PUBLIC UNDERSTANDING OF SCIENCE AND TECHNOLOGY: RESULTS FROM FIRST INDIA SCIENCE REPORT

Rajesh Shukla
National Council of Applied Economic Research, New Delhi, India

Abstract

The growth of any nation not only depends on the impact of its S&T efforts on technology exports but also on the lives of the common man. This first India Science Report marks a pioneering attempt at seeking to inject new dynamism in the country's database and statistical system related to science and technology. Such efforts are consistent with India's growing emergence in the global economy as well as her attempts at becoming a substantial player in the new knowledge-based services and products. One of the major issue covered in the report is the Public Understanding of Science and Technology (PUST), and is characterized by a first-ever primary data household survey.

The First India Science Report was aimed to focus on three major issues, namely, science and engineering education, utilisation pattern of human resources and public attitude towards science and technology. To achieve this goal a nationwide survey called 'National Science Survey- 2004' was undertaken to generate a statistically appropriate database to generate reliable estimates of various parameters related to these important issues. Although this was a household survey, the ultimate unit of selection and collection of primary information was the individual over ten years of age as he/she belongs to a society that is diverse in culture and socio-economic development.

Results show that despite the poor interest in science and technology (S&T) programmes, most Indians have great faith in science; over three fourths feel S&T is important for education, 58% feel the same way about the economy, and 72% about agriculture. The report also found that the level of knowledge the population has about scientific concepts is very high. India scores slightly lower than the US on attitudes towards science and technology. Overall, the perception is that the benefits of S&T are higher than its deleterious effects. This is a positive trend in a country that is poised to make a mark for itself in the field of science and technology in the next century.

Keywords: Science and Technology, Public Understanding of Science and Technology.

1. Introduction

Science has been man's greatest ally since the dawn of civilisation. It has created innumerable pathways to progress that have taken man from his primitive cave habitat to the moon, indeed a very long journey in terms of both space and time. The scientific and technological breakthroughs, along with the changing attitudes of the Indian society towards scientific thinking, have led to a change in every walk of life.

Individuals undergo a period of training, within the family, at school, in the college or university, at work, and, less formally, through reading and leisure. This increasingly lifelong process allows an individual to acquire knowledge and abilities, to construct an image of science, technology, and the professions associated with them, and to develop values and attitudes towards them. The degree to which these elements are mastered varies among individuals and groups, and also in relation to the social role these individuals and groups have. Thus, S&T reaches each individual differently, depending on his or her social role and position, which in turn explains why S&T culture varies for each individual.

Technological development in most developing countries is still at a stage where they are learning and mastering advanced achievements made elsewhere in the world. In this context, therefore, education efforts and scientific activities which enable the masses to manipulate and assimilate advanced technologies are perhaps more important than purely academic research. Despite these efforts, many citizens remain ill informed about scientific advances, about how science pushes back the frontiers of knowledge, and precisely how technology affects their lives. As a result, most members of the public are unable to arrive at substantiated judgments about matters involving science and technology, particularly in the area of policy.

There are many reasons to value Public Understanding of Science and Technology (PUST). Some experts emphasise its value in terms of the cultural development of citizens; some see it as a prerequisite for economic development and innovation; while others believe that it enables people to understand the scientific basis of modern society so they can play an active role in social debates. Thus, acceptable PUST extends from a minimum amount of scientific knowledge, which any individual should ideally possess, to a more global view of social mastery of scientific and technological developments. In between, the more practical view of PUST is as an asset for economic development.

So far, public understanding and perception about S&T has been a relatively unexplored area of study in India. The existing surveys carried out on the subject are only indicative but not representative in nature. This first India Science

Report marks a pioneering attempt at seeking to inject new dynamism in the country's database and statistical system related to science and technology. Such efforts are consistent with India's growing emergence in the global economy as well as her attempts at becoming a substantial player in the new knowledge-based services and products. One of the major issue covered in the report is the Public Understanding of Science and Technology (PUST), and is characterized by a first-ever primary data household survey. The aim of this paper is to understand people's perception about scientific and technological issues, awareness about these issues, and how closely the masses follow such issues. The results and discussion in this paper are primarily based on the analysis of primary data collected through the National Science Survey for the year 2003-04 for the First India Science Report.

