Science Communication and Science in Society: A Conceptual Review in Ten Keywords

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Abstract: Originating in science outreach and influenced by social studies of science, science communication is now an established field of graduate education, of empirical and applied studies and of theoretical reflection. The establishment of this field has been marked inter alia by the publication of dedicated journals, reference books and handbooks, and the organisation of regular international conferences and professional networks. The process reflects developments in science-society relations as expressed, for example, in notions of post-academic, post-normal, or mode-2 science, all of which posit the permeability of the previously conceived boundaries, leading to more communication between institutions and between the cultures of science and of institutions and the culture of the wider society. In this article we have selected ten terms that are frequently used in the public, professional and policy discussions about questions of science in society.

Keywords: science communication; science in society; lexicon; trends and challenges; conceptual review; keywords

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Over the past three decades, government and institutional programmes and professional and voluntary practices in public communication of science have multiplied and diversified. With their proliferation and their spread around the world, an associated educational and research endeavour has also grown. Originating in science outreach and influenced by social studies of science, science communication is now an established field of graduate education, of empirical and applied studies and of theoretical reflection. The establishment of this field has been marked inter alia by the publication of dedicated journals, reference books and handbooks, and the organisation of regular international conferences and professional networks. The process reflects developments in

science-society relations as expressed, for example, in notions of post-academic, post-normal, or mode-2 science, all of which posit the permeability of the previously conceived boundaries, leading to more communication between institutions and between the cultures of science and of institutions and the culture of the wider society.

The term 'science communication' has stabilised in the past two decades as the preferred descriptor for this field of practice and theory. Out of 79 papers, essays and chapters published over seventy years that we selected for an anthology of writings on public communication of science (Bucchi and Trench 2016), 21 referred to 'science communication'; just two of those were published before 1995, and the rest were published in that year or later. Recently, 'science in society' has come to be used as a near-synonym, though sometimes intending to make explicit the dimensions beyond talking, exhibiting or writing science, such as policies and practices in public consultation on science-based issues, science policy or research agendas.

This possible ambiguity reflects the nature of the developing field, as does the shifting terminology for some central phenomena. In this article we have selected ten terms that are frequently used in the public, professional and policy discussions about questions of science in society. We set out in lexicon-like form how these terms have acquired a range of meanings, including distinctly different ones, some of which co-exist in current usage. With a firm grasp of these terms, and an appreciation of how they may be deployed normatively, descriptively or analytically, the reader should be better placed to navigate the field of science communication research and policy-making.

The following glossary does not propose stabilized or final definitions of the selected terms, but rather aims to make their variable usage more transparent.[1] A lexical exercise of this type is clearly limited when it is based on terms that are prevalent in the English-language literature. Both authors of this article work in multi-lingual contexts and are keenly aware of this limitation. However, it is also the case that English-language terms in this field have been widely used in international discussions, either in direct translation or in their original form. We offer this conceptual review based on our knowledge of the literature and our participation in relevant discussions. We have included references to sources for some arguments and illustrations but we considered it would have made for difficult reading if we attached references at all possible points. We open the review with one of the longest-established (and still-used) key terms and, beyond that, the sequence of the review aims to link each section with the next or previous one by broadening the argument.

[1] This article draws on the work done by the authors for the *Annuario Scienza Tecnologia e Società* 2014 and the *Handbook of Public Communication of Science and Technology* (Bucchi and Trench 2014a; 2014b).

Popularisation

This is the term with the longest tradition among those used to describe a wide range of practices in making scientific information accessible to general, non-expert audiences. The near-equivalent terms in other languages, including *vulgarisation* (French), *divulgazione* (Italian), *divulgación* (Spanish), also have long and continuing histories and carry similar connotations. Early examples of popularisation – though not named as such at the time – include Fontenelle's *Entretiens sur la pluralité des mondes* (1686), a series of conversations between a philosopher and a marquise. During the 18th century, science popularisation gradually defined itself as a distinctive narrative genre, often targeting in particular female readers as supposedly ignorant and curious – "symbols of ignorance, goodwill and curiosity" (Raichvarg and Jacques 1991) – as in Algarotti's classic *Newtonianism for Ladies* (1739) or de Lalande's *L'Astronomie des Dames* (1785).

