

## Science communication in a diverse world

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**Abstract**

Recent years have brought a welcome and needed attention to diversity and inclusion in science communication. This diversity covers language, geography, religion, gender, sexuality — and politics. But with diversity comes complication, where our interest in public communication of science and technology comes in conflict with our identities, our politics, and sometimes even our moral positions. This paper presents a number of examples, highlighting the need for science communicators to be self-reflective about their commitments and how they shape their activities as science communicator practitioners and researchers.

**Keywords**

Decolonising science communication; Diversity, equity, inclusion and accessibility in science communication; Science communication and social justice

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Public communication of science and technology is an international, multi-lingual field. That means we are always confronting the different languages and meanings we use to describe our work. I originally delivered this paper to an audience in Zacatecas, Mexico, at a meeting that drew from across Latin America. Most of the audience spoke Spanish or Portuguese as their first language. Yet here I was, speaking in English. The different terms that we use in different languages for our field aren't simple translations, but actually convey different meanings. "Popularization" isn't the same as "divulgación", though it's close. But the labels of "inclusão social" in Brazil or "apropiación social de la ciencia" in Colombia carry a very different meaning about what our goals and methods can be. The early days of the PCST Network that sponsored the symposium where I spoke were consumed with the French label of "culture scientifique", an idea about science being perfused throughout culture in a way that the English translation of "scientific culture" doesn't capture. So language gets us immediately to the challenges of diversity.

In this paper, I'm starting with language. But I also want to look at religion, and geography, and gender, and sexuality — and politics. I'm going to suggest that our commitment to diversity is a complicated thing, where our interest in public

communication of science and technology comes in conflict with our identities, our politics, and sometimes even our moral positions.

Nearly 40 years ago, I published an article about the “arrogance” of popular science [Lewenstein, 1987]. In it, I argued that lots of beautiful science magazines and television shows (I’ve been in the field a long time — this was before the Internet as we know it came along!), that a lot of these science communication examples were arrogant — they assumed that everyone supported science. We needed to listen more to the audience, I said, to start where they are. In response, the famous science fiction writer Isaac Asimov wrote (using about these words), “I don’t understand who this fool Lewenstein is. Does he want me to listen to people who believe that photosynthesis works by magic or that prayer will cure their cancer? Those people are stupid. By Newton!” he said — not “By God!” but “By Newton! I’d rather be arrogant than stupid” [Asimov, 1987].

With all due respect to the late Isaac Asimov, I continue to believe that we need to recognize the diverse beliefs of our audiences. We *do* want to connect with communities who don’t believe that vaccines work, or who doubt the reality of climate change, or who deny the proven processes of evolution. We also want to engage with communities whose different beliefs don’t come from denying modern science, but simply come from not having access to modern science. Many people at the Zacatecas meeting spoke about ways of making those connections.

But addressing diversity can get complicated.

Some of the issues of language are practical ones, created especially by the dominance of English in science. Ana Maria Porras,<sup>1</sup> a Colombian biomedical engineer who trained in the United States and now works at the University of Florida, has written with her colleague Melissa Márquez about the specific inequities of relying on English for science communication [Márquez & Porras, 2020]. In many countries, English is the language of elites. If science information is primarily in English, then only the privileged people have access to it, thus increasing the inequality of who has access to the reliable knowledge that science produces. Many of you are working directly to address this, doing your work in Spanish, Portuguese, or other languages besides English. I want to celebrate that, not just because you’re reaching different audiences, but because you’re directly addressing issues of inequality that are at the heart of our attention to diversity. In another article written with a group of colleagues, Porras — who just won the AAAS’s Early Career Award for Public Engagement — has pointed to how scientific diasporas can contribute to science education [Avendano-Uribe et al., 2022].

Another practical issue of language involves citizen science (or what’s increasingly being called “participatory sciences”).<sup>2</sup> Many of us celebrate citizen science as a way of increasing access to science. While there are citizen science projects around the world, the United States has one of the largest sets of them. But none of the major directories of citizen science projects in the United States have a way of identifying projects in languages other than English, even though in the United States, Spanish is the home language of more than 12% of the population. Just

<sup>1</sup><https://www.bme.ufl.edu/dept-member/ana-maria-porras-ph-d/>.

