

## 34. Impact of Public Communication of Science and Technology on the Indian Society—Development of An Assessment Framework

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**Abstract.** There is a wide recognition that communication of science and technology plays a central role in the socioeconomic, cultural, and environmental development of any country. It has been a continuous national endeavor both by the governmental and the non-governmental organizations to infuse scientific temper in the society, thereby building a nation of scientifically aware and scientifically thinking people.

In 1980, science communication was given prominence in India's Vth Five Year Plan and two years later the National Council for Science and Technology Communication (NCSTC) was established with a mission to communicate science and technology, stimulate scientific and technological temper and coordinate and orchestrate such efforts to create excitement concerning advances in science and technology, to enable informed decision-making at the grass root level and to encourage intelligent debate on developmental issues. Social impacts of such activities cover a wide spectrum from behavioral/attitudinal changes of the individual to the alterations in the way people live, work, play, develop skills, relate to each other and organize their communities and institutions to meet their needs and guide their collective actions, as well as changes in their characteristic values, beliefs, norms, traditions and perceptions of quality of life and well being. Although much has been achieved, there is still an urgent need to make science communication activities more effective, both in terms of quality and quantity.

In this context, a study had been undertaken to design an impact assessment framework for the NCSTC-Network to assess the effects of public communication of science and technology impacted on the society from both theoretical and empirical angles. The proposed/suggested framework aims to clearly link and, if possible attribute, impacts in behavioral and attitudinal change on the ways in which the stakeholders organize, operate, work, and collaborate to fulfill their respective or collective goals/needs like knowledge gained/diffused, skills developed, awareness and understanding enhanced, contacts and network formed, confidence and credence developed through such activities.

**Keywords:** Framework, Impact assessment, NCSTC-Network, S&T communication

### Introduction

Science and technology is an integral part of the socio-economic developmental process of a country (Ahmed and Stein, 2004). It seeks to build the understanding, skills and knowledge base of individuals and institutions. The importance of science and technology to modern societies and the role of a technologically educated population in promoting social and economic development has long been recognized (United Nations, 2002, 2002a). Science and technology communication is broadly understood as the system of measures aimed at the dissemination (Libutti and Valente, 2006), appropriation and valuing of science and technology goods (Martinez, 1999; Simon, 2009) which include critical thought, ideas and values (Burns et al., 2003; Treise and Weigold, 2002), history and sociology of scientific knowledge, how science is practiced and the results of scientific research and technological development (Abreu, 2004; Lee et al., 2005; Miller, 2004).

The communication of science and technology plays a central role in the socioeconomic, cultural, and environmental development of any country (Miller et al., 1997; Rogers, 1976). In socioeconomic terms, the communication of science and technology makes it possible to spark new vocations and encourage talent for scientific research, technological development, and intellectual endeavors in general (Miller, 1995, 1998, 2004; Miller and Kimmel, 2001). It fosters creativity and innovation contributing in the production of better trained human resources, expands social opportunities and strengthens the educational system. Culturally and environmentally, the popularization of science enhances the critical sense of the population, by increasing its involvement in decision-making and contributing to democratic stability and sustainable development (Ahmed and Stein, 2004; Powell and Kleinman, 2008).

It has been a continuous national endeavor both by the governmental and the non-governmental organizations, to infuse scientific temper in the society, thereby building a nation of scientifically aware and thinking people (Mazzonetto, 2005). Despite the efforts, many citizens remain ill-informed about scientific advances. For example,

an analysis of survey results aimed at determining civic scientific literacy indicates that only slightly over 10 %

of the population of 14 industrialized countries has a good understanding both of scientific concepts and methods (Miller, 1996). Various agents are involved in popularizing science, each with different roles and functions. Therefore, popularization of science requires integrated action by knowledge producers, such as scientists, researchers and intellectuals, and knowledge disseminators, such as journalists, publicists, museologists, teachers, audiovisual aid producers, and members of scientific, cultural, and social institutions.

In India, NCSTC-Network has been doing pioneering work in this direction for the last twenty years with the objective of science and technology communication. It endeavors to communicate science and technology, stimulate scientific and technological temper and coordinate and orchestrate such efforts to create excitement concerning advances in science and technology, to enable informed decision-making at the grass roots level and to encourage intelligent debate on developmental issues. National Teacher's Science Congress and National Children's Science Congress are regularly being organized to enlighten both the teachers and children to share critical review of science education and to relate the learning of science to their immediate social and physical environment. Several schools, colleges and Non Governmental Organizations also contribute considerably in this perspective. Apart from these two programmes, NCSTC-Network has also organized several other programmes such as Year of Scientific Awareness-2004, Appreciating Physics in daily life-2005, Understanding Planet Earth Programme-2008-09 and also activities during the first run of the Science Express which was started on October 2007 and ended on May 2008.