Further channels of popularisation emerged later, with scientific discoveries frequently featured in the daily press, science museums, public lectures and the great exhibitions and fairs that showed visitors the latest marvels of science and technology. Particularly during the second half of the 19th century, popularisation and popularisers profited from changes in the publishing business and the increasing reading audience to become influential voices, but their success also testified to the increasing relevance of science as a cultural force. The sales figures of Brewer's *Guide to the Scientific Knowledge of Things Familiar* – 195,000 copies up to 1892 (Lightman 2007) – are impressive even by contemporary standards. Through their books and public lectures, popularisers ("showmen of science") like J.H. Pepper and J.G. Wood in England or Paolo Mantegazza in Italy became public celebrities of their time (Lightman 2007).

In the following century and particularly after World War II, the new global and policy landscape redefined popularisation in conceptual and even ideological terms, particularly in the US and Western Europe. With science's social and political role significantly captured by the metaphor of the "goose laying golden eggs" – e.g. delivering economic wealth, social progress and military power if appropriately fed – popularisation was expected to "sell science" to the broader public to strengthen social support and legitimation (Lewenstein 2008). The goose metaphor was coined by Vannevar Bush, scientific advisor to the US government during World War II, and author of an influential report (Bush 1945). The approach he, among others, proposed fueled the development of popularisation strategies and channels, including interactive science centres and partnerships between science institutions and Hollywood studios.

When a new phase of critical reflection on the role of science in development and (more broadly) in society opened, spurred by environmentalist, anti-war and anti-nuclear movements, the concept of popularisation also came under criticism as embodying a paternalistic, diffusionist

conception of science communication (Hilgartner 1990). More recent conceptualizations have reappraised the term, considering it suitable to describe specific types and contexts of communicative interactions among science and the public, for example, situations characterised by low public sensitivity or mobilisation, moderate perception of controversy among experts, and great visibility of science actors and institutions involved (Bucchi 2008). In China, "popularisation" has long been, and remains, the preferred term to refer to a wide range of science-in-society activities.

Model of communication

This is one of the key theoretical concepts in science communication. Despite this, only a few explicit models of science communication have been designed and proposed. Over twenty years ago, sociologists and communication identified theoretical and conceptual problems in the dominant practices in popularizing science (e.g. Dornan 1990; Wynne 1991). They referred in this context to the model of communication underlying such practices, meaning the hypothetical construction, by the initiators of communication processes, of the relations between the actors involved. These critiques identified the dominant model in terms such as 'top-down' and 'hierarchical' and pointed to the assumption that the target public was defined by a deficit (see Deficit below) of some kind.

Over the past two decades, science communication communities in research and practice have sustained a discussion about the limits of inherited models and about the characteristics of models that are more appropriate for the present day. Part of that discussion and research has been explicitly prescriptive and binary: it labels some models of communication, specifically, the deficit model, as old and discredited and others, such as dialogue models, as new and appropriate. In this context, the shift in preferences from one model to another is represented as evolutionary and irreversible.

However, another side of that discussion and research, more descriptive and analytical, has been aimed at understanding better the range of possible models, how different models are applied, how the language used to describe a practice may disguise the model that effectively shapes the practice (Wynne 2006), how different models can co-exist (Miller 2001; Sturgis and Allum 2005), and what governs the choices made. Some attempts have been made to set out a wide spectrum of models, incorporating more tightly defined options that might apply in specific and changing circumstances (Trench 2008).

Deficit

This is a central concept in identifying the intellectual (or ideological) foundations of some science-in-society ideas and practices and enabling their critique. Two assumptions often underlie this concept: public opin-

ion and political decision-makers are misinformed about science and the issues raised by its development; this misinformation is fuelled by inadequate and sensationalist media coverage of technoscientific topics. This situation is seen as being exacerbated by poor training in basic science and a general lack of interest among the institutions and the cultural intelligentsia in scientific research – in this last case, most famously by British scientist-author, C.P. Snow (1959) in his treatise on "two cultures". Consequently, citizens and political decision-makers are seen to fall prey to 'irrational' fears which fuel their hostility and suspicion towards entire sectors of research and technological innovation (e.g. nuclear energy, genetically modified foods, stem cells).