<sup>2</sup><https://participatorysciences.org/2023/07/14/announcing-a-new-name-for-this-association/>.

before the meeting, when I checked *SciStarter.org*, one of the biggest directories, after digging for a while I managed to find a section on “multilingual resources”, which listed just two projects and four other resources in Spanish, one project in the Native American language of Navajo, and nothing in any other language.

Yet I know there are many exciting citizen projects in France, Spain, and other countries. We even have scholarly analyses of them in our various journals. But finding projects by language is hard. Even the EU citizen science directory lets you choose by country, not language.

When I looked for projects in Spain, figuring many would be in Spanish, only four of the first 12 clearly had a Spanish component in their name. Although many of us think of citizen science as a way of increasing diversity and reducing inequality, in practice the reality does not yet match the goal [Lewenstein, 2022a].

But shifting away from English also raises deeper questions about the basis of our knowledge of the world, and the ways that language also reflects culture.

The issue of language is one that I first learned in South Africa. This was more than 20 years ago, which was less than 10 years after the end of apartheid. After a workshop I gave, one man told me “In my country, the issue of HIV and AIDS is the most critical issue to discuss. But in my native language, we don’t have words for genitals or sexual intercourse. We literally say ‘he fell on her’” [I’ll leave aside the issues of power and violence in that statement]. How, he said, “can I tell someone how to use a condom for protection, when I don’t even have a word for penis?” I didn’t have an answer for him then, and I don’t have a good one now, almost 25 years later. How can we address practical issues of public health if doing so challenges both language and cultural norms? (This is a place where we in PCST need to learn more from our colleagues in public health, who have been addressing these challenges for generations.)

On the other hand, introducing different languages can also help us understand the limitations of English. The South African science communicator Sibuyela<sup>3</sup> has written about how he has tried to enrich stories written in Zulu by not simply translating English words, but by inventing new words or phrases to directly engage Zulu-speakers with the core information and ideas he’s trying to convey [Biyela, 2019]. In the process, he can even correct problems with the English words. Most notably, he doesn’t use the word “dinosaurs”, which means “terrible lizards”. But we know now that many dinosaurs are more like birds or mammals than lizards. So Biyela uses the Zulu words “Isilwane sasemandulo”, which mean “ancient animal”, and then provides context. For Biyela, this is not just about linguistic diversity, but about decolonizing science writing [Pichon, 2021; Ro, 2020].

Decolonizing raises the question of whose story we are telling, whose meanings are most important, and what it means to protect those meanings. For example, the historian of medicine Eram Alam<sup>4</sup> has written about the challenge of describing the lives of physicians who came to the United States from India [Alam, 2023]. When they describe their professional lives, they speak in English. But when they describe their personal lives, or emotional topics, they shift to Hindi or Urdu. Alam

<sup>3</sup><https://www.linkedin.com/in/sibusiso-biyela/?originalSubdomain=za>.

<sup>4</sup><https://histsci.fas.harvard.edu/people/eram-alam>.

said they are doing so for two reasons: first, they experience those emotions in their native culture and language. But there's also a political dimension: English is the language of the British colonizers, and by keeping their personal reflections in their native language, the stories are explicitly anti-colonial. The physicians are reclaiming their individuality and personal power by speaking their native languages. But this poses a challenge for Alam, and for any of us who are writing about science: is it fair to translate things that our sources tell us, when the very act of doing so repeats the extraction that English often represents?

Science communicators face the same dilemma. The scholar Lauren Kilian [2024] just recently wrote about the ethical challenges of narrative science journalism, especially when the science writer puts herself into the story. Her example is Rebecca Skloot's 2010 book, *The Immortal Life of Henrietta Lacks*. The book is about the HeLa cancer cells that have been critical for cancer research for generations. They were taken, without her knowledge, from Henrietta Lacks, a poor African-American woman who was dying of cervical cancer. Skloot's book was a huge best-seller, and was made into a movie with Oprah Winfrey. But the book isn't just about the HeLa cells, or the pain that her family experienced years later in discovering that the cells had been taken and used and commercialized without their permission. It's also about how Skloot, a young, white journalist with no connection to the African-American community, built relationships with some of the Lacks family in order to write the book. Kilian notes that what makes narrative journalism work — as with so much of the story-telling that we celebrate in science communication — is the way it draws in the reader. Kilian says that “Skloot's decision to present a first-person account of her own journey invites the reader to join her in a reciprocal relationship [between author and reader]. Yet, in writing *herself* into the story, Skloot was to forever link *her* experiences as a journalist with the story of the cells and the family she was reporting on, *ultimately raising questions about whose story it is to tell*” [p. 177, emphasis added].

