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Global spread of science communication

Institutions and practices across continents

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Introduction

As an inherently international system, modern science has diffused institutional structures and practices across the continents from its earliest days. In an increasingly globalised world, these processes have accelerated and intensified and ideas and attitudes have also spread with cross-continental collaborations and movement of personnel. This includes ideas and attitudes on the place of science in society and on scientists' social roles. Partly based on this shared culture of scientists, but also driven by other globalisation factors in politics and economics, science communication has over a relatively short period become a worldwide phenomenon.[1]

With this global spread of science communication, its forms and its meanings have become a theme in science communication research in recent years. The proliferation of science communication activities and institutions across the globe, but also the differences and similarities between countries and regions in the organisation of these activities and institutions have become an object of specific interest in the worldwide science communication communities. A collection of country profiles and essays (Schiele et al. 2012) featured 31 contributors from six continents. The journal, *Public Understanding of Science* (2015) published a special issue on 'voices from other lands' – these included Ghana, Surinam, Taiwan and Thailand. A special issue of *JCOM – Journal of Science Communication* (2017) provided historical accounts of science communication's development and particular episodes in public science from ten countries.

An edited volume on national and international surveys of public attitudes to science and technology (Bauer et al. 2011) and an examination of the 'cultural authority' of science-based on public attitude surveys (Bauer et al. 2018) sketched global views of patterns of scientific culture. The rate of production of such cross-country studies has continued to increase, as have the number and distribution of the countries and regions covered in them. In several such publications, the same two or three countries repeatedly stand for Asia, Africa and Latin America. However, a recent edited volume proposing a 'global perspective' on science communication (Gascoigne et al. 2020) greatly increases the range of national experiences: the book presents profiles by over 100 contributors from 39 countries, many of them not previously covered in any depth. The book's lead co-editors introduce these country studies by referring to the setbacks as well as the advances, and the heterogeneity of developments, including the inconsistency of terminology (Gascoigne and Schiele 2020).

As that volume and the present one were in the final stages of production, the world was delivered a strong message about the necessity both of coordinated scientific research and coordinated science and risk communication: the coronavirus pandemic of 2020 severely tested the coherence and communication capabilities of the World Health Organisation (WHO), in particular. Through its senior leaders, WHO sought to present a unified global programme on combatting the new virus, but increasingly found individual countries – most volubly and noticeably, the United States – going their own way. A public health crisis that spread as a demonstration of globalisation and its impacts, simultaneously strengthened scientific collaboration and interdisciplinary communication and opened or widened fractures in international and national communities around policy advice and interpretation of science.

Science communication might be considered as operating in the spaces between these centrifugal and centripetal tendencies. Its *global spread* shows both at play – in the diffusion of models and formats from a single source to many countries, and the invention and adaptation of formats suiting the circumstances of particular countries and cultures. The science communication community has been aware of this tension from early days in its international networking. Reflecting on a conference theme of cultural diversity[2], Fayard et al. (2004: 28) wrote: 'Another interesting evolution is noticeable today in PCST outside Europe. Though modern science is international (global) by definition, when it comes to public communication of science, the local social and cultural values play a major role'.

In the business and economic spheres, *globalisation* has presented itself mainly as the uniform spread of brands, models, franchises and policies, sometimes driven through supranational agencies (e.g., International Monetary Fund), sometimes through transnational corporations (e.g., Starbucks), and often in a combination of both. In science communication, we see examples of a standardised format – more or less a brand – such as the Famelab competition running in over 30 countries, including in some where there are few other manifestations of science communication. On the other hand, there are science cafés in over 60 countries across all continents in the world that are highly variable, often very specific to local social and cultural conditions. Similar formats have also emerged, such as Bright Club, PubhD and Pint of Science, by means of which scientific ideas are shared in informal, everyday settings that can also be culturally quite specific.

Internationalisation of science and science communication has reflected and amplified the dominant position of the English language in the world. In science, professionals are increasingly required to network and be mobile on an international level and for those purposes to be capable of working in English. Research institutes and universities seeking to build international collaborations, to recruit 'world-leading' researchers, and to attract funding from international foundations require their public (and political) communication to be international, and thus in English. But this is, unavoidably, an impoverished English, a second or lower-ranked language for many of its users. The French science-essayist Jean-Marc Lévy Leblond has argued that we lose much nuance in communication when doing so through a compromise English; science has a choice, he wrote: 'be polyglot or silent' (1996: 257).

