JCOM

SCIENCE COMMUNICATION FOR SOCIAL JUSTICE

Scientific temper: towards an alternate model of science-society relationships

Siddharth Kankaria and Anwesha Chakraborty

Abstract

Scientific temper, a mainstay in Indian science policies and science communication/education programmes, conceptualises citizens as scientifically conscious and powerful agents that approach societal issues with a rational and critical mind rather than taking refuge in religious, superstitious and pseudoscientific worldviews. Our essay provides a brief history of this term and compares it with existing science communication models to demonstrate how, despite sharing commonalities, it is distinct from models like deficit, dialogue, and participation. We elucidate how scientific temper fosters critical features like a process-oriented approach, reflexivity, democratisation of scientific expertise and being a potential tool for decolonisation. Lastly, we propose scientific temper as an alternate framework for democratising knowledge-making and -sharing, building an engaged deliberative citizenry, and studying science-society relationships overall.

Keywords

Dewesternising science communication; Science communication in the developing world; Science communication: theory and models

DOI

https://doi.org/10.22323/2.23040403

Submitted: 30th October 2023
Accepted: 18th March 2024
Published: 3rd June 2024

Introduction

Finding better ways to bridge the gap between scientific knowledge and publics has been an active topic of discussion in the last few decades [e.g. Bauer, Allum & Miller, 2007; Irwin, 2014; Schäfer, Kessler & Fähnrich, 2019]. Prominent among these efforts are the various theoretical, analytical and practice-informed frameworks and models that have continued to document, dissect and develop science-society interactions, including the *deficit*, *dialogue*, and *participation* models of science communication [Bodmer, 1985; House of Lords, 2000; Bauer et al., 2007; Horst, 2008; Trench & Bucchi, 2010]. While most of these efforts emerged and evolved out of contexts within the Global North, there is a growing body of work documenting the rich history and diversity of science communication efforts from contexts within the Global South [Finlay et al., 2021; Rasekoala, 2023].

In this short essay, we critically reflect on one such key concept associated with science communication in India: *scientific temper*[1] [Mahanti, 2013; Raza, 2015; Chakraborty & Giuffredi, 2019; Chakraborty, Raman & Thirumal, 2020], a term often attributed in India's science policy circles to its first Prime Minister, Jawaharlal Nehru [Nehru, 1946, p. 512], and which has remained an enduring component of Indian science policies and educational strategies till date. We argue here that scientific temper is a novel approach to appraising science-society relationships, which is distinct from the existing Global North models that dominate most theorisation and analyses within science communication research, and argue in favour of its inclusion among these established analytical frameworks of science communication.

Further, while a lot has already been published on scientific temper, including essays, book chapters, research articles (and even a dedicated *Journal of Scientific Temper* being operational in India since 2013), the scope of most of these outputs have been restricted to the history of science in India [Chakraborty, Raman & Thirumal, 2020; Mahanti, 2013], the role of science and technology in India's post-colonial development [Arnold, 2013; Mahanti, 2016], or critiques of how scientific temper has been inadequately or wrongly deployed in social arenas like policy [Udgaonkar, 1980; Seager, 2015], education [Sharma, Akhter & Mir, 2020; Kumar, 2022], and the larger scientific enterprise of India [Prasad, 1982; Chadha, 2005]. There has been some limited discussion on scientific temper within science communication research, but here too it has been restricted to short notes [Chakraborty, Raman & Thirumal, 2020; Raza, 2015], or brief case studies within global comparative studies [Finlay et al., 2021; Schiele, Gascoigne & Schiele, 2021]. We, therefore, observe that there is little discussion and contextualisation available — especially for international audiences — for situating scientific temper within the broader global spectrum of science communication models and frameworks.

In the next section, we describe the historical journey of this concept in India and provide a definition for scientific temper derived from a close reading of Indian science policy documents alongside academic literature on science communication. We also use this section to briefly highlight some of its limitations and critiques of its application within specific Indian contexts. We then compare and contrast scientific temper with existing science communication models, followed by a critical analysis of some of the key learnings that it can offer to contemporary science communication practices and theories globally. We conclude by making a case for why scientific temper can serve as an alternate framework for studying science-society relationships.

The journey of 'scientific temper' in India

In 1947, with India's political independence, the term 'scientific temper' (ST, hereafter) gathered momentum in the country's political and scientific circles as a shorthand for developing its science and technology infrastructure and fostering a spirit of inquiry within its citizens, thereby enabling them to become important stakeholders in the nation-building process.

[1] An earlier invocation of the term *scientific temper* can be found in Bertrand Russell's introductory address titled *Free Thought and Official Propaganda* [Russell, 1922]. However, Russel's usage of ST remains restricted to a utilitarian view of science in service of society, while the broader concept of ST we elaborate on in this essay remains a brainchild of Nehru.

The socio-political context within which scientific temper (ST) was conceptualised and developed in independent India — and what we aim to describe further in our essay — is widely attributed to India's first Prime Minister, Jawaharlal Nehru, who in his book, *The Discovery of India* [1946] discussed the importance of developing a 'critical temper of science' or a scientific approach to problem-solving, while rejecting irrational and extra-scientific beliefs.