Data Sources

The results presented in this paper are primarily based on information collected through an all-India field survey called the "National Science Survey-2004" undertaken by the National Council of Applied Economic Research. Sample respondents, individuals over 10 years of age, were selected by adopting a multistage stratified random sampling design from a wide cross-section of people (age, education, and sex) in the country. In view of India's diversity in terms of languages and locations, the sample size and selection procedure were designed to provide state level estimates. Respondents were selected from entire country by covering both rural and urban areas, with the objective of enhancing the precision of the estimates.

The rural sample was selected from a representative number of districts from across the country, while the urban sample sampled from big metropolitan cities to small towns with populations below 5,000. A total of 346,000 individuals (115,000 rural and 231,000 urban) were listed covering 553 villages in 152 districts as rural and 1128 urban blocks in 213 towns as urban. Over 30,000 individuals were selected from the listed individuals to collect detailed information through a questionnaire approach involving face-to-face interviews.

The perception of students and teachers was sought by probing them on important aspects such as learning environment of science at schools as well as at home, teaching quality, liking for science subjects, preferred higher degrees, preferred stream, preferred occupation, etc. A separate set of questionnaires for students (6,722) and teachers (1,681) were independently canvassed during the survey.

2. Does S&T Benefit Us?

Though they spend very little time following science and technology news, and the usage of technology is low, Indians are very open to the benefits of S&T, and the level of knowledge of certain core science and technology concepts is quite clear. Fifty seven per cent people have given correct answers to basic S&T questions such as whether the centre of the earth is hot and 86% on whether the oxygen we breathe comes from plants. And while the proportion of illiterates giving the correct answer to whether the centre of the earth is hot is low (32% as compared to 85% in the case of graduates), their knowledge of other basic scientific concepts is quite high. Sixty per cent of those who are illiterate, for instance, say you should not sleep under a dense tree at night and 75% say that plants are living organisms.

Most Indians have great faith in science, as a result of which just a fourth think the government is spending enough money in the area. Over three fourths of Indians feel S&T is important for education, 58% feel the same way for the economy, 72% for agriculture and 58% for the economy.

While there is a large difference in the attitudes of people towards this depending upon their education, the difference due to income groups is a lot less pronounced. A little over 35% of the illiterates, for instance, are of the view that S&T has a significant impact on the economy as compared to 91% postgraduates. Yet, when looked at from the point of view of people in different income groups, the jump is only from 54% for those in the bottom-most income quintile (Q1) to 73% in the top-most income quintile (Q5).

More than three-fourths feel that S&T makes lives healthier and more comfortable. On the whole, people feel that the benefits of science and technology outweigh (by 1.1 times) the perceived harmful effects. The differences in perception are more pronounced depending on education classes in comparison with income classes. Just 56% of the illiterates feel that S&T makes lives easier and more comfortable as compared to 98% postgraduates – that is, there is a 77% increase as we move from illiterates to postgraduates. Yet, when we look at people in the bottom-most quintile, 72% feel S&T makes lives easier and more comfortable and this goes up to 87% in the top-most quintile. In other words, there is an increase of just 21% from the bottom to the top quintile.

While 68% of the illiterates could not say whether computers and factory automation will create more jobs than eliminate, 12% feel this is correct and 20% say the opposite is true – that is, computers and office automation will eliminate more jobs than create. In the case of graduates, 54% agree with the premise, 35% disagree and 11% don't know. In terms of income groups, an equal number (24%) of the bottom-most quintile is of the view that job losses

would be as great as jobs gained. Forty-one per cent of the top quintile feels more jobs will be created and 38% feel more jobs will be lost.