These circumstances also have implications for diversity and authenticity in science communication, which is culturally conditioned and linguistically differentiated. From their perspective as Spanish-speaking researchers working in English-language environments, Marquez and Porras (2020) write that 'as long as English remains the gatekeeper to scientific discourse, people of other cultural backgrounds will continue to find it increasingly difficult to participate in the scientific process and benefit from its outcomes'. They advocate measures to be taken in scientific publishing, in science journalism and science communication to mitigate these effects, including more media coverage of science from Asia, Africa and Latin America, 'culturally relevant content' in science communication and multicultural science communication training.

English-language dominance can mean that practices favoured in English-language zones pass more easily into other linguistic zones than, say, from Spanish-language zones to German-speaking zones. Linguistic dominance extends also to vocabulary: keywords of science communication originating in English, such as *public engagement* and *STEM* (science, technology, engineering and mathematics), are widely adopted in their English form into other languages. By writing and publishing in English – as we do here – about global dimensions of science communication, we need to be alert to these biases.

Key indicators of global spread

In seeking to build a global picture of science communication we first need to review its standing and development comparatively across countries. In the earlier version of this chapter (Trench et al. 2014), we adopted the terms of a then-recent assessment of science-in-society practices in Europe: the MASIS project surveyed 37 countries[3] and its final report categorised national science communication cultures according to six parameters, as 'consolidated', 'developing' or 'fragile'. The parameters 'collectively form a framework for analysing science communication culture' (Mejlgaard et al. 2012: 67), which appears valid beyond Europe. These parameters are, with slight modification for our present purposes: the degree of institutionalisation of the science communication infrastructure; the level of attention paid by the political system; the number and diversity of actors involved in science communication; the academic tradition for dissemination of research results; public attitudes towards science; the number and qualifications of science journalists. In a single-country study of Ireland co-edited by one of the present authors (Trench et al. 2017), the MASIS tripartite structure was adopted but it was observed that various aspects within a national science communication infrastructure – and not just between countries – might be considered 'consolidated', 'developing' or 'fragile': relatively sophisticated features can sit alongside more basic ones.

We can approach the institutionalisation of science communication through its place in the policies and programmes of national governments, national academies and research funders, professional networks, intergovernmental organisations, higher education and research institutions, international charities and commercial companies. The strength of the roles that these actors play and the relations between them can vary significantly but the state, in its various guises, tends to be the main driver of the institutionalisation of science communication. One of the first markers, if not *the* first, is the presence of government programmes to boost science awareness. Other markers include the presence of communication training for scientists; initiatives to support media attention to science; university taught programmes and research in science communication. In the following sections we examine each of these briefly, paying particular attention to their appearance in countries and regions outside western Europe and North America.

Government programmes to boost science awareness

Policy-making for the economy and for research and development have become ever more closely intertwined since the 1990s, as science and technology have been ascribed a central role in economic development, whether in taking a country from a largely agrarian or traditional industrial base to another phase of development. As in the industrially and technically more advanced regions, across the developing countries the knowledge economy and sustainable development have become central themes of public policy. Under either or both headings, government programmes and policies, with varying degrees of emphasis and explicitness, refer to the public's views of science and technology as a potential constraint on, or support for, economic and social development.

In the world's two most populous countries, China and India, the state's commitment to popularise science has been written into fundamental legislation for several decades. Many countries have made related policy commitments more recently. South Africa's 2019 White Paper on Science, Technology and Innovation includes commitments for a fixed percentage of public science funding to go to raising science awareness, and for research training and development grants to science councils and public universities to contain conditions that require grant recipients to communicate their research to the public (Joubert 2019). In line with Japan's five-year *Science and Technology Basic Plan* and its aim to raise awareness and understanding of science and technology-related issues Japan's Science and Technology Agency commits to communication conveying the knowledge and enjoyment of previous achievements in science and technology, [but] also seeks to promote constructive communication by sharing the tentative nature, uncertainty, and latent risks possessed by science and technology with the nation's citizens, its government, its research institutions, and researchers, for a better society and lifestyle.[4]

At the centre of government attention in many countries that are pursuing a path to a knowledge, or smart, economy are children's and young people's competence in scientific and technical subjects and their attitudes to developments in science and technology. The context of this concern is also competitive: some South East Asian countries have achieved high rankings in international surveys of school students' abilities in mathematics and science (e.g., PISA – Programme for International Student Assessment of the OECD), causing some alarm in western European countries. Government policies in these various regions are targeted, respectively, at closing the gap or maintaining the lead. In a largely linear conception of the relations between education and economy, the preparation of young people in STEM subjects is seen as assisting skills supply to the economy. In Malaysia, for example, the government's programme for building its digital economy drives its efforts to encourage young people to pursue STEM studies and careers. This, in turn, is the central plank of official initiatives in science communication but also the occasion of official concern about trends indicating the encouragement is not effective.[5]

