Science communication as an academic discipline: an Indian perspective

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Scientific ignorance can be a potential obstacle in the journey of India becoming a developed nation and a knowledge economy. Such ignorance can also be the cause of various myths, superstitions and blind faiths which can further hinder the development agenda of any nation. Science communication can potentially dissipate scientific ignorance in the society. Science communication is a rapidly growing area of expertise both academically and professionally around the globe. It is getting established as an academic discipline with several universities/institutions around the world starting academic and research programmes. Science communication is an effort to better understand how science and society interact, and to popularize and commonize scientific knowledge, scientific temper, scientific method of enquiry and scientific culture among the masses. However, the trends in India are not encouraging. This article discusses the emergence of science communication as an academic discipline, its global and Indian trends, and the need of science communication initiatives, training and capacity-building in India.

Keywords: Academic discipline, science communication, science–society interactions, training and capacity-building.

SCIENCE communication (SciCom) is a new, emerging multidisciplinary and interdisciplinary subject being introduced at graduate and postgraduate levels around the world[1–4]. With the study of the basic characteristics of how science and society interact, it is also about developing human resources and capabilities for communicating scientific knowledge and practices to the general public and other specialist and specific audiences. SciCom is rapidly getting established as an academic discipline with research being focused on better understanding of science communication practices and improvement of such capabilities.

SciCom also aims to popularize and commonize scientific temper, scientific method of enquiry and scientific culture among the masses. This can be achieved by developing efficient mechanisms and interventions for active public engagement and two-way dialogue between scientists and society by increasing the public understanding of science and scientists' understanding of the publics (different audiences). Commonization of science can help develop scientifically informed and aware citizens who are familiar with the scientific advances. While critically appreciating the achievements of science, such citizens can also have an informed say in the growth of science and science-related policies. SciCom can actually bring and build the relevance of science to society. Such relevance can build public confidence regarding science that can further lead to increased support to the cause of science[5].

There are many issues related to science and technology that are relevant to society, but at the same time, are surrounded by controversies. For example, global warming, climate change, nuclear power, genetically modified food/GMOs, embryonic research, designer babies, vaccinations, etc. The most common cause of public opposition to such scientific advances and policies is generally their ignorance[6], among several other factors. India has seen such public opposition to *Bt* brinjal, *Bt* cotton, Kudankulam Nuclear Power Plant, etc. Recently, the issue of allowing cultivation of GM mustard has been raised[7–9]; we are yet to see how it is received by the public, especially farmers, when government approval is given and actual cultivation begins. Further, we cannot straightaway turn down the resenting public voices merely because they are not subject experts, but ignorant in general. When public is at the receiving end for risks and benefits associated with such scientific advances and policies, it is essential to take them on board. Spreading awareness about such controversial issues can help them make informed decisions.

Here, communication and popularization of science and scientific practices will help improve public perceptions and attitudes to science, and will build a positive

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image of science in their minds. By offering a better understanding of science, it can also defuse the anti-science sentiments and prevent these from turning into anti-science movements, which are prevalent in certain parts of the world. While helping to get rid of superstitions, myths and blind faiths clouding our society and in solving mysteries, SciCom can potentially lead society to a progressive path of life.

A developing country like India cannot afford such controversies and ignorant opposition to important science and technology (S&T) projects which can be detrimental to the growth and development of the nation for ensuring basic amenities like food, water, power, healthcare, etc. to the citizens. This requires SciCom to play an important role in educating public about S&T and its use in making India a developed country. Further, India is an agriculture-based economy, but is fast aspiring to become a knowledge economy. With the present government at the centre pushing for 'Make in India', 'Digital India', 'Skilled India' and 'Startup India' schemes, the Indian economy is expected to change and move more towards a knowledge economy, powered by S&T. All this will not happen if the citizens are not provided with higher levels of scientific and technological knowledge and are not equipped with the required skills to use such knowledge in their daily lives[10]. Today, every citizen requires S&T knowledge and skills to better understand the Nature and perform their daily transactions in an efficient way.