> *"The applications of science are inevitable and unavoidable for all countries and peoples to-day. But something more than its application is necessary. It is the scientific approach, the adventurous and yet critical temper of science, 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, the hard discipline of the mind — all this is necessary, not merely for the application of science but for life itself and the solution of its many problems…"* [Nehru, 1946, p. 512]

Nehru's invocation of ST conceptualises citizens as scientifically conscious and empowered agents capable of making informed choices and solving societal problems. To do so, Nehru draws out several attributes that an individual needs to develop, including, critical thinking, the use of evidence-based reasoning, a healthy dose of scepticism, inculcating the processes of scientific reasoning in everyday life, as well as discarding irrational, superstitious and pseudoscientific beliefs.

It is important to also situate this concept within the historical contexts (and timing) of its emergence, given India would achieve independence from British colonial occupation just a year later in 1947. In this one term — 'scientific temper' — one can discern Nehru's imagination of India as an independent nation, where people, free from pre-conceived notions and religious dogmas, would use the scientific method to make sense of the world around them, improve their lives and solve social problems. Stressing on the importance of science and its applications in fulfilling the needs of a country and its people, Nehru framed ST as a critical approach of thinking and reasoning, 'a way of life', and 'the temper of the free man' [Nehru, 1946, p. 512].

A close reading of Nehru's book shows that he posited ST as firstly, a way of thinking about the world around us that informs our day-to-day decisions, and only then, as an instrument for achieving and enabling a free, socially cohesive and scientifically developed society. For the latter, he specifically viewed ST as a way to unify the country that was already polarised on the basis of caste and religion, and serve as an antidote to many of India's existing socio-cultural problems, which he located in irrational thinking, superstition, pseudoscience, as well as caste prejudices and practices [Nehru, 1946]. Therefore, not only did Nehru recognize the material and practical benefits of foregrounding science and technology for the development of a nation, he also strongly argued for science (including scientific method, approach and temper) as a philosophical approach to life [Arnold, 2013].

ST gained significant political currency as a term, with its addition to the Indian Constitution in 1976 under Article 51A(h), as part of the 42nd constitutional amendment, which declared 'to develop the scientific temper, humanism and spirit

of inquiry and reforms'[2] as one of the ten fundamental duties of every citizen. It is interesting to note here that instead of valorising the merits of science in a vacuum, the Indian Constitution carefully situates ST within the country's broader national, social and humanistic contexts by reiterating that "science and technology must be tempered with a sense of humanism because ultimately the end of all progress is the human being and the quality of life and relationships that is developed" [Irani et al., 2001, p. 32]. This contextualisation is particularly important for avoiding more scientistic framings of ST as a concept, which as we describe later has been one of the critiques of ST's application in specific Indian contexts.

Post-colonial India continued to witness greater political commitment towards developing scientific temper as an ideology and the phrase soon gained prominence both in policy circles — where it was viewed as the encapsulation of newly independent India's goals of nation-building [Mahanti, 2013] — as well as in scientific circles — where it was found to be the perfect antidote for opposing religious dogmas, superstitious thinking and pseudo-/unscientific ideologies [Raza, 2015]. Over the years, ST has continued to be repeatedly evoked in policy and intellectual discussions in different stages of India's post-colonial development, including collective statements by scientists and public intellectuals in 1981, 2011 and 2024 [Haksar, Ramanna & Bhargava, 1981; Various, 2011, 2024]; critiques of these statements by academics from the humanities and social sciences [Prasad, 1982; Chadha, 2005; Chakraborty, Raman & Thirumal, 2020; Nanda, 2010; Chakraborty & Pandey, 2023]; development of a government-led strategy in 1988 for operationalizing a countrywide programme for teaching Fundamental Duties (including scientific temper) in educational institutions [Irani et al., 2001]; as well as several national policies of importance, including the *Scientific Policy Resolution* of 1958 [Government of India, 1958], the *Science, Technology and Innovation Policy* (STIP) of 2013 and the draft STIP policy of 2020 [Department of Science and Technology, 2013, p. 1; Department of Science and Technology, 2020] and the *National Educational Policy* of 2020 [Ministry of Human Resource Development, 2020, p. 5].

Based on the above discussion, we assert that Nehruvian ST is a quality that allows people to make informed decisions about every aspect of their lives without taking recourse to unverified knowledge, such as religious doctrines and superstitious claims. The focus here is not on what knowledge to acquire but instead on how it is acquired, that is, on the methods and processes of knowledge gathering and evaluation. It is a quality that enables an individual to actively participate in the processes of knowledge-making, -sharing and utilisation to not only improve one's life but also contribute to the state meaningfully. ST, therefore, enables an individual to evolve from merely being a subject to becoming an informed and active citizen, who possesses the ability to be a knowledge expert, thereby also blurring the boundaries between scientific experts and non-expert publics. We contend that the term 'scientific' here is akin to a mathematical function that operates on input variables in order to yield specific outputs. The input variable here is active citizen participation in knowledge-building, which can then lead to the output of an independent, postcolonial state that is freed from the shackles of dogmatic views, superstitions and pseudoscience. Such a postcolonial state

[2] In a 2015 op-ed, Pushpa M Bhargava noted that he was one of the intellectuals responsible for persuading then Education Minister (in 1976), Nurul Hasan to include the clause of inculcating scientific temper as a fundamental duty of every citizen [Bhargava, 2015].

imagines its liberation through rigorously acquired knowledge in every sphere of activity, where its citizens actively participate in gaining both scientific temper and knowledge and its institutions actively promote this process.