In countries where science communication has been institutionalised more recently, the emphasis tends to be strongly placed on children and young people and the dominant forms of communication are strictly targeted and one-directional. However, in countries with a longer tradition of science communication government encouragement for public engagement with science has acquired a much wider scope during the past two decades. The public – or *publics* – are seen as including those with an interest and ability to participate in exchange of ideas and in policy formation. The dialogical turn in national programmes across the developed world reflects the diversity of publics these programmes encompass.

Based on a conception of science communication as (mainly) informal education and (mainly) targeted at children and young people, governments have committed over recent decades to building or supporting science centres as centre-pieces of institutional science communication. These centres are generally of the kind that has grown up since the late 1960s and the establishment at that time of Exploratorium in San Francisco. At the turn of the present century, a group of such centres was opened in Britain as a Millennium Project, with support from the National Lottery. Some smaller European countries built their landmark national science centres in the early 2000s, generally in the largest cities, as a representation of their country's openness to science and technology. In more populous Asian countries (e.g., India and South Korea), science centres are counted in their tens or twenties, and the networks have continued to expand through the 2000s and 2010s with support from regional authorities or state governments.

The most ambitious programme by far is that of China, where 190 science and technology centres were built over three decades.[6] The Chinese network of science centres is firmly integrated into a government programme of public education, as – in an apparently quite different political context – is Taiwan's National Science and Technology Museum, opened in 1986, with the vision to promote 'deeper understanding of the impact of various technologies and technological developments, and combine technology and life to promote the survival and development of individuals, social progress and the sustainable development of the country'.[7]

Elsewhere in Asia different models can be found, illustrating the uneven development of science communication. ArtScience Museum in Singapore is a 'cultural landmark' in an 'iconic' building that houses a large commercial, leisure and entertainment complex; it has museum partners in seven countries around the world. Miraikan, the National Museum of Emerging Science and Innovation, in Japan, 'considers science and technology to be one of many cultures in human society, each of which develops wisdom' and its 'daily science communication activities that … include creating opportunities for dialogue on science and technology'.[8] Mishkat in Saudi Arabia is part of the programme to 'enable a sustainable energy future for the Kingdom'; it was established in 2010 with support from museums and consultancies in western Europe and USA but has now become an influence on science centres elsewhere in the Middle East, notably through the regional network, NAMES (North Africa and Middle East Science centres). Science Gallery Bengaluru, due to open in 2021, is a joint initiative of the Karnataka state government and two major research institutes in Bengaluru, one of India's major science and technology hubs. This 'first space of its kind in Asia' is part of the expanding network of Science Gallery International, inspired by the art-science 'collisions' conducted at Science Gallery Dublin from 2008.

In these examples of science centres, but also in other cases, we see various configurations of state, public institution, foundation and corporate investment, local innovation and regional, sectoral or international coordination. A remarkable example of local innovation in science centres is MIDE (Museo Interactivo de Economia) in Mexico City, the 'first museum in the world dedicated exclusively to the science of economics'. Developed and funded mainly by Mexico's central bank, Banco de Mexico, it is located in a 16th century convent that took 15 years to restore; its exhibits cover some strictly financial topics, like money, but also large inter-sectoral themes like sustainable development.

National programmes for raising awareness about scientific developments incorporate other common manifestations alongside science museums and centres, including, for example, direct or indirect support for national *weeks of science, science festivals* or similar concentrated efforts in public science, and support for investments and innovations in science education. Comparing government science awareness programmes, Bultitude et al. (2012) found that Brazil's and China's were more oriented to development and addressing social inequalities than those of Australia and Britain; emphasis on education was stronger for China and Britain, and emphasis on culture was strongest for Brazil. An earlier study noted that it was not known if the Australian awareness programme of the 1990s 'caused Australians to become more or less aware of science and technology or of the part science plays in stimulating social and economic development' (Gascoigne and Metcalfe 2001: 75); the authors recommended that evaluation needed to be built into such programmes from the start. That recommendation remains valid and, as far as we can ascertain, has not been widely followed.

