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Science Communication in India: An Assessment

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Abstract

The paper explores science communication through diverse cultures in pre and post independent India. India is known for her early scientific wisdom and scientific heritage. Several sages and scholars have worked on medicinal, mathematical, agricultural, and other sciences, in Indian subcontinent during ancient and medieval periods. They had composed volumes based on self-earned experiences, using various means of communication, like oral communication, Guru-Shishya-Parampara (teacher-pupil tradition) of learning and dissemination of information through interaction. The tradition of oral communication continued through generations, in addition to knowledge creation. Then the modern science communication emerged. Publication of scientific books started in 1800 AD at Shreerampur in English, Bengali and Hindi. The historical perspective of science communication has remained almost untouched by researchers, except an attempt on scientific terminologies by Sharma (1964) and agricultural journalism by Parasar (1980), besides a few more research articles. The author of this paper worked thoroughly on *The Origin and Evolution of Science Communication in India* with comparative account in other parts of the world and published a book *Hindi Vigyan Patrakarita* (*Hindi Science Journalism)* in 1990, the first book on science communication in India, translated in different Indian languages, paving the way for other academics. The paper emphasizes on pioneering developments in various aspects of early and modern science communication and discusses the relevance and need of science communication by pointing out policy measures taken by the state. Finally, the paper summarizes the role of various individuals India.

Keywords: science communication, India, modes, networks, scientific temper, science popularization

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Comunicación Científica en la India: Una Evaluación

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Abstract

Este artículo explora la comunicación científica a través de diversas culturas en la India antes y después de su independencia. La India es conocida por su sabiduría y legado científico. Diversas sagas han trabajado en medicina, matemáticas, y agricultura, entre otras ciencias, durante periodos de medievales y antiguos. Diversos volúmenes se han producido basados en experiencias y usnado diversas formas de comunicación, como la oral, o la Guru-Shishya-Parampara (tradición maestro-alumno) sobre aprendizaje y diseminación de información a través de la interacción. La tradición oral se ha desarrollado durante generaciones en paralelo con la creación de conocimiento en la India. Sobre 1800 la comunicación de conocimiento en su forma moderna en la India surgió en Shreerampur, tanto en inglés, como bengalí e hindi. La perspectiva histórica de la comunicación científica ha quedado casi intacta, excepto, por ejemplo, en obras de Sharma (1964) y el periodismo sobre agricultura de Parasar (1980), entre algún otro trabajo. Yo mismo trabajé en el *Origen y la Evolución de la Communicación Científica en la India* con un estudio comparativo con el resto del mundo y publiqué el libro *Periodismo Científico Hindi* en 1990. Este fue el primer libro específicamente de comunicación científica en la India, traducido a varios idiomas del país, y supuso un camino a seguir para otros autores después. Este artículo muestra estos desarrollos pioneros en comunicación científica en la India y analiza la relevancia y necesidad de esta disciplina mirando a las medidas adoptadas por el estado en este sentido. Finalmente, se analizan el papel jugado por varios otros autores trabajando en este tema en la India.

Palabras clave: comunicación científica, la India, modos, redes, temperamento científico, popularización científica

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India has a rich tradition of communication, especially when it comes to communicating to masses. Folk plays, like *Nautanki*, and religious plays like *Ramlila*, folk songs and folk dances are immensely effective as the means of mass communication. *Ramlila* is one of the oldest of folk arts, possibly, which has communicated to millions of people over generations, the code of conduct and ideals of social life. More recently, Mahatma Gandhi was possibly the greatest communicator of all times, who aroused people of India to participate in the freedom struggle with their might against the mightiest empire the world had ever seen, and all this was through his extraordinary communication skills, which was so natural to him.

> Every cultural pattern and every single act of social behaviors involve communication, in either an explicit or implicit sense. (Sappier)

The might of mass communication, can be underlined as the root cause of any social change, let alone development. This speaks volumes on the impact of sustained science communication, in changing the way a society thinks and behaves; a change, which we want our country to undergo, sooner the better; to be transformed to a nation of scientifically thinking and scientifically aware people. Therefore, why not to think of internalizing science communication activities in our socio-cultural system like, *Ramlila* and other such rituals are. Arousal of people for developing scientific temper and scientific awareness is necessary for national regeneration through mass action, as was the case in freedom movement; unmistakably the only perceivable panacea for innumerous miseries of our people.

India had a tradition of acquiring knowledge, discovering the secrets of the nature; by examining and thorough observations and by applying certain procedure; what we call today, the method of science. The then Indian intellectuals transmitted this knowledge through oral communication and unique compositions, for generations after generations; that is precisely why we do not have enough documentary evidences for such a great treasure of earlier knowledge of science and technology. However, much later, they had written down such information on different surfaces, rocks, like palm leaf,

Bhojpatra, bark of various trees, copper and bronze plates, and eventually on paper. These communication materials have now become the potential sources of the information on early science and technology in India.

According to Toynbee (1976), in Asia, people were so intelligent to make boats and found their way to Australia crossing Timor Sea around 3,200 BC. Undoubtedly, the knowledge of production, use and control of fire was a great discovery of mankind, but it is uncertain that when it was made. However, according to various archaeological evidences, it appears that man first developed the primitive stone tools, followed by the knowledge of use and control of fire, and the development of the civilized society was the next step. According to Satyaprakash (1967), the fire churning technology was first invented by sage Atharvan, sometime around 4000 BC or earlier, as described in a number of hymns in Rigveda (6.16.17), and Yajurveda (11.32):

> The priests churn thee, Agni, as was done by Atharvan and bring him from the glooms of night, wandering deviously, but not bewildered. (Rigveda)

> O fire, thee the source of survival for living beings. Thee the energy for the universe. Sage Atharvan first invited thee by churning. O fire, Atharvan derived thee from the head of priest Vishwa by churning lotus. (Yajurveda)

However, there are ample evidences to establish that the use and control of fire was known even to the *Homo erectus*, the immediate ancestor of *Homo sapiens*, 0.3 million years ago ancient man was using simple forms of stone lamps, probably fuelled with animal fat and using grass or moss for a wick around 79000 BC. Possibly, Atharvan might have developed some simple technique for producing fire or disseminated fire-churning technology among the masses around 4000 BC. As mentioned by Satyaprakash (1967), Atharvan belonged to the Angiras clan. The fire churners were in great demand at that time who communicated knowledge of the fire churning techniques.

The Cro-Magnon man lived in Indian subcontinent, who prepared cave sketches, did experiments and prepared records some time before 40000

years (NCSTC Exhibition, 1998). According to Vilanilam (1993), the Neolithic Indians were producing handmade earthen vessels. The Indus valley civilization, which developed from early Harappan Neolithic cultures that are several millennia older, flourished around 2600-1800 BC, in northwestern parts of India during the Bronze Age. One of the major breakthroughs of this civilization was its original pictographic Indus script, visual representation of people, things, events, tools, processes, methods, and actions, etc., which represents the earliest type of real writing, which still awaits decipherment. However, it is believed that there may be some information on herbal medicines and astronomical calculations, in the Indus script, as far as the science communication is concerned (The International Encyclopaedia of Communications, 1989). Toynbee (1976), has written:

> The scriptures of Hinduism cannot be dated. They were composed and transmitted orally for an unascertainable length of time before they were committed to writing, but the oral transmission of them is likely to have been accurate, since the efficacy of a liturgy was believed to depend on its words being recited correctly.

According to Satyaprakash (1967), the Charaka Samhita, appears to be the proceedings of first ever symposium on the subjects related to medical sciences (Ayurveda). The world's first symposium held on the medicinal plants in relation to diseases was presided over by Sage Bharadvaja somewhere in Himalayas during 700 BC. The whole account appears in Charaka Samhita. Names of different participants are also given. Charaka Samhita also lays the rules for debates and discussions – a prominent form of intellectual discourse and creative communication!

