A comprehensive guide to Science Communication

Hindawi Limited
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Introduction

At Hindawi, we see scientific publishing as a collaborative effort that aims to make a transformative impact on society. And that collaboration – whether it is between researchers and journal editors, or between researchers and the public, or simply among researchers – is amplified through openness.

Open Access publishing – a scholarly publishing model through which publications are freely available for anyone to read and use in their research – has over recent years grown from a small radical movement to become a core part of scholarly publishing. As a fully open access publisher committed to driving greater openness in research, we often wonder what more can we do to ensure the widest possible access to science, as well as, perhaps more importantly, enable greater visibility of scientific research?

The answer to this is simple. Do everything we can to help science be better communicated.

The power of scientific research lies in its ability to transform people's lives. Helping colleagues, peers and the wider general public to get a better understanding of your research and the impact that it can have on society, is a win for everyone involved. It's a win for you – the researcher in the lab achieving a breakthrough. It's a win for us – the people trying to make sense of how scientific breakthroughs can change our lives for the better.

The research journey does not end when a paper is published. It is then that the work of helping others discover and understand the research begins. To help you be successful in this stage of your journey is why we, in collaboration with leading science communicators, created this science communication guide.

A Comprehensive Guide to Science Communication includes practical tips and examples of how to best convey science in an engaging way, dos and don'ts when communicating research to the general public, insightful interviews with people involved in public engagement and science communication campaigns, and much more.

It's a free resource available to read and use by anyone, anywhere in the world that can serve as a tool for you to increase visibility and thus maximize the impact of your work.

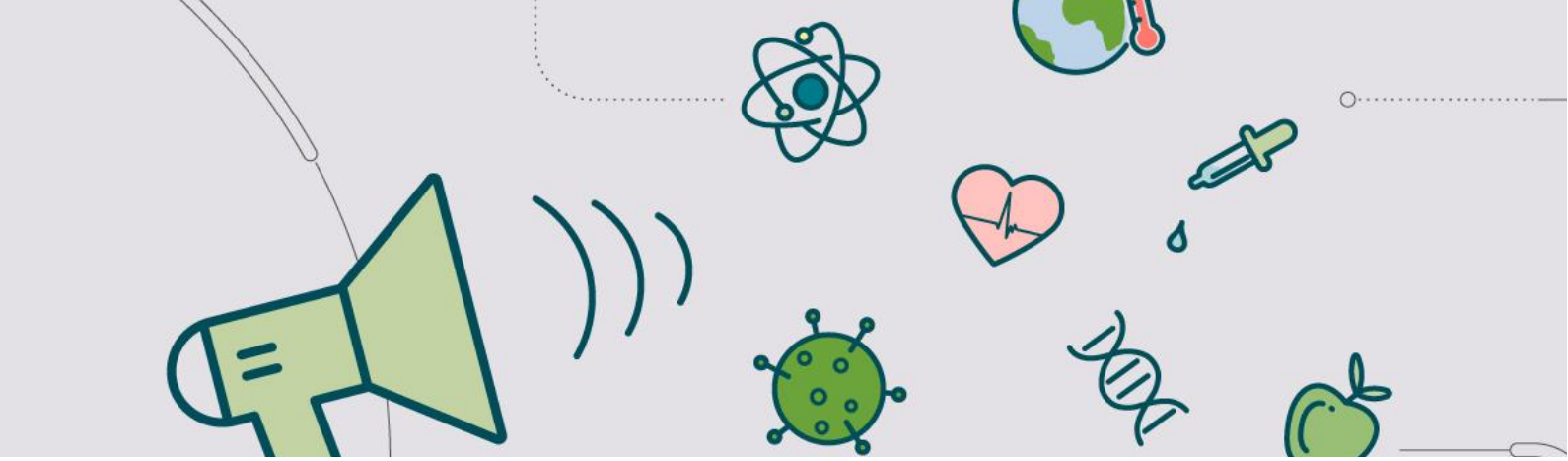
I wish to thank all science communicators and science writers who contributed their time and effort to this project. Their participation has been invaluable. I also wish to express my appreciation to Dr Elodie Chabrol, who played a key role in the completion of this guide. Her expert knowledge and enthusiasm for science communication is inspiring.

And to all of you who may be taking your first step into science communication, I wish to say this: there is true benefit in working together; there is true benefit in communication; and there is true benefit in communicating your work to the world.

Fani Kelesidou, Brand Marketing Manager, Hindawi Limited

Part A

What is science communication and how it can make me a better scientist



The Science of Science Communication: What it is and why it matters

Mike S. Schäfer

Facts and scientific evidence should inform public decision-making wherever possible. That is why science communication is important. As such, the act of science communication should also be evidence-based. Research on science communication analyzes what works, and what doesn't.

The COVID-19 pandemic and the *"infodemic"* [1] surrounding it have driven the point home once again on many issues. On timely issues like the distribution patterns of the new Coronavirus, climate change and gene editing, or generalized ones such as individual nutrition and healthcare, the public expects researchers to speak up.

Accordingly, political bodies [2], stakeholders, scientific academies and associations [3], science funders [4] and others have called for more, improved science communication in recent years on a worldwide scale. As a result, a myriad of science communication formats and activities abound; from public presentations to open days,participatory workshops to science slams, media appearances to Facebook posts and TikTok videos.

Directly or indirectly, many of these activities emphasize the importance of scientific evidence, and, with it, the importance of a scientific system that produces said evidence. These various bodies argue, albeit sometimes implicitly, that the knowledge produced by science represents the *"best available evidence"* [5] for many individual, organizational and societal decisions, and that science communication should therefore strive to make this knowledge widely available.

Science communication, whether in museums or elsewhere, should be evidence-based. (Picture: Natural History Museum London, Photo by Kevin Mueller on Unsplash).

Whilst this call for evidence-based decision-making has merit it should also be turned around and applied to science communication itself. The way science communication is done should also be evidence-based, too. After all, if you scicomm practitioners apply the principle to themselves how can one expect others to adhere to it? Hence, scientific analyses are required to analyze ways in which science communication works, towards what aims and the target audiences reached. Moving forward, these analyses should thus inform the practice of science communication.

In a nutshell, this is the M.O. of science communication research. It is an interdisciplinary field that some have called the "science of science communication" [6], which has grown exponentially [7,8] in recent years. There are hundreds of studies analyzing how scientists and scientific organizations, but also NGOs, think tanks and other institutions (strategically) communicate about science. Also included are how journalists portray science, how science-related issues are discussed in legacy media and online, which audiences these discussions reach and what cognitive, attitudinal and behavioural effects they have. By now, a number [9] of handbooks [9,10] have been published that summarize findings from the field. Specialized journals like *"Public Understanding of Science"* , *"Science Communication"* or *"JCOM – Journal of Science Communication"* have emerged. The international *"Public Communication of Science and Technology"* Network (PCST) is devoted entirely to both research and practice of science communication, with annual conferences that attract hundreds of participants.

Science communication should always be evidence-based: what works, and what doesn't? {Picture: Insung Yoon (@insungyoon, unsplash)}

The science of science communication has generated many instructive findings. It has shown, for example,that a substantial and growing number of scientists [11] are willing to communicate their findings. It has also demonstrated that different models of science communication [12] exist, each with their strengths and weaknesses. But it also shows that many scientists think of knowledge transfer as a one-directional process, [13] such as explaining things to 'lay' people when they communicate. Whereas the research clearly demonstrates different audiences of science communication [14] that exist, which need to be addressed, each with specific aims, channels and messages. This finding has become even more urgent in our modern times of digital, social and mobile media [15], which individualize communication, contribute to erosion of legacy media [16] and challenge the traditional infrastructures of public (science) communication.

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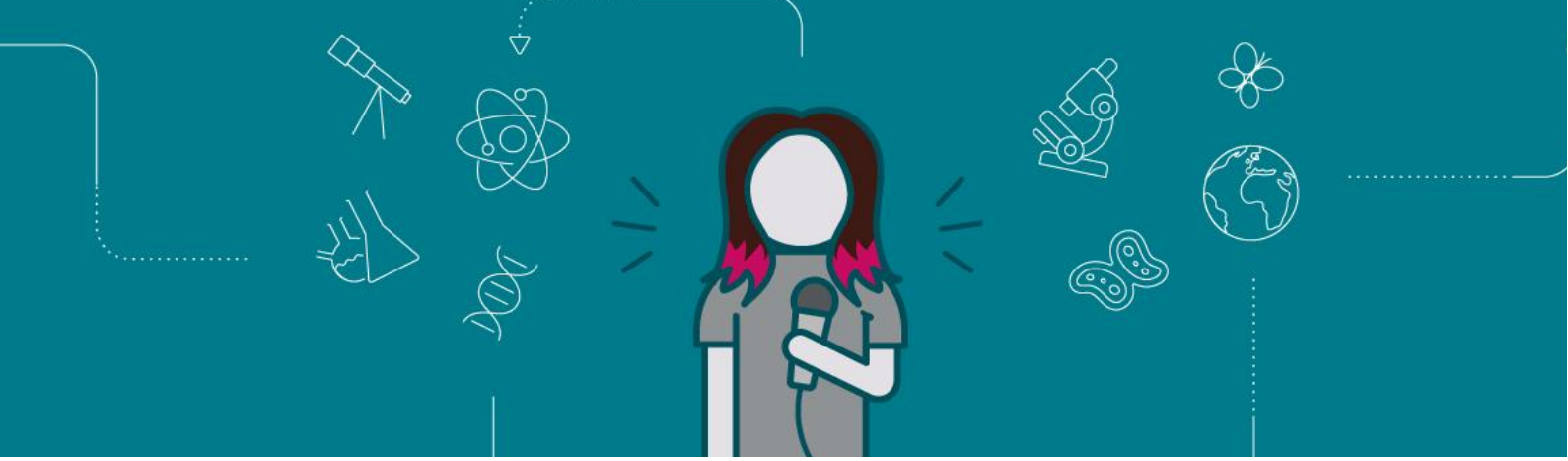

The Science of Communication: what's in it for researchers

Elodie Chabrol

Science communication is part of the research process. Elodie Chabrol explains why.

I am currently working as the International Director of Pint of Science, a science communication festival with events spanning 29 countries. Up until three years ago, however, I was still a researcher. For 12 years, I studied epilepsy. First in Paris, where I completed my PhD and then in London where I went on to pursue a postdoc, studying new therapies to treat epilepsy. I was fascinated by the brain and all its secrets yet to be unravelled and I still am. During those years, I often found myself feeling overwhelmed by the sheer amount of experiments, student training, article writing and grant proposals. I wasn't thinking about science communication at all. That was until 2013, when I first got involved in Pint of Science where I began organizing events and helping researchers to communicate their findings to the general public. It was then that I realized how vital science communication is to the research process. I firmly believe that science communication can help you to be a better researcher and here are three reasons why:

Killing two birds with one stone

By practicing how to share your findings with the public in a simple, jargon-free way, you pick up new presentation tips and skills. This kind of training comes in handy for interviews and funding auditions where you have to impress people that are not necessarily experts in your domain. When you become more accustomed to addressing a lay audience, you develop your unique style showing why your results and your ideas carry societal value in an accessible, more open way. Over time, you become your own personal marketer.