Training and other supports for scientists in public communication

Short courses in media and presentation skills are increasingly available to scientists and other academics from research funders, universities, professional societies and – increasingly – private providers. The number and spread of such courses are growing continuously; the common requirement of national and international research funders that results of projects are *disseminated* publicly is a strong driver of demand for such training. Two decades ago, an EU benchmark study of activities in the promotion of research, technology and development culture noted that few countries were doing very much to train their scientific research community to communicate with their fellow citizens or to engage with their concerns (Miller et al. 2002). A cross-country survey reported a significant correlation between, on the one hand, communication training and, on the other, confidence among researchers in communicating with the public (Peters et al. 2008). As the expectations increase of researchers that they undertake public engagement activities, so too does the provision of relevant training. Elements of communication training are increasingly found in doctoral and postdoctoral programmes, though generally more strongly oriented to communication with peers or prospective business users of research results than to communicating with broad publics or with policymakers.

Courses for early-career or established researchers in communicating with the public are often provided in English even for participants from non-English-speaking countries, as in the case of courses at the International Centre for Theoretical Physics and Third World Academy of Sciences in Trieste, Italy, for scientists in developing countries. These courses were offered on the basis that 'communication skills are particularly important for scientists in developing countries, where the infrastructure for science is weak and where science education needs more support at all educational levels … By improving their communication skills, scientists can play an important role in the development of science in their countries'.[9]. The India Alliance of Wellcome Trust, from the UK, and India's Department of Biotechnology organises 'SciCom101' workshops as part of its 'mandate to empower future leaders of science in India'.[10]

The Euro-Mediterranean and Middle East Summer Schools of Science Communication are an initiative of two international science centre networks, ECSITE and NAMES, aiming to build the capacities of science communication professionals in the region. The participants include staff of science centres and museums as well as those working with other science engagement organisations. In southern and eastern Europe, support for (mainly younger) researchers wishing to become involved in public communication has come from the British Council and UNESCO as well as from local sources. In October 2013, UNESCO organised the First Regional Science Promotion conference in Serbia, bringing together science promotion professionals, practitioners and enthusiasts from south-eastern Europe to 'share experience, network and formulate the next steps towards strengthening the link between science and society'.[11]

The cultural relations agency, British Council, is a primary player in science communication in several continents, principally through the Famelab competitions which have spread to the newer member states of the European Union but also to Egypt, Hong Kong and Israel; the British Council has provided the associated training, preparing mainly early-career researchers to present a chosen scientific topic in three minutes before non-specialist audiences. Another model of training originating in Britain and translated to other national contexts is that presented by the Science Media Centre (SMC) in its Introduction to News Media workshop. Developed by the British SMC, this and other workshops are offered by SMCs in New Zealand and Malaysia. The Stand Up For Science workshops developed by the British NGO, Sense About Science, have also been offered for export through the mainly European network, Voice of Young Science. The workshops aim to 'encourage early career researchers to make their voices heard in public debates about science'.[12]

Science communication training has become a significant professional and commercial activity, complete with branding, as in the case of the Alan Alda Center for Communicating Science. This centre at Stony Brook University in the USA has trade-marked its name and the 'Alda Method' and works alongside the Alan Alda Training Company offering training internationally with support from the Kavli Foundation. A development like this also stimulates the interest in science communication training as a topic of research. Introducing a collection of essays on science communication training, Newman (2019: 2) noted that 'with the growth of science communication training programs and courses around the world, there is a growing community of researchers focused on understanding the role of communication training in supporting scientists' communication efforts as well as scientists' motivation to seek training'. Newman added that the need for frameworks to evaluate science communication training programs was increasingly recognised but, as with other needed evaluation frameworks, those for training appear significantly under-developed on an international scale. Relatedly, the incentives systems for scientists who engage in public activities are under-developed. In a letter to *Nature*, correspondents from leading research institutions and the national science centre in Japan noted that the government 'has urged the researchers it funds to improve communication with the tax-paying public … [but time and effort spent on science communication will not help scientists to secure funding, promotion or employment' (Koizumi et al. 2013).

A key issue for the design and delivery of science communication training in general is the strength of emphasis on technical and formal aspects of communication. A media skills course may, for example, be largely or exclusively focused on the key elements of writing a news release or of doing a radio or television interview. In the same way, a course on skills for communicating with lay audiences may be largely or exclusively focused on techniques of storytelling. An alternative approach to public communication focuses on dialogue, preparing scientists to consider carefully the needs of their audiences and to listen well to their concerns (Trench and Miller 2012). Encouraging scientists to take part in informal conversation at science cafés or in public debates around science-related topics may require specific forms of support, that are not typically provided in standard short-course training.