Methodology and Observations

Science and communication in ancient, Vedic, classical and medieval India are well established as per the studies made by several scholars, and it can be taken as the precursor to the foundation of the emergence of modern science communication in Indian subcontinent. The present study involved survey of relevant literature, visits to scientific and literature and archival institutions,

and discussions with the experts and concerned people for gathering data by the author. The data was analyzed and observations made as follows:

i. Notable events in science media e.g., the first publication of a popular magazine, the first airing of a popular radio show: (a) 1818: Publication of monthly "Digdarshan", an educational magazine carries popular science articles, in Hindi, Bengali, and English languages begins; (b) 1821: The first popular magazine "*Pashwavali*" in Bengali language starts; (c) 1924: Radio broadcast begins (Agriculture and Health programmes in 1966); (d) 1959: Doordarshan telecast begins (School TV in 1961, Agriculture programme in 1967).

ii. Science in media, resources for journalists, like the establishment of Science Media Centres or other places where journalists can access expert advice on science issues: (a) 1956: Science feature service for press starts from the Council of Scientific & Industrial Research (CSIR).

iii. The First interactive science centre, like the Exploratorium, when did it open its doors for the first time: (a) 1959: The Birla Industrial and Technological Museum (BITM), Kolkata opens under CSIR.

iv. Science writing awards, where journalists, science communicators and scientists can gain recognition for their work: (a) 1951: On initiative of Mr. Biju Patnaik, former Chief Minister of Odisha, Kaling Foundation Trust, Bhuvneshwar, in association with UNESCO, establishes international "Kaling Prize for Public Interpretation of Science".

v. The first Science festival: (a) 1987: "Bharat Jan Vigyan Jatha" (BJVJ), nationwide public assemblage and march for science, organized by the National Council for Science & Technology Communication (NCSTC).

vi. The first significant national government programme to support science communication activities: (a) 1982: "National Council for Science & Technology Communication" (NCSTC) establishes. The first Council meeting takes place in 1984.

vii. The formation of a National association for science communicators: (a) 1985: "The Indian Science Writers' Association" (ISWA) establishes (involving all forms of science communicators - scientists, writers, journalists, broadcasters, performers, demonstrators, cartoonists, etc., interested in science communication).

viii. The formation of a National association for science journalists: (a) 1960s: "The Science Writers' Association of India" (SWAI) establishes (mainly science journalists; later reformed as ISWA)

ix. The first masters, research degrees in science communication: (a) 1993: NCSTC initiates setting up Institute of Mass Communication in Science & Technology at Lucknow University, and Centre for Science Communication at Devi Ahilya University, Indore for running M.Sc. courses in S&T Communication with academic and financial support from NCSTC.

x. The founding of research journals in science communication: (a) 2002: "*Indian Journal of Science Communication*" (Founder Editor Dr. Manoj Kumar Patairiya).

xi. The First national conference for science communicators: (a) 1993: The First National Convention of Science Communicators, organized by ISWA (Known as the "Indian Science Communication Congress", ISCC, since 2001).

xii. The First courses to train science communicators (possibly post-graduate diplomas, or even units in an undergraduate degree): (a) 1983: The *Vigyan Pravah*, a popular science monthly in Hindi, and *Ultimate Science*, a science policy quarterly in English (Founder: Dr. O.P. Sharma; Editor: Manoj Kumar Patairiya), New Delhi, commence a course in science journalism; (b) 1989: The NCSTC catalyses and supports a diploma course in science communication, at Jamia Millia Islamia, New Delhi on trial basis; (c) 1990: The NCSTC catalyses and supports a long-term regular course in science communication, at Madurai Kamraj University.

xiii. The date of the founding of National Science Week: (a) 1987: February 28 "The National Science Day" (the week, fortnight, or month either begins or ends on February 28th, i.e. The National Science Day). Indian physicist Sir C.V. Raman announced his discovery of Raman Effect on February 28, 1928, for which he was honoured with the Nobel Prize in Physics in 1930.

xiv. The year of graduation of the first PhD in science communication: (a) 1998: Manoj Kumar Patairiya.

xv. Date of important National initiatives, reports on science communication, events that changed the way the area was regarded: (a) 1958: "Science Policy Resolution" presented in the Parliament by the then Prime Minister Jawahar Lal Nehru, which emphasizes scientific temper; (b) 2002: “Report of the Review Group of the NCSTC” submitted to the Govt. of India with a number of workable recommendations for science communication. The Group was chaired by Dr. S.K. Joshi, Former Director General, CSIR, and the author has served as the Member Secretary of the Group and put together the report.

xvi. Other important milestones: (a) 1784: The first learned body “The Asiatick Society” was formed on January 15, 1784, in Calcutta. Later this name was changed to The Asiatic Society of Bengal and again in 1936 the name was changed to The Royal Asiatic Society of Bengal. As per original resolution, the society was to hold weekly meetings every Thursday evening. The need for meeting together was felt with a view to exchange notes, promote learned discussions and communicate their own findings (Bose et al (1971); (b) 1785: In April 1785, a paper in Persian, titled “The Care of the Elephantiasis and other Disorders of the Blood”, written by a Mohammadan medical man, and translated into English by William Jones, was the first scientific paper presented; (c) 1788: The Asiatick Society started the Transactions of the Asiatick Society as the first research journal under the title, *Asiatick Researches*, in

1788, which was divided into two parts in 1829, one devoted wholly to scientific papers, and the other to popular literary communications; it continued till 1839. The second part is important from the point of public communication of science. In 1832 the title of the journal was changed to *The Journal of the Asiatick Society of Bengal*, which, in the beginning was devoted to the publication of papers of literary and popular character; (d) 1826: A monthly publication under the name *Gleanings in Science* was started, but the purpose was to publish extracts and abstracts from the European scientific publications. It can be considered as the first attempt of publication of Scientific Abstract Service; (e) 1915: A popular science monthly in Hindi *"Vigyan"* was started in April 1915 from Vigyan Parishad, Allahabad (Founded 1913), is continue to exist without interruption and celebrating the year 2014 as its centenary year; (f) 1998: NCSTC/ ISCOS start the first course on science journalism through distance learning; (g) 2000*: Vaigyanik Drishtikon*, the first science newspaper in Hindi, Editor: Tarun Jain, a fortnightly publication from Jaipur (Rajasthan); (h) 2001: Indian Science Communication (ISCC) begins annually; (i) 2002: Indian Journal of Science Communication (IJSC), Founder Editor: Dr. Manoj Kumar Patairiya commences; (j) 2002: NCSTC/ ISCOS start the world's first online course on science journalism; (k) 2004: The Year of Scientific Awareness observed; (l) 2004: Vigyan Rail, science exhibition on wheels showcasing India's achievements in different sectors of S&T since independence; (m) 2004: NCSTC organizes the First Seminar on 'Scientific Temper' with international participation at Rajasthan University, Jaipur; (n) 2010: The 11th International Conference on Public Communication of Science & Technology (11th PCST-2010) held in India, the author serves as the Chair, Organizing Committee.

Historical Perspective

Various classical scientific works were carried out in Indian subcontinent, in the fields of mathematics, astronomy, medicine and material science, etc., during ancient, medieval and modern periods, which still form a huge treasure of our scientific and cultural heritage (Patairiya, 2002). However, a remarkable gap between scientific knowledge and the common man remained during the entire span of time and almost no effort was made to bridge this gap. These scientific texts were generally written in technical and classical forms and not in common man's language. With the passage of time, despite many political and social vicissitudes, scientific knowledge and more precisely custodians of that knowledge mostly remained centered around the corridors of power. This was the time when such knowledgeable gems used to be the *Navratnas* of royal courts.

Medieval age, however, saw a remarkable phenomenon. Classically coded scientific literature was made comparatively simpler and written in the popular forms of commentaries and analyses. One can observe a great tradition of such commentators in the Indian sub-continent, who contributed such secondary scientific literature for generations. Indian history is replete with this tradition. This was indeed an exceptional attempt towards presenting science in comparatively simpler form. Many of India's ancient works, be it '*Aryabhatiya*' of *Aryabhat* or '*Leelavati*' of *Bhaskar*, are available in these forms. This situation is continuing more or less even today and the gap between scientific knowledge and lay persons is still very wide. Scientific knowledge is still confined to the language of the elite and it is very difficult to access such information in common man's language especially in vernaculars.

There have been a few people in various parts of the country, always eager to take science to commoners through their uncommon efforts and with limited resources in more recent times before Independence. The formation of Asiatic Society in Bengal has historical significance. *Vigyan Parishad* was established in United Provinces (now Uttar Pradesh) at Allahabad in 1913, which brings out *Vigyan*, a monthly since 1915 without discontinuity. After independence, in Orissa, the *Orissa Bigyan Samiti* was formed on August, 7, 1949, which began science popularization in Oriya language.

Several other voluntary organizations continued to follow. Apart from organizations, several enthusiastic individuals also joined the movement. Some of them were Sir Syeed Ahmed Khan in Aligarh, Ruchi Ram Sahni in Punjab, Swami Satyaprakash in Uttar Pradesh, Shivram Karanth in the south, Hargoo Lal at Ambala, and several others.