This mandates for continuous two-way exchange and flow of information between science and society. Stopping or obstructing this flow of information creates a communication gap. The gap is not between just science and society, but also between different specialized branches within science (e.g., climate scientists may be hardly aware of the advances in nanotechnology or biology). Therefore, SciCom deals with this gap between different segmentations and fragmentations in society and science[11].

Further, science is generally being done, directly or indirectly, for the betterment, advancement and welfare of the society, however, due to the huge communication gap between science and society, the public is hardly aware of the scientific advances. With the ever-increasing volume of scientific knowledge, the gap between science and society is further widening. Such a scenario of communication gap leads to knowledge gap resulting in two cultures: science-rich and science-poor. Countries and societies which produce (and have access to) more science are science-rich, while those which produce (and have access to) less science are science-poor. Science and society are interwoven, complementing and reinforcing each other. Societies consuming more science become scientifically more aware. A scientifically aware society leads to the further advancement of science. Such scientific advancements contribute to the further progress of society, and this cycle goes on and on.

Knowledge gap

The knowledge gap so created has a direct relationship with societal and developmental issues. This was recognized by the late Malaysian Prime Minister Mahathir Mohammed way back in 1991 when he said, '… It can be no accident that there is today no wealthy developed nation that is information-poor, and no information-rich country that is poor and underdeveloped...'[12,13]. It was also recognized by the International Development Research Council in a report that the most vital difference between developed and developing, rich and poor countries, is the knowledge gap – the capacity to generate, acquire, disseminate, and use scientific and technological knowledge[14].

In India, thousands of different research institutions/laboratories are working for the generation of S&T knowledge[15]. There is no doubt regarding the capacity of Indian R&D institutions (be it ISRO, CSIR, ICAR, DRDO, ICMR or any stand-alone institute) in generating and acquiring S&T knowledge. But how that knowledge is being used by and for society is a big question. And a more serious question is whether such knowledge is being disseminated and made accessible to society for any use. If the S&T knowledge created is not being properly disseminated to and not being used by the stakeholders, then it is a national loss – a loss due to the gap created between knowledge generation and its proper utilization.

Here, mass media (news and entertainment) can act as a potential tool for SciCom professionals to bridge this gap because mass media are the primary source which feeds science to the public. After formal schooling, public learns about the scientific advances through newspapers, magazines, news channels, internet, etc.[16]. Other opportunities where the public encounters science are science museums, science centres, science cities, science melas, science exhibitions/expos, etc. and science–citizen interactions. This requires for better science–media–public relations and interactions.

Therefore, collective efforts on a larger scale are required for communicating scientific knowledge and practices to end-users and stakeholders or the public is general. To effectively communicate science to the public, skilled and trained manpower is required for (1) translating the jargon of scientific language into commonly understandable messages, (2) creating modules for public consumption through different formats and media, and (3) engaging the public in participatory events for sharing scientific knowledge and experiences. This can effectively bridge the communication or knowledge gap between science-producers and science-consumers, science-rich and science-poor.

Formal education and courses: global scenarios

To take the benefits of S&T knowledge to those who need it, formal and informal education can play a key

role[17]. Therefore, to address the formal educational needs for capacity-building in SciCom, it is being introduced as an academic discipline in different universities across the globe, and is also becomes popular as a profession. It evolved as a discipline due to the complexity and diversity of scientific knowledge itself, and the diverse levels and requirements of different publics (audiences) with which every scientist may not be able or willing to catch up. Scientists may find it difficult to speak in the language of different publics to make them understand what science they are doing and how useful it is for them. Use of scientific jargon by scientists in their communication/engagement activities is a big barrier to connect with the public. In the modern times, SciCom as an organized activity finds its roots in the 'public understanding of science' movement that started in the early 1980s in the West for increasing the general understanding of science among the public, and which later spread across the globe[4,18].