I once experienced myself the flip side, the audience side, when someone else — for good political and cultural reasons — wanted to control the story. I was teaching in the science communication course at Pompeu Fabra University in Barcelona. As some of you know, Barcelona is part of Catalonia, which has a complex political and linguistic relationship with the rest of Spain. During the trip, my wife and I went to Girona, where we visited a museum featuring the history of Catalonia. That evening, Vladimir de Semir, who created the course at Pompeu Fabra, asked how we had liked the museum. We thought it was OK, I said, but we weren't sure: the labels were only in Catalan! I said I understood why Catalan partisans would want to make Catalan the primary language, to assert that Catalan matters. But if you want people from other places to understand Catalonia, I told Vladimir, you need to put the labels in other languages. This is the conflict that diversity brings for us: whose interest is more important: the community's need to control its own story, or the need for that story to be available to a wider audience? For example, if a traditional community knows that certain plants have healing powers, should science communicators be trying to explain why? Or should they be helping the community maintain control over its own knowledge?

This is what I mean by diversity posing challenges for us, challenges of how to connect the different meanings that science can have in different languages or when viewed from different perspectives. We often talk about science as a single

thing, identified with the largely English-based, global North, Enlightenment-inspired, reductionist realm of modern science. On the one hand, different languages express different meanings, both literally and symbolically. On the other hand, we are trying to help people from those diverse languages and cultures understand each other's meanings. How do we protect the original meanings at the same time we make them accessible to others?

I mentioned citizen science earlier. Citizen science also lets me introduce another dimension of diversity: religion, and the meanings that people take away from our science communication activities. Many years ago, I was evaluating a citizen science bird-watching project. The project brought groups to a local science center and helped them learn how to identify different birds. The data they gathered would be used for studies of genetic change, a key element of evolution. Now, in the United States, many families choose to teach their children at home, instead of sending them to public schools or even to private academies. About 7% of school kids are home-schooled. Families do this for many reasons, but some of the most common reasons are for religious and moral reasons [National Center for Education Statistics, 2022]. Families want their children to be educated with a particular religious perspective, and, perhaps more important, to *not* be exposed to perspectives that challenge their religious beliefs. In particular, that includes not being exposed to evolution, which conflicts with biblical explanations of the origins of humans [Harmon, 2008].

In the project I was evaluating, I found that a lot of participants came from the home-school community. I asked the parents, "Why?" Since the whole point of this particular project was to gather data supporting evolution, why were the parents comfortable bringing their children to participate? Oh, they knew about the evolution goal, they said. But they didn't have to use the materials that discussed evolution. They were mostly interested in the opportunity to get out and observe birds. For them, one of the best ways to celebrate God's power is to observe the beauty of God's creation. Citizen science gave them an organized way to do that, a way to look for specific details (in this case, the differences among birds), that let them see and celebrate the miracle of Creation. But is it OK to welcome a community into a science communication activity if that community actively rejects the very thing we're trying to communicate?

Here's another example. My colleague Ayelet Baram-Tsabari works at the Technion, in Israel. She has made a substantial effort to include both religious and ethnic diversity among her students, advising Muslims, ultra-religious Jews, and Christian Arabs, as well as more secular students. Her institution is also trying to connect with these groups. However: for many ultra-religious Jews, women and men are not allowed to mix. The ultra-religious told the Technion that they (or at least the men among them) would be interested in taking courses, but only if they were taught by men. Ayelet told me: if their "inclusion" means she is excluded, that's not inclusion.

So now we have begun to hit the constraints of diversity. The title of the Zacatecas symposium was "New voices, new knowledge". What happens when those new voices bring knowledge that is fundamentally opposed to the Enlightenment, reductionist model of modern science? In one of the earliest issues of the journal *Public Understanding of Science*, the prominent historian of science Gerald Holton

warned against what he saw as the “anti-science” tendencies in some approaches to science communication [Holton, 1992]. Holton wrote that what anti-scientists offer is:

“to put it bluntly, an articulated and functional, and potentially powerful counter-vision of the world, within which there exists an allegiance to a ‘science’ very different from conventional science. And that counter-vision has as its historic function nothing less than the delegitimation of (conventional) science in its widest sense: a delegitimation which extends to science’s ontological and epistemological claims, and above all to its classic, inherently expansionist ambition to define the meaning and direction of human progress” [pp. 107–108].