This early Nehruvian understanding of ST, we contend, is about constant questioning of the world around us, and where the faculty of the mind of every single individual, irrespective of their educational or social background, is valued. However, with successive iterations of the phrase in India's science, technology and educational policies, we observe that the 'scientific' in scientific temper has been increasingly interpreted literally, with policies exhorting citizens — especially India's youth — to pursue careers in STEM [Chakraborty & Pandey, 2023]. 'Scientific' here, thus becomes a different function where the input is state-controlled science education (a top-down deficit model) and the output is national development. The interpretation of scientific temper under such '*scientistic*' framings is a rather narrow one, and is far from the purpose and objective of Nehruvian scientific temper. Over the years, other critiques of ST have also reiterated the need for adopting more interdisciplinary and pluralistic approaches to deploying ST that value other (non-scientific) ways of knowing as well [Chadha, 2005], and better engage with India's local and "cultural roots which has always supported scepticism, enquiry and debate" [Gopalkrishnan & Galande, 2021]. While the specific ways in which ST has deviated from its Nehruvian origins need further unpacking in future academic outputs, the focus of this short essay remains firmly on the original term and how it can serve as an alternative framework for understanding science-society relationships.

Situating scientific temper within the spectrum of existing science communication models

Over the last few decades, several theoretical models have been proposed (albeit for contexts within the Global North) for understanding the nature, scope and approaches of science communication activities, comprising one of the most significant areas of enquiry and scholarship within the field of science communication research [Trench & Bucchi, 2010]. Of these, perhaps the most well-known (and critiqued) model is the *deficit* or the *public understanding of science* (PUS) model of the 1980s [Bodmer, 1985] that advocated for the unidirectional dissemination of scientific knowledge from experts to non-expert audiences. The *deficit* model was based on the implicit assumptions that publics are 'deficient' in specific categories of scientific knowledge and that filling such knowledge deficits would automatically increase their appreciation for and trust in science [Brossard & Lewenstein, 2009; Irwin, 2014]. These assumptions were later heavily critiqued, and led to the development of newer models [Bubela et al., 2009; Miller, 2001; Trench & Bucchi, 2010], like the *dialogue* or *public engagement with science* (PES) model of the 2000s, which was characterised by more bidirectional forms of communication and engagement between scientists and non-expert audiences [House of Lords, 2000]. In a bid to restore public trust in science, the *dialogue* model explicitly prioritised providing a platform for public voices and concerns to be heard and emphasized the need for scientists to understand publics and their contexts as much as publics needed to understand scientists and the scientific process [Bauer et al., 2007; Horst, 2008; Trench & Bucchi, 2010].

Since then multiple deliberations have taken place regarding the terms 'public', 'understanding', 'participation' and 'science' alongside the development of frameworks like *Responsible Research and Innovation* [Chakraborty & Giuffredi, 2019;

Chakraborty, Baumann & Hultman, 2020], and *public participation in science* (once again, mostly in the Global North), which now largely recognise publics as key stakeholders in science. Specifically, the *participation* model envisages a multi-directional form of communication, which is characterised by two-way conversations between not only scientists and non-expert publics, but also amongst different kinds of publics themselves [Trench, 2008]. The *participation* model also advocates for the active involvement of publics within the process of science (for example, in *citizen science efforts*), and active consultation with stakeholders for collectively shaping the agenda, direction and pace of technoscientific developments (for example, in *upstream engagement activities*) [Bauer et al., 2007; Cunningham-Burley, 2006; Wilsdon & Willis, 2004].

It is important to note here that in principle, the *dialogue* and *participation* models might seem like obvious improvements over the *deficit* model, but *in practice*, science communicators often rely on a messy combination of models operating in tandem [Brossard & Lewenstein, 2009]. Further, the *deficit* model seems to be far more difficult to root out completely [Trench, 2008], and there is also some recent interest in revisiting its value in the long term [Metcalfe, 2019]. Further, various other science communication frameworks have been proposed over the years, but most of these have some degree of overlap with the *deficit*, *dialogue* and *participation* models described above [see: Horst, 2008; Brossard & Lewenstein, 2009], and are not entirely unique in their scope or function. In this broader context, we describe below how most of these existing models are plagued by three broad sets of assumptions and/or weaknesses, and how an ST-based framing of science-society relationships could partially alleviate these shortcomings.