After Independence, a number of government organizations also came forward for science popularization. Publications and Information Directorate, New Delhi (now National Institute of Science Communication and Information Resources) began publication of *Vigyan Pragati,* a Hindi monthly in 1952. *Science Reporter* (English monthly) and *Science Ki Dunia* (Urdu quarterly) followed this. National Research and Development Corporation (NRDC) started *Awishkar,* a Hindi monthly and thereafter *Invention Intelligence,* English monthly. Besides that, institutions like National Council of Educational Research and Training (NCERT), Central Institute of Educational Technology (CIET), Consortium for Educational Communication (CEC), Directorate of Agricultural Information and Publication, Indian Council of Medical Research (ICMR), Developmental Education Communication Unit (SAC), etc., also started spreading scientific knowledge concerning their areas of interest. Thus, science communication was taken up at various levels, institutional as well as individual. Indian editions of *Popular Science* and *Scientific American* also stepped in adding to international perspectives to science communication movement.

In order to integrate, coordinate, catalyze and support the efforts of science communication and science popularization, at micro as well as macro levels in the country, the Government of India established the National Council for Science and Technology Communication (NCSTC) in 1982 as an apex body. NCSTC began its activities in 1984. The prime objectives of NCSTC are - to communicate science and technology amongst all sections of the society, to inculcate scientific and technological temper amongst masses and to promote, catalyze, support and orchestrate such efforts in the country. In the year 1989, the Department of Science and Technology established an autonomous organization *Vigyan Prasar*, which undertook the task of mass scale development and dissemination of software for popularization of science and technology, such as TV programmes, audio cassettes, CD-ROMs, publications, etc. The National Council of Science Museums

(NCSM) under the Ministry of Culture is also contributing in this direction through setting up of science centers, science exhibitions, science fairs, science city and science museums, etc. Ministry of Environment and Forests has planned to create environmental awareness through Ecology Clubs in schools. All India Radio, Doordarshan, and other TV channels broadcast and telecast various science programmes. Many state governments, Birla Group and Jawaharlal Nehru Memorial Fund have established several planetariums at various places in the country. Government, non-government, international sectors are attempting towards science communication and science popularization and some individual efforts are noteworthy.

Emergence of Modern Science Communication

There were some enlightened Indians, with great zeal and devotion, who came forward either to establish scientific institutions or to conduct scientific research and communicate scientific information to the people over the period. Thus, interest in modern science in India assumed a new dimension in the last two decades of the 19th century. Scientists started writing scientific papers in various national and international journals. Prafulla Chandra Ray (1861-1944) conducted systematic chemical analyses of a number of rare minerals found in India to discovering in them some of the missing elements in Mendeleev's Periodic Table. He communicated a preliminary note on this in 1896 to the *Journal of the Royal Asiatick Society*. An extremely inspiring teacher, he was lucid and lively in his exposition. Dr. Mahendra Lal Sircar was a firm believer in the rationality of science. He had realised that science was the most powerful instrument of modern civilization. Mahendra Lal founded the Indian Association for the Cultivation of Science, Calcutta on July 15, 1876. The Association was intended to be a sort of a training school for the diffusion of scientific knowledge in its initial stages. In an eloquent address at the association, he said, “I would emphatically say that the Indian youth have shown as much aptitude for, and love of science, as the youth of any country in the world”.

The common newspapers and magazines now started carrying science items and news. Bengali periodicals took leading dissemination of science in the 19th century. It is interesting, however, that in subsequent years hardly anything was said about Darwinism in the major Indian journals and there

was no controversy similar to the great storm, which broke in Europe. According to Gosling (1973), the *Tatwabodhini Patrika*, a popular monthly founded by Debendranath Tagore in 1843, contained a regular column, Science News. Between 1843 and 1880, there were articles on geology, zoology, physics, chemistry and other branches of science. From 1873 onwards, illustrated articles about anthropology and the evolution of man began to appear. Gosling (1973), further observed that the *Sambad Prabhakar*, popular but somewhat conservative, founded by Iswar Gupta in 1839 was well accepted by the readers. It contained a number of well-informed editorials, often written with a strong orientation towards science and technology. Within a decade of its establishment in 1839, the *Sambad Prabhakar* was thundering the message to its readers:

> No country can progress without the advancement of technology. No useful purpose is served by teaching arts and literature. The work of Kalidas, Shakespeare and others may provide literacy pleasure but there will be no real progress without scientific instruction.

As recorded by Vaidik (1976), *`Buddhi Prakash'* was started from Agra in 1852, which carried articles on science, education, mathematics, geography and history. The government used to purchase it for distribution in schools. Bhartendu Harishchandra started *Harishchandra Magazine* on October 15, 1873, which carried articles on science as well. It was later renamed as *Harishchandra Chandrika*. *Kavi Vachan Sudha* also published science articles. Pandit Bal Krishna Bhatt started *Hindi Pradeep* from Prayag in 1877 carrying popular science and educational articles. Although the credit to be the first Hindi daily goes to *Sudha Varshan* brought out in 1854 from Calcutta, but in real sense the Hindi daily was started in 1885 with the publication of *Dainik Hindosthan* by Raja Rampal Singh of Kalakankar (UP). He had decided a special subject for each day of the week, purely there was no science, but it included some allide forms of rural, educational and physical health. *Sajjan Kirti Sudhakar*, brought out from Mewar in 1879, was containing articles on archaeological subjects. *Almora Akhbar* (1871) contained articles on science subjects such as forest management, child education and liquor prohibition, etc. Babu Totaram from Aligarh started

Bharat Bandhu weekly in 1887. Science was an important subject for this; it is evident from a line, which appeared regularly on the front page of the paper, just below the title, stating "A Weekly Journal of Literature, Science, News and Politics".

The *Kashi Patrika* was started by Pandit Laxmishankar Mishra from Banaras in 1882, and it contributed tremendously to the science writing in Hindi. It also carried a line on front page below the title, stating: "A Weekly Educational Journal of Science, Literature and News in Hindustani". It contained adequate material on science, technology, agriculture and education. Its editor, Pt. Mishra himself was M.A. in physics and Professor of physics in Banaras College. He had been the District Inspector of Schools of Banaras. The *Kashi Patrika* for certain, can be credited to have geared the major effort towards a popular science magazine in Hindi (Patairiya, 1990).

Monthly *Digdarshan* was started by Baptist missionaries of Serampore (West Bengal), in Bengali and English in April 1818, edited by Clark Marshman (1794-1877). Subsequently, its Hindi version was also started; Captain Gower sent two Hindi experts from Delhi for this purpose. But according to the second report of the Institution for the Support and Encouragement of Native Schools, the first three issues of *Digdarshan* were published in Hindi and sent to various schools of the country. Thus *Digdarshan* can be considered to be the first newspaper in Hindi and Bengali with a focus on science; however, some people think that *Udant Martand* (1826) was the first Hindi newspaper, but there are no references of science coverage in *Udant Martand* (Patairiya, 1990). There were two articles in the first issue of *Digdarshan* pertaining to science and technology - one on discovery of America, and another on travel in the sky by the balloons. The second issue also carried two articles on science, one on the trees prevailing in India (and not in England), and another on the steamboat powered by water vapor. During these days, textbooks on science subjects were very limited and as such Calcutta School Books Society purchased several issues of *Digdarshan* and distributed among schools as it carried adequate educational materials including on science and technology (Patairiya, 1990).

The author has discovered an unsung hero and pioneer of science popularization `Shri Hargulal' of mid-19th century (1857), who was a science teacher at Ambala. He had fabricated various scientific models, toys,

designed posters and eventually started lecture-cum-demonstrations/ exhibitions of his low-cost models among the children and common audience for popularizing basic principles of science in different parts of the country. As the demand of science models and posters/ charts increased, he started mass production of different models and was even able to export them. He also fought and won a court case against a Bombay based industrialist, who was trying to sell and export Lal's scientific instruments and models under his own name. Hargulal got compensation for the same (Patairiya, 1997).

According to Sehgal et al. (1994), Professor Ruchi Ram Sahni (born April 5, 1863) was a multi-faceted personality. He was a scientist, an innovator, an enthusiastic educationist, a fierce patriot and a devoted social worker and a science populariser. He started his career as Second Assistant Reporter to the Government of India in the Meteorological Department in 1885. One of his major achievements was the creation of scientific awareness amongst the common people of Punjab. In those days, Punjab also comprised of the present day Punjab, in Pakistan and some parts of Himachal Pradesh and Haryana. Alongside similar efforts in Bengal, his was the first attempt at popularizing science in Punjab. All his science popularization activities were organized under the auspices of the Punjab Science Institute, which he co-founded with Professor J. Campbell Oman. Popular lectures on various aspects of science organized created unprecedented enthusiasm among the people; they did not even mind paying a small fee for his science lecturers to Moffussil places. Probably this was the earliest instance in India of common people actually paying for listening to popular science lectures. He tried hard to improve the quality of science teaching in schools and colleges, since he had realized quite early that no science teaching was possible without facilities for repairs of simple scientific instruments used in schools and colleges. He hence established a workshop as part of the Punjab Science Institute for repairing and manufacturing of scientific apparatus used in schools and colleges, and this he did by spending his own money. The workshop also trained young people enabling them to earn a decent livelihood by engaging them in instrument repair. He was also very much concerned with the industrial development of the country. He established a Sulphuric Acid Factory near Lahore, which flourished for several years. In

this venture, P.C. Ray assisted him a lot. He also actively participated in the freedom movement.