And yet, some of the most interesting discussions in our field in recent years have come from exactly those new perspectives that challenge ideas of objectivity and progress in science. Thirty years ago, the PCST Network published its first book, edited by Bernard Schiele, a summary of science communication in about 15 or 20 countries (including just one chapter for all of Africa and a chapter on Mexico by Guadalupe Zamarron being the only entry from Latin America) [Schiele, 1994]. Now, in 2020, Toss Gascoigne led a team that summarized science communication in more than double that number of countries, increasing our perspectives especially in the global South [Gascoigne et al., 2020]. Those chapters show the diversity of the field worldwide.

And with that diversity comes new perspectives, new ways of thinking about what science is and what science communication is. Five years ago, for example, this journal published a series of commentaries about feminist approaches to science communication, raising questions about who speaks for science [Lewenstein, 2019]. Similarly, the science communicator Britt Wray drew on feminist theory to suggest an ethics of “care” — that science communicators are fundamentally “caring” for science, with all the benefits for science and risks to caregivers commonly associated with the idea of care [Wray, 2021].

More recently, we have seen the opening of discussion of queering science communication [Orthia & Roberson, 2023]. In a robust exploration of the intersection of queerness with the field, the authors collected in a book edited by Lindy Orthia and Tara Roberson examine not just the portrayal of queerness, not just the presence of queer people as science communicators, but even the possibility of “queering” science — that is, challenging what we even mean by science, technology, and medicine, trying to create different meanings of what science, technology, and medicine fundamentally *are*.

Exciting as these ideas are, they are the perspectives that Holton worried about: these works bring critical perspectives to science communication that force us to confront the limits of what we mean by new voices and new knowledge. What happens when those new voices challenge the fundamental beliefs that some of us bring about what constitutes reliable knowledge, about what it is about science that makes it a powerful way of approaching the world around us? Are there topics that are important, but that we should *not* label as “science” communication? Is there a place where science communication cannot — or should not — go?

These challenges arise because we have many different goals in public communication of science and technology. Some of us are more interested in education and learning, some of us primarily want to attract young people to scientific careers. Some of us have very specific behavioral goals, such as getting people to take vaccines or use clean sanitation systems. Others of us have broader goals. We want to promote science and what we call scientific ways of thinking. Others of us want to critique some of the actions of science, such as questioning the safety of nuclear energy or geo-engineering, or calling attention to ethical problems and misuse of power. Some of us want to enlarge the community of science, drawing in more people from traditionally marginalized groups. And yet doing so brings in these new perspectives that challenge the very thing we hope to strengthen.

Which leads us to: what is science? Here I am drawing on the insights of the academic field of Science & Technology Studies, which includes history and sociology and politics of science. From an STS perspective, “science” is at least three things: science is a body of knowledge, it’s a way of approaching the world, and it’s a set of institutions like universities and research institutes. Those institutions hold people, who act according to a set of norms or principles. Those norms were first identified in the middle of the last century, by the sociologist Robert Merton [1942, 1973]. Some years later, another sociologist, Ian Mitroff, identified a set of counter-norms [Mitroff, 1974]. It’s not that one is true and the other isn’t, but that both are operating at the same time.

Briefly, the norms and counter-norms are:

*Communalism.* This is the idea that knowledge is held collectively. It’s why we don’t think of Leonardo DaVinci, brilliant though he was, as a great “scientist”. He published his work only in coded mirror writing. If findings aren’t communicated, they aren’t “science”. I can give a whole other talk about why the work we do as science communicators is fundamental to the creation of reliable knowledge!

*Universalism.* This is the idea that knowledge is the same everywhere. This idea is particularly relevant for democracy, where in the ideal form only merit counts, not heritage or status or anything else — everyone is the same. According to universalism, culture, language, geography, religion — none of that should matter.

*Disinterestedness.* This is the idea that scientists put their work out there to be judged, and don’t have a personal commitment to the findings. Because of disinterestedness, scientists use passive language and write “The experiment was performed”, instead of “I performed the experiment” — the individual is not supposed to be part of the knowledge. That’s another place where we, as science communicators, are always struggling!

*Organized skepticism.* This speaks to journals and conferences and other public presentations of findings — they aren’t ad-hoc, but are an institutionalized, organized system for testing findings and conclusions.

The counter-norms highlight some of the issues of diversity.