Gaining a new perspective

The most interesting feedback I often receive from Pint of Science speakers is that somehow this experience changes the way they view their project. They get a chance to look at their research with a fresh pair of eyes. Often, at this type of event people are asking all sorts of 'unexpected' questions. Those questions can be a source of inspiration for scientists, an *"oh, I hadn't thought of that"* kind of moment, which enables them to think outside the box and drives

them to see their project from a different angle. When you've worked on a specific theory or subject for years, you could definitely use an outside-the-box perspective. *"I saw the big picture again",* one of the speakers told me last year.

Sharing is caring

You may have brilliant ideas but if you can't get them across, then what's the point? Research is a big commitment. You spend years on a project, sometimes spending more time in the lab than with family. Have you ever tried to explain your big breakthrough to your friends or at a family dinner only to be disappointed by the puzzled looks you got staring back at you?
I founded Pint of Science France because I wanted to share my passion for science. I wanted to do my part in breaking down the stereotypes that have scientists as distant, trapped in their science bubble and too preoccupied with their experiments; an image that can sometimes lead to distrust and suspicion about our work. This is particularly true when we talk about touchy subjects, such as GMOs or vaccines. I wanted to bring scientists and non-scientists together to create a platform that will enable a greater understanding of science and the research world.

It's never an easy time for research. We always need more funding and for politics to be on our side. But I think the way to go about it is by getting the public more involved. The work is not over after the publication of your paper in a scientific journal. Think about it like making a movie, the red carpet premiere is just the beginning of its life. If you want to top the box office, you need to promote your film to make sure you can secure the required budget. It's the same with research. If you publish a paper, the journey isn't over, it's just the beginning. You always need to get more grants and public or private funders on your side. For that, you need to draw attention to your work and create a community around your research by engaging the general public.

It can be something as simple as writing a blog post, participating in a science communication podcast or just tweet about your latest finding. And of course, you can always come and talk to an enthusiastic public at one of our Pint of Science events. We are available in so many countries – you can't miss us.

Scicomm and fake news

Jason Woolford

Answering the question of how scientists' own science communication can educate the public and help in the battle against fake news.

'Fake news' is everywhere and where there is fake news there is fake science. It is far from a new phenomenon - even the 19th Century had the *"Great Moon Hoax"* [1]. But with the internet age, fake science has become more ubiquitous and potentially harmful than ever.

While fake stories of the past had limited reach beyond newspapers, meetups and local rumors, with today's tools like social media, fake science can go global in an instant cheered on by anti-science advocates who seek to sow doubt to suit their own agenda and worldview [2].

Against this sea of misinformation, how can scientists push back the rising tide?

Before answering the how, it is important to emphasize why we must fight fake science news. Because the consequences of doing nothing could be catastrophic. A lack of reliable information about, say, health matters can result in a rise of dangerous, avoidable illnesses and even deaths. Perhaps the most infamous example being the fabricated scientific study of Andrew Wakefield [3] that insinuated that the MMR vaccine causes autism. The continued dissemination of this fraudulent idea, especially through social media, has led to a global resurgence in measles [4] and also fueled the development 'vaccine hesitancy' throughout many countries. This example alone demonstrates how false information can alter public perception and attitudes towards even a well-established science.

It is easy to feel that overcoming the mountain of fake science news is insurmountable for your average everyday scientist. However, scientists on the whole remain one of the most publicly trusted professions around the world (a UK study in 2018 found that 83% of the public trusted scientists [5]) and this gives us a unique position that should be leveraged to help spread facts, not fiction.

So how can scientists communicating their science help?

By communicating science publicly we put a human face upon a field that can be viewed as cold and aloof. Scientists are respected, but the public doesn't understand much about what

scientists do [6], By using all of the social media tools of the 21st century, scientists can create persuasive content that reaches large audiences quickly to tell the diverse and colorful story behind the science and the researchers who carry it out [7].

Playing the long game, it is vital for science communicators to focus on and advocate for the education of younger generations [8]. Scientists must speak out when they see false information and be proactive about inoculating young minds against fake science. Eventually, this will promote higher scientific literacy in society at large as well as provide the ultimate defence against the inability of susceptible individuals to critically examine the information before them and reach a conclusion based on evidence and reason.

This type of early intervention is known as 'pre-bunking' and research suggests that it is more effective than debunking [9]. It is difficult to convince a person to change their mind when it is made up.

Some quick tips for communicating science:

- Double check your facts. You can't beat fake news by being fake news.
- Present facts in layman's terms as much as possible.
- Make the fact more compelling and interesting than the lie. Focus on the human story behind the science.
- Point out the lack of rigor and fallacies of the fake fact as well as the techniques that are used to distort reality (e.g. fake experts, cherry picking, logical fallacies).
- Emphasize the breadth and depth of scientific consensus that unpins current knowledge.
- Avoid hype. While confidence in scientists is high, hype runs the risk of undermining science in the long-term.
- Use visual tools and aids - graphics, audio and video content can be more powerful than words alone.

Increasing scientists' involvement in the communication of science is vital to stalling the march of fake news. By generating real science news and communicating media content of their own, scientists can help shift opinions and influence public behavior. Scientists are trusted voices and hearing more of them can prevent the harm being caused by the no-evidence, fake science news.

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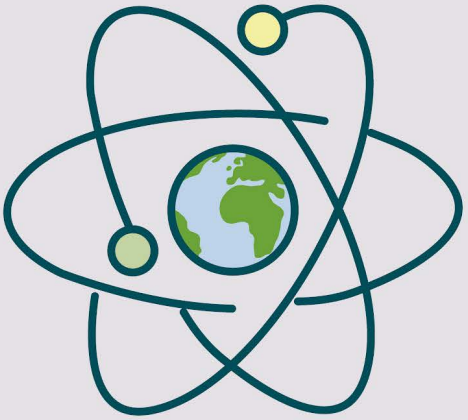


Science communication: key networks and initiatives around the world

Lewis Hou

Science outreach specialist, Lewis Hou, gives an overview of key networks and initiatives around the world aiming to promote evidence-based science communication, instill greater diversity and collaboration in the practice of science communication.

Following an evidence-based approach

The communication of science is a research field of its own. To gain a better understanding of the role and impact of science communication on society, we must explore the evidence of what works – and what doesn't. Over the past decade, the surge in science communication journals, academic courses, research programs and conferences across the world emphasizes the need for an evidence-based approach to science communication.

The Public Communication of Science and Technology (PCST) aims to improve the theoretical understanding and practice of science communication by bringing together professional practitioners with researchers. Drawing from interdisciplinary fields such as Science and Technology Studies, PCST organizes a bi-annual international conference. PCST also facilitates informal connections via the Global Science Communication FaceBook group.

There are also local conferences and networks that support a more evidence-informed approach to science communication on a regional level. Examples include SciCommSci Club in India, Scicomm Journal Club in the US, or the Art-Science reading group in Ireland.
Science communication is not just for scientists. Everyone needs to be involved.

Movements like citizen science, cultural democracy, Participatory Action Research and the global Science Shop support citizen-led research. These initiatives respond to the increasing demand for communication from society to researchers and provide a well-rounded approach to knowledge transfer.

To instill greater diversity in the practice of science communication, initiatives like the Inclusive SciComm Network in the US, Black in Science Communication week and the EQUITY @

ECSITE community aim to ensure all voices are being heard. Science, after all, works best when it is open and, most importantly, inclusive.

Falling Walls: a platform for raising awareness and collaboration

First founded as a commemoration to the fall of the Berlin Wall in 1989, the Falling Walls international conference now celebrates science communication. The event aims to make groundbreaking scientific work easier to access by breaking barriers between science and society.

In 2018, Falling Walls introduced 'Engage' - a global platform for science engagement. Falling Walls Engage was built with a mission to *"inspire and connect creative individuals who engage communities all around the world… and develop fresh approaches and innovative formats from the grassroots to the institutional level."*

There are many similar networks which work regionally, including prizes or funding to help share and promote good science communication. There is the AAAS in the USA, the Pacific Science Association, the African Gong network, the European Science Engagement Association (EUSEA), and the Network for the Popularization of Science and Technology in Latin America and The Caribbean (RedPOP).

Putting your science communication skills to the test

Apart from opportunities to network, share research and collaborate, there are numerous opportunities to actually do science communication and put your skills to the test. Competitions to explain research in three minutes, such as Famelab, have become a worldwide hit with international scope. There is even the opportunity to beam into classrooms anywhere around the world with Skype a Scientist. Many international fellowships and professional associations also provide the opportunity to focus on science engagement, including initiatives like Global Young Academy.

To help reach audiences wherever they may be, many of these events spring up in interesting places; from pubs across the world with the Pint of Science festival to train or metro stations with Mind the Lab and anywhere outside an academic context with Café Scientifique.

If you're keen on tweeting, there is the online Global Science Show, or if you're into visiting places for conferences, you could connect with your local Lecturers without Borders network. On top of that, there is Native Scientists for those who want to share their research in their non-English mother tongues in support of language diversity.

The range of science communication initiatives available across the world is simply too vast to describe in its entirety. I have only scratched the surface of the sheer mix of creativity out there. These international efforts are exactly what we need today with the pressing nature of our work in connecting science and society.

However, whilst we should be resourceful, we do not have time to reinvent the wheel. Sharing learning, ideas and research amongst ourselves is critical to ensure we work in ways that are evidence-informed and equitable, at scales big enough to truly make an impact.

Hopefully these formats from across the world have captured your imagination. I also hope they have sparked ideas amongst some of you to collaborate and connect in communicating your science. And even if there are no local activities happening in your area, what better time to get in touch with these networks or start one of your own.

Where to find funding for Science Communication

Lewis Hou

Ideas and passion are at the heart of science communication. Unfortunately, though, passion alone is not enough to pay the bills and expenses - trust me, I've tried. Obtaining funding for your project can vastly increase the quality, scale and impact of your science communication projects. As long as you spend it wisely.

To ensure your project is sustainable in the long term, funding to cover costs and time invested by yourself and your collaborators is essential. This is particularly true if you are working with creative professionals and community partners. Money in the bank means you can fairly compensate people for the work they do, which in turn will help ensure that your project is equitable.

First and foremost, you will need a great idea of how to share science with wider audiences. Also, you should have a target community and research partners on board. You may have even run a pilot and received feedback to help you better understand the audience and needs your project aims to address. If so, in many ways the most difficult parts of the process are done by this point. Nevertheless, you will need cash to take it to the next level. Here are a few ideas of how you can find that funding wherever you are in the world.

