Science Communication : Mission accomplished?

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Abstract

In an old civilization like ours, with diversity found in immense proportions and not having a so called culture of science embedded in the Indian ethos, communication of Science and Technology to the people is a difficult mission but this activity is essential for our national development particularly at this juncture when our country's economy is in transition from its resource based structure to a more open knowledge based platform. With a substantial support from the Government and an inclination for promotion of Science communication activities observed in our Government policies, a sizable network of institutions and agencies for science communication has been established in India during the last few decades. But how far the mission of creation of a scientific temper among the masses has been achieved? Are we observing any attitudinal change among Indians towards Science and Scientific issues because of the Science Communication activities being conducted? If so, are we trying to measure the success or failure of our missions?

In India, regular assessment and evaluation of outcomes are not practiced as essential follow up actions for science communication activities. As a result, we do not know how effective our missions are. We must understand that the number of Science Centres set up in the country and the number of visitors entering into an exhibition or a Science Train are not sufficient indicators of the achievement or efficiency of our missions. Time has come for a closer look into the issue for appropriate action.

Prof M S Thacker, while examining the social background of great developments in Science and Technology in his Presidential address to the 45th Indian Science Congress, mentioned that "*The lesson in history and the requirements for scientific progress all point to the need for promoting the public understanding of Science, and it is to the creation of this understanding that we should dedicate ourselves*".

That was 1958 and India was putting utmost faith in Science and Technology for the reconstruction of a post-independence resurgent India. A large number of institutions for Scientific and Industrial research were already functioning at that time and soon, more such institutions were planned and established to anchor the development strategy of the Government of India firmly with the rock-solid support of Science & Technology. At this point of time, almost entirely under the auspices of the Government of India, a plan to set up organized science museums in the pattern of the similar organizations in Europe was taken up. The objectives of these institutions for public education were to impart Science & Technology education to the masses, particularly to the young students and to showcase the post independent achievement in Science and Technology in India. The growing popularity of the science museums in Pilani, Kolkata and Bangalore led the policy makers to form a task force to expand the science popularisation activities in the country. On the basis of the recommendations of the task force, a large number of new centres for communicating science was established throughout the country in the following decades.

The basic engine in the form of various forums, science museums, science centres, science clubs and science communication journals for '*promoting the public understanding of Science*' as mentioned in Prof Thacker's address was in full steam from the eighties. By this time, it was well understood that the most important medium for taking the messages of S&T to the masses need to be operating in a non-formal mode and that it would also be effective to supplement formal science education imparted through the formal system in schools, colleges and universities. The systematic approach for offering science education in the public domain gradually took shape and institutions and forums came up with a large number of activities and programmes to encourage the public to participate in non-formal learning of Science. In a contemporary parlance this mode of learning is being termed as 'free choice learning'. The result of this effort can now be seen as India having one of the largest networks for non-formal science communication in the world set up largely with the support of the central and state governments.

Having a sizable and functional network in the country for science communication for quite a long period now, one would expect to assess its objective achievements and impact on the society. However, in the Indian scenario, the achievements are being shown as the number of institutions created for the purpose or the total number of visitors to such portals for science communication. Rarely do we find any objective evaluation of the activities or programmes. To measure achievements, science communicators often record the growth of the infrastructure, its reach – how many

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towns or villages or kilometers have been covered, increase in visitor footfall or even growth in budget and revenue earning. All these indicators are valued attributes of the network strength but the visitor-centric achievement indicators are often ignored. In other words, science communication organizations tend to measure the success or failures of their missions by the growth of their own institutional values but rarely by the measure of the value added to the users of these institutions.