A general perception is that scientists need to devote more time to doing research and communicating with peers, leaving them with little time for public engagement activities[19]. Further, scientists are commonly heard citing little benefits for them to engage in science communication activities with the public. Even with these limitations on the part of the scientists, their role in SciCom cannot be eliminated as such. Therefore, scientists need to be equipped with effective communication and media skills to connect with the masses for popularizing science and scientific practices.

Initially, enthusiasts from different backgrounds took charge of communicating science to the public. But with the advances in communication and digital technologies, public engagement arenas are changing. In order to keep up with the changing times and to meet the increasing demand for popular communications on science, intellectuals in the field of SciCom realized the need for training science graduates as a class of SciCom professionals. The primary job of such professionals is to communicate science with the public, and bridge the gap between science and society. They should be specialists in initiating dialogue between scientists and non-scientists, and in increasing public participation in scientific activities. This need for trained professionals led to the introduction of SciCom as an academic and professional discipline of formal education in the higher academic institutions/universities.

Academic courses in SciCom at UG and PG levels are offered around the globe[4,20,21] and the trend is growing further. SciCom as a discipline started getting global attention since the early 1990s (refs 4, 22). Some of the pioneering institutions abroad that started such courses are: Australian National University, Australia; Imperial College London, UK; Cornell University, USA; Dublin City University, Ireland; University College London, UK; University of California, USA; The Open University, UK; International School for Advanced Studies, Italy; Leuven University, Belgium; University of Helsinki, Finland; Louis Pasteur University, France; Free University of Berlin, Germany; Technion – Israel Institute of Technology, Israel; University of Padova, Italy; University of Twente, The Netherlands; University of Aveiro, Portugal; University of Otago, New Zealand; Hokkaido University, Japan and National University of Singapore. Europe, with emphasis on the UK, and the developed countries are leading the charts in the number of such courses[23].

Different people started using different terms for this emerging field. Some of these are: public understanding of science (PUS), public awareness of science (PAS), public understanding of S&T (PUST), public communication of science, public communication of S&T (PCST), scientific literacy (SL), scientific awareness (SA), public engagement with science (PES), public engagement with S&T (PEST), etc. Some have even attempted to define these different terms, for example, Burns *et al.*[24] defined SciCom along with some other terms.

Globally, there is no uniformity about what should be the name of a university course in SciCom. Different institutions/universities name their courses differently[23]. Even the structure and curricula of these courses vary across the globe[4]. However, a consensus is building up slowly to use the term 'science communication' as the name of the discipline for majority of university courses/programmes in the field.

What is taught?

As an academic discipline, SciCom creates human resources who master the art of communicating science and the science of communication. It involves creating, producing and packaging messages of SciCom for specific/general target audiences using different formats and media. This helps to initiate a dialogue between science and society for filling the gap between the two. Most of these courses offer an understanding and practical use of the various mass media channels and formats, communication theory and skills, media production, content creation skills, social media and digital media, advertising and marketing, publicity and promotions, media techniques like video/audio/image editing and manipulations, graphics and animation, media laws and ethics, case studies/project works, and an understanding of science, its history and its progress and advancement, etc.

These courses should include both theoretical and practical approaches, and provide a mix of theory and skills enabling students to translate scientific knowledge into the people's language and to encourage dialogue between science and society[4]. The sociological and philosophical aspects of science and its study should also be taught to help students put science in the right perspectives in accordance with the conventions of the audience.

Indian scenario

In India, postgraduate degree and diploma courses in SciCom were started at some universities[25,26] like Devi Ahilya University, Indore; Lucknow University; Anna University, Chennai; Makhanlal Chaturvedi National University of Journalism and Communication (MCNUJC), Bhopal and Madurai Kamaraj University (MKU), Madurai with the help and support of the National Council for S&T Communication (NCSTC), Department of Science and Technology, Government of India. The National Council for Science Museums (NCSM), Kolkata in collaboration with BITS, Pilani also runs an M Tech (previously M S) in Science Communication programme. According to Patairiya[26], some universities are offering science journalism or SciCom as a paper/semester course as part of their journalism and mass communication degrees.