In other words, while there is an increased acceptance of the benefits of computerisation and office automation as individuals get more educated, matters remain undecided even as one moves up the income ladder. When an overall tally is done taking all factors into account, however, the balance of opinion is that S&T benefits the country, and this remains true for all sets of people, ranging from the illiterate to postgraduates and from the bottom-most income quintile to the top-most income quintile.

Over three-fourths people in rural India also, for instance, feel that S&T makes life healthier and easier (against 80% for urban areas) and 57% feel that new technology makes work more interesting (68% for urban areas).

Four sets of statements have been taken to represent the pros and cons of S&T and people were asked to either agree or disagree with these positions. The results have been added up to give the 'promise' index (PI) and the 'reservation' index (RI).

Statements used to arrive at the PI:

S&T makes our life healthier, easier and more comfortable.

Scientists work on things to make our lives better.

The application of S&T makes work more interesting.

S&T will create more opportunities for the next generation.

Statements used to arrive at the RI:

We depend too much on science and technology.

Technology creates an artificial and inhuman way of living.

Science makes our life change too fast.

Computers and factory automation will eliminate more jobs than create.

Interestingly, while the actual values of the indices of 'promise' and 'reservation' differ for urban and rural areas, the promise to reservation ratio (PI/RI ratio), which can be interpreted as the willingness to accept new technology, is the same for both rural and urban areas. The PI is 56.4 for rural areas and the RI is 53.4, giving a PI/RI of 1.1. For urban areas, the PI is a higher 64.1 but so is the RI at 60.5 – the PI/RI for urban areas, however, is the same 1.1 as for rural areas.

3. Major Sources of Information and the Utilisation Pattern

Communication is a valuable means of generating interest among people. It influences attitudes, opinions, and behaviour in favour of various programmes and policies. Information on access to media and people's perception helps in understanding the comparative advantage of various media alternates. The *National Science Survey-2004* collected information from people aged 10 years and above regarding exposure to various media sources like television, newspaper/magazines, Internet/e-mail etc. and evaluated trends and differentials in the exposure to media sources.

Television remains the primary source (57%) of all information in the country, and is almost five times as popular as newspapers. Not surprisingly, given the availability of television, close to three-fourths of urban households rely on this as compared to half the rural households. What is surprising, though, is that even the literate rely on TV far more than they do on the written word – indeed, while 41% of illiterates rely on TV as their main source of information, the figure is 65% for graduates. Forty-eight per cent of Indians who watch TV do so on a daily basis (87% for urban areas and 31% for rural), but just 32% read the newspaper/s every day.

While even the literate rely more on TV for their information, the same remains true of each income class as well. A little less than 48% of the bottom-most quintile families rely on TV as their main source of information for current events while the figure goes up to as high as 72% in the top-most quintile.

The Internet as a source of information is very minuscule, which account for less than one per cent of all information sources. A little over 15% of people who access the Internet for information do so at home, while the bulk do so either at cyber cafes and other such public places (41.5%), or at their work place (15.7%).

By way of comparison, close to three-fourths of the people who access TV do so at home. Over 45% of people get their newspapers at home, while around 18% read them at neighbours' houses and another fourth do so at public places. Not surprisingly, while just a tenth of the people feel TV access is poor/not available, the figure is 20% for newspapers and over 55% for the Internet. While over 95% of people have never used the Internet, just 0.5% uses it on a daily basis.

4. Where do Indians get Information on S&T?

While 31% of Indians have never visited a cinema hall or seen a video, the figure is around two-thirds for places such as a science institute/park/museums/planetarium and zoos/aquariums. Under three per cent of the families (5.7% in urban areas and 1.7% in rural ones) have visited a science institute once while around 12% have visited a museum once, a fifth have been to a zoo, and just five per cent to a library.