To elaborate on the above view, it is necessary to bring in the learning outcome factors associated with science communication activities which are designed and offered for engaging the targeted users. It is intended that the experience the user gets catalyses some *change* in him or her. This change may be in the attitude or behaviour or in the awareness, knowledge or skill of the user. There may be changes in multiple areas also. But if the programme design does not have any outcome goal fixed for it, the end result cannot be assessed or measured. All science communication efforts have an ultimate aim of social empowerment. For years since independence, we are strongly advocating for creation of a scientific temper among the masses by widespread scaling up of science literacy and awareness level on scientific and technological issues. However, this cannot be achieved through a single or a few activities. To spread science education and awareness in a country like ours, efforts from multiple agencies, governmental and non-governmental must work in tandem. In India, this joint endeavour is currently in place and growing but the results are not apparent or clearly comprehensible. The main reason for this is a profound lack of seriousness in evaluating the outcome indicators to understand the extent of achievement of our missions although on the other hand, there is no dearth of professional expertise in India for producing excellent exhibit hardware with which we intend to take the message of S&T to our people.

There are internationally accepted parameters to define the state of scientific temper in a community or educational outcomes in a non-formal setting. There are assessment procedures researched and followed in practice internationally for measuring such parameters and establishing correlation between intended outcomes with science centre visits or with participation in other science communication activities. In the US and in Europe, particularly in the UK, mission achievements of cultural institutions, science museums, botanical and zoological gardens are regularly done through scientific evaluation procedures. Australia is another country that puts serious effort behind such assessments. Notwithstanding the fact that learning outcomes are intangible to some extent, these countries rely on the continuous research that goes on to make the evaluation procedures more scientific and comprehensive so that more and more plausible correlations between museum visits or participation in science communication activities with the benefits derived out of them by the user communities can be established. In many countries, evaluation results of this kind determine the quantum of funding by the government or private sources. There are records that show further investments being denied for not being able to establish a favourable cost-benefit ratio in some science communication activities or even for not making evaluation results available to investors. In the recent past, some science centres in Europe, large and small, had to cut down on their activities and expansion plans because funding was denied for the want of evaluation data and in some cases, the same showing insignificant positive results. In India, however, such a situation has not yet arisen but a time will soon come when funding from the Government or other sources would depend on a clear showing of mission achievements, not just in terms of the number of users or in the number of science centres established or by the number of kilometers covered by a science train or a mobile science exhibition but by scientifically evaluated data on achievement of learning outcomes. The Indian network of science communication agencies would rather prepare for this unavoidable situation well in time and consolidate outcome assessment efforts without further delay. Fortunately, such moves have begun during the last few years, particularly in the National Council of Science Museums (NCSM) but a lot is yet to be done.

One of the deliverables expected out of science communication activities is a change in the attitude of the user to science and scientific issues that impact his or her life. Through various communication initiatives, the methods of science or important S&T issues are introduced to the users. Awareness and understanding leads to a change in attitude and this change is expected to generate a collective empowerment with which different sections of the society come forward to take part in the decision making process particularly in the scientific and technological issues that affect the community or the society in a broader frame. If a change in attitude takes place through an understanding of the methods of Science, one would perhaps start looking at events happening around him or her with a logical frame of mind. On a collective scale, this would generate a *scientific temper* in the community. The most conspicuous effect of such a change would be a reduction in the belief in superstitions and apathy to reform age-old social systems which are not based on scientific truth.

Non-formal science education initiatives are to supplement formal science education given in schools, colleges and universities. It is known that learning of science should involve demonstrations of principles and plenty of hands-on activities. The obvious limitations of our formal science education system in this area can be obviated by the participatory methods of learning offered in the non-formal system. Science communicators, particularly science centres, design many programmes for participation of students but whether these students are actually gaining better concepts of scientific principles or not are not assessed properly. This is where our effort, though sincere and painstaking, falters. In many countries, communicators regularly study the effect of science centre visits of students on the development of better concepts in them. It goes without saying that such studies are also important for museums, zoological gardens, aquaria, botanical gardens or other non-formal science communication organizations. There are established methods for such evaluation and with a little change to suit them in the Indian context; these techniques can be applied effectively.