Unfortunately, at a time when SciCom as a discipline and as a profession is growing globally, the trend in India is not encouraging. Scientific knowledge must reach the grassroots level for India to become a developed country and a knowledge economy. But it is disheartening to note that SciCom initiatives and efforts in India are not in accordance with the aspirations of the diverse Indian society. NCSTC offered some initial academic and financial support to these above-mentioned universities to start SciCom courses with the hope that they will ultimately own and run these courses on a long-term basis. Unfortunately, as a consequence of NCSTC withdrawing financial support and/or some other reasons, most of these university courses in India have died a natural death or are on the verge of being discontinued. For example, Devi Ahilya University, Indore started the full time two-year regular M Sc in Science Communication programme in 1993–94 and the one-year PG diploma in Science Communication through distance in 2006–07, both the courses have already been discontinued a few years ago. Similarly, Anna University started the full time two-year M Sc in S&T Communication programme in 2008, which was discontinued in 2014. The PG Diploma course in Science and Developmental Communication offered by C-DIT, Thiruvananthapuram is also no longer available. MCNUJC has also discontinued its courses in science communication. Diploma courses in science journalism offered by MKU and Vigyan Parishad, Allahabad have been discontinued. The exceptions are the M Sc course of Lucknow University, M Tech programme of NCSM, Kolkata; and one-year Science Journalism course of Indian Science Communication Society, Lucknow, which are still running.

What can be the other possible reasons for the failure of SciCom courses in India? Let me enumerate some of them. These courses/semester papers in SciCom started with the support of NCSTC, were/are generally coordinated by some regular university faculty of science stream or mass communication departments. Most of these coordinators of SciCom courses/papers at Indian universities are themselves not experts in SciCom; but the main area of their academic activity (teaching and research) is different. They may hire a project scientist/teacher under the NCSTC project who is on the job till the project ends, with little chance of getting a regular position like a professor of SciCom. With no regular and full-time teachers, these courses generally rely on guest faculty pulled from industry, other departments, institutions and professionals from different fields, who teach specific papers and are paid on per-lecture basis or hourly basis. It is unfortunate that the number of skilled SciCom teachers in the country is too small. It is further discouraging to note that none of the Indian universities is having a full-fledged department/centre with regular professors for teaching and research in SciCom. Institutional or departmental politics can be another possible reason for closing down these courses. Also, not getting a regular stream of passionate and competent students, lack of study material in the Indian context and languages, curriculum/syllabus not being fully in tune with the country's needs, and lack of proper employment opportunities (especially in the government sector) can be other potential reasons behind the failure of SciCom courses in India. Almost all these courses are/were not job-linked. So after completing the course, students have to struggle for their survival as science communicators.

In a nutshell, not keeping with the changing times to meet the demand for trained science communication professionals, the higher educational institutions in India have considerably failed to contribute in the advancement of SciCom as a discipline. Although a large number of universities and colleges in India have mass communication and journalism departments offering degrees in these subjects, unfortunately the number of universities offering degree/diploma courses or semester papers in SciCom still remains miniscule. The state of academic research in SciCom in India is even more disappointing.

New approaches

There is a perceived demand for training programmes for enhancing SciCom skills and capabilities from different groups including scientists. Working scientists are now realizing that to put their research to any use and to give the visibility it deserves, it should be communicated to the end-users and stakeholders effectively, directly or through mass media.

Keeping in view such demands, we need to strengthen the existing SciCom courses at Indian universities and to establish new centres of SciCom in different universities/institutions, especially at the institutions working in the field of science, technology, engineering, medicine and agriculture. In order to revive SciCom as a discipline of formal education and research in India, S&T-based

degree awarding institutions like IITs, IISERs, NITs, AcSIR, central universities, etc. should take a lead.