The work of Sir C.V. Raman is attributed to both the dimensions. Besides his research interests, Raman had a deep understanding of science popularization. He was able to mesmerize the public during his popular lectures. He also used to demonstrate his apparatuses while delivering a lecture, which he termed as "performance". Interestingly, his critics were also admirers of his "performance". He had given several radio talks. An anthology of his radio talks was published by the Philosophical Library, New York under the title "The New Physics: Talks on Aspects of Science". The Indian Association for the Cultivation of Science in Kolkata has a plaque that depicts the Raman Effect:

> At this institute, Sir C.V. Raman discovered in 1928 that when a beam of coloured light entered a liquid, a fraction of the light scattered by that liquid was of a different colour. Raman showed that the nature of this scattered light was dependent on the type of sample present. Other scientists quickly understood the significance of this phenomenon as an analytical and research tool and called it the Raman Effect. This method became even more valuable with the advent of modern computers and lasers. Its current uses range from the non-destructive identification of minerals to the early detection of life-threatening diseases. For his discovery Raman was awarded the Nobel Prize in physics in 1930.

Present Scenario

Science communication has drawn the attention of policy makers, planners, scientists, technocrats and media personnel during the past decade world over and so as in India. Currently several activities, approaches and media have been tried and utilized by different agencies, both government and non-government, for S&T popularization. As a result, a lot of infrastructure, software and human resources are available in the country. Various means and modes of communication have been utilized in India by the science communicators to reach out to the masses. Every form has its own significance and utility keeping in mind the vast diversities existing in the

subcontinent. Different communications tools were employed for S&T popularization and inculcation of scientific temper.

Over the years, there has been a remarkable increase in science coverage in different media of mass communication, be it print, electronic, digital, folk or interactive media. Several national/ regional dailies have started weekly science pages and magazines are covering science columns. *Vigyan Prasar* started a unique activity and was providing ready-to-print science page to medium scale newspapers periodically in Hindi and English. Some 21 newspapers were incorporating the same page in their editions.

A variety of programmes are now available on AIR, like Radioscope, Science Today, Science Magazine, Science News, etc.; the interest was triggered by two joint NCSTC-AIR radio serials `Method of Science' and `Human Evolution'. On TV, 'Turning Point' a science based programme was able to catch eyes of viewers, besides the University Grants Commission (UGC), National Council of Educational Research and Training (NCERT), Indira Gandhi Open University (IGNOU), NCSTC science programmes from time to time. Several voluntary agencies like Kerala *Shastra Sahitya Parishad* (KSSP), Karnataka Rajya Vijnana Parishat (KRVP), *Eklavya*, *Puppet* are actively involved in taking science to the people by way of folk forms, street plays, theater, puppetry, folk songs, skits, etc. In fact, print and electronic media have certain limits, but the illiterates or neo-literates can also be enlightened through the use of folk medium, as it has no limitation, and offers two way channel of communication, which was proved to be very effective during Bharat Jan Vigyan Jatha (BJVJ-87), Bharat Gyan Vigyan Jatha (BGVJ-90) and Bharat Jan Gyan Vigyan Jatha (BJGVJ-92).

Other media for science communication, like exhibition, *Vigyan Mela*, slide shows, lectures, demonstration, and planetarium are also part of the ongoing science communication/ popularization movements in the country. A variety of popular science softwares have been produced. A number of potential science communicators are being trained through full time academic courses in science and technology communication and short term science writing/ journalism workshops to bridge the gap, who can in turn take up responsibilities of different science communication programmes/ activities (Patairiya, 2001).

Several government and non-government agencies such as NCSTC, NCSM, Council of Scientific and Industrial Research (CSIR), Indian council of Agricultural Research (ICAR), ICMR, NCERT, All India Radio (AIR), *Doordarshan* (Govt. TV Channel), NBT, CBT, UGC, KSSP, etc., are putting in effort towards dissemination of scientific information and inculcating a scientific temper among people. Although much has been achieved, the picture is not so rosy and there is an urgent need of appropriate leadership to work towards putting in every effort to make science communication activities more effective and sufficient both in terms of quality and quantity and a lot is still to be achieved.

It is, however, disappointing that Indian science magazines, like *Science Today, Bulletin of Sciences, Times of Science & Technology* have been closed and Indian editions of some foreign magazines, like *La Recherche* and *Scientific American* have ceased their publication, after bringing out a few issues. Whatever may be the reason, it is clear that science has no territorial boundaries, and so is true for the science communication activities. As far as coverage of science and technology in mass media is concerned, in developing countries, like India, it will increase in near future significantly, as very fast and rapid developments are taking place. On an average, the science coverage in India is around 3.4 %, which we intend to enhance up to 10-15 %, as per a resolution of the Indian Science Writers' Association (ISWA). So far, 5 Indian science communicators have won UNESCO's Kalinga Prize for outstanding contribution in the area of science communication/ popularization. In terms of international comparison, in India the efforts put in by NCSTC, KSSP, and other organizations/ individuals, like *Vigyan Jatha,* Children's Science Congress, explanation of so called miracles, etc., are widely acclaimed and have no match and are unique and first ever in the world. There is a wide scope of a broad spectrum of science communication activities in future to better serve the mankind.

Modes of Science Communication

The process of science communication can be interwoven into five principles. Generally, when we talk about science communication, it obviously incorporates science popularization, scientific temper,

technological temper and technology communication. Let us go into the details of these five mediums of science communication:

i. Print Media: Such as newspapers, magazines, wallpaper, books, posters, folders, booklets, etc.
ii. Audio-Visual Media: Mainly radio and TV, besides, films, slide shows, bioscope, etc.
iii. Folk Media: It has been a common observation, that through folk media, it is possible to achieve penetration to the segments where other media have limitations. Puppet shows, street plays skits, stage performances, folk songs and folk dances, *nautanki* and other traditional means of communication belong to this category. This media is cost effective, entertaining and offers two-way communication.
iv. Interactive Media: Science exhibitions, science fairs, seminars, workshops, lectures, scientific tours, conferences, *vigyan jathas*, etc. The advantage here is being man-to-man and two-way communication.
v. Digital Media: information technology has given birth to comparatively a new media, known as digital media. It includes Internet, CD-ROM, multimedia, simulations, etc. This is proving to be an effective medium and it can illustrate difficult concepts through text, audio, graphics, video, animation and simulation. It has also made science communication simpler to handicapped segments of the society. This new media has given birth to a more instant and global mode of communication in the form of 'Social Media', involving social and individual networking sites.

That apart, we are popularizing science through our 22 regional languages, to penetrate into local populace effectively. Selection of target audience has greatest significance. Our science communication efforts are aimed at various target groups, such as, common man, children, students, farmers, women, workers or specialists, etc. Various forms for presentation are being used to make science communication more interesting and enjoyable, such as science news, report, article, feature, story, play, poem, interview,

discussion, lecture, documentary, docu-drama, scientoon (science + cartoon), satire, etc. Following are some of the important modes and means of science communication in India:

i. Popular S&T literature (articles/ features in daily newspapers, periodicals; newsletters and specialized S&T magazines: comic strips, picture-cum-story books, wall charts etc.).
ii. Exhibitions of S&T themes (temporary, permanent and mobile).
iii. Science Train- Science Exhibition on Wheels.
iv. S&T and Natural History Museums (with permanent galleries on basic topics, on country's heritage and on famous discoveries and inventions, among others).
v. Science Centres and Parks (participatory and interactive activities and demonstrations to learn about S&T principles, applications and to encourage development of a spirit of enquiry among children and adults).
vi. Contests (quizzes, essays, scientific models, toy and kit making, public speaking, debates, seminars etc.).
vii. Popular lectures on S&T subjects (for general public, for children and students at schools, colleges, universities and other institutions).
viii. Tours (guided tours around botanical, zoological gardens, museums, planetariums, bird sanctuaries, industries, factories, etc.).
ix. Planetariums (including mobile ones; sky watching with naked eyes or telescope to learn about planets, stars and other celestial objects).
x. Radio broadcasts (for general as well as specific audiences).
xi. Television telecasts (for general as well as specific audiences).
xii. Audio-Video Programmes (on tapes and cassettes for special or general audiences; slide shows, bioscopes.
xiii. Digital software, CD-ROMs, etc. (for special or general audiences).
xiv. Science Films (for general and specific audiences).
xv. Folk forms (song and drama, street plays, puppet shows, march, festival, fairs, Jathas, etc.)
xvi. Science Club activities, etc.
xvii. Community Radio, Community TV

xviii. Webcasts, Podcasts, and Social Media
xix. Workshops, symposiums, seminars, roundtables, discussions, etc.
xx. Low cost kit/toys and other hands-on-activities (with specific training modules).
xxi. Non-formal Science & Technology Education.