Improvement of technical skill base in communities is another deliverable targeted by many science communicators. The outcome in this case is not very intangible but seldom have we found long term assessment of activities designed to measure the achievement of such missions. Some communicators try to show results by recording data on the number of community members to whom training modules have been offered or the number of villages or towns covered but these feeble evaluations do not usually highlight long term economic gains in the community as an outcome of the communication activities.

Science centres often act as catalysts between the experts and the users in the field. Birla industrial and Technological Museum (BITM) at Kolkata did a pioneering programme in the backward district of Purulia in West Bengal three decades ago in which appropriate agricultural implements were intended to be introduced for cultivation in the tribal areas of the district where traditional techniques and implements did not yield good crop. The land there is not fertile and inefficient agricultural practice led to abysmal poverty among the tribal population who did not possess any other skill to allay their hardship. Looking at the purpose, one must agree that it was a very important mission, whose success might lead to a significant change in the lives of the tribal communities. The programme involved agricultural experts under whose supervision appropriate implements were fabricated and field trials were rigorously done. BITM and the District Science Centre at Purulia functioned as the catalyst in this Lab to Land experiment all through b as adequate records were not kept and evaluation of t activity was not done on a scientific basis, t successes and failures of that important mission cou not be assessed or studied for future reference. Initial the results were encouraging and the tribal communi apparently took interest in the programme but stopped all together after sometime and no evaluat record is available to find the reasons for which t mission came to an end. Any scientific assessment the programme would have generated information immense value to science communicators. Anoth example of deficiency in programme design associated with the 'School Science Centre' project the National Council of Science Museums. The idea regenerating science communication activities at t school level had potential and a promise proliferating science popularization activities to t grassroots and to a very wide clientele. T programme, started two decades ago with great effo put behind it did not yield expected results and so became dormant. This programme, however, had evaluation component added as a follow up action b actual evaluation was feeble and not plausible to large extent as the data gathered from the schools d not match with the real functional status of the centr observed on physical inspection. Thus, a programm with good potential lost its direction because of t absence of a regular evaluation process.

Different persons come to participate in scien communication activities with different motivations a interests. Some have serious intentions of learning, so visit museums and exhibitions to be aware of cutti edge science. Some others are chance visitors who do n have any motivation at all for the first visit. Scien communicators try to motivate respective audiences so to arouse and enhance their interest in various areas Science and Technology. This, unlike in most form settings, is a complex function as visitors to scien centres or other similar institutions have to cater to heterogeneous audience from varied socio-econom background, diverse age groups and of course dissimil degrees of initiation to Science. Effective programme therefore, need to have a judicious mix of educatio and entertainment components. The exhibits in permanent science gallery need interactivity and go display incorporated in the design for enjoyab participation while the so called *edutainment* faciliti like Large Format Film shows or Laser shows need have supporting exhibits to validate the experience h by the visitor in these shows. Care must also be taken ensure that the visitors do not get negative or wro experiences *(scale models of howling dinosau exhibited in incorrect relative sizes)*. On both coun assessment of the visitors' experience is importa

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Otherwise, the main objectives for investing in exhibits or high-value facilities would be defeated. There is also the risk of science cities and science centres being classified as amusement parks in the public perspective. The permanent science communication facilities like science museums, science centres, zoo gardens and the like have an advantage that visitors can come there repeatedly as they wish to see new additions or to study the old exhibits more intensively as they encounter more of science in their science curriculum.

A count of such persons repeating visits roughly indicates the degree of importance science learners give to a particular science communication facility. For a temporary event like a Science Jatha, Science Fair, Children's Science Congress or a mobile exhibition like a Science Train where there remains no scope for the visitors to come back once the event is over at a particular venue, outcome assessment need to be on the spot. When the intended outcomes are not evaluated, the organizers have only the number of visitors or the number of venues as measures of the achievement of respective missions. There is no doubt that such science communication events are important for spreading Science awareness but these commendable endeavours certainly need careful evaluation of intended outcomes as an imperative follow up action on the spot.