Initiatives to support media attention to science

National and international bodies have become involved in efforts to encourage media interest in science, and to support journalists giving special attention to this *beat*. There is a strengthening trend of governments encouraging publicly funded broadcasters to increase and maintain levels of science coverage, in some cases providing support through national awareness programmes, or less directly, through state agencies and institutes in the science and technology sectors. High-technology companies also sometimes feature as sponsors of science programming on television.

In Asia, the Pakistan Biotechnology Information Center has organised media workshops and training courses aimed at enhancing 'the capacity of electronic and print media to objectively cover biotechnology-related issues' (Choudhary and Youssuf 2011: 254) and, more recently, a seminar bringing journalists and scientists together around the theme, the Significance of Popular Science Writing. In Africa, global and continental intergovernmental organisations supported a 2012 workshop in Addis Ababa on 'making science and technology information more accessible for Africa's development'. This event was organised in association with scidev.net, a non-governmental initiative supporting the worldwide development of science coverage in mass media that has attracted support from leading science journals and other institutions, agencies and foundations.

Scidev.net provides an Internet platform for reporting, analysis and discussion of scientific developments particularly in – or from the perspective of – developing countries. It is a publishing outlet for correspondents across the world's regions and has built an extensive archive from their contributions. It encourages emerging talent, organises online and offline training with a particular focus on Africa, and publishes practical guides on various aspects of reporting science. Similarly, the World Federation of Science Journalists (WFSJ) provides experienced mentors for journalists in developing countries who wish to specialise in science, and offers an online course in science reporting. The Federation's biennial conferences have secured substantial sponsorship that supports increased participation by journalists from developing countries.

As traditional forms of specialist science journalism have shrunk (see Dunwoody in this volume), some alternative employment opportunities are provided with state or institutional support, such as Internet-based services for research news found in Denmark, Netherlands, Norway, Spain and elsewhere. The British model of Science Media Centre has been applied in other countries, as mentioned earlier; it supports journalists covering science but also scientists engaging with media. In 2013 SMC reported that similar centres had been established in Australia, Canada, Denmark, Japan and New Zealand and there were 'more on the way in China, Italy and Norway'[13] but by 2020 it was being claimed more modestly that 'the emergence of a network of sister centres based on the UK SMC is rapidly gaining credibility on a worldwide stage, with SMCs now well-established in Australia, New Zealand, Germany and Canada. And as we continue to welcome interest from around the globe, the family looks set to grow'[14].

University programmes in science communication teaching and research

Over the past 30 years, university programmes leading to (mainly postgraduate) awards specifically in science communication have come to be recognised as one of the features of a developed science communication infrastructure. From the earliest examples of masters degrees and postgraduate diplomas in science communication established in Australia, Britain, France, Italy and Spain, such programmes are now found in many European, Asian and Latin American countries.

In New Zealand, Otago University in 2013 recruited a second professor of science communication for its programmes; over half of its students in this field come from abroad. In Brazil, a Masters in Scientific and Cultural Communication was added to the longer-standing offering in science journalism at the University of Campinas (Vogt et al. 2009) and a Masters programme on Popularisation of Science, technology and Health was established in 2016 in Rio de Janeiro based on collaboration between a university, research institutes, a science museum and a botanical garden. When Massarani and colleagues (2016) surveyed such programmes in Latin America, they found 22, of which 14 had been established in the previous decade, though the longest-running programmes have been in existence since the mid-1990s.

By contrast, North America has been a late adopter. A postgraduate programme at Laurentian University, Ontario, Canada, was declared at its instigation in 2013 to be 'North America's first and only comprehensive Science Communication program' and, more recently, as 'the first and only program of its kind in Canada'.[15] Historically, there has been a preference in the USA for more tightly focused professional programmes in science writing and science journalism, though there are specialisation strands in science communication and/or health communication within broader programmes at Drexel University, Philadelphia, University of Florida and Utah University.