Local research grants

If your science communication project is focused on a specific field of research (your own, maybe), or with researchers within academia, this is a good place to start looking. *"Public engagement with research"* and *"research and innovation"* agendas are increasingly prominent in higher education and research councils across the world. They recognize that research should directly involve and benefit citizens. After all, as is the case of publicly funded research, it is everyday people who subsidize it.

Outreach like this is embedded in research culture. In the UK, for example, researchers are often obliged to incorporate some form of public engagement into their grants and/or have access to additional funding to *"enrich"* their research too. At the very least, this can be used to pay for expenses.

If you obtain enough, it can cover staffing too. This means buying-out a researcher's time, or by outsourcing skills elsewhere. The latter could take the form of dedicated employees, such as consultants, science communicators, artists, designers, videographers or other skills required by the project. As such, external resources free up time for researchers to dedicate their efforts to their core work, leaving the communication activities to specialists instead. It also recognizes the need for specialist expertise – an important factor in successful science communication projects.

To access these grants, you will need to be either a researcher yourself or work closely with one. If you are not in this position, many research institutions employ dedicated public engagement professionals who can help you find the right researcher and navigate funding too. The labels and remits of these staff vary from one establishment to another. Common umbrella terms include *"widening participation", "outreach", "community engagement"* and *"research communication, enrichment and/or administration."*

Funding outside academia

Many research councils, funders and national learned societies and associations have dedicated funding streams which can be open to those outside academia. These include the Royal Society of Chemistry, European Geosciences Union, the International Brain Research Organisation, Robert Bosch Stiftung Foundation and The Wellcome Trust, to name a few. The funding they offer ranges from small to very large envelopes depending on the stage, scope or scale of your project.

Calls for funding will have set deadlines, some of which only happen once a year. Hence, it is worth keeping an eye out for them and signing up to mailing lists or social media accounts of your key organizations. Even if you cannot find anything available, it can be worth getting in touch with them directly. You can always present your idea or request information about funding opportunities. Whilst there are not always grants, sometimes other support can be available through collaboration and partnership. Be bold: if you don't ask, you never get. Indirect help can come from local organizations and networks dedicated to science communication and public engagement, too. They often share information about funding opportunities. For this, you could keep an eye on the National Coordinating Centre for Public Engagement (NCCPE) in the UK, Informal Science in the US, Asia Pacific Network of Science and Technology Centres (ASPAC), European Science Engagement Association (EUSEA), La Red de Popularización de la Ciencia y la Tecnología en América Latina y el Caribe (RedPOP), North Africa and Middle East Science Centres (NAMES) and the Public Communication of Science and Technology (PCST) networks. These are all good places to start and you can also check an open-access resource of networks for more.

Other networks which have been set up may be able to help with funding opportunities via mailing lists and online groups. Why not register for the British PSCI-COMM mailing list, or the Science Communication Africa and Global Network for Science Communication Facebook groups?

Looking beyond science-specific funding

Many science communication approaches span disciplines and audiences. As such, they can open up different funding options from cross-over fields. If your project has a strong community element and impact, you may want to explore local funding which is available for broader charities and non-profit organizations. This can be done through local councils and schools, for example.

You could even strike up a sponsorship deal with local companies. Talk with your partners as they could know what grants are available to support your work. Bear in mind that in these settings you should place emphasis on the social impact of your project – not just the scientific aspect.

Similarly, if your project crosses over to the arts or a creative field, and have a strong community element, you could look into local funding for cultural projects. Alongside that, there is always crowd-funding, Patreon or the prospect of generating income from social media views. Some platforms like Lifeology help match scientists with artists for joint endeavors and can suggest funding opportunities.

Finally, don't be afraid to consider social entrepreneurship models where you can charge for services, products or tickets for those who can afford it. This can help make your work more self-reliant and potentially sustainable. It can even subsidize or fully support other targeted activities for communities who may have financial barriers in accessing it otherwise.
No matter where you are in your search for funding, remember that the core of good science communication focuses on the social aims and impact. Get that right, don't be afraid of networking proactively and the rest will follow. Enjoy the journey and best of luck!

Is scicomm making me a better scientist?

Esther Ngumbi

Is time devoted to science communication a valuable investment?

With every passing month, a science communication workshop is happening, with professional societies embedding many of them into their annual meetings. Scientific journals and universities are also stepping up their efforts to support science communication.

This interest in science communication, which acts to ensure the general public understands scientific discoveries and findings, occurs despite the fact that those doing so are rarely rewarded for it. As such, graduate students, scientists, and professors (including untenured ones) are adding these activities to their already demanding careers without reward.

Why *do* they do it, then? Is time devoted to science communication a valuable investment? Does engaging in science communication make researchers better scientists? What are some of the benefits that derive from science communication?

Scientists consistently engaging in science communication create a sort of 'personal brand', making their profile more visible to peers and the scientific community. And that increased visibility can pave the way for many other benefits including drawing attention from grant funding agencies and opening up pathways to influence science policy.

There is research evidence showing that in ecology and conservation research scientific communication correlates positively with increased number of citations. Another recent study demonstrated that tweeting has the potential to disseminate research results more widely, raising the scientist's profile.

Secondly, sharing your research with the wider public can open doors to new networks while broadening your existing ones. Importantly, engaging in science communication enables you to interact with researchers at different stages of their career, from different regions of the world, thus building a broader network. Connecting with peers from across the world can lead to future collaborative and interdisciplinary research and can be a gateway for scientists to learn about different conferences and training programs, all of which can help to enhance a researcher's career trajectory. The Informal science network includes a collection of all the conferences that are available for scientists that are interested in science communication.

The growing interest in science communication has opened up new funding opportunities such as the ones offered by the US-based National Academies of Sciences, Engineering and Medicine, the Swiss National Science Foundation, Alfred P Sloan Foundation, and the VolkswagenStiftung Foundation. This is in addition to the MIF's Science Communications Funders Network representing a cohort of funders who are recognizing the need to communicate more effectively around science.

The academic community, including grant funding agencies, is slowly but surely beginning to change how impact is defined. For instance, scientists submitting grant proposals to the National Science Foundation are requested to list their research products or "broader impacts" rather than just their peer-reviewed publications. This means that other products, such as those generated by engaging in science communication can be included. Not only that but also, academic institutions are now allowing scientists to use metrics provided by blog sites or social media platforms on which they post their articles about the research they are doing.

Time devoted to science communication is a valuable investment that can have a tremendous societal impact. And the return on this investment is truly rewarding. Dr. Michelle Rodrigues at the University of Illinois at Urbana Champaign who is an avid science communicator, sums it all up in a Twitter comment: "*The major reason I do it is because it's so fulfilling to have people interested and engaged in your work in a way that you don't often get without public engagement.*"

It is our obligation as scientists to continue to highlight many of these benefits. Doing so will inspire other researchers to raise awareness of the role that science plays in everyday life.

Citizen science: scientists and the public working together

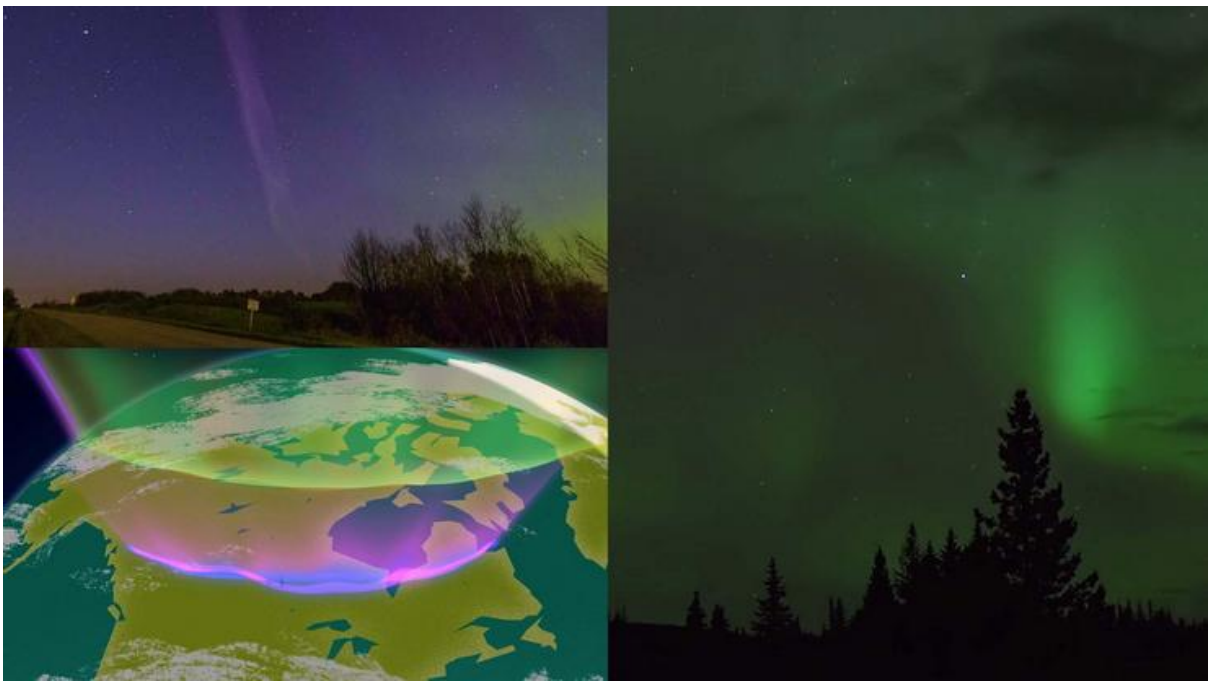
Dr Liz MacDonald

How can everyday citizens help in making discoveries and, in doing so, move science forward while gaining a better understanding of the scientific process along the way?

In citizen science scientists and non-scientists collaborate. Participation from volunteers empowers science communication and science communication empowers participation from volunteers. These volunteers, or citizen scientists, contribute to the scientific process by playing a variety of roles. These include data collection and analysis, communication of results to their communities, and asking important questions based on their unique skills and experiences they bring to the table. In turn, scientists contribute in-depth knowledge, guidance for best practices, and mentorship in sector-specific activities such as publication. Hence, there is a reciprocal social contract founded upon respect, which uses FAIR data practices, and two-way science communication. Listening with humility is critical, particularly on the part of the scientists, for whom this may be contrary to 'business as usual'.

An illustrative example is the story of the platform Aurorasaurus that I founded in 2012, to study an unusual auroral form. Even though it had long been noticed by citizen scientists, the form had not yet been formally identified. Through this global citizen science platform, we created a scheme for partnering with local enthusiast groups (most notably the wonderful Alberta Aurora Chasers on Facebook), gathering verified reports and building up more detailed information like time lapse videos.

