

## **ENHANCING PUBLIC ENTHUSIASM FOR SCIENCE: THE ROLE OF A SCIENCE ACADEMY**

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### **Why should citizens be informed about science?**

In a broad sense, *science* means *knowledge* or a *system of knowledge*. In a more specific sense, it is a systematic endeavour that collects and organizes knowledge to explain real-world phenomena following a process that tests alternative possibilities of explanation. This endeavour also makes predictions that are useful to the citizen. Since all citizens are keen observers of real-world phenomena and are curious to know why such phenomena – for example, a rainbow – happen, we are all interested in science. Citizens look up to scientists to satiate their curiosity and to move society forward by predicting the future and empowering preparedness. The pursuit of science requires money; citizens provide the funds. Not just as taxes paid to the Government a portion of which supports scientific activities, but also by philanthropic donations to science institutions. Therefore, citizens need to be informed of the outcome of their support. By being informed, citizens enrich their own lives. By being enriched they in turn enrich science by seeking to understand more complicated phenomena, ultimately increasing their science literacy and the prosperity of society as a whole.

### **Why enhance public enthusiasm for science?**

Public support for science is the key to progress of science. Public enthusiasm, understanding and support are needed to fund scientific research and to improve science education. Isaac Asimov (1984) has claimed that "*Without an informed public, scientists will not only be no longer supported financially, they will be actively persecuted.*" The difference between understanding and non-understanding, Asimov suggests, rather dramatically, is "*the difference between respect and admiration on*

*the one side, and hate and fear on the other.*” Lack of knowledge and understanding of science is the root of much evil in society. And, also the major reasons for opposition to science and propagation of baseless ideas and fear. By promoting public understanding of science, we can cause a dent to such negativities and thereby uplift society. Upliftment of society results in national development, both economic and social.

When the understanding of science enhances in a citizen, the citizen becomes a more responsible person in society. Just to give you a personal example, a person living two doors from us would regularly burn on the road in front of his house dry leaves, torn plastic, paper and such rubbish that his household produced. About two weeks back, I was walking past him when he was burning a pile of rubbish. I decided to stop and explain to him the perils of burning plastic and such rubbish. He listened. Didn't utter a word. I have not seen him burn his household rubbish since! There is so much of wastage of water in our neighbourhood. Many residents do not turn off their water faucets when they are not collecting water. The local municipality provides piped water free-of-cost; there is no financial incentive to saving water. Water, in the coming few years, will become very scarce. We ought to enhance public understanding of benefits of water conservation and entuse citizens to turn off their water faucets when not in use.

Knowledgeable citizens become better citizens individually. Informed citizens are more likely to make better decisions. Collectively, better citizens improve public health and other public traits. They also become more employable. Therefore, it is essential to empower citizens with a scientific attitude and raise their enthusiasm for science. Citizens empowered with scientific knowledge can influence decisions that have a social impact. Globally, public policy is influenced by national opinion. If people are better informed about science, they can make better decisions personally and can influence decisions that affect the nation. One sure way of influencing that public decisions are not taken arbitrarily is for citizens to insist that public policy is guided by evidence. If the enthusiasm of citizens for science can be sustained and enhanced, then the aims of science, the norms of science, the processes of science and the products of science will sink in their minds permanently. They will become torchbearers of science and national development.

## **From whom do the citizens wish to hear about science?**

Unfortunately, with the low level of basic education of citizens in our country, the appreciation for science is limited. Consequently, the urge to learn about science is also limited. It is, therefore, difficult to gauge public attitude towards learning science and influencing public policy. In our country, citizens with high-school education are generally enthusiastic about science. I do not know of any serious assessment of enthusiasm for science in different sectors of our society. However, in the UK, a survey was undertaken among 1,524 adults in 2015. The published report of the survey – Wellcome Trust Monitor Report, Wave 3: Tracking public views on science and biomedical research (published April 2016) – stated “*The majority of the public say they are interested in hearing directly from scientists about the research they do, but would prefer to hear from them via passive means, such as television, radio, newspapers, and websites, rather than interacting with them directly. Hearing from scientists about the latest findings from scientific research, and about research of personal relevance, are of greatest interest.*” In our country, most citizens do not know a scientist personally. Most cannot even name a scientist, except perhaps, C.V. Raman and Albert Einstein. Those of us who engage ourselves with students at various levels, including school children, are aware that students love to hear science directly from scientists. However, communicating science is no trivial activity. Scientists who communicate well are received well. Such scientists can leverage that receptivity so that society is more informed about science and they think with greater scientific rigour on issues of societal importance. We must make sure that our research findings do not remain confined to our own science community, but percolates to citizens.