First, most existing models have been primarily designed for dominant, white, cis-heteropatriarchal, ableist, Anglophone, and Eurocentric contexts, actors and cultures [Finlay et al., 2021; Orthia, McKinnon, Viana & Walker, 2021] and might not translate to other marginalised milieus uniformly. Scholars from a wide range of Global South contexts and disciplinary backgrounds have described how acknowledging diverse lived experiences, incorporating 'local' contexts and histories, and treating indigenous knowledge systems as valid forms of knowledge can all help broaden the scope of knowledge-making and sharing practices, find newer ways to democratise science, and establish more nuanced ways of co-producing knowledge with different stakeholders [Chakraborty & Giuffredi, 2019; Finlay et al., 2021; Orthia et al., 2021; Kankaria, Chakraborty & Manna, 2023].

Second, most existing frameworks of science communication operate on the basis of a science/public binary [Orthia & de Kauwe, 2023; Lock & Armstrong, 2023]. Such a distinction between the public and experts, while useful in many ways for theorising science-society interactions, can also pose several constraints on the scope and extent of these interactions. Considering an alternative ontology of the public — such as that envisaged by ST — can enable citizens to interface with scientific information in ways that focus on individual skills and competencies rather than the binary of expert vs. non-experts, and can allow for the creation of (as we shall argue later) more democratic forms of public interfaces with scientific knowledge.

Third, most existing models also operate on the assumption that we need to force conversations about science across this binary of scientific experts and public

stakeholders. In doing so, these models often fall into the trap of progressively finding better ways of redistributing power and agency across participants involved in these science communication interactions. For instance, over the years one can plot the evolution of public stakeholders from being passive listeners (*deficit* model), to engaged stakeholders (*dialogue* model), to becoming active participants in the enterprise of science, technology and innovation (*participation* model). But despite some progressive improvements in their process and approach, all of these frameworks still inherit and reproduce the epistemic hierarchies, power structures and implicit assumptions embedded within a science/public binary that views them as inherently unequal.

While not a complete substitute to these models or a panacea to all their shortcomings, we propose that scientific temper can serve as an alternate — and perhaps complementary — way of thinking about how stakeholders engage with science. And do so in ways that eventually empower citizens with much-needed critical competencies for navigating the world around them. In such a theorisation of ST, it is important to note that the interactions of citizens with science, its institutions, its products, and most importantly, its processes are completely citizen-led and driven by their specific needs, contexts and agendas, rather than being led by science. The latter is often the case with many existing science communication frameworks, where both the agenda and drive for these efforts are led by scientific actors and institutions, making them especially vulnerable to reproducing systemic issues in science, including hegemonic ivory towers, power dynamics and information asymmetries. For a quick comparison of the key features of ST as compared to other existing science communication models, please see Table 1.

We argue that ST, therefore, provides a new paradigm of thinking about science-society relationships that steps away from the entrenched binaries of expert vs. non-expert and instead mainstreams a process-oriented, citizen-centric and decolonised way of citizens interfacing, engaging and questioning not only expertise and knowledge, but also the institutions and actors behind them. Therefore, ST presents an alternate way of building a healthy ecosystem of science-society interactions that instead of primarily being concerned about injecting more STEM *content* into the public or inducing greater engagement with science, is more fundamentally focused on the *process* of developing individual competencies of citizens. Essentially, rather than providing curative 'antibiotics' of STEM knowledge or encouraging more regular 'medical check-ups' at scientific spaces/events, the ST model is more focused on 'vaccinating' publics with critical skills and competencies to navigate the complex and rapidly-evolving landscapes of science-society interactions. Further, these critical competencies can also help create more robust, democratic and transparent institutions and systems, and rather than being a coincidence, this is very much an intended feature of the ST model.

Table 1. Key features of existing science communication models and frameworks in comparison with scientific temper.(please note that this table only intends to summarise key features of these models for the ease of comparing them, and there could be exceptions, features or nuances of these models that are not fully captured here).

Aspects of the model	Deficit model	Dialogic model	Participation model	Scientific temper
Origin of idea/model	1990s	2000s	2000s	1950s
Definition	Transfer of STEM knowledge to help fill deficits in public knowledge	Engagement of different publics to help shape their views of science, as well as shaping scientists' understanding of the publics	Active participation and involvement of stakeholders in the process, outputs & outcomes of science	Pursuit of rational thought/scientific way of thinking that can inform & guide one's approach to life
Direction of flow of information	Unidirectional flow of information from experts to non-expert publics	Bidirectional flow of information between experts and non-expert publics	Multidirectional flow of information, experiences, and values between multiple stakeholders	Instead of an expert/non-expert binary determining the flow of information, citizens constantly use multi-directional inputs of information to reflexively arrive at more accurate understandings of the world
Scope & purpose	Filling gaps in knowledge that allows people to improve their lives and better appreciate STEM topics	Facilitating a dialogue between scientists and the publics for building an appreciation of STEM concepts, applications and processes within publics and improving scientists' understanding of public concerns and agendas	Getting first-hand experience of engaging in the process of science and obtaining a more process-driven and participatory understanding of STEM topics	Constantly applying new information and knowledge to question and assess ancient traditions, pseudoscience, superstitions and previously-held beliefs; curbing existing ills of society through an open mind; developing rational thinking, scepticism and critical skills; and eventually creating an empowered citizenry in a newly decolonised nation
Primary target audiences	Non-expert publics 'deficient' in specific aspects of STEM knowledge	Non-expert publics 'deficient' in specific aspects of STEM knowledge as well as expert scientists 'deficient' in relevant public contexts, agendas and knowledge	Different expert as well as non-expert stakeholders in society, including government, NGO, corporate, academic, interest groups, etc.	All citizens irrespective of their level of expertise