I first heard of the purple and green feature from these citizen scientists in 2015. Later, it would come to be known as STEVE, or Strong Thermal Emission Velocity Enhancement. The paper about STEVE in 2018 revealed the underlying physics behind it as well as the discovery that while the phenomenon had been seen by scientific satellite instruments before, the optical feature had not been recognized by science from the ground. In fact, it was citizen scientist aurora photographers who had the knowledge, motivation, and tools to capture STEVE in a way that science had not. This is just one example of how the relationship with a good citizen science project design can lead to impactful research.



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"People were out observing the aurora and they started noticing something that was overhead as well, when they were seeing aurora far to the northern regions. It was unlike most aurora. They talked to the scientists, and we didn't know what it was. And together, they said we will keep taking observations, and we will call it STEVE in the meantime. STEVE is mostly a very narrow purple arc and sometimes it has these little green features that go along with it as well that are kind of like a picket fence. We now have satellite observations from the ESA satellite called SWARM that show that STEVE optically is associated with a very strong flow in the particles in the ionosphere, the upper level of our atmosphere. STEVE is important for a number of reasons. It's really exciting that people armed with cameras all over the globe can capture something that we didn't fully understand and shed new light on that. It's also really exciting that this happens further to the south where there are more people. So, it might be a kind of aurora that more people can see than the usual kind. Thank you to the citizen scientists around the world who help us explore as one."

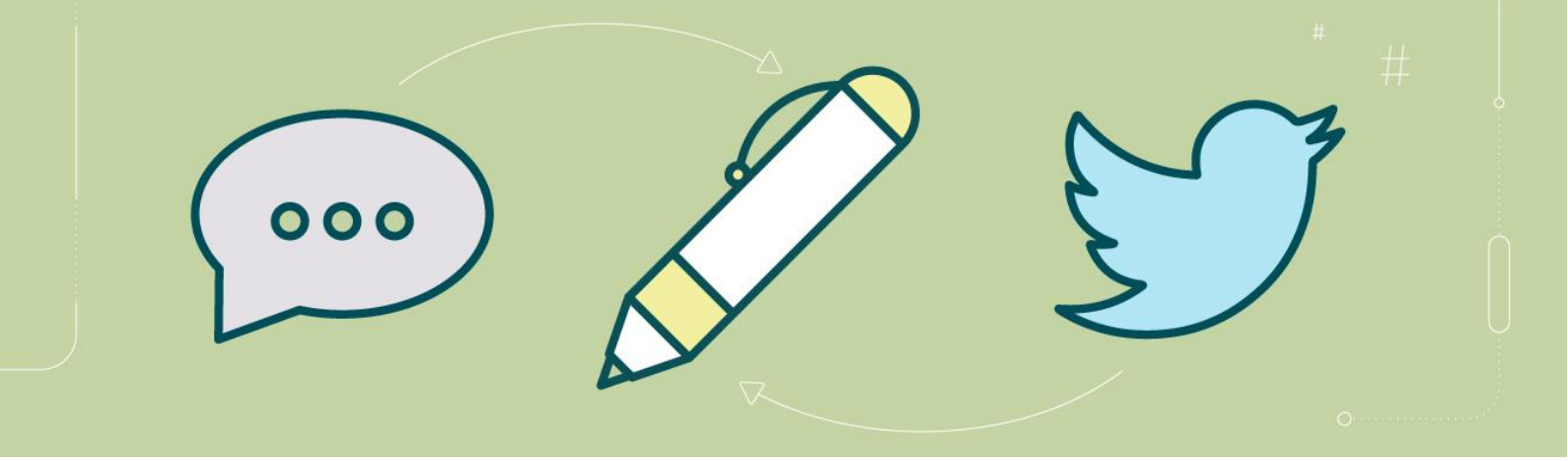
The STEVE citizen science story has gone viral around the world multiple times. Indeed, it ticks all the boxes of what makes science communication newsworthy as recommended by the American Geophysical Union. Citizen scientists and scientists have been interviewed, and the public has responded in many ways with a science podcast for kids, a documentary film, and even the minting of a Canadian coin.

Because of the power of STEVE, many more people have come to understand that science is an ongoing group effort and that everyday 'non-professionals' can make profound contributions. Citizen science projects regularly contribute such 'disruptive innovation' to the world, usually around science or aspects applied to society. Underlying it all is a level of contagious enthusiasm that inspires much more creative and effective science communication. It is our opportunity to get out of the lab, learn about the citizen science field and science communication, and work together to serve the interested public.

Caption: UK citizen scientist, Hannahbella Nel, exemplifies a pathway of deepening impacts as she evolved from auroral photographer and tourist to citizen scientist and aurora guide. She has captured observations of STEVE on two continents including recognizing a rare high-latitude appearance. She takes opportunities to broaden her knowledge and was even one of two “amateurs" who presented at European Space Weather Week 2019, making a large impact along with Dr. Michael Hunnekuh.

Part B

Practical tips and advice from science communication experts



Speak, write, tweet: ways to communicate science

James Bowers

Sharing your science: what type of communication is best for you?

"Not only is it important to ask questions and find the answers, as a scientist I felt obligated to communicate with the world what we were learning." Wise words from Stephen Hawking. And many scientists are doing just that. A 2014 survey carried out by AAAS showed that 98% of scientists interviewed are interacting with the public, at least some of the time. Personally, I think that is great news.

What are the ways to share your research findings? Where best to start? Of the possibilities, I think we can break science communication outlets down into three categories: public speaking, written communication and all things digital. Here is a whistle-stop tour through some of the different ways of communicating your science to the public.

Speak about it

Speaking about science is my personal favorite. It allows you, the credible expert in your subject, to share your findings and experience directly with the world. However, there are certain drawbacks to take into account: the stress of speaking to an audience or camera, the effort of preparing in advance and the risk of making a *"live"* mistake.

For PhD students across the world there are pitch competitions like Three-Minute Thesis or FameLab. The idea is to present a science topic in under three minutes and against the clock. Public speaking does not always have to be competitive, though. There are other, more laid-back, opportunities to talk about your science. In a bar, for example, at festivals like Pint of Science, standing on a soap box at a Soap Box Science event or, more generally, lab tours. Also, the media in general can be a great way to speak about your work, primarily because TV or radio channels will already have a steady viewership and a large scope to reach the masses. Just take the example of successful radio shows like The Naked Scientists (UK) or La Méthode Scientifique (France). For programs about science, they have a great number of listeners and regularly invite real researchers into the studio to talk about their area of expertise.

Write about it

When preparing a written piece, you have time to put your ideas down on the page and edit at your own pace. What stumps a lot of people, though, is that the art of writing well is a skill. Finding your voice and expressing ideas in words takes practice.

How to get around that?

Option one: you give it a shot and accept that your writing isn't perfect, but you will get better. A great place for this is in a blog. You can edit a blog post as often as you like, even after you have posted it online, so you can keep refining your work if you wish.

Option two: let a journalist or writer pen the piece. That means allowing yourself to be interviewed and trusting someone else to do a good job – which most journalists do, by the way. In a recent webinar organized by Science Magazine, Washington Post editor, Laura Helmuth, encouraged scientists to give journalists some of their time to answer questions. Scientific expertise is invaluable to good journalism.

Option three: Collaborate. Your research institution, university or funding body will all have a communications team. Let them know you want to write something and ask them to give you a hand. Otherwise, there are brilliant magazines such as The Conversation, who will pair you up with a journalist to co-create an article.

Tweet about it

In this category, I include any social media or internet-based communication outlet: Twitter, YouTube, Facebook, podcasts, websites and all the rest. A 2014 survey by Nature highlighted that many scientists use Twitter and LinkedIn for professional reasons, but Facebook not so much.

The internet is a great place to test things out with minimum risk, connect with other people in your community and produce content cheaply. YouTube is a go-to for science dissemination in video format and podcasts are a great way to dive deeper into the nitty gritty of a topic. Be aware, though, that the biggest disadvantage of digital content is the risk of zero audience. You could spend weeks making a beautiful clip, post it online and get only three views. Social media and online presence require regularity.

It takes time to build a following, but when you get there, the data says it's worth it. A 2018 study published in Facets showed that the audience reach of scientists Twitter accounts increased exponentially over the threshold of 1,000 followers. The scope for reaching a wide audience is there; it just requires a healthy serving of patience and perseverance in the meantime.

Speak, write, tweet…

To conclude, whether you choose to talk, write or tweet about your work, remember that there is always something interesting to say. Test out new ideas and have fun with your scicomm activities. The more you enjoy it, the more you will get out of it.

Your message is in your hands

James Bowers

Integrity in science communication: how can you be sure that communication won't change your message?

Only last week I went to a talk by a widely respected scientist. He started his presentation with "just bear with me, it will all become clear." My heart sank. A promise too often broken. He is without a doubt at the top of his research field, but I knew from that one introductory point I was in for a long thirty minutes ahead.

Scientists are often apprehensive that when they simplify a topic, they are trading a slice of their integrity along with it. That is a mistake. Scicomm experts agree that your message should be simple and easy to understand. If you know what you want to tell your audience and why, then they are much more likely to leave with that concept clearly in their minds.

Your message: a one-liner

Whenever you enter any type of communication activity, from an interview with a journalist to writing a blog article, you should go in with a plan. What do you want your audience to remember? This is your message. Your primary goal is to be understood. So, whilst your message will be based on fact, in most cases it will not contain specific scientific evidence. TED Talks successfully rack up millions of views online on a regular basis. Many of them are about topics in science or technology. What makes them so successful is the strength of the messages they convey, without deforming the facts. In each talk, limited to just 18 minutes, the speaker must deliver an idea "worth spreading". Just one. Once you have your idea, you can then build your talk, article or even tweet around it with facts, data and a good storyline. In a blog article about crash diets, Head of Research Communications at Diabetes UK, Dr. Emily Burns used this tagline, *"TV programs don't prove scientific theories. Scientific research does"*. Her two (very) short sentences are clear. Even though she provides an evidence-based argument in her written piece, she rightly chose not to complicate her take-home message with those nitty-gritty details.

Simple does not mean wrong

Like many scientists, you may share that fear of "dumbing down". As if, by simplifying an explanation, the message is somehow no longer true. On the contrary, a simple, clear

message cannot easily be deformed or misinterpreted because there is just less room for interpretation. You can cite or reference factual work to support your argument if you wish, but don't let them distract from your main idea. In his communication skills series, science presenter Greg Foot even goes so far as to argue that if you *"try to explain everything, [then] you explain nothing."* Pick what is important to say and cut the rest.

Professor of cognitive neuroscience Sophie Scott (UCL) studies what happens to our brain when we laugh. Whilst it sounds like a fun topic, at first glance it does not necessarily seem like it is of global importance. In a 2017 interview, she explained that *"laughter in evolution is associated with social bonding and play"*. By putting her topic in the context of a vital evolutionary adaptation, she tells her audience why they should care in simple terms whilst staying true to her body of scientific evidence.