*Solitariness or miserism.* Though knowledge may be held in common, individual scientists also hold knowledge close, not releasing their findings until they are ready.

*Particularism.* While “knowledge” is ideally true everywhere, specific scientific findings are tied to the specific sites, experimental designs, or methodological approaches used to produce them. One of the standard defenses against critics of particular findings is that the critics did not use the same experimental design, or reagents, or in some other way did not replicate the *particular* conditions that generated the findings.

*Interestedness.* Scientific papers are often arguments for a particular interpretation of the data. Scientists have a deep personal (and human) interest in showing their arguments to be the correct one. According to one maxim, “science only advances funeral by funeral” (an idea first articulated by physicist Max Planck, then rephrased by economist Paul Samuelson).

*Organized dogmatism.* The institutional mechanisms for skepticism have their own momentum and commitments. Certain journals (and the reviewers they draw on) may be more likely to publish research based on particular theories or methods — and to reject research based on competing approaches. Perhaps most famously, in the 1960s, molecular biologists and natural historians sharply disagreed about whether to study life at the molecular or whole organism scale, and fierce institutional battles (about who to hire, for example) were the result.

The counternorms are equally present in how science operates.

I especially want to highlight the tension between universalism and particularism, because I think it’s critical to our understanding of diversity. Our belief in science is often a belief in expertise, in the value of systematic reliable knowledge that is stable, and the same everywhere. It’s universal. At the same time, many of us deeply believe in democracy, in the value of bringing everyone equally into the ways we govern our societies. We want to bring those interests into the discussion of science. This is the source of so many activities focused on co-creation with communities, which appeared often on the program of the Zacatecas meeting. Building community participation is often a response to the deficit/dialogue tension that also is often discussed in meetings of our community. This tension is fundamentally between expertise and democracy. In the deficit model, experts provide information to fill the deficit. But all of our research and practice over the last two generations has taught us that simply providing information doesn’t change a lot of knowledge, attitudes, or behavior. The lesson of the limitations of the deficit model is usually taken to mean we need more dialogue, more democracy, more true multi-directional communication.

But truly listening to our many audiences means accepting that they have expertise, too, of a different nature — expertise about ways of knowing or about ways of experiencing the world or about the goals of exploring the natural world [Jasanoff, 2003; Wynne, 1989]. We have to confront the tension between our commitment to the vision of science as a universal, reliable source of knowledge and our commitment to a particularism that recognizes different cultural and epistemological contexts [Kinchy, 2017].



I think it's OK for us collectively to have these diverse — and sometimes conflicting — goals [Lewenstein, 2022b]. We don't need to decide among them as a field. But we do need to be *individually* self-reflective. And that's hard work. The science writer Ed Yong once wrote about his commitment to including different voices in his stories, especially the voices of women [Yong, 2018]. He was committed to it. And then he discovered that despite his commitment, only 25 percent of his quoted sources were women, and 35 percent of his stories had no women sources in them at all. He had to take positive actions, like creating spreadsheets to track who he quoted — and who he even asked for interviews. Yong has also reflected on the issue of what his goals are [Yong, 2023]. Is it just to explain the science? Or is it to find the stories where science has failed society, such as in coverage of long COVID or chronic fatigue syndrome? We all need to do this kind of self-reflection.

I wish I could stop there, and say “can't we all just get along?” I actually tried that once, during the so-called “science wars” in the 1990s, when people (often natural scientists) committed to science as expertise attacked people (often STS scholars) who wanted to explore the complexities of how science operates in democratic society [Labinger & Collins, 2001; Lewenstein, 1996]. I thought maybe we could all just be reasonable and accept the value of different positions.

But sometimes diversity creates conflicts that are deeper, and that make us uncomfortable. Self-reflection isn't enough. Sometimes, there's no simple way to proceed. Almost always in these cases, politics is part of the issue.

For example, a lot of the resistance to Covid-19 vaccines wasn't because of lack of knowledge. Instead, people objected to elite groups making decisions for everyone. The challenge of populism vs. elitism, democracy vs. expertise, was literally a life-and-death issue around the world.