Social impacts of such programs include changes that affect individuals, groups, communities and populations as well as the interactions between them. They are alterations in the way people live, work, play, relate to each other and organize their communities and institutions to meet their needs and guide their collective actions, as well as changes in their characteristic values, beliefs, norms, traditions and perceptions of quality of life and well being. In this short span of twenty years, NCSTC-Network has several accolades to its credit. Its activities have different effects on the audience with different impacts. It has developed a network of around 70-80 strong S&T based members to propagate its mission/goals and to help it in planning various activities. However, in spite of all efforts, there still exists a huge gap between the desired and the actual social perceptions of scientific knowledge. Little studies have been carried out to measure and evaluate the civic scientific literacy and impacts of science and technology communication programmes being performed by the NCSTC-Network.

The present study aims at designing an impact assessment framework for the NCSTC-Network from both theoretical and empirical angles taking into account various activities/programs performed by the network members. Although, rigorous analyses can be performed, it will be appropriate to mention that the methodologies/framework adopted/suggested would be 'indicative' in nature.

## **Methodology and Approaches**

### ***Selection of programmes***

As a preliminary step in the application of impact assessment study, selection criteria has been applied to shortlist the S&T communication related programmes for which societal impacts are easily visible along with available data. Two major programmes performed and executed by the NCSTC Network viz., National Teacher's Science Congress (NTSC) and National Children's Science Congress (NCSC) have been considered in the present study, though they are conducting several other programmes during this twenty years of time, viz., Year of Scientific Awareness- 2004, Appreciating Physics in Everyday Life- 2006, Understanding Planet Earth Programme-2008 & 09.

### ***Background analysis***

Background analysis is the preliminary step to determine whether social effects are likely to occur as a result of the proposed programme. Background analysis has been performed to identify as many as possible of the user groups and communities that may be affected by the action. Various clues to the nature and intensity of possible social impacts obtained from different stakeholders and network members participating in the process have been recorded.

### ***Data collection strategies***

Data collection is not only a very challenging job but also labour intensive, time consuming and expensive. A brief description of various kinds of data collection strategies which can successfully be explored to capture the science communication activities performed by the NCSTC Network is presented below:

1. Case studies: Case studies are a structured and detailed investigation of an organization. They are designed to analyze the context and the processes involved in science communication. The questions asked and methods used generally differ from case to case, so they cannot be considered strictly comparable. Because case studies
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are in-depth investigations, they can make good use of any combination of different evaluation tools, including direct observations and reviewing existing documents.

- Direct observations: This tool is particularly useful in assessing scientific awareness built. It highlights the potential value of enlisting external experts to observe an organization's activities and facilities, and how they are mobilizing people from scientific capacity building perspective. Internal staff and managers are often so familiar with the organizational environment that they no longer notice good or bad aspects of the organization. An outsider with knowledge of similar organizations might see these immediately. This tool can be particularly effective when combined with self-assessment.
  - Review of existing documents: Archives, websites, annual reports, budgets and minutes of meetings are an indispensable source of information and a good starting point for discussion about the impacts of science popularization activities. They also provide a focus for the collection of additional information. If records are well kept and complete, they can provide essential quantitative information about inputs to scientific awareness building, staffing issues, remuneration and working conditions, the utilization of resources, and the overall performance of an organization over time.
2. Interviews: Interviews can be conducted to obtain more detailed information on aspects of the science communication activity. Interviewees can be selected on the basis of their responses to survey questions, an affiliation with important interest groups or expert knowledge. Different types of interview methods can be used to elicit different kinds of information.
- Self-assessment workshops: Self-assessment workshops provide an extremely useful means of gathering and analyzing information from organizational science communication initiatives and interpreting results. They also help to build awareness and commitment to the evaluation and support the validation and enrichment of information, conclusions and recommendations. High-level facilitation skills and the proficient utilization of tools for group analysis, synthesis of findings and reporting of results are essential for the successful implementation of these workshops.
  - Key informant interviews: Key informant interviews are generally in-depth, face-to-face discussions with individuals selected on the basis of their affiliation with certain interest groups, or because they are regarded as particularly experienced, insightful or well informed. This tool enables evaluation specialists to capture the views and expectations of stakeholders, such as staff members, clients and end users, concerning awareness-building efforts and changes in scientific rationality and performance over time. These interviews with individuals who are part of the organizational supply chain can also provide important insights into why changes did or did not occur.
  - Group interviews: Group interviews lie somewhere on the continuum between key informant interviews and self-assessment workshops. If competently facilitated, group interviews can capture consensus views of relatively homogeneous groups. They are less appropriate with more heterogeneous groups or when certain individuals tend to dominate the conversation.
  - Personal histories: It is particularly useful when the evaluation covers a long period and/or documentation is limited. Personal histories can capture the perspective of key players concerning the history of an organization, their own personal and professional development.
3. Surveys: The questionnaire survey is probably the most frequently used tool for collecting information for evaluations. Surveys tend to be time- and resource intensive, however, require specialist skills for the preparation of the survey forms, sampling techniques, administration of the survey, management of databases for quantitative and qualitative information, statistical analysis and research. They may also require translation into a number of local languages, in which case the results then have to be processed in those languages and reconstituted into a single set of results. Questionnaire surveys are an extremely useful tool in science communication evaluation. They can be used to identify the skills and knowledge gained as a result of training, workshops, conference activities and what skills they have been able to use on the job. Ideally, surveys are conducted:
- before training, workshops, conference to establish baseline capacities
  - on completion of training, workshops, conference to assess capacity built
  - post training, workshops, conference and return to the work environment to collect information on capacity utilized
  - some time after to assess the impact of the training, workshops, conference.
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### *Selection of variables*