From this perception arises the need for initiatives bridging the gap between experts and the general public, reversing public attitudes towards science and technology or at least attenuating their hostility. Such emphasis on the public's inability to understand the achievements of science – according to a model of linear, pedagogical and paternalistic communication – has warranted the label of 'deficit model' for this view of the public understanding of science (e.g. Wynne 1991; Ziman 1991).

From the early 1990s, scholars such as those just named have criticised the deficit approach by highlighting the weak empirical foundations of its assumptions and the limited results achieved by the communicative actions it has inspired. Critics of the deficit-based approach do not deny that relevant awareness problems may exist across publics (see Publics below) on issues related to science, but suggest that this is not the best starting point: researchers should focus instead, they say, on what the audiences do know, and on their questions and concerns.

Discussion has continued over many years on what kinds of knowledge about science the public generally lacks and needs to have: knowledge of scientific fact, of scientific theory, of scientific methods, of the organisation and governance of science, or, more colloquially, of how science works and how science *really* works (see Durant 1994). However, the notion of absent knowledge of facts, expressed as a low level of scientific literacy, or scientific illiteracy, remains widely assumed in contemporary science-in-society practice, notably in contexts where there are perceived problems of anti-science, pseudo-science and superstition, as, for example, in Indian programmes of science awareness (Raza and Singh 2013).

Dialogue

Dialogue came to be presented as the acceptable alternative to the deficit model from the late 1990s. As public concern over specific science and technology issues became evident – sometimes despite significant promotional efforts – the demand for scientists to become involved in public discussion of such issues increased. Multiplying examples of non-experts or alternative experts actively contributing to shape the agenda of

research in fields like biomedicine have led to rethinking the very meaning of science communication in several arenas. A frequently cited report of the House of Lords (2000) in Britain acknowledged the limits of science communication based on a top-down science-public relationship, and detected a "new mood for dialogue". In many countries and at the European level, funding schemes and policy documents shifted their keywords from "public awareness of science" to "citizen engagement," from "communication" to "dialogue," from "science *and* society" to "science *in* society".

The claimed shift from deficit to dialogue remains a powerful narrative in public communication of science. The two approaches are widely seen as distinct and one as inherently superior to the other. The shift is often stated as an irrefutable fact: commentaries speak of the "dialogical turn" as a historical change that has taken effect across Europe, and more widely (e.g. Phillips et al. 2012). Dialogue and related approaches are now much more frequently proposed and enacted than those that might be defined as deficit-based, at least in Europe, Australasia and North America. However, closer examination reveals a complex picture; for example, the striking case of Denmark – for decades very strongly associated with pioneering dialogical initiatives – where there is an apparent reversal of the trend (Horst 2012).

The study of this case links to a thread running through the research and reflection of the last decade of skepticism about the scale, or even the reality, of the claimed shift to dialogue. It has been suggested, for example, that dialogical approaches may be used in order to more effectively remedy public deficits. It has been argued that some dialogue methods are not genuinely two-way or symmetrical, in that the original sponsors of the communication (generally scientific or policy institutions) stay in control and the citizens taking part have no significant influence on the final outcomes (Davies et al. 2008; Bucchi 2009). There is yet another strand to the discussion and to the communication and cultural practices; this draws attention to the possibilities and pleasures of dialogical events which are not oriented to specific political or informational end-goals, but rather to the process of "taking part" (e.g. Davies et al. 2008). In science cafés, a spreading form of science communication (see Einsiedel 2014; Trench et al. 2014), for example, the satisfaction of those involved may reside in the exchange itself rather than anything beyond it, such as acquiring and processing formal scientific knowledge.