With the current scenario of existing courses of formal university education in SciCom being discontinued, we also need to look for alternative modes of capacity-building in SciCom in addition to the formal education (full-time degree/diploma courses). Many working scientists, science graduates interested in SciCom, SciCom enthusiasts, etc. may find it difficult to attend a full-time one or two year course through formal education. However, they can acquire new knowledge and skills in their free time. Short-term (e.g. one-day, two-days or one-week) hands-on and skill-building modules on various SciCom aspects can be useful. Here, distance education is also helpful. Now, on-line education can be a better option for those who have access to internet and IT-enabled platforms where not only text but audio, video, live-streaming, discussions, debates, evaluations, etc. are possible. In the continuing education, MOOCs (massive open on-line courses) are making new waves. These can be effectively used to expand SciCom training to those who are interested. In MOOCs, everything from enrolment to study, evaluation and certification is done on-line. Recognizing the shortage of skilled SciCom teachers and lack of SciCom university courses, MOOCs can fill the gap and can even take SciCom to remote and less-privileged students. MOOCs can be designed for specific demands of scientists and other target groups.

We also need to give due attention to on-line platforms and social media. With the proliferating use of smartphones by the younger generation and the expected increased penetration of high-speed internet access to the wider public under the Digital India scheme, disseminating scientific content and engaging publics in an interactive way has got a high potential as a tool of SciCom. Social media and other on-line platforms can be used for the rapid spread of science and attracting responses from the users. It can also be a potential tool for capacity building in SciCom.

With the launch of the Digital India scheme, all the S&T ministries, departments and institutions (among others) have already been instructed to register their presence on the various social media platforms and to disseminate information to the public and to engage with them through such platforms. Most of these government institutions are already present on platforms like Facebook, Twitter, YouTube, etc.

Conclusion

We may be having several R&D institutions/laboratories in the country doing cutting-edge R&D, publishing a large number of papers in international journals, having global patents, etc. However, all S&T knowledge will be of little use if it does not reach the end-users or the general public. It only divides us into science-rich and science-poor: a bunch of highly knowledgeable scientists and a large ignorant society. When we are aspiring to become a knowledge economy, we cannot afford to keep our citizens scientifically less-informed or ill-informed. While living in a world driven by S&T and its products, it is suicidal to remain scientifically ignorant. For example, we cannot go on developing chemical or biological interventions for better agricultural produce with farmers having no scientific knowledge and skills to use them safely. Such interventions may have adverse repercussions on the life of farmers and their practices. So nothing should enter the farmers' fields without their informed consent and having complete understanding of such interventions and their repercussions.

In transforming a developing country into a developed nation, every citizen's contribution counts to overcome the obstacles in the development goals and to convert challenges into opportunities. In the modern world, the biggest obstacle and challenge is scientific ignorance. This is also the cause of various myths, superstitions and blind faiths, which can further hinder the development agenda. It can be overcome with the popularization and commonization of scientific knowledge, scientific temper, scientific method of enquiry, scientific thinking and scientific culture among the masses. To achieve the popularization and commonization of science in society, we need a strong force of trained and skilled SciCom professionals. This requires consistent efforts for capacity-building in SciCom. It may include strengthening the existing SciCom courses while creating new avenues for formal and informal education and capacity-building in SciCom, and exploring the alternatives like MOOCs and social media.

We also need to encourage research in SciCom in India. For successful efforts in communicating science to the public, research on the public (audience) perceptions, attitudes, requirements, values, social context and structures and on the perceptions and attitudes of scientists toward public communication of S&T, about the role of media and its capabilities in engaging with the public is required. This is imperative keeping in view the complexity and diversity of the Indian publics with multi-cultural and multi-lingual backgrounds. Disseminating scientific knowledge to such socio-linguo-culturally divergent society/publics in India and engaging them in two-way dialogue with science is a challenging job. Therefore, to address this issue, more trained SciCom professionals are required who can connect with the masses and can infuse new S&T knowledge in them while respecting their own socio-linguo-cultural ethos.

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