Get your message right

You are the expert. You have all the knowledge you need to talk about your topic. But you should also know that you have control over what you say and how you say it. With a punchy, concise message your audience will understand you better. Define it. Make it clear. That way, instead of *"bearing with you"* we will be following you through all the way to the end, with your integrity fully intact.

To conclude, just remember that a simple message does not mean a simple body of scientific evidence supporting your argument. You can be clear and concise about your research, whilst staying true to the facts.

Three steps for breaking out of the scicomm echo-chamber

James Bowers

Science communication is generally consumed by people with at least some interest in your topic. How can you go beyond that to reach the unconverted?

In a recent article, scicomm expert Craig Cormick warned that *"One of the most common faults in science communication [1] is talking to fans of science and thinking you have reached the wider community."* Whilst we often hope to reach a broad public with science communication, much of the time we end up simply preaching to the already converted. It is only natural. Audiences are drawn to things that they like, not the opposite.

A 2018 study based on data from Switzerland [2] attempted to divide up the population according to their perceptions of science. They categorized the different audiences of science communication into four main types. These groups varied from *"Sciencephiles, [those] with a strong interest in science"*, to *"Disengaged, [those] who are not interested in science"*. The latter category contained people who, in addition to paying little attention to scientific topics, were also very wary of science too. Elsewhere in the world such as in the USA [3], similar groups of science-phobes have also been identified.

As a scientist, it is easy to forget that outside of your circle people do not always recognize the profound impact that research has on humanity. The problem, though, is that science affects everyone – not just science fans. Hence, we owe it to the world to step outside the boundaries of the already converted. But, as I'm sure you are already aware, this audience is a much tougher sell. Nevertheless, here are three things you can do to increase your chances of success.

#1 Bring your science to them

If you want to reach the unconverted, you must first find a way to meet the people you are aiming for. To do that, you need to recognize who you are actually talking about when you decide you want to communicate with the *"public"*. Once you know who they are, then you can identify where they are and take your scicomm to them.

In 2019, the first *"On the Moon Again"* project saw thousands of people from around the world take their telescopes out onto the streets in 77 countries. Each positioned in different locations – parks, sidewalks, town centers – the idea was to attract passers-by, giving them the chance to look at the moon close up. For many of them, it was a rare opportunity to engage with astronomy, which they surely would have missed had the organizers not brought the telescopes to them.

You may also want to target virtual places where you know your audience gathers. For young people, YouTube is a great place to find them. A recent study carried out by the OCDE [4] in France showed that 75% of the 1,000 15-25 year-olds questioned visit the online platform daily. As a result, as many as 4 out of 10 watch science videos at least once a week; some of whom are not particularly *"fans"* of science.

#2 Don't explain, entertain

In a world where *"impact"* and *"outcomes"* are high priorities, we can often lose sight of the notion that pushing research into the limelight is no easy task. When targeting non-science fans, the mere fact that someone saw your tweet is sometimes a win in itself. Go you! A listener may not walk away from your podcast understanding all the elements in string theory. But hold on, they listened to your podcast all the way through? That is a massive win. They will surely have at least retained some of what you said, and it means they enjoyed themselves too.

Podcasts like The Infinite Monkey Cage, with Brian Cox and Robin Ince do this really well. Anyone can have fun whilst listening and learn some stuff along the way. Scientists have even started to turn their hand to stand-up with projects like the Science Comedy Show. Applying techniques like these doesn't mean you are lowering your expectations, it simply implies that you are aligning your scicomm style with entertainment, which is about as accessible to everyone as you can get.

#3 Speak up, not down

As passionate lovers of science, we sometimes forget that most people know much less about certain areas than we do. Consequently, it is easy to sound patronizing when talking about your topic of predilection, if only by accident. No one likes the feeling of being spoken down to or having conversation topics thrust upon them over dinner. Nor does anyone enjoy being reminded that you are smarter, wiser or more knowledgeable about an issue than most. Consequently, it is worth bearing in mind that facts have rights and wrongs. Values, less so. In an article for The Conversation, Prof. John Besley affirms that there are *"many things you probably can't change about your audience through communication [5] – like an individual's core values – although these can affect how what you communicate gets interpreted."* That means adapting your approach to the person in front of you, whilst being respectful of their knowledge level and beliefs. Speak up when the time is right, whilst keeping a neutral approach.

Apply yourself

Breaking barriers is never without risk of falling on deaf ears. Reaching a truly wide audience means applying yourself in a different way and adapting to who those people are. Take yourself over to their side – go where they are, provide them with entertainment and respect their values.

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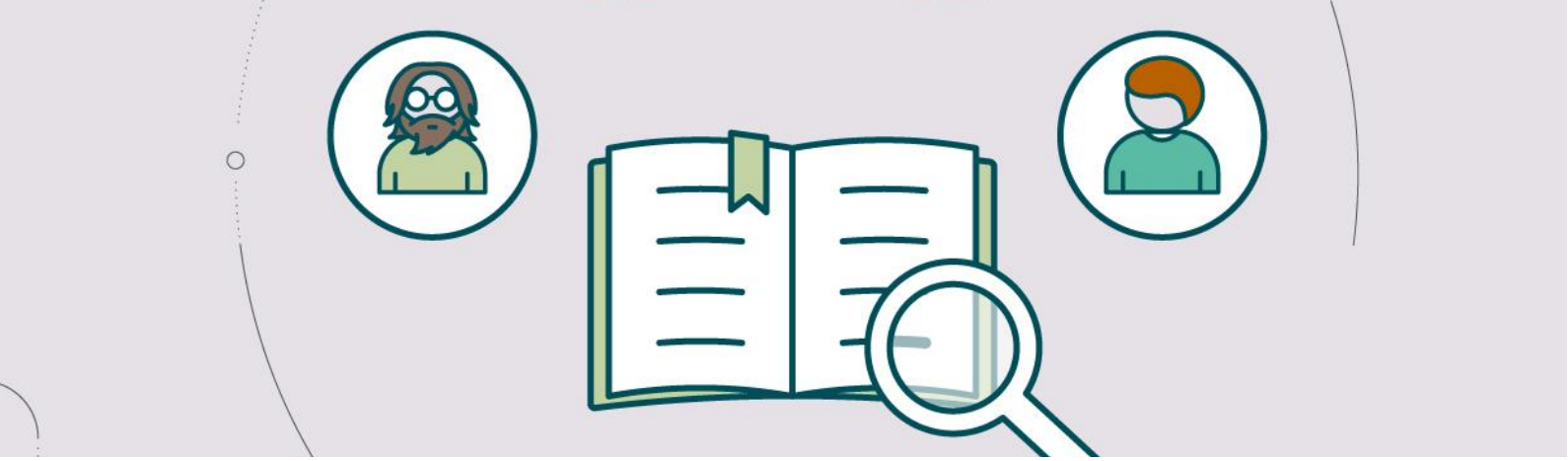

Captivate the public by finding your research story

Richard Berks

Storytelling is the foundation of great science communication. Find the story in your research and make your message appeal to a wide audience.

Communicating your research to a wide audience is tricky. They have varying levels of knowledge and interest, and different ways they prefer to consume information – blogs, podcasts, diagrams, videos, and so on. Tailoring your research message to this audience is like trying to make a pair of jeans that fit everyone perfectly.

But there is one way to make your research appeal to a broad audience – through stories. As humans, we are hard-wired to absorb information through stories. Present a series of unconnected facts and people might forget. But bring them together in some sort of narrative, and they become much more memorable.

Stories come in all shapes and sizes, but there are fundamental patterns which underlie them all – and which can be applied to your research. In this article, we'll look at the basics of how to do this, looking at one story arc and the key elements that make it so powerful.

The Hero's Journey

The classic story structure we will look at is the 'monomyth', or 'The Hero's Journey'. In brief, it is a circular story which starts with a main character, the Hero, in their Known World – the environment they're familiar with. They then travel into an Unknown World – a place different from what they understand – and face challenges along the way. Eventually, the Hero returns home to Known World, changed from their experience.

This structure might not sound familiar, but the stories which follow it will be. Think of films like The Wizard of Oz, Star Wars, Disney's Moana and Mulan, The Lord of the Rings – they all follow the Hero's Journey.

What has this got to do with science?

Well, your research can follow a similar story arc. The Hero (that's you) starts off in the Known World (the background to your study), moves into the Unknown World (your investigations and

experiments), and returns back to the start with new knowledge (your conclusions, and impact of your work).

How can you apply this to telling the story of your research?

First, identify your 'Known World', and how you fit into it. What's the background to your research? What's the status quo? What's the problem you're trying to solve? Next, identify the 'Unknown World'. What don't we know? What's the knowledge you're trying to seek? What are you trying to change? What do you think is the solution to the problem? And then finally, return to the Known World. What have you learnt? Has the problem been solved? How has the status quo changed?

Important events

In many stories, there are two key events that have a crucial role. Let's call them the Inciting Event, and the Climax.

The Inciting Event is what sets the Hero off on their journey. Think of Frodo finding the Ring. Or Luke Skywalker finding the message inside R2D2. Or the tornado in The Wizard of Oz. It's what gets the story going – in fact, it's the reason why there's any story at all.

Thinking about your research – what's your inciting event? Is there a specific moment which started the ball rolling for you? Perhaps it wasn't an event, but a question which was raised that you just had to answer.

The second key event is the Climax. It's the moment that all the action has been building up towards. Frodo throws the ring into the volcano. Luke destroys the Death Star. Moana returns the heart to Te Fiti. It's the resolution of the Hero's Journey, the moment the audience have been waiting for.

What's the climax in your research? What was your *"Eureka!"* moment? What was the moment you found the knowledge or solution you were seeking?

Building upon these foundations

What we've discussed so far are the foundations of your story, on top of which everything else is built. Two more elements to consider are emotions and details.

Conveying emotion helps your audience feel invested in the story. They feel more connected to you as a person, and so to your journey – your research. How were you feeling during the key events in your research story? Anger? Sadness? Excitement? Confusion? And why?
Details can also help to bring the story to life. For example, you could illustrate the Known World with an anecdote – for example, the time you met a patient with the disease you now study. You can also add details to key events. Where were you when you started on your journey, or made your big discovery? What exactly were you doing? What time was it? Who was there with you?

Conclusion

It's important to note that this is not about making stuff up. This is about looking at your research and finding the elements which can be retold as a story – not inventing them. By finding this story, you will be more able to connect your research with a wider audience.

To recap:

- Find your 'Hero's Journey'. What is the 'Known World' you're leaving, and the 'Unknown World' you're entering on your quest?
- Identify the key events in your journey – the Inciting Event, and the Climax.
- Add emotions and details to bring your story to life.

Further reading / listening

"The Science of Storytelling" by Will Storr is an excellent overview of the research into why humans find stories so powerful.