Learnings from scientific temper for the contemporary world

Based on findings from policy documents and existing science communication literature, we have already proposed ST as a distinct model of science communication. In this section, we elucidate the key features of ST that can serve as learnings for contemporary science communication practices and theories.

Process-oriented approach

We have shown in the previous sections how ST seeks to develop several critical competencies in publics that enable them to adopt a 'scientific approach' to looking

at the world around them. Specifically, developing critical skills and a spirit of scientific enquiry and temper, we argue, is an increasingly relevant skill for navigating complex digital media ecosystems today that are fraught with misinformation, fake news and post-truth tendencies [Khan & Idris, 2019; Arechar et al., 2023]. Cultivating such a process-focused approach also compels us to rethink several aspects of our science communication initiatives: how we plan and develop strategic considerations for our science communication activities (including its aims, objectives, outputs, outcomes, approaches and evaluation methods); how we access and navigate infrastructure, resources, and technologies available for conducting our activities; and how we choose to frame the cultures, contexts and stakeholders of/for our science communication initiatives.

Reflexivity

The ethos of scientific temper strongly mirrors ideas like dynamic feedback loops and reflexivity, which are increasingly finding acceptance and value in science communication. By helping develop criticality, scepticism and rationality in citizens, scientific temper engenders values like questioning assumptions, looking out for cognitive biases, using logic to arrive at sound conclusions, and building more reflexive ways of looking at the world and knowledge systems around us. This process-oriented and reflexive way of engaging with knowledge can also help challenge fixed binaries of scientists vs. publics as well as more deterministic and linear relationships between science and science communication, wherein the former is always assumed to feed into the latter. By enabling more circular, dynamic and reflexive ways of thinking, and adopting more citizen-centric approaches to building knowledge interfaces, ST often blurs the rigid boundaries between knowledge-making and -sharing as well as its linear directionality, while simultaneously, creating space for questions, interrogations, expertise and lived experiences from science communication to also flow into and inform the practice, process and content of science [see for instance, Anderson, Dupré & Wakefield, 2019].

Democratisation of scientific expertise

As described earlier, scientific temper not only encapsulated the spirit of the newly independent Indian state's political and policy aspirations but also contained within itself an idea of deliberative citizenry with a strong democratic ethos and essence in its conceptualization and deployment. It was but a natural, expected (and to a large extent, intended) consequence of cultivating ST in citizens that it would also enable and empower them to become more sceptical of not just 'scientific knowledge', but also its applications and governance, and by extension, of the various social, political, and cultural institutions, actors and systems around them. We argue that scientific temper's historical focus was as much intended to protect people from superstition and pseudoscience, as it was to equip them with tools to fight regressive social norms, dogmatic religious beliefs, and oppressive social structures, and eventually contribute towards making them a more informed, engaged and critical citizenry. This was not an easy undertaking in a country like India: the world's biggest democracy, the most populous one currently, and one embodying an eclectic potpourri of diversity in multiple dimensions. Specifically, case studies of the various People's Science Movements in

India exemplifying the cause of 'science for social revolution' are a direct case in point of the principles of ST leading to more democratic outcomes [Zachariah & Sooryamoorthy, 1994; Varma, 2001; Pattnaik & Sahoo, 2014; Abrol, 2014]. The idea of scientific temper therefore contains within itself an entire framework (or at least the foundational blocks) for building an engaged deliberative citizenry.

Potential tool for decolonisation

It has not escaped our attention that reflecting on these existing frameworks of science communication also carries a lot of political significance. Most of the existing models have been conceptualised within contexts in the Global North, keeping in mind their respective audiences, social milieus and cultural realities. Reflecting on a model like scientific temper that was conceptualised, developed and applied directly within Global South contexts explicitly makes room for acknowledging and building on alternative frameworks for thinking about how people engage with and make sense of scientific information around them, as well as what skills and competencies they may need to navigate local contexts around them. Further, the richness of scientific temper's process-oriented, democratic and reflexive features cannot be divorced from the historical contexts and social realities of how and why it was specifically developed and deployed in a post-colonial country like India. ST was also enshrined in the Indian Constitution in a way that explicitly focused on it being citizen-, process- and skill-centric, in order to enable it to function as a tool for elevating people from social/political/epistemic oppressions, injustices and hegemonies brought about by 200 years of British colonial occupation in the country. Moreover, the potential to use the principles of ST to rationally and critically question and resolve current social issues such as caste-based hierarchies and discrimination [Sahoo, 2020] remains as valid today as they were just after India's Independence more than seven decades ago.