Close to two-thirds of the population gets its science-related information from the TV as compared to under eight per cent from newspapers. Of all the programmes related to science and technology, weather remains the most popular (60% of people watch these), followed by health programmes (36%), and scientific discoveries (25%).

Entertainment is the highest ranked in terms of preference by individuals, and is closely followed by news. Cultural/religious news/coverage is ranked higher than sports or politics, and science and technology is ranked lowest. Both the richer groups as well as the more educated have a higher interest in science and technology news, though the ranking remains the same as it does for others – last.

There is not much of a difference between rural and urban areas as far as ranking of programmes is concerned and entertainment followed by news remains the preferred ranking in both regions. Urban areas rank sports ahead of cultural/religious events while rural areas do the opposite.

5. Classifying the Public as Attentive, Interested, or Residual

While those surveyed were asked if they were interested in various subjects and whether they felt they knew enough (were informed) about the subject, this query was subjected to one more test – did the surveyed individuals read a newspaper/magazine regularly on subjects of interest. Those who passed this last test were categorised as 'attentive' public.

On an average, 19% of Indians can be classified as 'attentive', and another 11% as interested. The degree of 'attentiveness' varies dramatically from rural to urban areas (16% of rural India is attentive as compared to 26% for urban areas), between illiterates and postgraduates (from 1.2% to 60.4%), and between different income groups (12% for the lowest quintile and 39% for the top one).

As regards the age group, the percentage of attentive individuals is highest for the 31-45 year age group followed by 19.5% for 10-30 years and 16.4% for more than 45 years. Amongst the educated groups, the percentage of attentive individuals is naturally at a minimum among the illiterate (1.2%) and maximum among postgraduates (60.4%). A positive correlation exists between attentive individuals to various issues and the level of formal education. Only 19.2% individuals up to class 12 are categorised as attentive individuals whereas 49% graduates are categorised as attentive individuals. Occupational data indicate that maximum percentage of attentive individuals are professionals (48.6%) followed by clerical workers (46.3%), administrative workers (45.7%), service workers (34.2%), production workers (24.4%), and other workers (15.9%).

Between 20-25% individuals are classified as 'attentive' for issues relating to agriculture, local issues, employment, poor people, old people, women, and rural/urban development (Fig. 4.10). Between 10-20% individuals are considered attentive for issues relating to handicapped people, economic affairs, politics, environment, and S&T discoveries. Less than 10% individuals are attentive for issues pertaining to foreign policy and space exploration.

Between 10-15% individuals are categorised as 'interested' in issues relating to agriculture, local school, employment, poor people, old people, women, handicapped people, rural/urban development, and economic affairs. Less than 10% people are interested in issues relating to politics, foreign policy, environment, S&T discoveries and space exploration. Between 60-86% individuals are residual for all issues under reference.

Over 27% of Indians fall in the 'attentive' category as far as local school issues are concerned, 23% do so over agriculture issues, and 18% for economy/business issues. Not too many Indians are interested in foreign policy issue (nine per cent) or space exploration (eight per cent).

6. Public Understanding of S&T Issues

On an average, the level of knowledge the population has about scientific concepts is very high – 57% of people answered correctly that the centre of the earth is hot, 86% that the oxygen we breathe comes from plants. Not surprisingly, given how women are blamed for not having a male child, just 38% know that the sex of the child depends on the father!

While the answers to science-related questions tend to be increasingly correct as the education levels of the respondents rise, the extent of the difference was quite high. Just 32% of the illiterates know that the centre of the earth is very hot, as compared to 85% graduates. But an indication of an understanding of traditional knowledge came from the fact that 60% of illiterates said one should not sleep under a dense tree at night and 75% said plants are living organisms.

Indeed, the same difference can be seen in different income groups as well. There is, as in the case of the question of whether the centre of the earth is hot, a huge difference in the answers given by people in different income groups. Less than half of those in the lowest quintile have got the answer right, unlike the over three-fourths in the top quintile.