In South Africa, Stellenbosch University has become 'an African hub for research and postgraduate training' in science communication, offering a fully online six-week course, completed by 200 people from across Africa in its first five years, and options in science communication for students of science and technology students at the university. In western Europe, the number of programmes continues to increase, with individual programmes adopting particular emphases, such as innovation at Trento University in Italy, media ethics and professionalism at Karlsruhe Institute of Technology in Germany, social media in University of Salford in England, and history of science at University of Valencia in Spain, all programmes started in the 2010s. A map of science communication training projects prepared by the EU-funded project, QUEST, shows a heavy concentration of these programmes in the older EU member states.[16] Among the relatively few outside that region are Masters programmes in Eötvös Loránd University, Budapest, Hungary, with tracks in media and in museums, and ITMO University, St Petersburg, Russia, with a specialisation in communicating biotechnology and medicine; both of these programmes were also established in the 2010s.

These programmes show some common characteristics across quite different cultural and educational settings, though the relative emphasis on social studies of science, communication theory and professional skills can vary considerably (Mulder et al. 2008; Trench 2012). Of the 22 Latin-American programmes identified by Massarani et al. (2016), 'twelve explicitly stated that their programme aims to train professionals in science communication, whilst eight responded that their goal is to train researchers in the field' (this survey covered doctoral as well as graduate diploma and Masters programmes). In this respect and in others, the global spread of science communication is not a uniform diffusion of a universal model. Nor is the trend in one direction only: there are also examples of science communication programmes that have survived a few years before being cut as part of their host institutions' rationalisation (Trench 2012).

Individual projects and institutional programmes in science communication research have grown up alongside postgraduate taught programmes. A first wave of doctoral research projects in science communication was populated mainly by trained scientists who were converting to science communication. More recently, the taught programmes in science communication have been a major source of doctoral researchers and those completing such studies, in turn, become teachers and researchers associated with the taught programmes. The countries and institutions that were earliest to establish postgraduate taught programmes have tended also to be the most strongly represented in formal academic research. Australian National University, which was the home of one of the first taught programmes in science communication, has established a research centre, Centre for Public Awareness of Science (CPAS) and in May 2020 listed 16 PhD research projects as current.[17] More typically, clusters of doctoral researchers in science communication are counted in low single figures.

A further outgrowth of postgraduate teaching and research in science communication has been the publication of specialist academic journals in the field. *Public Understanding of Science*, whose title reflects its provenance in Britain in the years following the 1985 report of the Committee on the Public Understanding of Science, emerged in the early 1990s from the same impetus that led to the Masters in Science Communication in Imperial College London. *JCOM – Journal of Science Communication*, an online, open-access publication from SISSA, Trieste, grew from postgraduate teaching and research in this institution. The addition to *JCOM* in 2015 of a Latin America edition in Spanish and Portuguese reflects the growing demand from non-Anglophone regions for publication outlets.

Catering to more local markets, *Quark* was published in the 1990s-2000s by the Science Communication Observatory at Universitat Pompeu Fabra, Barcelona, also a pioneer in postgraduate teaching of science communication. The *Japanese Journal of Science Communication* (Kyoto), *Indian Journal of Science Communication, Science Communicator* and *Journal of Scientific Temper* (India) emerged in more recent years. *Cultures of Science* started as an initiative of China's National Academy of Innovation Strategy and then moved in 2018 to an international publishing house, albeit still managed from China. In this and other examples, science communication publishing shows globalisation and localisation trends simultaneously.

International and comparative dimensions of science communication are also receiving increasing attention as objects and issues in research. *JCOM* editor Weitkamp (2016) listed 19 countries where corresponding authors that published in that journal during 2015 were based. While the number of countries represented in the affiliations of science communication researchers' publications has grown in the past decade (Trench and Bucchi 2015), imbalances remain. Guenther and Joubert

(2017) found that for multi-author papers published in *Public Understanding of Science*, *Science Communication* and *JCOM – Journal of Science Communication* since 1979, 'the number of authors representing institutions in different countries increased significantly over time … confirming a trend towards more internationalisation': the top eight countries for authors' affiliations were in North America and western Europe, with Japan and Brazil placed ninth and tenth.

Case studies from around the world

For the 2014 edition of this Handbook, we asked correspondents in five countries that have received modest attention in the research literature to outline developments in those countries. Each of these reports referred to several of the elements outlined above. As *Science Communication: A Global Perspective* (Gascoigne et al. 2020) offers more detailed accounts of science communication's development in these and 35 other countries, and as some of our correspondents are contributors to that volume, we sought brief updates on the most recent trends.

