent teaching, organizational and time management skills are an asset to educational and research organizations. As a part of the institution building exercise, it is important to train them through Faculty Development Programs (FDP) and in-house orientation programs within an education and technology cells to help shape their professional inclinations and capabilities. It is essential to retain the good faculty and allow sufficient time for them to prove competence in a core area and confidential reports of performance reviews and key performance indicators should be considered for further promotions. Specific faculty selection based on appearance, birth, class, caste, community, creed, gender, race, religion, region and language or the social, financial, political status of the person, and rural and urban divides are detrimental to research/educational progress. The protection and promotion by godfathers in the field of science should not be encouraged at any cost to make significant scientific contribution by adapting strategies and tactics to the specific scientific environment in which we work. The work culture adopted by some people to reap the benefits while skilled work is carried out by others should be strongly discouraged. There are some cases that illustrate how research was carried out earlier in careers spanning many years, but also exposing an objective reality to jump from one bandwagon to another and lack of creativity, innovation, originality and individuality. The numbers of placement opportunities for high capacity talent are limited in Indian organizations. The increased number of people with higher education and employment will add new dynamics to transform personal and professional lives. Tackling educated unemployment and underemployment problems early could dramatically reduce associated short and long-term problems such as behavioral issues. This will change the actual state of things and the current situation and they will become very useful members of mainstream society. Further, some drastic steps on an emergent basis are required to remove the evils of corruption, red-tapism, nepotism, criminal activity, gender bias, selfish motives and favoritism, injustice, adoption of double standards, to facilitate operational requirements of the education system, enhance the intrinsic value of the system and the universal value of life. A coordinated approach and streamlining of the educational processes is necessary to curb these practices and then we will be able to do a much better job of adopting or

sharing best practices. A significantly concentrated proposal with realistic projection and with the necessary ingredients rather than a dilute version would play an important role in creating a remarkable education system. Appropriate regulatory regime has to be developed after examining the various educational issues form techno-legal perspective and to implement higher education related policies so that India does not miss out from an opportunity. It is pertinent to frame and adopt suitable ordinance and laws, bills and acts, rules and regulations to check any misuse of different schemes meant for promotion of higher education in India.

Ahead of time - window to the world

The recent trend in higher education is increasing globalization and science students are migrating to other countries in search of better educational opportunities as the Indian institutes fall behind in international ranking. An organized approach to improve the overall quality of higher education in India is needed to instill confidence in students about institutions where they wish to study. We are on the path of achieving international quality through several educational products, processes and operational performance to reach the position among the top twenty institutions. We have to expand our educational activities while significantly improving quality in the emerging educational scenario and helping them to choose better institutes in the future. It is becoming increasingly evident at the national level that higher educational reform is an important issue to be approached sensibly and top priority should be given to its delivery. The strengths and weaknesses, opportunities and challenges (SWOC) analysis of the various science departments and the institute as whole will help set up future plan of the department/institute for further participative executions. The identification of internal strengths/ weaknesses is helpful in achieving the objectives. The identification of external opportunities/challenges requires strategy to achieve the objectives. This has implications in implementing appropriate pedagogic training in a phased manner, development of professional competency and personality development or expansion of research activities in specialized areas of science. As leading multinational companies (MNCs) are looking for relevant experience in respective fields, encouraging more universities and colleges to offer courses on industry relevant subjects in their educational programs would also stimulate learners' curiosity and help to fulfill their dreams or aspirations. The firms should be encouraged to set up their manufacturing facilities to progress the Indian industry. They have to spend a huge amount per year on manufacturing, research and development activities and high productivity services considering ecofriendly options. A link should be provided between theoretical principles and experimental techniques in a course to help them understand the basic principles of science in an interesting manner. The link between theory and practice helps reinforce lecture topics, better understanding of fundamental concepts,

data analysis and interpretation, understand socio-scientific context of the topic and eventually follow environmentally benign methods.