Concluding remarks

Our essay proposes scientific temper as a distinct science communication model and framework for understanding science-society interactions. It further reiterates how it places a premium on an engaged deliberative citizenry, serves as a tool for democratising knowledge-making and -sharing, instils an ethos of reflexivity and process-oriented thinking, and enables decolonisation of both scientific enterprises and science communication. Through a critical evaluation of the term in the Indian policymaking arena, we lay out a comprehensive foundation of ST as a model situated not only within India's historical and sociotechnical contexts, but also critically appraised alongside existing science communication models. Specifically, we argue that ST challenges several fundamental assumptions and binaries presupposed by these models, including the idea of knowledge-making and -sharing as being two distinct steps which require explicit dissemination, engagement or participation of/with/in science.

At the same time, we also acknowledge that there have been deviations between the Nehruvian understanding of ST and its actual deployment and implementation in the Indian context; that it could benefit from being situated within more pluralistic and inclusive epistemological framings; and that it is not by any means a perfect replacement for existing science communication models or a panacea for all their shortcomings. However, through this paper, we contend that scientific temper

needs to be considered as a powerful and alternative epistemological enquiry for appraising science-society relationships that is distinct from conventional Eurocentric conceptualisations of science communication frameworks. We, therefore, argue that ST merits critical introspection, interrogation and possibly, implementation as a framework for studying science-society interactions. In doing so, we also acknowledge that there could, very likely, be similar framings of science-society relationships akin to ST in other (especially, Global South) contexts, which could be integrated into a broader cross-cultural research agenda on decolonising science communication models and frameworks [see for instance, Plessis, 2013; Seager, 2015].

To conclude, we invite our readers to reflect on the broader question of whether and how well could the framework of *scientific temper* be applied to their own respective contexts and cultures, and what could be some of the benefits and challenges of doing so.

References

Abrol, D. (2014). Mobilizing for democratization of science in India: learning from the PSM experience. *Journal of Scientific Temper 2* (1&2), 10–32. Retrieved from http://op.niscpr.res.in/index.php/JST/article/view/7007

Anderson, G., Dupré, J. & Wakefield, J. G. (2019). Drawing and the dynamic nature of living systems. *eLife 8*, e46962. doi:10.7554/elife.46962

Arechar, A. A., Allen, J., Berinsky, A. J., Cole, R., Epstein, Z., Garimella, K., … Rand, D. G. (2023). Understanding and combatting misinformation across 16 countries on six continents. *Nature Human Behaviour 7* (9), 1502–1513. doi:10.1038/s41562-023-01641-6

Arnold, D. (2013). Nehruvian science and postcolonial India. *Isis 104* (2), 360–370. doi:10.1086/670954

Bauer, M. W., Allum, N. & Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science 16* (1), 79–95. doi:10.1177/0963662506071287

Bhargava, P. (2015). Scientists without a scientific temper. *The Hindu*. Retrieved from https://www.thehindu.com/opinion/op-ed/scientists-without-a-scientific-temper/article6794464.ece

Bodmer, W. (1985). *The public understanding of science*. London, U.K.: Royal Society.

Brossard, D. & Lewenstein, B. V. (2009). A critical appraisal of models of public understanding of science: using practice to inform theory. In *Communicating science: new agendas in communication* (pp. 25–53). doi:10.4324/9780203867631

Bubela, T., Nisbet, M. C., Borchelt, R., Brunger, F., Critchley, C., Einsiedel, E., … Caulfield, T. (2009). Science communication reconsidered. *Nature Biotechnology 27* (6), 514–518. doi:10.1038/nbt0609-514

Chadha, G. (2005). Towards an informed science criticism: the debate on science in post-independence India. In *Culture and the making of identity in contemporary India* (pp. 247–258).

Chakraborty, A., Baumann, H. & Hultman, M. (2020). Science communication and social LCA: can the twain meet? Initial findings from an Oatly study. In *7th social LCA conference abstract book* (pp. 206–209). Gothenburg, Sweden: Chalmers. Retrieved from https://hdl.handle.net/11585/798824

Chakraborty, A. & Giuffredi, R. (2019). Science and technology for the people? On the framing of innovation in policy discourses in India and in EU. *JCOM 18* (03), A05. doi:10.22323/2.18030205

Chakraborty, A. & Pandey, P. (2023). Constructing 'responsive' publics: the politics of public engagement under India's 'decade of innovation' framework. *Asian Studies Review 48* (1), 140–158. doi:10.1080/10357823.2023.2226818

Chakraborty, A., Raman, U. & Thirumal, P. (2020). India: tracing science communication in independent India. In *Communicating science: a global perspective* (pp. 371–394). doi:10.22459/cs.2020.16

Cunningham-Burley, S. (2006). Public knowledge and public trust. *Public Health Genomics 9* (3), 204–210. doi:10.1159/000092658

Department of Science and Technology (2013). *National science, technology and innovation policy*. New Delhi, India: Ministry of Science and Technology, Government of India. Retrieved from https://dst.gov.in/sites/default/files/STI%20Policy%202013-English.pdf