ARGENTINA[18]: A summary assessment of nearly a decade ago noted 'the creation or consolidation of groups and structures for public communication in science and technology institutions' and 'political tendencies where intellectuals, scientists and public figures in general have recovered their public role' (Polino 2013). More recent empirical evidence demonstrates that universities, public research centres and scientists are credible sources of information for citizens and important for guiding public policies. The credibility of science – and its professionals – is a structural feature and constitutes an indication of social authority that is both epistemic and cultural (Polino and Muñoz Van den Eynde 2019). However, a national survey indicates that two-thirds of those surveyed think that university scientists make little effort to communicate the results of their research to society (OEI 2020). Empirical researches also show sociological identity strongly determines the access and some social groups are well positioned to assert their rights to training, information and cultural participation in science and technology while vulnerable segments of the population are more exposed to cultural exclusion (Polino and Muñoz Van den Eynde 2019).

ESTONIA[19]: Science communication has matured and professionalised here. There are now employment opportunities for both science journalists and science communication professionals; science-related activities and content are more varied and accessible; museums and science centres are still big attractions. National policy still has the focus on educational activities but the Estonian Research Council, which manages national science communication activities, is ambitious to expand its scope: in 2019, they initiated the formulation of a national science communication strategy. In the wider public sphere, science enjoys high trust by the public despite suffering from scarce funding. The latter problem has been a strong driving force in recent years for scientists and research institutions to intensify their communication activities in the hope that a positive public image will lead to increased funding.

MALAYSIA[20]: Recent and current government policies have continued to emphasise science culture. The Malaysia Education Blueprint 2013–2025 presented a roadmap to strengthen the delivery of STEM education across the system. There has been a significant increase in science, technology and innovation (STI) programmes with major government initiatives through science- and health-related ministries and agencies, supported by public and private higher education institutions. Science culture is promoted through science centres and museums but also emerging spaces in social media and theme parks which offer entertainment activities incorporating STI elements (Akademi Sains Malaysia 2018). In 1999, the state energy company Petronas established Petrosains as 'a Science Discovery Centre that uses a fun and interactive approach to tell the story of the science and technology of the petroleum industry'; it is housed in one of the world's tallest buildings, accentuating its national symbolism.[21] Somewhat different priorities guide the initiative of the state body, Academy of Sciences Malaysia, which in 2020 sought proposals for art-science projects as part of its mission to 'nurture creativity at the convergence of the arts and the sciences'.[22]

NIGERIA[23]: The adoption of advanced mobile phone technologies in healthcare and the overcoming of religious objections to the polio vaccine (Falade 2015) and, with it, the effective elimination of Wild Polio Virus Type 2 strain are seen as examples of the increasing application of science to meet societal needs. Alongside government initiatives, DRASA, a privately funded initiative set up in memory of Dr Ameyo Adadevoh, who died from the Ebola virus, is undertaking public health awareness campaigns to strengthen Nigeria's preparedness for future outbreaks. In the promotion of science culture, the federal government's dream of establishing science centres across the country remains on the drawing board but the University of Nigeria, Nsukka, now hosts the Loin Science Park Project. University teaching and research in science communication is dispersed across several faculties. The Nigerian Academy of Science has entered into partnership with the Nigerian Film and entertainment industry for a Science-Entertainment project as part of its commitments to 'selling science'.

TURKEY[24]: The value of science communication has been acknowledged through significant investment in enhancing public engagement with science and technology and promoting scientific culture in the country. However, the ambitious plan by state agency TÜBITAK to complete a science centre in all 16 metropolitan areas by 2016 and in all 81 cities from 2023 has been modified.[25] In six newly established centres, TÜBITAK is responsible for the development of exhibitions, training of explainers and academic consultancy and the partner-cities for the establishment and administration of the centres; in some cases, it has been observed, the cities are using them as political arenas (Kalkan and Turk 2017).

The Turkish Ministry of National Education has also been working with TÜBITAK and the Turkish Radio and Television Corporation on developing science programming; the ministry's involvement reflects how creating engaged and scientifically literate citizens has become a focus of the new science curriculum, and encouraging public participation in policy debates about science-related social issues is seen as essential to maintain a healthy democracy (Cakmakci and Yalaki 2018). However, these activities and the establishment and sustainability of a community of practice in science communication are not given the same importance as material outputs such as science centres. Frequent changes of minister of education have shifted priorities, agendas and favoured different kinds of science communication, causing tensions among the public, policymakers, science communication researchers and practitioners.

Concluding remarks

These summary reports can be taken as evidence of trends that are not merely born of international diffusion through contagion but represent a global phenomenon. The term *science communication* is far from being universally recognised nor is it used uniformly, where it does occur. But in diverse countries, with notably different cultural contexts, a similar kind of commitment is being made to promoting science and, with it, to promoting awareness and appreciation of science. Across these examples, there are similar references to science's role in technological and economic development and to the need to encourage interest in science particularly among children and young people.