Yet, in the case of the question as to whether the oxygen we breathe comes from plants (which concerns traditional knowledge), there is not too much of a difference in the answers given by those in different quintiles. Eighty-two per cent of those in the lowest quintile have got it right as compared to 93% in the topmost. As for the response to the question whether plants are living organisms, there is very little difference between the quintiles.

Given the low levels of literacy (especially when it comes to higher education) the degree of knowledge of more complex S&T questions is low. Just 30% of the people know that electrons are smaller than atoms (six per cent of the illiterate have got it right as compared to 78% of the postgraduates), and only eight per cent of the people know that antibodies kill viruses as well as bacteria. Almost 70% know that vaccines must be administered prior to infections.

7. International Comparison of Opinions Regarding Science and Technology

Science and technology is forming an ever-closer relationship with industry and society, and expanding its influence on our everyday lives. This, coupled with the growing impact of socio-economic globalisation, has caused people to experience a rising interest in S&T, not just at a domestic level, but at the international level as well. Against this background, some of the indicators generated through the *National Science Survey-2004* have been compared with similar indicators from the most recent *Science and Engineering Indicators-2002* of the National Science Foundation.

Table 1. 'Attentive' Public: India versus the US
(% of population)

Public Policy Issues	Attentive Public		Interested Public		Residual Public	
	India (2004)	U.S.A. (2001)	India (2004)	U.S.A. (2001)	India (2004)	U.S.A. (2001)
Agriculture and farming	23	6	11	23	66	71
Local schools	27	31	10	28	63	41
Economy and business conditions	18	12	10	33	72	55
International and foreign policy	9	5	6	23	86	72
Environmental pollution	18	10	10	38	73	52
New scientific discoveries	12	7	8	39	80	54
Space exploration	8	5	7	21	85	74

Source: India Science Report 2004; U.S.A: *Science and Engineering Indicators - 2002*

Though India compares unfavourably with the US on parameters like the proportion of its population that understands certain scientific concepts, such as, are electrons smaller than atoms, or whether the centre of the earth is hot; it does reasonably well given its relatively lower income and literacy levels. Indeed, when it comes to issues like an 'attentive' public (that is, the part of the public that is not only interested in certain issues but also follows up with regular reading of newspapers/magazines), India scores much higher than the US.

While India obviously scores over the US when it comes to the proportion of 'attentive' public in agriculture (given the relatively large size of the sector in this country), it also scores better on issues like economy and business conditions where 18% of its population is 'attentive' as compared to 12% in the US. India also has a larger proportion of people who are interested in new scientific discoveries and tracking them regularly in newspapers/ magazines.

Table 2. Level of Scientific Knowledge
(% of population who gave correct response)

Y/N Queries on Scientific Terms and Concepts	India (2004)	U.S.A. (2001)
The centre of the earth is very hot	57	80
The oxygen we breathe comes from plants	86	87
Whether a new born is a boy or girl depends upon the father	38	65
Electrons are smaller than atoms	30	48
Antibodies kill viruses as well as bacteria	8	51
The universe began with a huge explosion	34	33
The continent on which we live have been moving for million years	32	79
Human beings developed from an earlier species of animals	56	53
Cigarette smoking causes lung cancer	87	94
Which travels faster– light or sound?	60	76
Does earth go round the sun or the sun round the earth?	70	75
How long does it take?	41	58

Source: India: NCAER's *National Science Survey-2004*; U.S.A: *Science and Engineering Indicators-2002*

Despite the low levels of literacy and spread of higher education, India doesn't fare too badly vis-à-vis high-income countries like the US. India scores lower than the US on attitudes towards science and technology, but not much lower. Seventy-seven per cent of Indians feel S&T makes our lives healthier and easier as compared to 86% for the US. Sixty-one per cent feel technology makes work interesting as compared to 89% for the US. Indians gave fewer correct answers than Americans to queries on scientific concepts. Just 57% of the Indians know that the centre of the earth is very hot as compared to 80% Americans, 38% versus 65% for the question that the sex of a newborn baby depends upon the father, and eight per cent versus 51% on the question whether antibodies kill viruses as well as bacteria (Table 2). It runs pretty close (around 86%) on the question whether the oxygen we breathe comes from plants, or whether the universe began with a big bang or not (around 34%) and whether cigarette smoking causes cancer (87% for India versus 94% for the US).