Department of Science and Technology (2020). *Draft 5th National Science, Technology and Innovation Policy*. New Delhi, India: Ministry of Science and Technology, Government of India. Retrieved from https://dst.gov.in/sites/default/files/STIP_Doc_1.4_Dec2020.pdf

Finlay, S. M., Raman, S., Rasekoala, E., Mignan, V., Dawson, E., Neeley, L. & Orthia, L. A. (2021). From the margins to the mainstream: deconstructing science communication as a white, Western paradigm. *JCOM 20* (01), C02. doi:10.22323/2.20010302

Gopalkrishnan, S. & Galande, S. (2021). Scientific temper and nehruvian influence: how the millennials are handling the mythologization of science in India. *Cultural Studies of Science Education 16* (1), 231–249. doi:10.1007/s11422-020-10001-z

Government of India (1958). *Scientific Policy Resolution (SPR)*. New Delhi, India: Government of India. Retrieved October 29, 2023, from https://indiabioscience.org/media/articles/SPR-1958.pdf

Haksar, P. N., Ramanna, R. & Bhargava, P. M. (1981). *A statement on scientific temper*. Bombay, India: Nehru Centre. Retrieved October 29, 2023, from https://resources.aipsn.net/sites/default/files/2019-04/Nehru_Centre_Scientific_Temper.pdf

Horst, M. (2008). In search of dialogue: staging science communication in consensus conferences. In D. Cheng, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele & S. Shi (Eds.), *Communicating science in social contexts: new models, new practices* (pp. 259–274). doi:10.1007/978-1-4020-8598-7_15

House of Lords (2000). House of Lords select committee on science and technology. Retrieved from https://publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm

Irani, C. R., Lall, K. B., Venkatataramni, R., Dhagamwar, V., Hameed, S. S., Dayal, S., … Sharma, A. K. (2001). *Consultation paper on effectuation of fundamental duties of citizens*. India: National Commission to Review the Working of the Constitution, Citizenship Development Society. Retrieved October 27, 2023, from https://legalaffairs.gov.in/sites/default/files/(V)Effectuation%20of%20Fundamental%20Duties%20of%20Citizens.pdf

Irwin, A. (2014). From deficit to democracy (re-visited). *Public Understanding of Science 23* (1), 71–76. doi:10.1177/0963662513510646

Kankaria, S., Chakraborty, A. & Manna, A. (2023). Making knowledge visible: artisans, craftsmen, printmakers and the knowledge sharing practices of 19th-century Bengal. In *Race and sociocultural inclusion in science communication* (pp. 222–238). doi:10.51952/9781529226829.ch014

Khan, M. L. & Idris, I. K. (2019). Recognise misinformation and verify before sharing: a reasoned action and information literacy perspective. *Behaviour & Information Technology 38* (12), 1194–1212. doi:10.1080/0144929x.2019.1578828
Kumar, V. (2022). Science teaching in schools and scientific temper. *SSRN Electronic Journal*. doi:10.2139/ssrn.4027450
Lock, S. J. & Armstrong, E. S. (2023). The possibilities of queer in science communication teaching and pedagogies. In *Queering science communication* (pp. 181–190). doi:10.51952/9781529224436.ch027
Mahanti, S. (2013). A perspective on scientific temper in India. *Journal of Scientific Temper 1* (1&2), 46–62. Retrieved from http://op.niscpr.res.in/index.php/JST/article/view/1099
Mahanti, S. (2016). Nehru's vision of scientific temper. *Journal of Scientific Temper 4* (3&4), 154–166. Retrieved from http://op.niscpr.res.in/index.php/JST/article/view/20886
Metcalfe, J. (2019). Comparing science communication theory with practice: an assessment and critique using Australian data. *Public Understanding of Science 28* (4), 382–400. doi:10.1177/0963662518821022
Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science 10* (1), 115–120.
Ministry of Human Resource Development (2020). *National education policy*. New Delhi, India: Ministry of Human Resource Development, Government of India. Retrieved from https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
Nanda, M. (2010). Scientific temper: arguments for an Indian enlightenment. In *Indian political thought*. New York, NY, U.S.A.: Routledge.
Nehru, J. (1946). *The discovery of India*. New Delhi, India: Oxford University Press.
Orthia, L. A. & de Kauwe, V. (2023). Queering science communication theory beyond deficit and dialogue binaries. In *Queering science communication* (pp. 191–203). doi:10.51952/9781529224436.ch028
Orthia, L. A., McKinnon, M., Viana, J. N. & Walker, G. (2021). Reorienting science communication towards communities. *JCOM 20* (03), A12. doi:10.22323/2.20030212
Pattnaik, B. K. & Sahoo, S. (2014). Communicating science in India through people's science movements (PSMs). *Journal of Scientific Temper 2* (1&2), 33–85. Retrieved from http://op.niscair.res.in/index.php/JST/article/view/7008
Plessis, H. D. (2013). A comparative perspective for functional application of scientific temper in southern Africa. *Journal of Scientific Temper 1* (1&2), 9–28. Retrieved from http://op.niscpr.res.in/index.php/JST/article/view/1100
Prasad, R. (1982). The debate on scientific temper. *Social Scientist 10* (1), 56–60. doi:10.2307/3517123
Rasekoala, E. (Ed.) (2023). *Race and sociocultural inclusion in science communication: innovation, decolonisation and transformation*. doi:10.51952/9781529226829
Raza, G. (2015). Scientific temper: an arena of contestation in a globalized world. *Journal of Scientific Temper 3* (1&2), 34–43. Retrieved from http://op.niscpr.res.in/index.php/JST/article/view/9598
Russell, B. (1922). *Free thought and official propaganda*. BW Huebsch Incorporated. Retrieved from https://www.gutenberg.org/files/44932/44932-h/44932-h.htm
Sahoo, S. (2020). Recast(e)ing scientific temper in a democracy: the eccentricities of ambedkarian science. *Sociological Bulletin 69* (2), 174–190. doi:10.1177/0038022920923206