Role of Various Organizations

Various Government, non-Government, voluntary organization are playing significant role in science communication. Some of them are described here:

i. National Council for Science and Technology Communication: The NCSTC is an apex body of the Government of India for promotion, coordination and orchestration of science and technology communication and popularization programmes in the country, with two major objectives of popularization of science and technology and stimulation of scientific and technological temper among people. Programmes began in right earnest with the finalization of the VII Five Year Plan and the first meeting was held in early 1984. It has ten major elements, viz., (i) training in science and technology communication, (ii) software development, (iii) information networks/ databases, (iv) field projects, (v) incentive schemes, (vi) research in science and technology communication, (vii) international cooperation, (viii) women component plan, (ix) environmental awareness, and (x) policy advices. A number of training programmes have already been organized and supported to train people/ resource persons in various tasks of science communication as well as in different media. A number of science communication software items for electronic as well as for non-electronic media have been developed and disseminated to the users. Information networks developed and a number of research projects have been undertaken. Besides a number of projects/ programmes, a mega project on science and technology for promoting voluntary blood donation has been formulated by NCSTC. Preparation of an annotated bibliography of popular science publications in all major Indian languages was undertaken. A project to develop self-

sustaining science communicators, who can generate income by selling software, produced by and with support of NCSTC was formulated, besides a Software Jatha.

ii. Vigyan Prasar (VP): It was set up by the Department of Science and Technology, Government of India, as an autonomous registered society in 1989 for taking up large scale science popularization tasks. Its broad objectives may be summarized as follows. (i) To undertake, aid, promote, guide and coordinate efforts in popularization of science and inculcation of scientific temper among the people and to increase the knowledge, awareness and interest about science and technology among all segments of the society. (ii) To provide and promote effective linkages on a continuous basis among various scientific institutions, agencies, educational and academic bodies, laboratories, museums, industry, trade and other organizations for effective exchange and dissemination of scientific information. (iii) To undertake the development of software materials for different media, so as to enable the masses to better understand, appreciate and comprehend abstract scientific principles and practices. (iv) To organize research projects, courses, workshops, seminars, symposia, training programmes, fairs, exhibitions, film shows, popular discussions, street plays, quizzes, song-dance-dramas, etc., in furtherance of the objectives of the organization. It also organizes an annual Science Film Festival involving short films and TV documentaries, etc.

iii. National Council of Science Museums (NCSM): Having its headquarters in Kolkata, NCSM is an apex body of science museums and science centers in the country. It has a National Science Centre in New Delhi, and some 30 regional science centers, including Lucknow, Bhopal and Bhubaneswar, etc. A Science City has been set up in Calcutta by NCSM. Several states have also setup science cities under collaboration with NCSM, i. e. Gujarat Science City, Ahmedabad; Pushpa Gujral Science City, Kapurthala, Punjab; and Science City, Chennai, etc., and a few more are coming up.

iv. National Institute of Science Communication and Information Resources (NISCAIR): Formerly it was known as the Publications

and Information Directorate (PID). It was renamed as National Institute of Science Communication (NISCOM) on September 26, 1996 and further transformed into NISCAIR, incorporating INSDOC. It brings out eleven professional scientific journals, besides three popular science journals, *Vigyan Pragati* (Hindi monthly), *Science Reporter* (English monthly) and *Science Ki Dunia* (Urdu Quarterly). It has also brought out an encyclopedic series, titled, The Wealth of India, a compendium of knowledge on the economic products and industrial resources of the country. The institute also undertakes the publication of popular science books in Indian languages. Monographs on different scientific subjects are also published from time to time.

v. Science Communication Networks: An All India People's Science Network (AIPSN) was catalyzed in 1987-1988, with 27 constituent voluntary organizations, which organizes All India People's Science Congresses and is also known as All India People's Science Movement. The NCSTC Network was brought into existence in 1991 with the objective of taking popularization of science activities to all nooks and corners of the country. Presently it has over 70 organizations, including government, NGOs and voluntary organizations. It is now known as National Science and Technology Communication Network (NSTC-Network). There is the need of a Science Media Network.

vi. Voluntary Organizations: There are several voluntary organizations in India interested in science communication programmes. Some of them even existed when there were no efforts from the side of state to popularise science among people. *Kerala Shashtra Sahitya Parishad*, *Karnataka Rajya Vigyan Parishat*, *Vigyan Parishad*, Allahabad, Vikram A. Sarabhai Community Science Centre, Ahmedabad, Eklavya, Bhopal, etc., are among important voluntary organizations involved in science popularization movement in the country. The Indian Science Writers' Association brings out a newsletter and organizes meetings with prominent scientists as well as media persons.

vii. Indian Science Writers' Association (ISWA): The ISWA was founded by a group of highly motivated and enlightened science writers and journalists in April 1985, with a view to develop and nurture science writing profession in the country. Now, ISWA has some 500+ members from across the country comprising scientists, science writers, science journalists and science communicators from various Indian languages. In pursuit of its broad objectives, the ISWA undertakes a broad spectrum of activities on science writing, science journalism and science communication. ISWA is an active, vibrant and visible organization. Here is a glimpse of its activities:S ince its inception, the ISWA has been publishing an occasional newsletter to have a channel of communication with members spread all over the country. It has initiated ISWA Chapters at various places in the country. Some 10 ISWA chapters have come up so far, which are undertaking various kinds of activities, like training in science writing and science journalism involving students, teachers, journalists and scientists. The ISWA had introduced a Millennium Lecture Series. A number of lectures have been organized so far on various frontline areas of science and technology. The ISWA confers ISWA Fellowships and ISWA Awards on distinguished persons for recognizing their efforts towards promotion of science popularization in the country. The ISWA organizes national seminar every year on some current topic, concerning science and technology. Some of them were; Post GATT India, What is Wrong with Indian Science, Patenting System and Intellectual Property Rights, Challenges in Public Appreciation of Science in Digital Age, etc., with a view to discussing and addressing the issues and problems emerging in this field. An exhibition on Popular Science Periodicals in Indian Languages is also part of these activities. It also publishes the directory of ISWA members from time to time. The Directory is sent to various scientific and media organizations in India and abroad. ISWA has been working in collaboration with government and non-government organizations and has linkages with various agencies interested in science popularization, such as, the CSIR, NCSTC,

National Institute of Science Communication (NISC), ICAR, ICMR, Society for Information Science, Indian Science Communication Society (ISCS), etc. We have organized training programmes with the Department of Atomic Energy and other organizations. Efforts are being made to make joint programmes, with Indian Space RESEACH Organizations (ISRO), British Council Division and UNESCO, etc., including visits of ISWA members to various scientific establishments for writing/reporting on various R&D activities in the country. We are looking forward for more such joint programmes in future and are planning to have many more activities to strengthen ISWA as well as the efforts towards the cause of popularization of science and inculcation of scientific temper among masses. ISWA is an active partner of India-Brazil programme on public communication of science, technology, culture and society.