Selection of variables depends to a large part on the availability and reliability of data. The researcher undertaking the analysis will establish standards and criteria for the analysis after reviewing data and considering the time and effort needed for the analysis. The goal of variable selection is to select social factors, from those in the baseline studies, that can be measured in a quantifiable way, thus ensuring that the analysis and assessment can easily be replicated and increasing the objectivity and defensibility of the analysis. Qualitative data is normally used to supplement and interpret the quantitative one. In some cases, information will be primarily qualitative supported by one or two quantifiable variables. Development of matrices of variables, the baseline case and alternative scenarios is often the simplest way of showing social change and social impacts. The selection of the key sub-variables from each general category should meet the general standards and criteria such as relevance to the analysis; significance; availability; efficiency; sensitivity; accuracy; and validity. However, without adequate baseline data and careful analysis, an impact assessment does not provide the decision-maker with assessments which help understand long term impacts. Availability of historical time series data can provide further objectivity and clarity to impact assessment studies.

### Identification of indicators

Identification and selection of indicators is one of the most important steps in the impact assessment process. Care must be taken to ensure that the indicators identified actually reflect the potential social effects. Further, the indicators are issue-driven and reflect issues that arose prior to the impact assessment process. Indicators selected should articulate the dimensions of the social system. The indicators associated with the issues can be utilized as major analytical backgrounds for impact assessment studies.

### *Design of framework / model*

Variables, indicators and tools can be integrated into an analytical framework to develop a viable impact assessment framework covering a wide spectrum of impacts through qualitative and quantitative estimation relating to productivity and efficiency effects on NCSTC Network and broader impact on the societal welfare etc.

## **Suggested Framework**

### Impact assessment framework

The impacts of NTSC and NCSC which facilitate a wide platform to exchange views on scientific education and enlighten the teachers and students sometimes seems to be overlooked due to shortcomings in attributing/ observing benefits of the conference, training workshop, plenary session and exhibition being conducted by the NCSTC - Network. For example, the exposure of the teachers of rural area to such national event and interaction with educationists of country give them new ideas to teach the students more effectively. However, attention is rarely paid to elucidating and substantiating the assumed linkages between the above activities and the intended or observed impacts on society.

The proposed framework aims to clearly link and, if possible attribute, impacts in behavioral and attitudinal change on the ways in which the stakeholders organize, operate, work, and collaborate to fulfill their respective or collective goals/needs like knowledge gained/diffused, skills developed, awareness and understanding enhanced, contacts and network formed, confidence and credence developed through such activities.

The framework has three parts:

The analytical framework presents the array of pathways through which generation of scientific awareness by way of investments in different activities of the NTSC and NCSC can result in nurturing a sufficient pool of knowledge intensive human resource. The focus is on the teachers and students. However, the benefits accruing to other individuals (like backward communities in the society) flowing indirectly from these activities can also be identified for estimation.

Applying the framework requires assessing what can be measured, how the data can be analyzed and assigning the responsibilities for measurement and analysis. While the goal is to measure impact flows, this may be too costly or, where the pathways are indirect, too complex, so other evidence of impacts should be identified for collection.

Tools for estimating impacts are the third part of the framework. Fig. 1 summarizes the impact framework.