## **What’s a good place to start?**

There are three national science academies in India; many States also have science academies. Each of these academies is a collective of scientists who have made significant contributions to science. In addition, there are separate academies of agricultural, medical and engineering sciences. Every academy can and should undertake activities to enhance public enthusiasm for science. We need to make a head start. What we can effortlessly do is to address the lack of familiarity of students and citizens with scientists. A science academy can easily arrange meetings in

schools and neighbourhoods. Members of the academy can take turns to engage with students and citizens. Of course, a science academy is not known widely among citizens, but is certainly well-respected among the educated public. Therefore, we need to reach the general citizen through those who are educated, such as leaders of civic groups, teachers in schools, directors of museums, etc. For a start, we may even begin by engagement with highly educated persons and elected representatives of the government. If members of our academy engage with such persons who are influential in the community, there will be faster percolation of a rational attitude and rational behaviour among people. Perhaps, we should begin our engagement by addressing such topics that pose serious and immediate challenges to undermine science.

It is possible for any science academy to print and distribute brochures, especially among school students, describing the benefits of scientific research to enhance appreciation of science and consolidation of “scientific temper” – a phrase introduced by Jawaharlal Nehru in *The Discovery of India*. The “*search for truth and new knowledge, the refusal to accept anything without testing and trial, the capacity to change previous conclusions in the face of new evidence, the reliance on observed fact and not on pre-conceived theory,*” are some of the cardinal features of scientific temper, Nehru said. It is scientific temper that helps in developing secularism, humanism and the spirit of enquiry and reform. The Constitution of India has, therefore, correctly emphasized development of scientific temper as a fundamental duty.

Science academies ought to undertake well-designed sample-surveys to collect data on how citizens perceive science. The results of these surveys must be shared with policy makers and members of the academy. These results will inform the academies of the actions that must be undertaken to enhance public understanding and enthusiasm for science. Such surveys must be conducted every three to five years to enable an assessment of the impact of the activities undertaken by the science academy.

What I am emphasizing is that while science academies annually carry out the important task of recognizing scientists who have done scientific research of high significance, there is much more that a science academy can and should do. In many

countries, such as the USA, the government falls back on their National Academy of Sciences and commissions reports and advisory notes on many relevant scientific and societal matters, which are then used to formulate public policies. Unfortunately, in our country this culture has not developed. In the past, some science academies have produced on their own reports on scientific issues of societal importance and submitted these to the Government of India. However, there has been no felt outcome of the submission of most of these reports. As members of a science academy we do not have to give up in despair. Based on our own investigations, we can draw inferences and propose policy changes, which we can publish in national newspapers. Hopefully, if we are persistent, then in the long run there will be some positive impact on public policy. If the citizens perceive that the positive impact was due to actions undertaken by a science collective, then the respect for science and the science academy will enhance.

### **What must we do to make ourselves impactful on citizens?**

First, we must learn to communicate science. Communicating science is not easy. It involves simplifying: the results of scientific research must be made comprehensible to non-experts. Not just made comprehensible, but made comprehensible in an attractive way. The listener must like to listen to what is being said. What is being said must be narrated as a story. "*Storytelling humanises scientists*", Laura Helmuth, an Editor at The Washington Post, has said. To be a successful popularizer of science, that is, to arouse curiosity and enthusiasm for science, the speaker must develop a clear understanding of the subject and of fellow human beings, and of the world around them. While communicating my science, I must ask myself 'who are the persons I am talking to? Why should they care about my work?' We must empathise with our listeners, if we wish to communicate science effectively. A science academy may organize discussion sessions among their members so that they become effective science communicators.

A science academy must promote science in the public media. And, regularly engage with journalists and provide them science feeds. Not just verbally describe the latest scientific findings, but actually prepare written notes for journalists with properly distilled scientific information. Journalists may be invited to public lectures organized

by a science academy. Not every invitation will be taken, but every science academy must patiently and regularly engage with the media.

In the past years, social media, blogs, podcasts, etc. have become important channels of communication. They are a great way to communicate with the general public, but such communication must be done in a responsible manner. Furthermore, they also create opportunities to exchange information and ideas with fellow scientists and build scientific communities. A science academy must use these new channels of science communication that are more dynamic than traditional methods of communication, and hence more effective in raising public enthusiasm for science.