Major Initiatives in Science Communication

Following are the highlights, where major achievements were observed in the area of science communication in India:

i. Human Evolution: A 144-part radio serial *Manav Ka Vikas* was jointly produced by NCSTC and AIR was broadcast on Sunday mornings simultaneously from nearly 84 stations all over the country in 18 Indian languages during June 1991-February 1994. Among the listeners there were 100 000 children and some 10000 schools registered as dedicated listeners. They were provided kits, posters, etc. as supplementary material. Two unique radio bridge programmes of half-hour duration each were broadcast live through the satellite on February 13th and 20th, 1994. Selected children, who had assembled at five different places in the country, participated in these programmes, which included questions, answers and discussions.

ii. Bharat Ki Chhap: The NCSTC has produced a number of TV programmes on scientific subjects. A 13-part film serial on the history of science and technology in the Indian subcontinent and its

impact on the world, titled *Bharat Ki Chhaap*, originally in Hindi was produced by NCSTC and telecast on Doordarshan in 1989. Regional language versions were subsequently produced in Tamil, Malyalam, Telugu, Gujarati, Marathi, Bengali and Kannada, along with an English subtitled version.

iii. Vigyan Jatha: *Bharat Jan Vigyan Jatha-87* and *Bharat Jan Gyan Vigyan Jatha- 1992* (BJGVJ- 92) were catalyzed by NCSTC, could be considered as the biggest ever science and technology communication movements attempted anywhere. The main themes of BJGVJ - 92 included health, water, environment, appropriate technology, superstitions, scientific thinking and literacy. Science and technology communication software, on the main themes of the *Jatha*, was developed and duplicated both at the central and state levels, which included brochures and posters for publicity, poster sets on water, environment and housing, booklets on topics such as the preparation of science posters and charts, puppet plays, low-cost exhibitions, etc. Some 2,500 government/ non-government organizations were actively involved. The *Jatha* covered nearly 40,000 locations in about 400 districts touching almost a third of the country's population. During the course of *Jatha*, various modes of science communication, especially folk forms, publications, lecture-cum-demonstrations, etc., were employed for science communication among people in far-flung areas. Subsequently, Regional *Vigyan Jatha* is organized to cover a geographical region on a focused science theme relevant to the area.

iv. Children’s Science Congress: The first National Children's Science Congress (NCSC), with the focal theme Know your Environment was organized by the NCSTC Network in December, 1993. The children were selected on the basis of their presentations on their scientific projects at the district level Congresses, followed by state level presentations and finally for the National Congress. The main aim of the congress was to provide open laboratory of the nature for learning with joy and to adopt the method of learning-by-doing. The other objectives were to extend classroom learning to inculcate an understanding of the environment, its problems and prospects and to

help find feasible solutions. Participation was open to children of the age group 10 to 17 years. Until now 21 such congresses have been organized at different places of the country; and it has become an annual feature like Indian Science Congress. Select groups of children from NCSC present their project reports in the Indian Science Congress. Selected children from National Children's Science Congress visited Germany in connection with Germany Festival in India and India Festival in Germany in 2001.

v. Scientific Explanation of so-called Miracles: This is a very popular programme implemented across the country, wherein various tricks and miracles are demonstrated and explained by trained science activists to make the gullible people aware of the scientific tricks/ facts behind such so-called miracles, so that the self-styled god men cannot cheat them. In the event of so-called milk miracle, when religious deities started drinking milk in 1995, the author of this paper demonstrated the phenomenon on television news and the hoax was declined as a result.

vi. Science Communication Courses: In order to develop trained manpower in the area of science communication, training/ educational programmes are being offered at various levels in our country, which are catalyzed and supported by NCSTC: i) Short term courses, which are of 3 to 7 day's duration; the participants are all science activists and enthusiasts, whether students of science at higher level or not; ii) Medium term courses, which are of two to four month's duration; usually for those who want to improve their science communication skills; and iii) Long term courses, which are of 1 to 2 year's duration; run at different universities/ institutions and offer post graduate degrees or diplomas in science communication. Besides, a correspondence course and an online course in science journalism of one-year duration are also available. The main aim is to develop as many science communicators as possible to meet the present and future challenges and requirements. 30 universities/ institutions are running these courses with NCSTC's initiative. Recently, the University Grants Commission (UGC) has

also introduced science communication under its thrust areas of studies.

vii. Research, innovation and development initiatives: There has been a significant and continuing increase in quality, quantity, diversity in this growing area, i.e. science communication, the world over. A good deal of R&D work was done to strengthen and enrich such activities in India.

viii. Knowledge diffusion through science - media orientation: A countrywide programme for training scientists, journalists, writers, teachers, students, and science activists in science writing/ journalism/ broadcasting/ telecasting/ communication in regional languages was conceived by the author and implemented through NCSTC in over 500 district by conducting regional/ state/ national level short-term trainings benefiting 20,000 trainees directly through participation and 500 million audiences indirectly, i.e. ½ population of the country through coverage.

ix. Science & Health Communication through Folk Forms: A Nationally Coordinated one year's Programme on science and health communication through folk forms was developed focusing on woman and child nutrition and implemented. The countrywide project included: i) Zonal Orientation-cum-training of Folk Groups (7 Zones); ii) Performances in States (30 States); and iii) National Performances. The Zonal Orientations held in July-August 2007 at Delhi, Kolkata, Nagpur, Allahabad, Udaipur, Guwahati and Tanjavur. The programme was assessed for its efficacy and impact and was found to achieve the intended objectives. The programme has triggered an interest and excitement in science in general and in health related issues in particular.

x. Science Exhibitions/ Innovation Fairs/ Demonstrations: Thematic science exhibitions/ science fairs/ demonstrations, etc., on different occasions and on specific themes are being organized from time to time, including innovation fairs on National Technology Day, Science Publications, Science Communication Software, Science Communication Products in Regional Languages, etc.

xi. Declarations: To focus on particular aspects of science communication, the following declarations were issued after negotiations and adoption of various consensus decisions at different forums: (a) *"The Benaras Document on Science Fiction 2008"* was adopted on November 13, 2008 at the concluding session of the First National Discussion on "Science Fiction: Past, Present, Future" held at Varanasi focusing the policies and directions for advancing SF in India; (b)*"The Hands-on Science India Declaration 2009"*, was adopted on October 30, 2009 as a major outcome of the 6th International Conference on Hands-on Science (HSCI-2009) held at Ahmedabad; (c)*"The New Delhi Declaration on Science Communication 2010"* was adopted on December 09, 2010 as an important directive document at 11th International Conference on Public Communication of Science & Technology (PCST-2010) held in New Delhi.

xii. Impact Assessment of Science Communication Programmes: A National Review Meeting was organized at Himachal Pradesh State Council of Science, Technology & Environment for assessing and giving future directions for short-term training courses on science writing, science journalism, science broadcasting, and science communication. A National Consultation & Review Meeting was organized at Rajasthan University, Jaipur to review NCSTC's academic courses on science communication and science journalism run by various universities and to consolidate and update syllabi for the same. A National Assessment Workshop for exploring job possibilities and assessing job potential in science communication was organized at Devi Ahilya University, Indore with active participation of representatives from industry, media and academics and the proceedings suggested that there is a need for such specialized courses and demand for the graduated students.

xiii. Centres for Science Communication: Centres for Science Communication at Lucknow University (U.P.); Devi Ahilya University (M. P.); Cochin University of Science & Technology (Kerala), and Krishna Kant Handiq Open University, Guwahati

(Assam) were established to promote higher studies and research in S&T communication/ public understanding of science.

xiv. Science Communication Archives: A Science Communication Archives at Madhavrao Sapre National Media Repository & Research Centre, Bhopal has been started to preserve and retrieve science manuscripts, publications and other information products to facilitate researchers in S&T communication.

xv. Indian Journal of Science Communication: An international peer reviewed research journal in science communication is being published since 2002, which has an International Advisory Board and peer review system and offers print, electronic and open access edition available at < *www.iscos.org* >

xvi. Public Debates on Current S&T Issues: Public debates on current affairs in S&T where public requires adequate awareness to take decisions in matters, like, Bt Cotton, Bt Brinjal, Nuclear Controversies, Iodized Salt, etc., were initiated. A recent debate on "Public Awareness of Nuclear Energy Controversies" was able to attract a house full at 11th PCST-2010.

xvii. Technology Communication: More often, we talk about science communication and scientific temper and less on technology communication and technological temper. A major initiative was taken by NCSTC on 'Technology Communication', including hands-on science, with the objectives: i) to inculcate a technological temper; ii) to develop and nurture the spirit of innovativeness, and iii) to focus on technological approach to problem solving. The programme has 3 major elements: i) orientation of artisans and techno-students towards innovativeness; ii) identification of areas of innovation and developing innovative ideas; and iii) technology awareness. The module was successfully tested and being implemented across the country.

xviii. Science Fiction: The first ever National Discussion on 'Science Fiction: Past, Present, Future' by Indian Science Fiction Writers' Association and Indian Association of Science Fiction Studies at Varanasi during November 10 - 14, 2008 to emphasize role of Science Fiction and S&T communication.

xix. Science Communication through Digital Media/Blogs/Social Media: A module on S&T Communication through Digital Media on various popular science topics were developed including science Webcast and Podcast. A series of training programmes on science communication through visual media was organized across the country.

xx. Science Communication through Cultural Events: The module includes: i) Workshop for Developing Scripts and Exhibits; ii) Demonstration of Exhibits at Cultural Events, i.e. *Shiva Ratri, Durga Pooja, Ganpati Festival, Eid, Pongal, etc.; and iii) Road Show/ Procession/ Prabhat Feri*.