Engagement

In the context described under Dialogue, Engagement has become in many countries, particularly English-language countries, a prevalent and inclusive term to describe a wide range of science-in-society practices in policy, educational, information or entertainment contexts. 'Public engagement' has become a label for organisational units and individual roles

within organisations; it can refer to the actions and attitudes both of knowledge producers and of various sectors of the public. When researchers, for example, go to the streets to talk about their work, this may be called "public engagement". Equally, the attention and interest shown by their audiences may also be called "public engagement". Especially in Britain, public engagement is as comprehensive a term as public communication; the acronym PEST (public engagement with science and technology) is used as the catch-all term in preference to PCST (public communication of science and technology) or PUS (public understanding of science). The change of vocabulary carries with it, at least implicitly, a shift to an understanding of relations between the partners in the process as more equal and more active.

Different levels and modes of engagement are envisaged, for example, by reference to downstream and upstream engagement (Wilsdon and Willis 2004). The latter has been proposed for priority attention, on the basis that early involvement of the public in discussion and eventually negotiation of new developments in science and technology will likely lead to more satisfactory outcomes for all involved, and specifically to knowledge that has earned public trust. The case of genetically modified foods and crops is cited as an example of late, or downstream, public engagement; citizens in many countries across the world were presented with products ready for use and, in many cases, they reacted in a hostile manner. In Europe, in particular, governments, researchers and businesses applied what they saw as the lessons of that experience when they sought to ensure earlier (upstream) engagement with nanotechnology.

Public engagement activities are nowadays regarded in several countries as a relevant dimension of the mandate – as well as a responsibility – of research and higher education institutions in the context of the so-called "third mission", where "engaged research" or "engaged universities" are frequently referenced. This development has been further reinforced by the European Commission's adoption and advocacy of the concept of responsible research and innovation (RRI). On this basis, scholars and policy-makers are discussing the most appropriate indicators to identify and analyse the range and impact of such activities (Bauer and Jensen 2011; Bucchi and Neresini 2011).

Participation

Through association with ideas of participatory democracy and participatory communication, Participation has come to be used in science-in-society to represent a stronger form of engagement by the public both with scientific ideas and with the governance of science. In these contexts, participation implies strongly active citizens, who can take part in many ways and at many levels, including in deliberation on the very topics for negotiation and communication. Thus, participation tends to be

used in science-in-society to refer to a third option that goes beyond the deficit-dialogue binary split and overcomes the need to refer, for example, to "real dialogue" in order to insist on the authenticity of the process (e.g. Riise 2008). If deficit and related modes of communication can be considered one-way, and dialogue two-way, then participation can be represented as three-way, because it implies publics or citizens talking with each other as well as talking back to science and its institutions.

In the European Commission's latest framework programme of research, Horizon 2020, valid for 2014-2020, support is being given to exploration of participatory mechanisms for deliberating on science, including on agendas for science, where the main agents of public participation are civil society organisations. Some contemporary science centres seek to facilitate similar participation through articulation of relations between arts and sciences, offering cultural representations of science as open-ended and available for interpretation and critique (Schiele 2014). In this context public participation in science is equivalent to that of critical audiences at the theatre or in the concert hall.

Yet other forms of public participation in science are represented by "citizen science" and "open science" (Bonney et al. 2009; Delfanti 2013). In the first, citizens may contribute to scientific research as collectors or contributors of data, for example adding observations of certain animal species to an online database to be later analysed by researchers; in the second, researchers make all protocols, data, analyses and publications available online for public scrutiny, allowing the interested public to access not only "ready-made science" (as was typically the case in popularisation) but also "science-in-the-making". In some cases, this accessibility paves the way for an actual contribution in terms of scientific content – historically and currently in amateur astronomy, more recently in ornithological or biodiversity field observations, and in various applications of 'hacking' (Einsiedel 2014; Delfanti 2013).

Publics

This plural form has become common in discussion and study of science-in-society, indicating in shorthand that "the public" is multi-faceted, even fragmented. Because it is not a common, much less everyday, word, "publics" often carries quote marks around it that draw attention to its deliberate use. Adopting the plural form was an important part of recognising that generalisations about the public – specifically in terms of its deficits – are very rarely valid, and often seriously misleading (Einsiedel 2000). Referring to publics has been associated with the proposal of a contextual model of communication (e.g. Miller 2001), according to which the communicators inform themselves about, and are attentive to, the various understandings, beliefs and attitudes within the public.