### **What should we do to preserve the respect and trust that citizens have for scientists?**

Integrity in research is of paramount importance. Citizens believe that scientists are honest and trustworthy. Individually and collectively, as members of an academy of science, we must strive to ensure that this belief does not waver. There have been plenty of discussions on what constitutes trustworthy research and the principles of research integrity. Hundreds of essays have been written on these topics. At the fundamental level, results of scientific pursuits need to be reproducible. Therefore, very often independent efforts are undertaken to reproduce scientific results. To enable independent reproducibility of research results, detailed documentation of every step of research and their availability in the public domain are essential. However, for various reasons – mostly commercial – journals have increasingly insisted on brevity of articles. This has led to a serious compromise in describing the methodology of research that is so crucial to reproducibility. Without the ability to undertake replicative studies to verify reproducibility, the very special hallmark of science which is self-correction cannot be realized. The citizen is aware that before scientists publicly narrate their results, they have taken all steps to ensure that the results are correct. However, this belief of the citizen is now being seriously shaken, especially because instances of irreproducibility are now being narrated in the public media.<sup>2</sup> It is the responsibility of the science academies to ensure that the ability to check the reproducibility of scientific results is not hampered because of the commercial interests of journal publishers.

The quantum of irreproducible results – often resulting in retraction of published articles – is increasing. In recent times, there have been many high-profile instances of irreproducibility; these have been in respect of properties of vaccines, stem-cells, materials, etc. Irreproducibility is not entirely attributable to the lack of adequate description of methodologies adopted to carry out the research. Sometimes, haste to publish is a contributing factor. However, there are now a large number of instances of fraud in science. Deliberate misconduct. Plagiarism, data fabrication and falsification, image manipulation, and the list goes on. Scientific misconduct is on the rise. Some factors contributing to the rise have been identified. A science academy can play a leading role in alleviating many of these causes and develop codes of conduct.

One major factor contributing to scientific misconduct is that assessment procedures for providing employment or promotion or recognition to scientists are now strongly based on number of publications and some metrics, such as, as impact factors of journals in which published, citation index, H-index and i10-index. Although the number of publications is relevant, the quality of the publications is certainly more important. Although the stated metrics reasonably correlate with the quality of a publication, overemphasis on these metrics without any assessment of quality is detrimental to the assessee. These practices have resulted in hypercompetition, which in turn has promoted scientific misconduct.

A science academy is a body of scientists with proven record of significant contributions to science. Such a body should provide leadership to raise consciousness about the problem of scientific misconduct and provide guidelines on good practices in science. Members of a science academy often actually carry out assessment of their peers. They should provide a set of cardinal attributes based on which institutions should assess scientists for recruitment, promotion and recognition of their contributions to science.

A science academy should be the place where whistleblowers can confidently and confidentially report their anxieties about possible misconduct. A science academy should help with investigations of misconduct. An academy can undertake the design of a formal system for addressing allegations of misconduct in research and steps to

implement redressal and punishment. I must emphasize that misconduct does not include honest error or honest differences of opinions.

A science academy must not admit a scientist as a member if there is reasonable evidence of scientific misconduct against the scientist. By admitting such scientists the face of the academy becomes tainted. Scientific misconduct is increasingly being reported in the public media. Therefore, by not acting against the irresponsible and unethical behaviour of a peer, scientists risk the loss of public trust and public enthusiasm for science.

However, it is not my belief that taking action against irresponsible and unethical scientists is the best way to retain public trust in science. Positive actions are necessary by collectives of scientists to raise the overall level of scientific integrity. A science academy is a collective of accomplished scientists. Therefore, such positive actions are best taken by a science academy. Teaching the value of integrity is far more important and long-lasting than issuing warnings against dishonesty.