### *The analytical framework*

The analytical framework set out here focuses on evaluating the impacts attributable to NTSC and NCSC activities. This requires mapping the pathways from the science communication to impacts. These pathways may be direct or indirect, strong or weak, and certain or highly uncertain. The mapping should seek to classify the pathways identified according to these criteria.

Application of the analytical framework is the first step in valuing impacts considered attributable to the conference, training workshop, plenary session and exhibition being conducted by the NCSTC Network. Evaluation of benefits is generally easier when the pathways are direct, strong and certain. However, even when they are indirect and somewhat uncertain, a good case should be possible for SWOT analysis if data is available.

The analytical framework is presented in Fig. 2. It shows an array of potential pathways for a range of NTSC and NCSC activities. The framework aims to identify the changes at each level. Working from bottom to top, these changes are as follows.

1. NTSC and NCSC inputs:
  - Expenditure on conference, training workshop, plenary session and exhibition by suppliers and participants,
  - including the value of time and in-kind support
2. Capacity built in the individual teacher/student/participant. This may include:
  - knowledge gained
  - skills developed
  - awareness and understanding enhanced
  - contacts and network formed
  - confidence and credence developed
3. Capacity utilized by the organization from which the participants take part. The change in practice and/or behaviour resulting from the utilization of new experience built could include:
  - training of other staff, which in turn leads to:
    - i. application of the capacity to work to improve quality, effectiveness and/or efficiency of service delivery,
    - ii. policy advice
    - iii. utilisation of new technologies
  - greater networking, accessing information, improved communications etc.
4. Impact on the clients (teachers/students) arising from capacity utilized. These can be:
  - observable changes in low cost innovation techniques employed by teachers, and/or
  - changes in the operating environment where teachers educate the students in school or colleges.
  - changes in skill and problem solving capacity among the students to meet the needs of the society.
5. Observed benefits and external factors:
  - the benefits accruing to teachers, students and other stakeholders (backward communities) as a result of the newly adopted scientific knowledge.

### **Applying the Framework**

This section of the impact assessment framework guides the user through five steps for applying the framework. These steps map the pathways and establish the means by which the validity of the identified changes can be substantiated:

1. utilise the framework to identify the changes occurring as a result of conference, training workshop, plenary session and exhibition (map the pathways)
2. determine the measures and indicators required to verify the identified changes
3. establish the data required for the measures and indicators, verify the availability of these data from appropriate sources and select the most appropriate tools for the collection and analysis of the data
4. determine the extent to which benefits can be attributed to the capacity-building activity
5. assign responsibilities for data collection and evaluation and reporting.

### *Tools for estimating impacts*

The intended impacts to be effected on the society have been explicitly expressed in the NTSC and NCSC programmes itself. Examples of the potential measures and indicators of this change in the scientific awareness, as well as the data required, the data sources and appropriate evaluation tools are outlined in Table 1.

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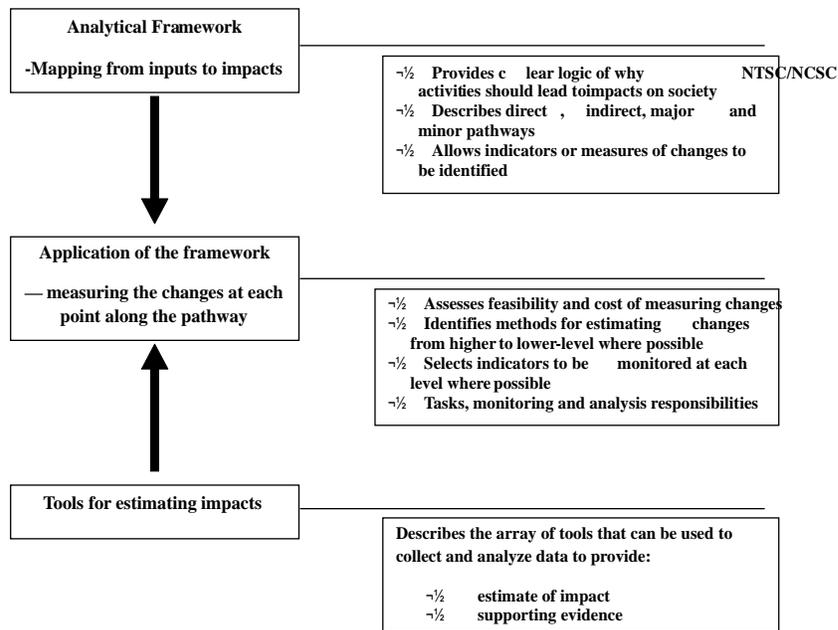