Beyond the demographically-based differentiation of publics as young or old, male or female, and scientifically educated or not, the plural-

publics approach has been supported by the accumulation of evidence on the widely varying interest, attention and disposition towards scientific matters by the populations of individual countries and, comparatively, across countries and continents. From surveys of public knowledge of scientific facts initiated over fifty years ago, these studies of publics have become increasingly sophisticated and nuanced. They measure fine distinctions within and between national populations on, for example, levels of trust towards scientists and scientific institutions and attitudes to emerging technologies. They allow such attitudes to be correlated with educational experiences and world-views. On the basis of cross-country analysis of survey findings, the patterns of national cultures of science (see Scientific Culture below) can be sketched (e.g. Allum et al. 2008; Bauer et al. 2012). A strong focus on publics is almost standard now in the training of scientists for public communication; short courses offered to researchers by research councils, universities, professional organisations and others very often start by asking: who are the publics you want to communicate with, and why (Miller et al. 2009)?

Expertise

One of the most common forms through which scientific knowledge and actors enter the public domain is as "expertise", when scientists take on public roles validating, interpreting, and commenting on developments in science, and advising governments and other social institutions on their implications. As producers of knowledge, scientists tend to operate in tightly circumscribed and increasingly specialised spaces. When scientists are called on to be experts in public arenas, they are expected to take a broader view and answer media questions or offer policy advice on themes in which they may not be strictly competent (see Peters 2014).

Studies of science in society have often focused on how scientific expertise is expressed and becomes a recognized authority in public. Increasingly, expertise of several kinds is involved when complex scientific issues are played out in public arenas. Contemporary developments in science, such as those in the nano-, bio- and neurosciences, typically happen at the interfaces of several scientific and technological specialist practices. Sometimes they also have political, economic or ethical implications which invoke contributions from experts in those fields. Scientists active in public communication are increasingly required to relate their own expertise to that of scholars and practitioners in topics that were previously considered remote, sometimes even antagonistic. When complex environmental and medical matters are negotiated through legal or parliamentary systems, perhaps with a view to establishing constitutional ground rules or setting down regulations, scientific expertise may be scrutinised in contexts and by criteria very different from those of the natural-scientific communities.

Scientific expertise has come to be further problematised by reference to the tacit, less formal, knowledge that various social groups possess through their experience or culture. In case studies in health and agriculture in the 1980s and 1990s, the term "lay expertise" (or "lay knowledge") was coined to refer to the knowledge that, in these cases, patients and farmers brought to a particular issue and that qualified the definition of that topic given by scientific experts (Wynne 1992; Epstein 1995). On the other hand, ripostes to that approach have insisted on the attribution of expertise only to those with formal qualifications (e.g. Durodié 2003). Scientific expertise in contemporary societies is being challenged by factors like expanded accessibility of specialist information to non-experts, increasing questioning of the choice and competence of experts, and public exposure to controversial specialist debates and competing expertise. Technological developments, specifically the proliferation of Internet forums and platforms, are making the "extended peer review", that was envisaged two decades ago, more real.

Visible Scientists

Public or visible scientists have been present in every generation since modern science emerged in the 17th century. Some of the founders of modern science were visible public figures, and some of the earliest institutions of modern science such as professional societies and academies dedicated themselves, at least in part, to making the achievements of science visible and public. However, those who did science were not defined as "scientists" until the 19th century and, up to then, the potential public for science was restricted to a shallow layer of the highly educated. With the professionalisation of science, the rapid growth in the number of scientists and the development of a mass public, a particular concern grew about the relative invisibility of science: the vast majority of science and scientists were invisible to the vast majority of society. A classic American study (Goodell 1977) coined the term "visible scientists" when it drew attention to selected scientists in psychology, anthropology, molecular biology, and other fields who had achieved public visibility as informers and explainers of contemporary science. But it also highlighted institutional constraints, which meant that scientists might be punished as often as rewarded for seeking such visibility.