The supposed turn from deficit-model approaches to dialogue – however valid or not it may be for regions with longer traditions of institutionalised science communication – does not appear to have the same relevance in regions where the science communication culture is, in the terms of the European mapping mentioned above, 'developing' or 'fragile'. This observation is not a judgement, nor does it imply an evolutionary perspective. It is a reminder that different social conditions shape institutions and practices of communication differently, that trends validly observed in one region of the world do not necessarily apply elsewhere, that discussions of *old* and *new*, or *better* and *best*, in science communication need to be modulated with reference to specific circumstances. We have seen plentiful evidence that didactically oriented programmes of science awareness can coexist with open-ended, interactive and conversational forms of communication. Indeed, the spread of science cafés across the continents is a strong example of a format with global appeal and capable of being adapted very widely to local circumstances.

As we have seen, several other science communication formats have also spread globally including science weeks, science festivals, science media centres, short-course communication training for scientists and postgraduate professional education for science communicators. While the international science communication communities have in many cases networked effectively to learn from each other, they may need to develop more sophisticated tools for thinking about and analysing science communication in a global context. Taking a global view draws attention to the patterns of difference as much as to the patterns of similarity.

With the continuing accumulation of descriptive and historical accounts of science communication in so many countries, emphasis might now shift to understanding better these patterns of difference and similarity in relation for example, to political cultures, educational philosophies, quality of civic life, as well as economic, scientific and technological development.

Notes

1 This chapter represents a substantial revision of the original version (Trench et al. 2014), including consideration of some broad concerns of the global spread, additional and updated examples, and shortening of individual country reports.
2 8th international conference of the PCST (Public Communication of Science and Technology) network, Barcelona, June 2004.
3 The reports are posted at the website of a follow-up project, RRI Trends, http://www.rritrends.res-agora.eu/masis; accessed 11 May 2020.

4 https://www.jst.go.jp/EN/programs/PE.html.
5 'Ministry: Waning STEM student numbers concerning', Malay Mail, 29 September 2019; posted at https://www.malaymail.com/news/malaysia/2019/09/27/ministry-decline-in-students-opting-for-stem-subjects-concerning/1794928.
6 'Modern science centers in China help promote public science literacy', posted at https://news.cgtn.com/news/3d3d414f35557a4d7a457a6333566d54/share_p.html; accessed 11 May 2020.
7 https://www.nstm.gov.tw/Administration/AboutUs/Prospect.htm.
8 See https://www.miraikan.jst.go.jp/en/aboutus/.
9 Workshop materials in possession of this chapter's lead author as tutor at the event..
10 https://www.indiaalliance.org/science-communication-workshop.
11 http://www.unesco.org/new/en/member-states/single-view/news/first_regional_science_promotion_conference_on_the_agenda_in/.
12 https://senseaboutscience.org/what-we-are-doing/voys/; accessed 7 May 2020.
13 See www.sciencemediacentre.net/.
14 https://www.sciencemediacentre.org/international-smcs/accessed 7 May 2020; the SMC in Malaysia is not mentioned here, though it sees itself as part of the international network (see URL).
15 https://laurentian.ca/program/science-communication; accessed 8 May 2020.
16 https://questproject.eu/where-are-science-communication-courses-in-europe/; accessed 7 May 2020.
17 https://cpas.anu.edu.au/research/research-projects; accessed 7 May 2020.
18 This section is based on personal communication (March 2020) from Carmelo Polino, researcher at Centro REDES, an institution associated with the Conicyt (National Council of Science and Technology).
19 This section is based on personal communication (February 2020) from Arko Olesk, lecturer at Talinn University.
20 This section is based on personal communication (February 2020) from Latifah Amin, professor at Universiti Kebangsaan Malaysia.
21 See www.petrosains.com.my.
22 See https://www.akademisains.gov.my/artscience/; accessed 8 May 2020.
23 This section is based on a personal communication (April 2020) from Bankole Falade, researcher at Centre for Research in Evaluation of Science and Technology, Stellenbosch University, South Africa.
24 This section is based on a personal communication (April 2020) from Gultekin Cakmakci, professor of science education at Hacettepe University, Ankara.
25 See https://bilimmerkezleri.tubitak.gov.tr/Icerik/program-hakkinda-146.

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