xxi. Campaigns on Total Solar Eclipses: Science popularization programmes built around the total solar eclipses on the belt of totality for viewing total solar eclipses in 1995, 1999 and 2009 have been hugely successful.

xxii. Year of Scientific Awareness (YSA 2004): With an initiative taken by DST, the Year 2004 was observed as Year of Scientific Awareness across the country; followed by Year of Physics 2005, Year of Planet Earth 2008, and Year of Chemistry 2011.

xxiii. Indian Science Communication Congress (ISCC): With a view to providing a platform for encouraging scholarly interaction between science communication researchers and practitioners, scientists and communicators, science communication faculty members and students, etc., for further advancement of science communication profession, the Indian National Science Communication Congress was started in 2001. Since then 10 annual congresses (2001-2010) have been organized so far involving over 2000 researchers, scientists, journalists, including international delegates. A special session for young researchers from over 50 universities has been an attractive feature of the ISCC. The aim is to establish S&T communication as an independent discipline of scientific knowledge and expertise and promote research. The 14th ISCC-2014 is scheduled to be organized in December 2014.

xxiv. Science Communicators' Meet at Indian Science Congress: The 1st Science Communicators' Meet was organized at Indian Science

Congress, Visakhapatnam, 2008; followed by 2nd Science Communicators' Meet at Indian Science Congress, Shilong, 2009; 3rd Science Communicators' Meet at Indian Science Congress, Trivendrum, 2010; and 4th Science Communicators' Meet at Indian Science Congress, Chennai, 2011. The programme is being implemented through Indian Science Congress Association. The 8th Science Communicators Meet will be organized as part of Indian Science Congress at Mumbai in January 2015.

xxv. International cooperation: A variety of programmes are envisaged for developing international cooperation in science communication, some important ones are given here: (a) 11th PCST-2010: The 11th International Conference on Public Communication of Science & Technology (PCST-2010) was organized in India in December 2010 with International Network on Public Communication of S&T, Australia attracting 600 science communication experts from 51 countries; (b) 6th HSCI-2009: The 6th International Conference on Hands-on Science (HSIC-2009) was organized in India in October 2009 with International Network on Hands-on Science, Portugal attracting 350 delegates from 20 countries.

xxvi. Online Science Communication Networks: Online science networks are immensely beneficial for connecting science communication professionals and bringing them together in India and abroad: sciencefictionwriters@yahoogroups.com; popularsciencewriters@yahoogroups.com; iswaindia@yahoogroups.com.

Science Policy and Science Communication

Jawaharlal Nehru, the first Prime Minister of India, introduced the concept of modern scientific temper in India. He dreamt of the children of the country acquiring scientific temper (Pattnaik, 1992) Accordingly the Constitution of India has special provision 'to develop the scientific temper, humanism and the spirit of enquiry and reform' as one of the 'Fundamental Duties' mentioned under Part IV A, Article 51 A (h).

i. Scientific Policy Resolution: Prime Minister Nehru presented the Scientific Policy Resolution on March 4, 1958, which has been a guiding factor for development of science and technology in the country. Special attention was given to the scientific approach in the resolution, which reads as follows:

It is only through the scientific approach and method and the use of scientific knowledge that reasonable material and cultural amenities and services can be provided for every member of the community, and it is out of recognition of this possibility that the idea of a welfare state has grown.

ii. Technology Policy Statement: To give direction to the technological development in the country the Government of India announced the Technology Policy Statement in January 1983. The spirit of innovation and awareness about balance in technological development and environment was given special importance, among others in the statement.

iii. The Sixth Plan: The promotion of scientific temper and dissemination of scientific information among people was given due importance in the report of the working group on science and technology for the sixth plan (December 1980). Special provision was made for science popularization under science and technology chapter in the Sixth Five Year Plan, approved by the National Development Council. Consequently, the NCSTC was formed in 1982. Thereafter, the NCSTC was given the mandate for formulation of policy, programmes for science communication in the country. The need for national science communication policy was emphasized in the first convention of the Indian Science Writers Association (ISWA). Efforts were under way in the NCSTC for formulating a science communication policy.

iv. Reviews of NCSTC Activities and Programmes, 1989, 1996, 2002: The Department of Science & Technology, Govt. of India has formed different review groups to review NCSTC activities

and programmes and to suggest future strategies for science communication from time to time. The First Review Group was formed under chairmanship of noted physicist and science fiction writer Dr. Jayant V. Naraliker had given its report in 1989. The Second Review Group had worked under chairmanship of noted ocean scientist and Member, Panning Commission (Science & Technology) and gave report in 1996. The Third Review Group had Prof. S. K. Joshi, noted physicist and former Director General, CSIR as its chairman, which gave its report in May 2002.

v. Science and Technology Policy 2003: Govt. of India has announced a comprehensive 'Science and Technology Policy 2003' that carries a section on "Public Awareness of Science and Technology" (Govt. of India, 2003, 25).

vi. Science Technology & Innovation Policy 2013: The new policy was unveiled at the 100th session of the Indian Science Congress, Kolkata on January 03, 2013 that emphasizes science communication as well.

Challenges and the Way Forward

In spite of well-planned and well-structured efforts of science communication in India, there are certain challenges before us, to be met. In spite of repeated and multifold efforts of spreading scientific information and inculcation of a scientific temper among Indian people, even today there prevail lots of superstitions among people who are still ignorant about common scientific principles of day-to-day life. Hence illiteracy and ignorance are major challenges. The level of literacy has increased as compared to earlier times, though it has not reached the desirable level. Scientific literacy is drastically low in the country. The science communication has still not succeeded in attracting the media to the extent that it could appear on the front page or become a lead story, like the politics, films or sports. The coverage of science in print as well as in the broadcast media has not arrived even up to a minimum desirable level (Patairiya, 2001). It is rather disappointing to note that leading science magazines have ceased their publication, like *Science Today*, *Science Age*,

Bulletin of Sciences, Research and Industry, *Invention Intelligence,* etc. and Indian editions of foreign science magazines, like *Vigyan* (Scientific American), *World Scientist* (La Recherche), etc., could not survive. Several Hindi and Indian languages' science magazines have faced the same fate. India has 22 recognized regional languages. Hence, communication in many languages is yet another great challenge. The quality of scientific translation could not achieve the level of excellence in most instances; this is mainly due to lack of equal command and training in both the languages and non-availability of appropriate terms

Mass media has its commercial compulsions, which superimpose all the science communication efforts and leave a negative impact in the minds of the audiences. Instead of including scientific information, they prefer to generate more revenue by including non-scientific, meta-scientific or occult information, etc (Bruce, 2005).

The science writing is still dry and boring, and interesting styles of writing, like fiction, poetry, satires, skits, discussions, etc., have not found adequate space and time in the media. Even most of the science writers could not contribute sufficiently such an interesting science material to the newspapers/ magazines. Merely occasional appearance of something in the name of science fiction cannot serve the purpose.

In view of the present pace of science communication programmes, their potential and impact towards shaping the lives of the people and making them more informed and rational, nobody would be able to afford not to have the scientific information confronting day-to-day life of the people, as it will be going to become essential and integral part of most of the human activities in the near future. That is why, even today, almost every parent is intended to provide modern scientific and technological knowledge to his or her child. Although, there may be ample scope for unevenness, deprivations, limitations and lack of effectiveness of various science communication programmes and activities, however, despite various constraints and impediments, it may not be an unrealistic idea that science communication has a promising future in India and other developing countries.

As obvious from the preceding paragraphs, India has been able to take initiatives in a number of newer programmes in the area of science communication, which were not tried out elsewhere and can take lead in

these innovative areas. Similarly, we would also like to welcome other new ideas, methodologies, programmes available in other parts of the world and we can work together to better serve the mankind. Recently we have been able to develop cooperation at bilateral and multilateral levels with different countries. Of course there is ample scope for furthering such efforts in developing countries, especially in South Asian Regional Countries in matters of science communication. We can take initiative in mobilizing likeminded people in these countries to form Science Writers'/Journalists' Associations in their respective countries, with help from international organizations, in order to enhancing scientific literacy and scientific temper, which are considered to be the basic elements for development of any society in a more coherent manner.

A common science and technology news and features pool can be formed to facilitate writers/journalists to get/exchange information on scientific research and developments for further dissemination through mass media. There is a great shortage of properly trained science writers, journalists, communicators, illustrators in various parts of the world, though, a number of training programmes are conducted at various places. Therefore, more training programmes are needed, which may preferably be conducted jointly to give more opportunity to developing countries and their participation must be ensured. That apart many more joint collaborating programmes in the area of science communication can be worked out and implemented for further advancement of science communication to better serve the people.