Table 3. Attitude towards the Social Impact of S&T
(% of population who agreed)

Social impacts	India (2004)	U.S.A. (2001)
S&T makes our lives healthier, easier and more comfortable	77	86
We depend too much on science	74	51
Science changes our life fast	75	38
New technology makes work interesting	61	89
S&T will create better opportunities for the next generation	54	85
Technological discoveries will eventually destroy the earth	39	29
S&T offers us a simpler life	44	44
S&T offers an artificial and inhuman way of living	42	30

Source: India: NCAER's *National Science Survey-2004*; U.S.A: *Science and Engineering Indicators-2002*

Despite this, India has a higher proportion of 'attentive' population (people who are interested in a subject and follow up by reading about it regularly in newspapers/magazines) as compared to the US. While the figure was 23% for India versus six per cent for the US in the case of agriculture and farming, it was 18 versus 12 for economy and business conditions. While 26% of urban Indians can be considered 'attentive', the figure is almost 16% in rural areas.

In overall terms, of course, what matters most is the country's attitude on whether science and technology helps the country or not, and here India scores positive. Indians believe that the positive attributes of S&T outweigh the negative attributes by 1.1 times, a figure that is not too much lower than the US' 1.3.

Indians have an exalted view of the work scientists do and their contribution to society, but since they view scientists almost as ascetics, this also discourages people from wanting to become scientists when they grow up. Close to two-thirds Indians agree that scientists work for the good of humanity (86% for the US in 2001), yet over a third of Indians feel that scientists usually work alone as compared to just 17% in the US (Table 4). Over 45% of Indians feel scientists do not enjoy themselves as much as others do; just 19% feel this way in the US. And 42% of Indians feel that scientists are peculiar people as compared to 26% in the US.

Table 4: Attitudes Towards Scientists and Scientific Works
(% of population who agree)

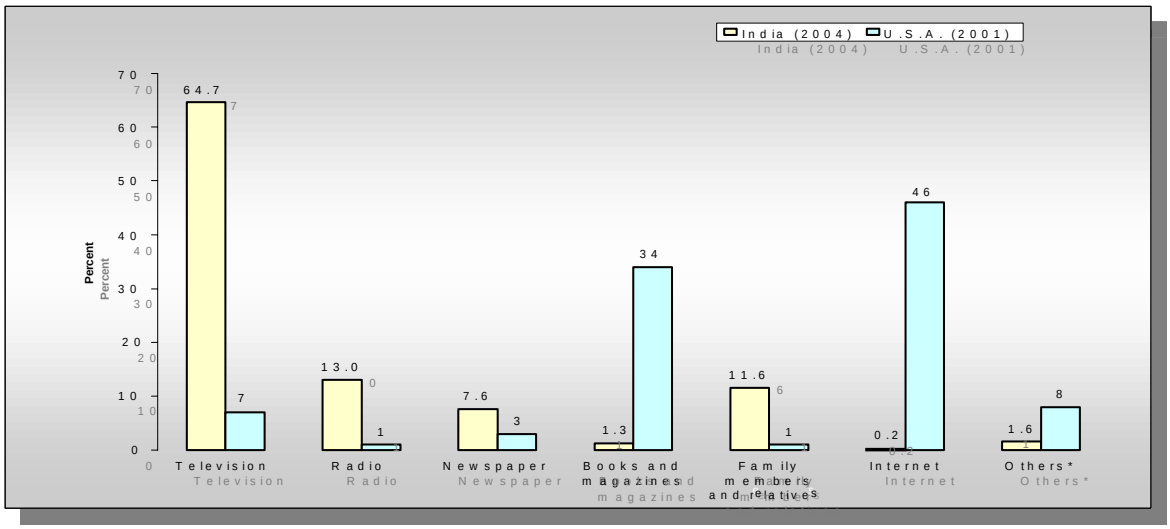
	India (2004)	U.S.A. (2001)
A scientist usually works alone	36	17
Scientific work is harmful	37	53
Scientific researchers work for the good of humanity	64	86
Scientists don't enjoy themselves much as other people do	45	19
Scientists help in solving problems	64	96
Scientists are peculiar	42	25
Scientists are not likely to be religious minded	33	30