Encouraging students to select a career in Science is another aim of many science communication activities. Some industrial sectors, like Oil & Gas, where trained manpower shortage persists most of the time, are now keen to launch long term science communication programmes right from the school level to encourage participating students to choose careers in specific industrial sectors. The success of such programmes can be ascertained only through a long term evaluation process through which career directions of the participants can be tracked. Information and data received through this process are extremely valuable to modify the strategy and delivery logistics of these very specific result oriented programmes.

So far, in this article, stress has been laid to highlight the importance of evaluation of science communication activities. Such activities are widespread in our country but very little effort goes into the assessment of the results of the missions as the aimed outcomes are considered to be intangible and in most cases, the evaluation techniques are beyond the capability and training of the communicators for putting them in practice. Professionals in this field are seldom hired by museums and similar institutions to conduct evaluation. In other words, the practice of assessment as a follow up action for science communication missions has not developed in India so far. Major thrust has been given to improve the infrastructure and the reach of the activities but hardly any investment has been directed for assessment of results derived by the society from out of the nationwide effort in this field.

A systematic approach is therefore needed to make up for this deficiency. To make a start, the following points may be kept in mind

1. Each science communication activity to have a reasonably defined goal. If such an effort is intended to effect a change in the user's level of comprehension of scientific principles or if it is attempted to change the attitude of the participants toward specific scientific or technological issues, the same must be considered in planning the mission.

2. The exhibits or programmes are to be designed in such a way that one or more measurable components are embedded in them so that the achievement of the goal can be assessed. This can be done by suitably incorporating these components in the hardware or software of the communication tools. *For example, a hands on exhibit explaining aerodynamic lift and drag can be followed by a game on choosing the right kind of wing section of an aircraft or the profile of a car. The selection in the second exhibit would indicate a measure* edge science, while some visitors look for entertaining *of the learning outcome of the preceding one for the visitor.* The key factor in the design of the second exhibit would be its ability to store the data of 'right' and 'wrong' selections. Often, such exhibits are built on digital platforms. There are other designs which can be followed to record the same data mechanically. The other alternative for gathering relevant information is by recording the visitor's response through direct evaluation techniques. There is a current debate on this issue in which some scholars express the view that insertion of measurable components in science communication activities may contradict the very approach of 'free choice learning' but for the time being, Indian communicators may bypass the debate and carry on with capacity building efforts in evaluation techniques.

3. Data gathered through evaluation must be reported to the exhibit or programme designers for modification of designs, if required. Data and resulting changes in design should be archived for future reference.

4. Visitor response is extremely important. They must be heard to achieve mission goals.

5. Interested groups in the audience are to be created across all sections of visitors. Programmes and exhibits must try to enhance the interest level of the visitor to scientific issues. For those who do not have any initial

motivation, new programmes are to be offered to attract them. To identify specific target groups who need special attention, front end evaluation is necessary. *The author, on a recent visit to the galleries of a national level science centre observed that a large group of students from a corporation run primary school walked through the gallery in single file without even looking at the exhibits. Probably the group was brought by the school to the science centre on an instruction from the authorities and the students apparently did not receive any memorable experience in their visit. In this case, the number of student visitors to the science centre increased but learning outcome was almost nil evidently.* For such student groups who visit the science centre almost daily, proper evaluation of their requirement must be done in consultation with their teachers and useful programmes are to be designed. The irony is, even though such visitor groups are regularly found in science museums, science centres or other non-formal science communication institutions, serious evaluation is seldom done to find out what is lacking in the offer and how more value can be added to it to engage the visitors more fruitfully.

6. Evaluation and impact assessment studies are to be continuous processes.

In India, a good infrastructure for science communication activities is in place. Support from the Government of India and state governments are also available to carry forward such activities. The intensity and spread of the efforts have grown substantially in the last decade. Institutions working in this field cannot ignore impact assessment studies any more as accountability and funding justification can be established only through scientific assessment of the impact made to the society by these institutions and agencies. Capability in this important follow up action can be built in stages.