"Houston, We Have A Narrative" by Randy Oslon is an entertaining guide for scientists to use to tell their stories.

"The Story Collider" is a regular podcast featuring scientists telling engaging personal stories about themselves and their work.

Communicating science and inspiring audiences of different ages

James Bowers

Children, teenagers, parents and grandparents; science can inspire people of all ages.

Shrek, the 2001 movie produced by Dreamworks was hailed by experts as a *"turning point"* in animated films [1] because of its appeal to both children and their parents. If you have seen the film as a grown-up then you may have noticed that this is because there are two clear subtexts: one aimed at children and the other, adults. Of course, this did not happen by accident. Like the producers of Shrek, as a science communicator you are likely to come across audiences of mixed ages too. The main reason for this is that children and young people rarely come alone.

For example, national schemes across the world, such as the French science week called *"La Fete de la Science"*, encourage scientists to take the time to chat with the public about their research. At such events, audiences are essentially made up of young people or children who are accompanied by their parents, grandparents, older siblings or teachers. Knowing how to adjust your approach to appeal to these different age groups is a crucial skill when dealing with mixed audiences.

Choose to inspire

When communicating science to the general public of any age, *"to be inspired"*, is generally somewhere at the top of the list. A 2013 EU study [2] found that the main motivation for children to take part in science outreach activities is because they are *"…interesting and you can get enthusiastic about something."*

Your audience will, without a doubt, want to learn something new and exciting that makes them see the world, at least a little, differently. I always advise to stick to *"inspiring"*, rather than *"explaining"* as it helps steer the tone well away from *"patronizing"*. Inspiring people keeps us on the same level, an important factor for any age group.

And a great way to inspire is to appeal to the senses. If you can create a demo, bring in a piece of your lab or show a video of something original, then it helps generate a lived experience that will make more of an impact than words alone. When working on a written piece, you can achieve this by prioritizing action verbs, like *"to drive"*, *"to throw"* or *"to climb"*.

For young whippersnappers

Keeping an audience engaged can be difficult at the best of times. And when it comes to science activities for kids [3], it can be even more complex. As a rough guide, children just starting out in primary school may only be able to focus on an activity for around 10 minutes or so. Whereas, by the time they are ready to move on to secondary school, they can pay attention for closer to an hour. This means that the younger your audience, the more regularly you should change activities to keep them engaged [4].

Also, particularly when communicating to young people, you need to be pretty strict with yourself about time management. You are responsible for structuring your talk or workshop. Of course, if you want to inspire then you need to adapt to their needs, which may mean digressing from your planned activities based on questions or topics they find particularly interesting. But be careful to avoid going off on tangents; children can be very good at pulling discussions towards things they want to talk about, rather than what you had planned!

If your audience is made up of teenagers, then you are in luck. Another EU survey from 2008 [5] showed that two thirds of young people (15-25 years old) are interested in news about science and technology. This can be helpful, as both spectators and readers will pay more attention if they already care about science. Although, watch out as this also means that their expectations will be higher; it takes more clout to inspire somebody with new information who already knows a lot about your topic.

For those who are advanced in years

The older age bracket may seem like it should be an easier win, but there are nonetheless different challenges. You will probably find that anyone past retirement age will come with a willingness to listen to you, but with a worldview that is more set-in-stone than younger audiences. You will need to be both clear and convincing if you are to shake off some of the myths or misconceptions that have been drilled into them over the years.

Moreover, back in the day, school science was different to what is taught now. So, terms like *"molecules"*, *"evolution"* or *"DNA"* may not be so evident to a more mature audience. I have often been surprised with the amount of knowledge that children may have about complicated topics or terminology in comparison to their accompanying adult. Try and bear this in mind. You can even play on that interaction and call upon the kids to explain something to the grown-ups. Again, that helps even the playing field, keeping everyone on the same level.
To conclude, old or young, a general public audience wants above all to be inspired. Think about what excites you about your work and then build it into a talk which is suitable for your audience. But most of all, let yourself be surprised. The greatest thing, for me, about science outreach is engaging with people and creating a dialogue, which will happen organically if you let it. Enjoy.

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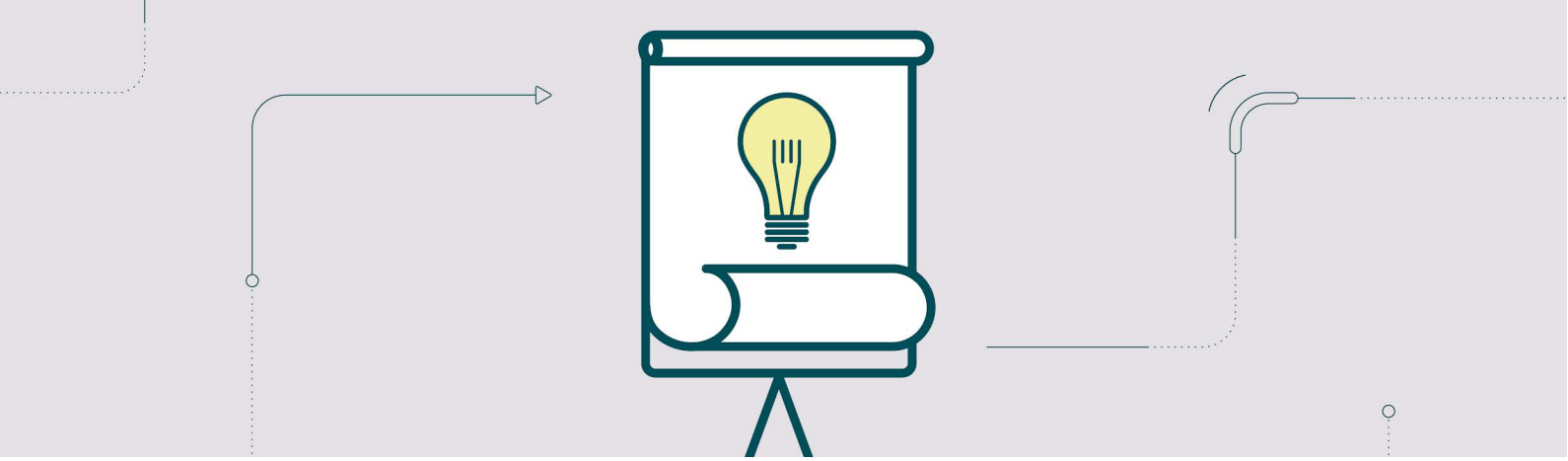


Pitch your research in three minutes

James Bowers

Wake up your audience, take them by the hand and send them home with one clear idea.

How many times have you looked at your phone today? Five, 10, 20 times, or more? Now think about how long it took you to decide whether you were interested in an item or not. I can bet it was pretty quick. Our minds are saturated with incoming data from people, companies or even artificial intelligences. Some useful, most not.

A three-minute pitch is your way to demonstrate to others why they should pay attention to your research. Nothing more, nothing less. One hundred and eighty seconds of somebody's time is all you need to make an impact and be remembered.

You may have heard of international competitions like My Three-Minute Thesis or FameLab where PhD students are challenged to use this format. It is a great way of putting your ability of breaking down a complex topic to the test. You will come across different, less competitive, situations to pitch too, though. This could be in an interview for funding, a poster session at a conference or, if you are really lucky, an awards ceremony. Here are three tips to bear in mind.

Know your take-home message

First and foremost in any communication activity, you should define your message. This should be a punchy one-liner that sums up the idea that you want your audience to leave with. You do not actually have to say that message out loud, but it is the main concept that you are trying to explain.

Matthew Thompson, winner of the 2011 Three Minute Thesis competition in Australia gave a pitch with a very clear message. His take-home idea was: there may be human error in how current fingerprints are analysed in criminal cases (emphasis on the may). Whilst those might not be the exact words he would have used, I can still distinguish a message because he spells it out and uses his entire pitch to describe it. He states facts such as:

- *"it's not computers that match prints, it's humans"* ;
- *"in Australia, there are as many as 5,000 of these comparisons made per day to be used as evidence in convicting criminals. And occasionally mistakes are made"*;
- *"despite them testifying in court for the past 100 years, fingerprint examiners have never been scientifically-tested for how accurately they can match prints"*.

If you are clear about the point you want to make with your three minutes, you can then use your time to describe, defend or argue it to your audience. In a pitch, there is no time to digress. Stay on track with a simple message.

Grab your audience's attention

A good pitch starts with a good opening sentence because the attention span of the audience is not constant. Whilst experts in the world of presentations do not all agree, a common theory is that audience interest will peak at the very beginning of a talk. They consider that once you start speaking, your audience will gradually switch off and the attentiveness of the people in front of you will wane.

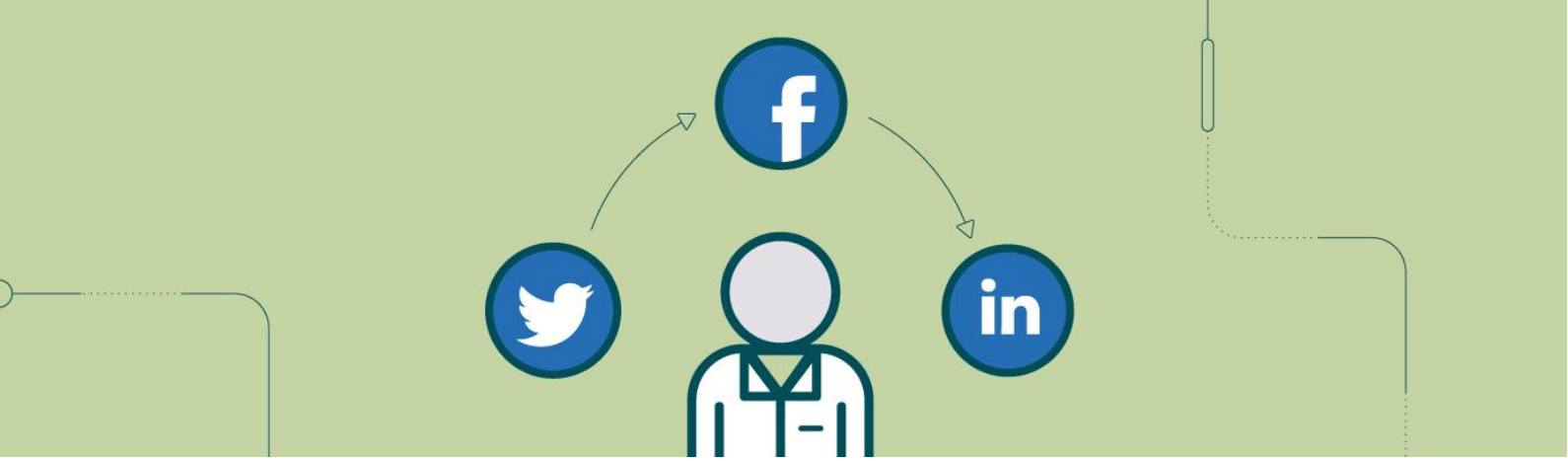
As a consequence, most coaches (myself included) will tell you to do something as early as possible to hook your spectators; a joke, a surprising demo, an exciting fact, a question or so on. The objective is to pique the curiosity of the people in front of you whilst their attention is highest. Hook your audience, then all you have to do is keep them there.
Prepare your path

Three minutes is short enough for an audience to listen from beginning to end without you ever losing their attention. However, to keep them with you, you need to take them by the hand. You need to walk them through your pitch as if you were helping an old lady to cross the road; reassuringly without patronizing. In simple terms that means making the link between what you just said and what you are about to say as clear as possible.