Schäfer, M. S., Kessler, S. H. & Fähnrich, B. (2019). Analyzing science communication through the lens of communication science: reviewing the empirical evidence. In *Handbooks of communication science* (pp. 77–104). doi:10.1515/9783110255522-004

Schiele, B., Gascoigne, T. & Schiele, A. (2021). Communicating science: heterogeneous, multiform and polysemic. In B. Schiele, X. Liu & M. W. Bauer (Eds.), *Science cultures in a diverse world: knowing, sharing, caring* (pp. 3–45). doi:10.1007/978-981-16-5379-7_1

Seager, J. (2015). *Promoting an enlightened scientific temper in BRICS: a contribution to a youth policy dialogue*. Science, Technology and Human Sciences Research Council, South Africa. Retrieved from https://repository.hsrc.ac.za/bitstream/handle/20.500.11910/3161/7528.pdf

Sharma, N., Akhter, Y. & Mir, S. A. (2020). Science education in India: a misnomer for scientific temper. *Journal of Scientific Temper 8* (3&4), 135–145. doi:10.56042/jst.v8i3-4.67420

Trench, B. (2008). Towards an analytical framework of science communication models. In D. Cheng, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele & S. Shi (Eds.), *Communicating science in social contexts* (pp. 119–135). doi:10.1007/978-1-4020-8598-7_7

Trench, B. & Bucchi, M. (2010). Science communication, an emerging discipline. *JCOM 09* (03), C03. doi:10.22323/2.09030303

Udgaonkar, B. M. (1980). Scientific temper and public policy. *India International Centre Quarterly 7* (1), 25–38. Retrieved from https://www.jstor.org/stable/23001793

Various (2011). *Scientific temper statement revisited: the Palampur declaration (2011)*. Retrieved October 29, 2023, from https://resources.aipsn.net/sites/default/files/2019-04/Palanpur-declaration.pdf

Various (2024, February 28). *Statement on scientific temper in the current context*. Kolkata, India. Retrieved May 14, 2024, from https://aipsn.net/wp-content/uploads/2024/03/ScientificTemperStatementWithSignatories.pdf

Varma, R. (2001). People's science movements and science wars? *Economic and Political Weekly 36* (52), 4796–4802. Retrieved from https://www.jstor.org/stable/4411529

Wilsdon, J. & Willis, R. (2004). *See-through science: why public engagement needs to move upstream*. doi:10.13140/RG.2.1.3844.3681

Zachariah, M. & Sooryamoorthy, R. (1994). *Science for social revolution? Achievements and dilemmas of a development movement — the Kerala Sastra Sahitya Parishad*. SAGE.

Authors

Siddharth Kankaria Simons Centre for the Study of Living Machines, National Centre for Biological Sciences, Tata Institute of Fundamental Research, India.

Siddharth Kankaria works at the intersection of science communication research, practice and teaching in India. He holds a BS (Research) in Biology from the Indian Institute of Science and an MSc in Science Communication and Public Engagement from the University of Edinburgh, U.K. He currently works as a Communications and Program Coordinator at NCBS Bangalore and serves on the Scientific Committee of the Public Communication of Science and Technology (PCST) Network. Siddharth spends his time contributing to mentorship, capacity-building

and social justice efforts, and developing intersectional science engagement practices for the Global South.
siddharth.kankaria@gmail.com

Anwesha Chakraborty University of Bologna.

Anwesha Chakraborty is a Research Fellow at the Department of Political and Social Sciences, University of Bologna. Her research interests include science and technology policies, responsible innovation, digital society and qualitative methods. Her work has appeared in international journals such as the Journal of Science Communication, Asian Studies Review, Visual Studies, First Monday, Telecommunications Policy and Sociologia del Lavoro (the Italian journal of sociology of work).
anweshachakrabortyunibo@gmail.com

How to cite

Kankaria, S. and Chakraborty, A. (2024). 'Scientific temper: towards an alternate model of science-society relationships'. *JCOM* 23 (04), Y03. https://doi.org/10.22323/2.23040403.

ISSN 1824-2049. Published by SISSA Medialab. jcom.sissa.it