Sometimes, we have incompatible values, as the example I quoted before from Ayelet Baram-Tsabari suggests. Earlier this year, Lea Taragin-Zeller and her colleagues published a paper exploring the ways that religious communities tailor science information to meet their needs [Taragin-Zeller et al., 2024]. Taragin-Zeller and the others wrote:

“While examining these processes of tailoring can (potentially) be used as a model for religious-sensitive science communication, our analysis also highlights their prices. We found that information about the process of making science is omitted, female scientists are pushed to the margins, and scientific epistemologies are framed as second place to religious knowledge. *Exposing the prices of this tailoring, we question the limits of culturally specific science communication when it seems to justify the exclusion of important factual information about the world*” [Taragin-Zeller et al., 2024, p. 2, emphasis added]

We know from studies of cultural cognition that we need to work with these different sets of beliefs if we want to communicate with different audiences [Kahan, Jenkins-Smith & Braman, 2011; Kahan & Landrum, 2017]. Sometimes, the conflicts are about priorities, such as whether to focus on stopping climate change or mitigating its effects. But sometimes the conflicts are about what counts as reliable knowledge. Do we need to take a stand? This is really hard: on the one

hand, many of us are here because we deeply believe in modern, Western science — scientific knowledge, scientific processes, and scientific institutions. Yet simultaneously, many of us who have been active in learning about science communication believe that we need to be open to new ways of knowing, different ways of defining what counts as reliable knowledge, sharp critiques of scientific institutions, and other things that run up against our belief in modern science. This is an explicit struggle: do we need to draw a sharp line between science and non-science? Or do we use the new voices and new knowledges that we celebrated at the Zacatecas symposium to challenge what science is?

Put another way, part of the problem is the conflict between our theoretical commitment to diversity and our practical commitment to the value of modern science. I'm reminded of an old joke: a group of mathematicians and engineers are put into a room, standing on one side. On the other side of the room are bags full of gold. (Actually, in Zacatecas, it should be bags of silver, which is mined there). "Each time the bell rings," the people are told, "you can go halfway to the other side." At that point, the mathematicians go home, because they know that if you can only go half-way, you'll never get there. And so the engineers get all the silver, because they know you can get close enough!

Maybe, if we stay focused on the practice of modern science, we're close enough that it's OK to not worry about the theoretical conflicts in what we're trying to accomplish? Maybe. But I think we have a responsibility to address these hard problems.

And the question about the nature of knowledge might not even be the hardest problem. Other conflicts are about politics even more directly. These conflicts are not just about the nature of knowledge, but about who we are as science communicators. After Russia invaded Ukraine in 2022, the PCST Network had a long and difficult internal discussion about whether to issue a statement condemning the war. Ultimately it did so, stating that "The PCST Network joins scientific societies, universities, media organizations and other cultural associations around the world in denouncing the Putin-led invasion of Ukraine, which is causing countless deaths, injuries and displacements of people" [Metcalf, 2022]. A few months later, at least one person declined to participate in the 2023 PCST Rotterdam meeting because the network's scientific committee continued to include a representative from Russia who had not publicly criticized the war — something they were probably not in a position to do, given the risks of openly opposing the Russian government while working in Russia.

There have been proposals to hold PCST conferences in countries that have restrictions on who could enter that would have affected members of the PCST Network's scientific committee. Later this year, another PCST Network symposium will take place in China, which some people will object to because of China's treatment of the Uyghur minority population. And of course, we could continue this list of conflicts around the world — in Israel/Palestine, but also in the Philippines, in Myanmar, in India, in the Central African Republic, in Sudan, and so on and so on. The Wikipedia page on "ongoing armed conflicts"<sup>5</sup> has 5 conflicts with more than 10,000 deaths in the last year, 17 conflicts with between 1,000 and 10,000 direct violent deaths, and almost 40 other armed conflicts. If we move on to

<sup>5</sup>[https://en.wikipedia.org/wiki/List\\_of\\_ongoing\\_armed\\_conflicts](https://en.wikipedia.org/wiki/List_of_ongoing_armed_conflicts).

policy conflicts, almost all of us — certainly me, from the United States — come from countries where people elsewhere in the world object to some of our policies.

How do these conflicts intersect with science communication in a diverse world, with new voices and new knowledge? As I said a minute ago, sometimes we have to decide whether to continue our professional interactions with people in these countries. Scientists have faced this challenge many times. For example, during both World War I and World War II, scientists in the United States, the United Kingdom, and other countries had to decide whether to continue collaborating with German scientists. To do so, some argued, would honor the universal knowledge that science produces. But others pointed to particularism, highlighting the German development of poison gases in World War I and the need to protect the development of atomic weapons in World War II. Now, as the example of Russia and Ukraine suggests, science communicators as well as scientists face this.