Take a look at this example by Megan Pozzi, winner of the 2013 QUT Three Minute Thesis competition. In the first minute, every sentence she says flows smoothly from the one to the next. At about one minute in, she says *"I set about asking two questions. First, which of these strategies are grade-8 girls using in their status updates? And second, how and why are grade-8 girls using their status updates more broadly?"* Succinctly, she informs us that she is going to tell us two things, then does as promised. It is such a simple technique but, as an audience, we know what to expect, which is reassuring without feeling patronised.

Enjoy it

Finally, for me, the most important thing about pitching your research is: believe in yourself. Surely you care a lot of your subject – let that passion shine through. If you have a clear message and a plan, you will do yourself justice. Good luck!



I’m a scientist and I want to use social media. Now what?

Paige Jarreau

In this post, you’ll find some common goals that scientists have for using social media, and what social media platforms and approaches might best fit those goals.

There are many ways that you can use social media to share your work and your research. With such varied social media platforms and approaches to creating content, it’s worth taking the time to think about your ultimate goal and who you want to reach before you jump into creating content.

Before you say that your goal is to reach broader audiences, take a moment to think about whether and why this goal is really important to you right now in your scientific career. It’s ok if it’s not – maybe at this moment what you really want is to reach a broader community of your peers, to find job opportunities or attract research collaborations. Dedicating some thinking space to your current communication goals will help you decide what social media platforms and content approaches will work best and be most rewarding for you. Feeling rewarded is very important to the sustainability of the communications effort you are about to undertake.

Below you’ll find some common goals that scientists have for using social media, and what social media platforms and approaches might best fit those goals.

I want to advance my scientific career and make an impact on my field

Many scientists who contemplate using social media ultimately hope that doing so will help their work have more scientific impact.

Faced with a competitive academic job market and an exploding number of scientific journals, modern researchers may struggle more to make their mark and get tenure. The exact average number of views and citations that most scientific research papers receive is controversial.

But it's fair to say that the number is probably underwhelming.

Scientists today are turning to social media to publicize their research papers and network with potential collaborators. The good news is that this works. A 2014 study showed that researchers who tweet and talk to media professionals about their published findings gain more citations of their work than researchers who do only one or the other. And it makes sense – like most people, scientists are increasingly turning to social media to get their news. Scientists are using social media to stay up to date with happenings in their field. Social media platforms like Twitter and the now universal hashtag have also made it easier (nearly automatic in some cases) for people to instantly reach others with similar interests. This means that a scientist's tweets are likely to reach other scientists in the same field, yielding more reads and ultimately more citations.

Do you want your research to have more scientific impact? Do you want more of your peers to read your papers? Use Twitter to share work in progress and published research findings. Share your papers on ResearchGate. Update your LinkedIn profile with your latest publications and projects. Try to blog about your research, whether for your own blog or for an institutional or media blog.

If you can find where scientists in your field "hang out" online (my peeps hang out on Twitter and Instagram, using the hashtag #scicomm), your social media updates about your research will be even more effective.

I want to become a better science communicator

For some of us, using social media is more than anything a fun way to practice our communication skills. Do you enjoy telling your lab mates stories in between benchtop tasks? Have you always loved writing, or do you hate it but know you should work on it more? Have you considered becoming a professional science communicator? You might find social media a natural venue for practicing and building up your communication skills and experience.
If you want to become a better science communicator, either because you just love it or because it would help you with job or funding prospects, practice makes perfect. Push your comfort zone by trying new forms and formats of science communication. But also pick a platform and approach and stick to these for as long as it takes to "master" them.

Long-form science blogging, podcasting or creating science videos for Youtube or Instagram are great activities for improving your science communication skills. They require ongoing effort and practice, which is key. Each blog post, podcast episode or video that you produce will also require you to find a story, translate scientific information for a broader audience (because non-scientists may read, listen to or watch this content), decide on a message and think about what you want your target audience to walk away with.

I want to inspire future scientists. I want more people to understand what it looks like to be a scientist in my field.

Many scientists today are drawn to social media not necessarily to tell a particular research story, but rather to share their experiences as scientists. Sometimes the goal is to help

diversify the scientific community. Sometimes the goal is to open up the scientific process. Sometimes the goal is to change the culture of science and how it is done.
There are many different social media platforms that can help scientists bring others on their journeys in the lab or the field in a very visual, experiential way. Instagram stories and live videos, science selfies (#scientistswhoselfie) and other visual content are awesome mediums for inspiring others with "cool" science in action or showing people what it looks like to be a scientist (and what a scientist looks like).

If you want to inspire future scientists or want more people to understand what it looks like to be a scientist in your field, consider using social media outlets that reach young audiences and involving students and other young scientists in your efforts. (You may want to join efforts with your institutional or university social media efforts.) Bring your audiences on a journey with you via photos and live video. You'll have to get personal – share your story and daily experiences. Leverage Instagram and platforms for live streaming or recording video to bring your audiences behind-the-scenes footage of science in action.

I want to help non-experts make better decisions in their lives, based on science.

Of all the goals you could have for your social media science communication efforts, this one is the toughest to achieve.

First of all, social media platforms are working against you, surfacing your content mostly to other people who are like you, who share your interests and who use similar hashtags (aka other scientists). To reach broader audiences, you will need to work hard to break out of your own social media "bubble". You will need to find the online spaces where your audiences "hang out", use their language and take their interests and values into account. You will need to create content that doesn't share science for science's sake, but that is focused on entertainment or answering the questions that your audiences would have about this science. To reach broader audiences with scientific information they can use, you will need to create content that is relevant, approachable, accessible, entertaining as well as educational, visual, shareable and actionable.

You probably can't do this alone. Even if you have training in science communication and its theories, reaching broader audiences and helping them actually engage with and leverage scientific information in their lives is going to be a team effort. You will need to collaborate with artists, storytellers and other professional communicators to create accessible, visually appealing content in spaces that actually reach non-experts (think news media, popular mobile apps, podcasts and video games). I'm currently exploring such collaborative science communication with a new sci-art platform and community space where scientists can meet artists, called Lifeology.

Creating social media content for broader audiences may look like creating content for popular health tracking apps or collaborating with media outlets that have a wide reach and editors to help you create messages that speak meaningfully to non-experts. It may look like doing a TED talk or collaborating with a designer to create an engaging video series. It may look like creating mobile apps or video games or entertaining podcasts that help people learn

about science in bite-sized pieces. And it will definitely look like pushing the boundaries of your content generation and storytelling skills, and going beyond the social networks where you talk with your peers.

Practical tips for scientists using Twitter

Elodie Chabrol

Twitter is increasingly important in science communication as a way to share published work and talk to fellow scientists and the general public alike. In this article, you'll find tips to guide you along your way into the Twitter-verse.

In a previous article, Paige Jarreau shared some common goals that scientists have when using social media, as well as an outline of which social media platforms and approaches might best fit those goals. Here, I focus on some practical aspects of Twitter and how to use it at its best to share your science.

Twitter can be used for several purposes, namely to promote your own work. But another way scientists use it is to keep up with research in their field. Twitter allows you to follow fellow scientists, discuss topics with them and read what they share about their current work. It can also be very useful for building your network or finding out about opportunities: jobs, grants, meetings and so on. There is a big academic community on Twitter chatting about all the aspects of academia other than the research itself. You can find out about these things with relevant hashtags like #ScienceTwitter or #AcademicChatter.

Similarly, Twitter can enrich a conference experience. If you use the conference # before and during the event you might be able to meet interesting people virtually. That way, you can start some amazing conversations with them before the conference, have some follow-up chats during the meeting, as well as stay connected afterwards.

Getting started

Make sure you have a good bio and handle (Twitter name). You need to add a photo, cover image and short bio to show people who you are and what kind of things you will talk about. Ideally, you should use your bio to link to relevant accounts. For example: "Researcher at @ucl working on xxx funded by @fundingbody". It also helps to add common hashtags of the topics you will talk a lot about: #scicomm, #SciArt or #OpenScience, for example.

Make lists. If you want to follow lots of people without being lost in too many subjects, making lists is amazing for that. You can then focus on tweets from a specific list. I also find them very useful for events. I add all the people I met at a certain event to a list. It's like sorting out

the people you follow. You can have public lists if you want people to be able to access them and subscribe, and private lists that only you can see.

Tweeting the world

Avoid jargon if you want to share your science with the public. Research shows that complicated terms confuse people even if a definition is given [1]. Try being succinct, using layman's terms where possible.

Make threads about publications. Don't just share the link to a scientific paper. The title is usually confusing and hard to understand for people outside your field. The best way to share a paper, whether it be yours or someone else's, is to make a thread – several tweets linked together. To do this, you write a tweet, then click on the + sign at the bottom to add a new one, and then keep adding. The first tweet serves as a cover of the thread, so don't forget to explain what article you are talking about and add the link if possible. A PhD student, Timothy Fuqua, recently made a really great and fun example you can get some inspiration from.

Add visuals that everyone can understand. Images are your way to catch people's attention as they scroll down the newsfeed. Richard Becks put together some advice to make diagrams for science communication [3].

Be careful with sensitive data. Sometimes you might not be sure about your data and whether you can share them on social media. If this is the case, don't give away too many details. You can explain the importance of repeating an experiment, for example. Don't claim you have discovered a new treatment when you have only done the experiment once.

Twitter-specific hints

If you are tweeting about a paper or a particular scientist, include the journal or scientist's Twitter handle in the tweet. For example, if I tweet about a Hindawi paper, I would include "@Hindawi" in the tweet to show the editor your interest and maybe start a dialogue. The same goes for the authors.

Don't start a tweet with @, especially when you want to promote a person or initiative. Tweets starting with @ are considered as replies by the Twitter software so they are hidden from everyone's newsfeed meaning they are not seen by everyone; only the people following you and the account after the @. You can start with .@ if you want to be sure, or find a word or emoji to start your tweet.

Finally, if you want to do some science communication on Twitter with a large audience, you can apply to take part in curating generic scicomm accounts like @realscientists. They offer the possibility to tweet on that account for a week, sharing your work and life as a scientist with their followers.

Follow your metrics

With Altmetric you can measure online attention that your article received. Not only on social media but a lot of different online media like blogs, Wikipedia and media outlets, too. It can be a very useful tool to quantify online activity around your scientific articles.