Stage I

* Sensitise science communicators, exhibit designers and educators and most importantlythe heads of institutions and agencies in the field about the importance of conducting evaluation and long term impact assessment studies.

* Study the latest techniques being followed in other countries for evaluating learning outcomes. Plenty of published materials are available.

* Start small evaluation projects linked to the programme goals and analyse data.

* Gather data from all sources. Carefully check authenticity through corroboration.

* Heads of institutions may start allocating budget for activities on the basis of evaluated results.

* Train people in formative and summative evaluation techniques.

Stage II

* Identify important activities like permanent exhibitions in galleries, mobile science exhibitions including Science Trains, internet based communications etc. for systematic evaluation.

* Collaborate with organizations having experience in evaluation and impact assessment projects. There are several institutions abroad who are world leaders in this field. The Smithsonian Institution, Washington DC, University of Leicester and the Imperial College, London in the UK or the Australian National University in Canberra have ample experience in learning outcome evaluation. The NCSM network in our country which is already collaborating with the Smithsonian Institution for conducting its course on 'Science Communication' leading to MS degree may consider initiating a new collaboration entirely on this subject. The Education departments of a few major universities in India and other institutions like the Indian Statistical Institute or some evaluators in the private sector in India may also be contacted for collaborative projects. Moreover, there are several projects sponsored by the science centre networks, universities or the National Science Foundation of the US which can be tapped for data. NCSM, with its all India network and substantially large visitor base, may join hands with other science centre networks like ASTC or ECSITE to partially sponsor such studies by professionals and offer direct participation for the part of the project conducted in India. This will help in yielding good results not only in terms of data collected but also in building indigenous capability.

* Link budget demands with evaluation and long term assessment results. Programmes found more valuable and relevant to the society need more money to be spent on them while less successful ones need money for modifications and further trial.

* Carry out formative and summative evaluations extensively and regularly once the scientific methods are learnt and build up in-house expertise gradually.

Stage III

* Publish and exchange data.

* Encourage other science communication agencies to carry out evaluation studies even though their intended learning outcome focus may be different.

* Institute permanent fellowships to form dedicated groups of mission evaluators.

Notwithstanding the absence of a scientifically evaluated proof of the popularity or relevance of science communication activities in our country, it is encouraging to find that the demand for such activities has been high and growing. New science centres are being set up in different corners in the country and the states are always demanding more. The popularity of these institutions and the growing demand indicate that the activities conducted by these institutions are adding values to the communities. Our problem is that we are not very sure which of the activities are valuable and relevant and which need modification or discontinuation. Had we conducted adequate follow up assessment of the activities, the entire effort could be made more meaningful, efficient and cost effective.

It is heartening to note that of late, impact assessment studies and evaluation programmes have been initiated by some institutions in this field. This author has direct experience of being associated with one of them initiated by NCSM. The studies to assess the personal and societal impacts of the activities conducted by one of the major science museums under NCSM were conducted following methods similar to those followed by others earlier in the international field. The adoption was somewhat feeble having some deficiency in formulating the study questionnaires for school students and teachers but the analysis of the collected data yielded valuable and encouraging information about the impact of the activities of the particular science museum. It was the first long term impact study conducted by NCSM and by nature was very different from the routine visitor studies conducted in various science centres and other non-formal science communication agencies. Such pioneering efforts need to be taken further to position the Indian science communication efforts at the forefront in the international scenario on our own strength.

Professor Thacker in his Science Congress speech said '*If history has a lesson, it is this : everything that sustains and progresses comes as an upsurge from within, not as a result of something imported or invited, from without. Nothing sustains unless it is of the people and by the people.*'

Our own science communicators, dedicated and dynamic, will certainly take this challenge.

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