From the 1950s, developments in society required scientific expertise to be more accessible. The space race engaging the two major geopolitical blocks drove efforts to increase public investment and interest in the new scientific and technological discoveries and conquests. Rapid developments in medical science and in information technologies needed explainers. The most successful popularisers exploited the opportunities of the rapidly spreading medium of television to become household names. In astronomy, new technologies and natural history, in particular, photogenic or otherwise charismatic scientists developed highly visible

careers as TV presenters. Some others, called on to be expert sources for the political and media systems, became public scientists in myriad ways, as newspaper contributors, TV show panellists, advisory committee or expert group members, and as politicians.

From the 1970s, governments around the world created ministries of science, technology or research and individual scientists were drawn into the political systems as ministers or advisers. The strength of presence of such public scientists – whether in media, politics or public affairs more generally – and the features of their visibility may be taken as a relevant dimension to analyse a country's scientific culture (see Scientific Culture below). Fueled by further developments of mass media, the celebrity culture that grew up around entertainment and sport has affected many other sectors; many societies have their celebrity scientists, just as there are celebrity actors, authors and economists (see Fahy and Lewenstein 2014; Fahy 2015). Their views are sought and broadcast on topics well beyond their areas of recognised expertise and their private lives become public affairs: it is also through such dynamics that the deepening interpenetration of science and society that characterises contemporary scenarios takes place.

Scientific Culture, Culture of Science

Several variations of these terms are used to refer to the standing of science in the general culture of a country or other cultural context. Two interconnected uses of the term have largely dominated debate in the past few decades. One use, significantly influenced by Snow's concept of "two cultures", contrasts scientific culture with that of the humanities and the arts, and it deprecates their separation and the lack of public attention for scientific culture (Snow 1959). The second use has been almost interchangeable with "public understanding of science" in its more traditional and limited meaning. This equates scientific culture with public attention to and interest in scientific topics and levels of scientific literacy and thus, through a deficit and diffusionist perspective, to public acceptance and support of different science and technology developments. Such usage has been extended to encompass technology explicitly, as in the French term *culture scientifique, technique et industrielle*, generally shortened to CSTI, or the European Commission's chosen term for a short period, "RTD culture", referring to research and technological development (Miller et al. 2002).

The narrow, diffusionist interpretation of scientific culture takes for granted, in a similar vein to Snow, that scientific culture can be defined as a distinct, coherent and monolithic object that can be infused or injected into general culture and society through appropriate communications. This view has been widely criticised as limited and unfounded on several grounds (see Deficit, Models above). Empirical studies have shown that concern for and skepticism about certain scientific developments may ac-

tually be associated with higher levels of literacy and information (thus, in one usage, stronger scientific culture) and vice versa, that blind trust – and in some cases even expectations of 'miracles' – with regard to science can be largely disconnected from actual knowledge and understanding (e.g. Bucchi 2009; Bauer and Falade 2014).

A more comprehensive view underscores increasing diversity and fragmentation within science practice; significant permeability of the boundaries between contemporary science and society; cross-fertilisation between images and narratives in general culture and scientific concepts and ideas; significant visibility and presence of scientific figures and concepts in the public sphere as well as in contemporary arts. This culture of science in society encompasses not just understanding of specific scientific content, but also an awareness and social intelligence of science as part of society and culture, and an ability to discuss and evaluate science's role, priorities and implications in an open, balanced and critical fashion. Also more recently, but in a more technically-oriented fashion, a discussion has started on defining indicators to "measure" scientific culture as a combination of traditional indicators (e.g. R&D investments and output), indicators of science communication activities (e.g. media coverage intensity, science museum visitors) and of public attitudes to science.

Recent Trends, Future Challenges

Contemporary changes require new approaches and possibly new concepts, models and research strategies: it is crucial to think about the reshaping of communicative relationships and, above all, to resist conceptualisations of science and society as separate and distinct from each other. This remains perhaps the central challenge for contemporary research on science in society but there are related challenges that arise from the co-evolution of science, society and communication media.