A recent article in *Nature*<sup>3</sup> has identified some ways to promote research integrity. Many other organizations have published reports, notably the report on “Best Practices for Ensuring Scientific Integrity and Preventing Misconduct”<sup>4</sup> by the Organisation for Economic Co-Operation and Development - Global Science Forum, and the book titled “On Being a Scientist: A Guide to Responsible Conduct in Research”<sup>5</sup> by the The National Academies of Science, Engineering and Medicine of the USA. The research environment in which a scientist works should be free of hypercompetition and excessive publication pressure, and fair assessment procedures should be adopted. There have to be active training programmes on skill development, including on scientific integrity. Confidential counselling for researchers may be established and promoted. Each science institution must formalize procedures that will protect whistleblowers and also those accused of misconduct. The Global Science Forum has noted<sup>4</sup> that “*Lack of awareness of the rules and standards of proper scientific conduct, of the investigative processes that are in place, and of the penalties that can be imposed on those found guilty of misconduct. In some cases, individuals (especially students) may be truly unaware that certain behaviours (notably plagiarism) constitute misconduct.*” Thus, awareness campaigns and training of science students and scientists on what constitutes scientific misconduct are crucial. A science academy



can play active roles. Some science academies in India are now taking active steps to draft and implement codes of conduct for the practice and administration of science. This is most welcome.

Not every institution has the capability of implementing these action items. This is another area where a science academy can offer its help to institutions. Regular workshops and training sessions in different science institutions or even in a public auditorium can be held by members of a science academy. Unfortunately, after being admitted to a science academy, many do not actively contribute to the efforts of the academy to improve science environment in our country. If we did so, I am certain that a science academy would catch the attention of the general public and the good practices promoted by the academy. Most science academies in India are investing minimal efforts to help raise public enthusiasm and trust for science. Many academies do not see such efforts as appropriate or necessary, and members are generally unwilling to invest their time and energy on such activities. My personal views differ.

**When there are assaults on the edifice of science, does the silence of a science academy augur well to enhance the enthusiasm of citizens for science?**

The first exposure to a scientific achievement for the citizen is through newspapers, television and other public media. Once exposed, a subset of citizens will search for details that may be available in the public domain. Such exposures, therefore, enhances social enthusiasm for science. A direct assault on science takes place when the public media reduces space or time allocated for science related stories for citizens. Most media houses are commercial and they take decisions based on commercial considerations. We can't fault them. However, if a science academy engages with public media houses and encourages them to publish or show more science-related stories, it will reduce the pressure to assault science as pseudo-science, or to promote pseudo-science as science. For this, an academy must play an active role by encouraging scientists to provide short attractive narratives of their research in a language comprehensible to the layman. These should be forwarded to the media by the academy. Creation of a media-cell within a science academy can be helpful to snowball these activities. When the public gets opportunities to read science stories that are attractively written, they will read these. If these measures are taken, then TRP or other similar metrics will not reduce and hence commercial interests will

not be adversely impacted and the space or time for science are unlikely to be shrunk. A science academy must spend time on promoting science stories so that the citizen's enthusiasm for science is enhanced.

When government-supported institutions of science are stifled without adequate or even without any discussion with scientists, it is a major assault on science. In our country, when institutions are created a certain number of faculty positions are sanctioned in principle by the government. However, in most institutions the approval to fill sanctioned positions is delayed by the government. In nearly every institution, sanctioned positions are lying vacant because of lack of approval. Of course, negotiations for approval have to be done with the government by individual institutions, but a science academy can collate facts and figures and engage in dialogue with the governments – central and state – to win them over to approve filling of sanctioned, but unfilled, scientific positions. A major impediment for enhancement of public enthusiasm for science is that there has been a loss of quality of science teaching. In every institution there is a dearth of scientists available to teach despite sanctioned positions lying vacant. Those in service are overburdened with teaching that adversely impacts on their quality of teaching and on their own scientific research.

Associated with the quality of teaching is the issue of what scientific ideas and thoughts should be taught to students and at what level. This has been a matter of discussion and debate in recent times. A science academy ought to proactively make suggestions to national bodies such as the NCERT on such issues, when revisions of syllabi are undertaken. To arouse interest in science among students, ideas and facts of science should be introduced in a logical and systematic manner at an appropriate stage when these can be comprehended by them. Otherwise, they will learn by rote without understanding, just to score well in examinations. They will not grow up to become citizens with an enthusiasm for science.

### **In summary ...**

It is the duty of all practicing scientists, individually and collectively, to promote public understanding of science and enhance the enthusiasm of citizens for science. If citizens understand and are enthusiastic about science, the collective behaviour of members of a society becomes rational. To accomplish these tasks, each scientist has

to individually undertake activities that are beyond their normal duties. Also, collectives of scientists, such as a science academy, must undertake activities to improve the science climate and the scientific temper of a nation.

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