Science has relevance to daily life and science education incorporates certain core values that transform our life with the security of higher education tag. The qualities of optimism, courage, determination, dedication, discipline, teamwork, leadership and resourcefulness should be inculcated as a part of the higher education. It is also important to sensitize young minds about the basic human values of connectivity and collective responsibility, courtesy, compassion, patriotism, fairness, hygiene and a regard for the rules. The application of scientific concepts and principles as part of curricula make science teaching relevant to the societal situation. This connectivity with social situations and involvement, motivates the learners. The pursuit of excellence should be our source of inspiration and driving force on which a progressive society can be built. In the current scenario one can influence mindsets by choosing best methods and practices after analyzing a sequence of possible methods and their educational impact at the national level. The availability of online education and offline resources including supplemental learning materials enhances the interest of learners. The current industrial practice rather than using the alternative green chemistry practice represent weakness. The industrial and academic placement opportunities encourage the learner to progress in studies. We have to engage the youngsters to attain growth and equip them with life skills which will lead to skill development for our nation. It is a major challenge for Indian educationists to upgrade the slow learners to have a better comprehension of the subject in a class consisting of students of mixed ability including brighter ones. The level of prosperity of a nation is determined by the education and the science and industry leaders of tomorrow are being shaped in our higher educational institutions. It is not only necessary to impart solid information but also ensure effectiveness in learning and high levels of retention. It is desirable to have learners' active participation in extracurricular activities and a transparent mechanism should exist in the institute to control indiscipline among students. The following are the representative aspects of various strengths, weaknesses, opportunities and challenges that are indicators of trends and several aspects may be important for a particular department/institution. We have to match the strengths with opportunities and convert the weaknesses into strengths and this SWOC analysis furnishes the institution with information that helps in the formulation of future plans and their effective implementation in further development of the organization. It's like painting a portrait of a person as a whole, while giving attention to detail without losing the whole perspective. The development project should be considered within the larger perspective of sustainable development. Scholars really interested in the true development of the nation come together to demand meaningful reforms to restore the ideals of higher education; more emphasis on merit in recruitment to faculty positions, academic

freedom, and fair distribution of research project funds as higher education is the major defense of a nation.

Strengths

Qualified and experienced faculty members, Well-equipped laboratories, Availability of State-of-the - art modern scientific instruments, Active engagement in research activities and consultancy services, Updated curriculum according to industry/society needs, Academic collaboration with universities of repute, Strategic research in topical areas, Conducive atmosphere for research and teaching, Strong multidisciplinary research culture, Research collaboration with leading industries, Regular faculty development programs, Core competencies in diversified fields of science, Excellent academic results and campus placements, Advanced computational facility, Counseling and follow-up of weak students, Faculty and student exchange programs, International student exchange for technical experience, Well-developed ecological parks.

Weaknesses

Lack of external research funding, Geo-location away from industrial hub, Limited placement opportunities in domain area, Non-availability of competent research scholars, Inadequate institution-industry tie-ups, Locational disadvantage for consultancy work, Less focus on multidisciplinary research, Lack of international collaborations, Difficulty in attracting quality students, Limited linguistic skills, Lack of quality and workmanship.

Opportunities

Ample scope for collaboration with industries, Scope for interdisciplinary research, Adequate scope for entrepreneurship, Pursue cutting-edge research in frontier areas of science, Strong alumni support base, Availability of national facilities for research, Good alumni support to campus recruitment, International academic collaborations, Conduct workshops on need based areas/themes, Learners' involvement in science projects/events of national importance, Proximity to departments/institutions/centers with excellent research facilities, Expansion of development activities through multinational companies.

Challenges

Up-gradation of infrastructure in a short period, Creating placement opportunities during economic slowdown, Attracting external research funding, Improving industry-academia relationship, Attracting competent research scholars, Attracting quality faculty with international exposure to meet the increased demand, Retention of quality faculty members, Offering integrated program in applied science and education management,

Increase the research in interdisciplinary areas, Establishing state-of-the art laboratories, Attracting students from various parts of the country, Modernization of learning and development centers, Review of educational issues from techno-legal perspective.