Source: India: NCAER's *National Science Survey-2004*; U.S.A: *Science and Engineering Indicators-2002*

To the statement `scientific researchers work for the good of humanity', a majority of Indians (64%) and Americans (86%) are in agreement. Although there is a difference between the two countries in the view that scientists are conducting research aimed at improving people's lives, it can be said that unlike the Americans, Indians are somewhat relatively less 'in agreement' irrespective of statements posed to respondents.

The biggest difference, of course, between India and the US is the source of information for citizens, especially for S&T related news. While the TV is the biggest source of all information for Indians, which is the same for the US, the US has a much larger readership of newspapers and usage of the Internet.

Figure 1. Leading Source of Information for Specific Science Related Issues



Source: India Science Report-2004; U.S.A: Science and Engineering Indicators - 2002

Indeed, 46% of all US news on S&T issues is got from the Internet as compared to a mere 0.2% for India (Figure 1). Another 34% of US S&T news is got from books and magazines as compared to a mere 1.3% for India. In other words, owing to its higher literacy levels and greater spread (and lower cost) of the Internet, the average US citizen's knowledgebase is not as restricted to just television programming as it is in India.

8. Conclusion.

Despite the low levels of literacy and spread of higher education, India doesn't fare too badly vis-à-vis high-income countries like the US. India scores lower than the US on attitudes towards science and technology, but not much lower. Seventy-seven per cent Indians feel S&T makes our lives healthier and easier as compared to 86% for the US. India compares unfavourably with the US on parameters like the proportion of its population that understands certain scientific concepts, such as, are electrons smaller than atoms, or whether the centre of the earth is hot; it does reasonably well given its relatively lower income and literacy levels.

However, when it comes to issues like 'attentive' public (that is, the part of the public that is not only interested in certain issues but also follows up with regular reading of newspapers/magazines), India scores much higher than the US. Close to 19% of India's population can be considered 'attentive' compared to fewer than ten per cent for the US. While the figure is 23% for India versus 6% for the US in the case of agriculture and farming, it is 18% (US) versus 12% (India) for economy and business areas.

As expected, the findings reveal that television is the most popular source of information for most people. But this also calls for a conscious action on the part of all concerned to generate quality S&T programmes for television. Quality S&T TV programmes are few and far between. This source of dissemination of scientific information needs to be exploited fully.

But what is of concern is the extremely low percentage of people visiting science museums, planetaria, aquaria, science fairs, etc. Is this due to less awareness or less motivation? This needs to be ascertained, for, these are places that document scientific and technological developments and could be a great source of scientific information as well as inspiration for children.

Another important point the report makes is that over 45% of S&T information in the US is obtained from the Internet as compared to 0.2 per cent in India. There is here a vast potential still waiting to be tapped in India. Modern channels of information need to be harnessed to the fullest potential. ICT penetration is an issue that needs to be looked into to maximize the scientific returns from the vast cyber source of knowledge. There is also perhaps a need to ensure greater penetrability of Internet and other ICT tools at the school level as also in rural and remote areas so that access to reliable and updated information is considerably improved.