Conclusion

Looking at the population, size and make up, variety of languages, urban-rural, digital divides, prevalent disparities, poverty, illiteracy, inadequate opportunities, facilities, services, reach of mass media, and so on, India is poised with many challenges, that offer opportunities and possibilities in S&T communication:

i. The beginning of science communication during ancient period can be traced back from the dissemination of the information about development of primitive stone tools, through the pedestrians from

one place to another, sometime around 150000 years ago in Shivalik region of Himalayas.

ii. The exchange of technical information about the use and control of fire and fire churning technology by sage Atharvan was the next step.

iii. The cave drawings and cave paintings depicting human life of Stone Age as well as illustrations of animals, plants are the true examples of science communication, by the early man in Indian subcontinent, about 40000 years ago.

iv. Then the ancient man started exchanging information and knowledge about sowing, irrigation and other agricultural practices through public relations or mutual discussions some 10000 years ago.

v. The process of communication progressed from body language to the well-developed oral and written languages during the course of the time.

vi. Guru-Shishya Parampara communicated knowledge through oral communication to generations after generations.

vii. The scientific outlook has always existed in Indian Society, in the form of logic, reasoning and method of acquiring knowledge, as evident from a number of ancient scientific works, rendered during Vedic, post Vedic and classical periods, in India.

viii. The medieval period has been important for the preparation of a large number of commentaries on earlier and contemporary scientific works. This can be considered a great milestone on the road of communication, as the information about most of the ancient and classical works mainly reaches us only through these commentaries and commentators.

ix. Construction of Jantar Mantar by Sawai Jai Singh II, preparation of scientific volumes under Mughal emperors, etc., are the notable examples of science communication during medieval period, although such information was not available to the public at large, and was limited to the privileged class only.

x. The science communication in its real term took shape during modern period, with the publication of the first scientific journal,

"Asiatick Researches," a quarterly from the Asiatick Society, Calcutta in 1788.

xi. There has been a continuing development in the formation of scientific institutions and publication of scientific literature. Subsequently, scientific publications also started appearing in Indian languages by the end of 18th century. The publication of ancient scientific literature and textbooks at mass scale started in the beginning of the 19th century.

xii. Scientific and technical terms had been a great difficulty for a long time for popular science writing. Even in the absence of scientific terms science books could not be written, some authors had refused to write, while some accepted the task, if they were provided with the technical terms in the desired language along with their explanations.

xiii. Science journalism started in 1818, with the publication of *Digdarshan* in Bengali, Hindi and English. Other newspapers had also started giving scientific information.

xiv. Science communication activities could not grow sufficiently during 19th century, however a number of publications were brought out in different Indian languages and on various scientific subjects. The science communication was mainly limited to publication of books and scientific journals, except a few popular science articles on latest developments.

xv. In the beginning of the 20th century, some new trends emerged. Science congresses, scientific and industrial exhibitions, seminars, industrial and technological museums, public lectures, popular science magazines, etc., were a few among the newer developments towards science communication. However, the pace of these activities remained low and no significant effort was seen to popularize science among the people and inculcate a scientific outlook among them. More or less the same pattern continued until independence.

xvi. The first Prime Minister of India, Pundit Jawahar Lal Nehru gave an impetus to scientific pursuits and development of scientific outlook. The independent India is witnessing a rapid growth in the efforts on

science communication and popularization. The use of broadcast and digital media has opened new vistas of science communication. The revolution in information technology has made possible to get scientific information from around the globe within seconds, on our fingertips.

xvii. The Indian science was translated from Sanskrit to Arabics and other languages probably without mentioning the fact of the source; that is why the majority of world literature does not cite Indian contributions to the important discoveries, i.e. the discovery of the Zero (0), the Decimal System, the Astronomical findings, the Discovery of Wireless Communication by Jagdish Chandra Basu, and so on.

xviii. The present study underlines the significant history of Indian achievements, one substantially ignored in the West. While the author of this paper visited the Central Library of the Moscow State University in Russia, he was happy to see the copies of the Vedas in the library, but the index card indicated: "The Vedas – Composed somewhere in Asia"; though, as a matter of fact the Vedas were composed in India during the Vedic Period.

In more developed nations, "the science museums, planetariums, exhibitions, lectures, audio-video media and high-end technological application" approach dominates the 'state-of-the-art' in this field, which is capital intensive and urban oriented. In India, same results are achieved through "folk forms, Vigyan Jatha, print and visual media, road-shows, and people's involvement" approach, which is cost effective and fits into our social milieu. However, India is not legging behind in modern approach and has been able to make world records, especially in case of Science Express - Science Exhibition on Wheels. India was able to win international bids and organize international forums - 6th HSCI-2009, and 11th PCST-2010. Many developing countries are more or less following western approach but it is refreshing to note that after organization of these forums in India, not only developing but several developed nations are willing to try Indian models. Moreover, if scientific literacy implies disseminating knowledge of science, its wonders, its scope, its application, etc., then perhaps in Indian context

scientific and technological temper has more meaning and relevance. What we would like to see is that our population at large, particularly the illiterate and backward rural community, develops a scientific outlook rather than being told about facets of science alone that allows informed and logical application of S&T and elimination of superstitions and ignorance. In India, therefore, more organic approach has taken shape and making inroads. Use of local languages, dealing with everyday S&T problems, using surroundings and environs at home, in field and outdoors, learning by doing, are some of the elements of this parallel approach of science communication and popularization movement in India.

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Appendix

Science communication courses in India:

i. M.Sc. in Mass Communication in S&T, Lucknow University, Lucknow
ii. M.Sc. (Tech) in Technology Communication, Indore University, Indore

iii. M.Sc in Science & Technology Communication, Anna University, Chennai
iv. Postgraduate Diploma in Science Journalism, Makhanlal Chaturvedi National University of Journalism & Communication, Bhopal
v. M.Phil. in Science Communication, Kannada University, Hampi, Karnataka
vi. M.B.A. in Science Communication, Makhanlal Chaturvdi National University of Journalism & Communication, Bhopal
vii. Diploma in Science Journalism, Madurai Kamraj University, Madurai
viii. Postgraduate Diploma in Science Communication through Distance Education, Devi Ahilya University, Indore
ix. Diploma in Science Journalism through Distance Education, Indian Science Communication Society, Lucknow
x. Diploma in Science Communication through Web Enabled Online Learning, Indian Science Communication Society, Lucknow
xi. Certificate Course on Science Fiction, Indian Science Writers Association, New Delhi
xii. Special Paper in Science Communication as part of PG Course in Journalism & Mass Communication, Rajasthan University, Jaipur
xiii. Special Paper in Science Journalism as part of PG Course in Journalism & Mass Communication, Purvanchal University, Jaunpur
xiv. Semester Course in Science Journalism as part of PG Course in Journalism & Mass Communication, Hyderabad University, Hyderabad
xv. Semester Course in Science Communication as part of PG Course in Journalism & Mass Communication, Gandhi Gram Rural University, Gandhi Gram
xvi. Special Paper in Science Journalism as part of PG Course in Journalism & Mass Communication, Saurashtra University, Rajkot
xvii. Certificate Course in Science & Environment Journalism, Vishwa Bharti University, Shanti Niketan
xviii. Special Paper in Science Journalism as part of PG courses in Journalism & Mass Communication, Cotton College, Guwahati

xix. Special Paper in Science Journalism as part of PG courses in Journalism & Mass Communication, Guwahati University, Guwahati

xx. Special Paper in Science Communication as part of PG course in Journalism & Mass Communication, Banaras Hindu University, Varanasi

xxi. Special Paper in Science Communication as part of course in Media Studies, Anna University, Chennai

xxii. Diploma in Science Communication, K.K. Handique State Open University, Guwahati, Assam

xxiii. Certificate Course in Science Communication & Media Practices, Indian Science News Association, Kolkata

xxiv. Certificate Course in Science Communication & Media Practices, Science Association of Bengal, Kolkata

xxv. Certificate Course in Science Journalism, Vigyan Parishad, Allahabad

xxvi. Certificate Course in Science Journalism, Jeevaniya Society, Lucknow

xxvii. Certificate Course in Science Communication, Punjab Agricultural University, Ludhiana

xxviii. Certificate Course in Science Communication through Television, Development & Educational Communication Unit, Space Applications Centre, ISRO, Ahmedabad

xxix. Diploma in Science Communication through Audio-Visual Media, C-DIT, Trivandrum.

xxx. MS degree programme in science communication, National Council of Science Museums (NCSM), Kolkata in collaboration with BITS, Pilani.

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