India has the huge potential to improve its higher educational system and to enhance the scale of Indian contributions to contemporary research, but it has a long way to go in enhancing productivity as the level of competition is the key determinant of the quality of education in a country. For instance, we can place India in the nanotechnology research map of the world and gain the respect of international research community. There is an immediate need to seek the involvement of several stakeholders in maintenance and improvement of higher educational standards and it is necessary to create conducive environment for the public to increase their participation in educational administration activities. The active participation of academic leaders, authors, coordinators, critics, directors, educationists, futurists, journalists, industrialists, liberal intellectuals, opinion makers, leading researchers, liberal reformers, revolutionaries, subject experts, science teachers, scientists, scholars, social workers, nationalists, radical activists, thought leaders, science writers and explorers is essential to provide a new education system perspective on higher educational reforms and voice concern for the educational transformation. It is necessary to create a platform where scientists can interact, enrich their experiences, share with their science-loving audience and to remain firmly focused on higher educational issues in the larger public good. A strong voice in the academic community on social platforms gives a whole new dimension to the upright and enlightened future society to redirect our focus. The higher education department should prepare a vision document on higher education in India to tackle problems associated with higher education, to make headway. The learning of new facts or theories and information with insight through a multidisciplinary and integrated approach acts as a catalyst for change. This will have a cumulative effect resulting in the substantial beneficial effects to inspire young people to pursue higher education in science and the eventual growth of high value added manufacturing industries.

There are two important immense challenges; the need to identify people who are interested in science, engineering, technology and medicine, and motivating people to life-long learning with the three Es' of education, empowerment and employment as targets. Another dimension of change is to publicize the various schemes and provide financial support to promote research by identifying talented students and directing them towards creative research. It is important to 'walk the talk' with wisdom, ability, love and knowledge and it can have a profound impact on our higher order thinking process. The application of useful knowledge is active and powerful, and cultivating the capability to do something with care, concern and consideration adds value to remain at a reasonable comfort level. It is essential to take a close look at the educational issues

from the right scientific perspective and also keep the perspective right. The important attributes of competency of teachers, infrastructure availability, innovation in teaching, overall reputation, customer care and institutional environment should be considered while ranking the higher educational institution. The design and development of resource materials, use of best teaching strategies and proper technology, two way communications and development of motivation, principle of clarity and effective use of feedback are important in scientific knowledge transfer and to make the whole experience and activity a lot more useful. It is important to realize that the intrinsic value of one breakthrough research output with unique ideas is more worthwhile than publishing several routine research papers or doing extension work or incremental development. The revolutions in technology and the long term perspective in science higher education give a clear direction and certainty to the research and industrial base of India. The unique blend of modern science practices along with ecologically sensitive activities provides a strong signal for sustainable development in an Indian context. Adequate thinking, unique location, world class infrastructure/facilities, supreme educational service and a sense

Fig. 7. An individual and collective self-expression from a macro-perspective to enable people to eventually achieve their place in the world

of national interest along with speed of growth is required to achieve huge success. The seriousness, sensitivity, dynamism, enthusiasm and preparedness in converting conventional education to modern high impact education make the educational process more effective and able to meet innovation challenges (Fig.7). Positive thoughts on the education system and implementation of practical and mature schemes help us to build up a reputation for academic excellence in a short period of time.

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NOTES

1. http://www.pogil.otg/resources/curriculum-materials/classroom-activities
2. http://www.icce2014.org
3. www.studygs.net/activelearn.htm ; www.scientoon.com
4. For example see, www.coursera.org; www.ted.com; www.khanacademy.org; www.ocwconsortium.org ; www.apple.com/education/itunes-u; www.en.wikiversity.org; http://www.learning.com/stem
5. www.inspire-dst.gov.in
6. http://www.mission10x.com
7. National workshop on "Perspectives in Science Education and their Relevance to Technology" held at M.I.T. Manipal, on March 19-20, 2013.
8. National Symposium on "Chemistry and Humanity" held at M.I.T. Manipal on July 8-10, 2011.

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