Fig. 1. The Impact Assessment Framework

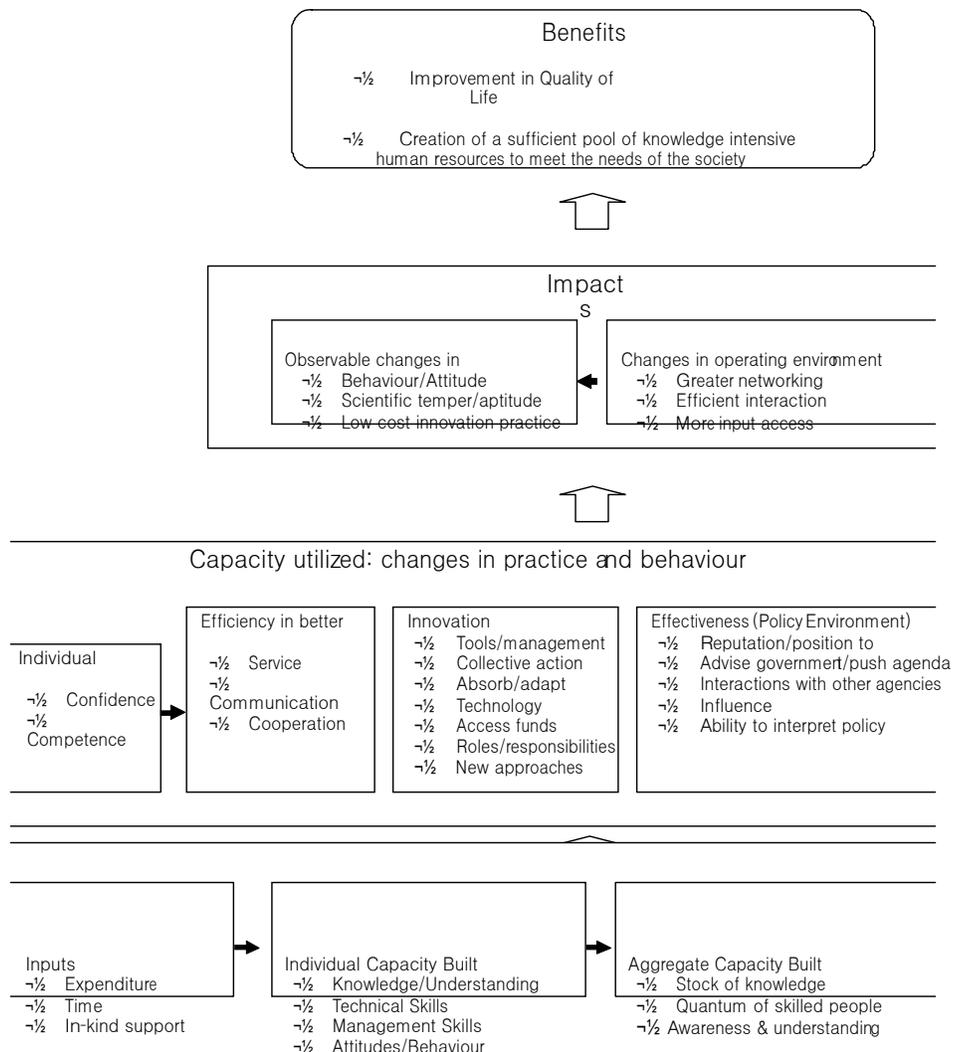


Fig. 2. The Analytical Framework

**Table 1. Potential indicators and tools for estimating impacts**

Indicator	Data required		Data source
<b>Tool</b> Quantum of scientific temper built	Existing capacity: sum of study years plus years of experience	Records kept by NCSTC review	Document
(knowledge gained/skill developed/ awareness and understanding enhanced/ contacts and network formed/ confidence and credence developed etc.)	Capacity added by conference, equivalence to experience etc.	involved in relevant work in target area(s);	Key stakeholder interview
Quality of conference, training workshop, plenary session and exhibition etc.	Assessment of content of conference, training workshop, plenary session and exhibition	Previous similar estimates Expert opinion	Expert document review
Attendance many participants/how	how	NCSTC/Conference sessions	Document review
	many sessions		
Quality delivery of Conference/Workshops etc.	Participants opinions	Attendance sheets kept by the organizers	Post-training survey

Participants satisfaction  
Post-training survey

Participants opinions

Participants

Quality of Reports to stock of knowledge

Reports to stock of knowledge

NCSTC  
Expert review