In 2011, the World Conference of Science Journalists met in Qatar. With support from the World Health Organization, I had organized a panel on science journalism in the Arab World. At the last minute, an expert from a Palestinian university on the West Bank was unable to attend, because Israel would not allow him to exit the West Bank. Is science communication universal or particular? And yet the World Conference of Science Journalists also gives us an example showing that contexts can change. Many years ago, a member of the International Science Writers Association was held hostage by FARC revolutionaries in Colombia [Hargrove, 1995]. Even as the situation improved there, I heard many science journalists say they could not consider visiting Colombia. But the situation changed more and just a year ago, the World Conference of Science Journalists met in Medellin.

When we're talking about the demographic, or geographic, or linguistic differences, it's fairly easy for most of us — not all — to say there's a clearly a moral "right" and "wrong". It's hard to argue that men should have more authority than women, or that people from one part of the world or one language deserve less respect and attention than old white English-speaking guys like me. The benefit of respecting diversity is clear — studies that show that more diverse teams are more productive [Blackwell, 2017; Hofstra et al., 2020; Malcom & Malcom-Piqueux, 2013; Nielsen et al., 2017]. And our societies need collective moral disgust at instances of unprovoked violence against individuals because they happen to be Latine or Asian or indigenous. (There is a counter-argument: some people say that attention to difference is morally wrong — if we are all equal, then we should all be treated equally. But since that's not the real world, I agree with those who say that is just a thinly veiled attempt to continue to maintain political and social power.)

For the religious or political differences, deciding who is morally right is more difficult. If we look at the Russia-Ukraine war, we see a region with borders that have changed many times over the last 1000 years. (I have a colleague at Cornell, a Nobel-prize winning chemist, who was born before World War II in Poland, in a town that later became Russian, and is now in Ukraine.) If we look at the violence and conflict in Venezuela or Colombia or Cuba, we see resistance to colonial powers and arguments about what economic systems will better serve complete populations, ones where inequalities have been exacerbated by complex histories. And, in the Israel-Palestine war, we see a horrific terrorist attack by Hamas, an organization that has explicitly called for the destruction of a country and a

religious group — Jews — while we see a response from Israel that includes government ministers calling for the mass emigration of the Palestinian community. Both Israelis and Palestinians argue that their positions are justified responses to generations of attacks and oppression. It's much harder to come to collective agreement about which side is "right".

How does this affect science communication? As I said earlier, in a diverse world, we have to be able to hold multiple positions simultaneously. We have to recognize that what we call "modern science" has made tremendous achievements of understanding, with practical implications for health and medicine and diet and material living that have made all of our lives better. We have to recognize that thinking scientifically is itself one of the supreme achievements of the human mind. At the same time, we have to recognize that mining for silver or cobalt or rare earth metals to give us these wonderful science-based technologies has come at the cost of human lives and environmental degradation. We have to recognize that knowledge of plants and regions held by traditional communities through knowledge systems that don't depend on statistics and hierarchical trees of species identification also have value for creating medicines and healthy diets. We have to recognize that knowledges held by families or regional cultures or different languages have power in the world, by shaping how we decide which problems are important and worth trying to solve [Kimura & Kinchy, 2016]. Do these new voices and new knowledges create a fundamental conflict with modern science that, as science communicators, we have to choose between?

I will be honest: I don't know how to choose between expertise and democracy. I'm in this field because I believe the world would be a better place if more people had access to the kind of reliable knowledge that science produces. But I also know, after almost exactly 45 years in the field, that science is not a simple thing, that whether we're talking about science as knowledge, science as method, or science as a set of institutions, science has too often excluded knowledge, excluded ways of knowing, and excluded people who bring critical ways of knowing and acting in the world. I have good friends and colleagues who say I need to make a moral choice between these perspectives. I still keep hoping there's a way to reconcile them, that the most moral choice is to try to hold both perspectives at the same time.

So, as we move into discussions of new voices and new knowledge, let's use our commitment to science communication in a diverse world to help address the obvious kinds of diversity (language, gender, sexuality, geography) as well as the hard kinds of diversity — our very different positions about what is right and wrong with the world and what kind of knowledge we need to make it a better place. Let's use our tools of collaboration and explanation and journalism and exhibition design and community engagement to overcome both the obvious differences and the hard ones.

I look forward to continuing these discussions.

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