For example, permeability and heterogeneous networking between science and society intersect with the increasing fragmentation of publics, of media and of their social uses. Science institutions and actors are diversifying their attitudes and practices, also in the domain of communication, which makes it problematic to continue using traditional expressions like "scientific community", implying internal homogeneity and a shared commitment to specific norms and values (Bucchi 2009, 2015). But it is no less important to reflect on and investigate the diversity and articulation of the 'publics' of science communication. The traditional usage of 'public' evoked a notion of passive and target-like readers and spectators, often addressed and defined in marketing terms. But around public science events and technoscientific controversies there is much evidence of audiences as active participants, just as there is evidence that significant portions of the public may remain disenfranchised or alienated from interactions and participatory processes with regard to science. Social transformations, which are represented in characterisations of con-

temporary society as pervaded by uncertainty, risk or distrust, along with changes in media technology and use, are playing relevant roles in redefining and multiplying public spaces for science communication. These changes require research to develop more complex maps of the relations between sciences and publics.

Moreover, the traditional sequence of the communicative process (specialist discussion/didactic exposition/public communication or "popularisation") is increasingly disrupted. The didactic and public exposition of science is no longer, as in Kuhn's theory, a mere static and carved-in-stone page written by the winners in the struggle to establish a new scientific paradigm (Kuhn 1962). Even science museums, the places par excellence of 'fossilised' science, increasingly hold exhibitions on current and controversial science issues. Users of scientific information increasingly have access to science in its making and highly controversial debates among specialists. Some of the implications of this new scenario have been dramatically highlighted by cases like Climategate in 2009, when email exchanges among climate change researchers became available on the web, exposing internal communication dynamics traditionally confined to the 'backstage' of knowledge production processes: increasingly frequently, expert controversies unfold in real time and in public view. Research is required, more and more, to consider how and by whom the substance and the mode of such communication are shaped in exchanges within and between sciences.

Understanding these situations may benefit from renaming the object of science communication research as 'How Society Talks About Science'. This implies researching the cultural contexts – scientific, artistic, every day, and other – of such talk. The increasingly blurred boundaries of communication contexts should also encourage researchers to explore with more courage conceptual affinities and potential inspiration in the humanities, arts and culture, largely neglected by science communication scholars, despite the growing science/art practice. For example, concepts such as style may be relevant to understanding variety in science communication as well as addressing the challenge of quality (Bucchi 2013). This resonates with long-standing invitations to "put science into culture" (e.g. Lévy-Leblond 1996), emphasising its connections with other domains rather than its separation from society and culture, as expressed in models and visions of knowledge translation and transfer. It also invites us to recognise the importance of a broader culture of science in society that goes beyond familiarity with technical contents to include an awareness of its role, implications, aims, potential and limits. It eventually demands that not only society, the public and culture are problematised in their relationship with science, but that science problematises its own cultural premises. In this way, research on science in society can contribute to increased reflexivity within society and within science.

Research and reflection on science communication and science in society have traditionally suffered from disconnection with the broader area

of science and technology studies. Over the past few decades, however, concepts and approaches from STS have become more present and influential. Indeed, some of the works now regarded as 'classics' are works that have challenged longstanding stereotypes of the public, the media, and scientific actors from STS perspectives (see Bucchi and Trench 2016). At the same time, revisiting classical concepts (e.g. trust, community, authority, norms, gatekeepers) could provide new insights, in an STS or even broader social sciences perspective, on themes that were traditionally seen as limited to a specific, practical interest in communicating science to the public.

Building on and reappraising classical concepts by highlighting their relevance and transformation to face future challenges is an opportunity to look at science communication not only as a means to achieve certain objectives but as a central space to understand (and participate in) the interacting transformations of both science and public discourse. In this perspective, communication is not simply a technical tool functioning within a certain ideology of science and its role in economic development and social progress, but has to be recognised as a key dynamic at the core of those co-evolutionary processes (Nowotny et al. 2001; Jasanoff 2004, 2005), redefining the meanings of science and public, knowledge and citizenship, expertise and democracy.

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