If you're not convinced yet if you should use social media, then maybe the data will help. A study from 2020 showed that scientific papers, which were tweeted, in turn received 4 times more citations on average than ones not shared on twitter [3].

I hope those tips will be helpful and that you enjoy getting on Twitter.

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How to organize a science communication event, a few practical tips

Praveen Paul

We all know science communication events are important, but where and how do you start to plan an event and what should you consider?

Public engagement and outreach events can take many forms from talks to panel discussions, demonstrations to art, theatre to music, and even comedy or exhibitions. You may not know where to start or what to do, but the journey of creating and being part of a science communication event will have many benefits; from discovering your own hidden passions to inspiring people who in turn will inspire you.

Decide on the type of event

To start out, it's good to think about the kind of event you want to run and your primary target audience. Different formats, locations and times suit different audiences. Interactive and hands-on demos are good for families and children in open spaces and weekends. Talks and comedies are better for adults in more intimate venues. And exhibitions in large galleries appeal to everyone. In all cases, good hosts and/or volunteers are crucial to guide the audience, introduce activities and speakers and help the event to flow.

An important word about your guests: don't assume your intended audience is automatically interested in your event. It is up to you to make an effort to know who they are, what they may like and things they are likely to engage with. If you don't know these things, you could find somebody or a group who does. For instance, if your event is about a medical condition then you can find charities or patient groups and get their feedback or input that will help you shape an event that would benefit them. They may even have an event space for you.

Speaking of which, you could always check with your university or research institution to see if there are similar existing events or festivals that you can be part of. You never know, your idea may already be out there or they could at least have some resources you could use.

Get people on board and identify roles

It is good to recognize that you cannot do everything by yourself. In almost all cases, there will be many roles involved in bringing an event together. As such, it is important to get support from friends, colleagues and your organization.

Delegate and define roles for each person involved, whether they are front of house or behind the scenes. Who will be responsible for each aspect and what is their timeline and itinerary? Roles may include: event hosts, event managers who book venues, set up and tidy up, an activities manager, a comms person (social media and publicizing events), technical set up and support, website manager, treasurer, checking tickets and welcoming guests.

Getting the word out

There are plenty of ways to advertise your events. Your team and networks is an obvious choice, but again, consider and identify the demographic of people you want to reach as your immediate networks may not reflect them. For instance, if you're using a community hall to demonstrate how robots work to people who live in the local area, find out who else uses the space and invite them to your event.

Put your event on a website, create flyers, approach publications and listings. Share with groups associated with your target audience. Going back to the example of an event about a medical condition, you may be able to enlist the help of charities or patient groups.

Creating a Facebook event is a very effective method that allows people who are interested to easily share details with their own networks and groups. For Pint of Science, because of the sheer number of people involved and the scale that we operate on, our most powerful advertising method has always been word-of-mouth. However, targeting on Facebook has helped to reach people with similar interests who may not necessarily be within our networks. Another very effective method is email campaigns – if you're just starting you can ask organizations to include a line about your event in their mails or newsletters to subscribers. Likewise, compose social media posts and send them to organizations to copy and paste on your behalf.

Having some kind of registration or booking system will give you an indication of how many people intend to come. At time of booking you can capture key information about your audience which will help in evaluations, improving your events and potential future funding.

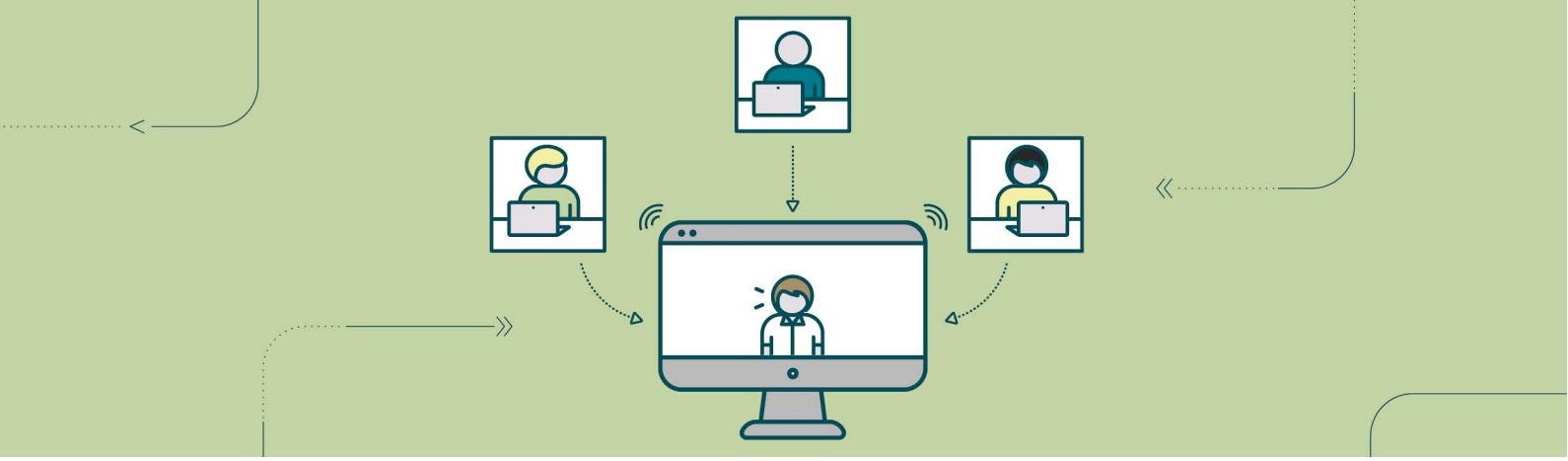
Key considerations for events

- Practical issues include: choice of venue, time of day, date, length of the event, costs, technical set-up, risk assessments and evaluations.
- For talk-based events, it is important to use non-specialist language; assume attendees have no knowledge of the area. The aim of science communication is to make science (and you) approachable. Focus on one key message and avoid jargon, abbreviations and cluttered slides. Instead use images or bring props or a small piece of equipment or sample – I'm sure there are things you use every day that most people will have never seen.

- Show your personality and share your stories, hearing your journey will make you appear more approachable and human, and will break up the science.
- Attention spans are short, so either keep talks to 20 minutes followed by some time for questions, or break up the event with activities. Pint of Science aims to create an informal feeling and we've found that, in general, talks mixed with something like a quiz or hands-on artistic activity creates a rounded and relaxed, fun event.
- Stick to your advertised times. Having a 'doors open' time and an 'event' time will help your guests plan their arrival and expectations. Your guests will have other commitments; they may need to plan their way home or have childcare responsibilities, you should be considerate of their time.
- Personally thank the audience as they leave the event – they have made the effort to come and see your event, and chatting to people can lead to interesting feedback.

Just do it

To conclude, just do something, no matter how big or small. As scientists we can sometimes spend far too much time planning and thinking. Your scicomm event may not be perfect and you may muddle through it, but the experiences you create and the networks you become part of may go well beyond what you thought possible.



How to organize an online science communication event, a few practical tips

Praveen Paul

The COVID-19 pandemic has changed our world, Science and its communication are vital, but where and how do you start to plan an online event and what should you consider?

In May 2020 the Pint of Science festival had planned thousands of events in nearly 30 countries. However, the pandemic meant that we had to switch to running events online. This is what we learnt from it.

Public engagement and outreach events can take many formats: from talks, panel discussions and demonstrations, to art, theatre, music, comedy and exhibitions. However, some types of events do not translate well to an online format and in many cases you may have less engagement. On the other hand, going online offers you the potential to reach new audiences – even after the event has ended. Here are some important considerations for running online events.

Identify your audience and event format

As with any science communication event, before deciding a format you should identify your primary target audience and build your event around them.

It's tempting to think that because it's online your event is for everyone (who has access to the internet)! However, different formats and times suit different audiences: interactive demonstrations or virtual fairs during the day or at weekends may work well with families and children. Talks and panel discussions during the evening may suit an older audience. Pre-recorded material and online exhibitions can be for a wider audience and can run for longer periods.

In all cases, good hosts and/or teams and the right platforms are crucial to guide the audience, introduce activities and speakers and help the event to flow. Watch existing online events and science festivals to get ideas and a feel for what works and suits what you're trying to achieve.

How to engage online

How can you maximise audience interaction with live or recorded shows? For live events, audience participation is paramount, otherwise you may as well pre-record the event and upload it for people to view. Participation can take many forms: polls and quizzes (using platforms such as Kahoot, Mentimeter, Slido), activating and making use of online chat, encouraging your audience to get involved in Q&As, or asking people to bring or prepare items in advance which they can then use for activities and ask them to post to social media afterwards. It's important to involve your audience – they have made the effort to tune-in and science communication is about reaching your audience.

What type of event are you going to run?

Once you have identified the format, there are many more questions regarding the type and details of the event.

- How many events do you want to run, running times, should they be spread out at different times over days and weeks or happen concurrently – will that confuse your audience?
- Are the events going to be live or recorded? Live events will require a lot of preparation and practise, recorded events will require editing skills.
- Do you want your events to remain on the internet or be removed at the end of the broadcast? You can get more exposure and views by making it publicly available to view afterwards.
- Should people register? This can be a chance to ask for donations and learn more about the demographic of your audience, especially if you include questions within the booking process and ask for evaluation afterwards.
- Will your event be 'open' or 'closed'? With an open event you can stream straight to YouTube, Facebook or an open Zoom room (beware of unwanted guests!). This is the easiest way for the audience to join, they just click and watch. A closed event may involve creating accounts and logins, downloading software, or booking a ticket, however they can create a feeling of exclusivity and your audience may be more likely to pay attention and/or engage.

Find your audience

Advertising online events can be challenging. Using your team and networks is an obvious choice, but again, consider and identify the demographic of people you want to reach as your immediate networks may not reflect them. Working towards a date can help to build up momentum and attention.

Put your event on a website, approach publications and listings. Share with groups associated with your target audience; For instance, if your event is about a medical condition you can find and share it with charities or patient groups.

Creating a Facebook event is a very effective method that allows interested people to easily share amongst their networks and groups. For Pint of Science, because of the sheer number of people involved and the scale that we operate on, our most powerful advertising method

has always been word-of-mouth. However, targeting on Facebook has helped to reach people with similar interests who may not necessarily be within our networks.

Another very effective method is email campaigns – if you're just starting you can ask organizations to include a line about your event in their mails or newsletters to subscribers. Likewise, compose social media posts and send them to organizations to copy and paste on your behalf.

Key factors for online events

- Practical issues include: website for events, choice of streaming platform, time of day, date, length of the event, costs, technical set-up (camera angle is good and microphone works), producers, good host, chat moderators and evaluations after the event.
- For live events, run through the tech with participants a week before and an hour before you go live. Have a plan if something goes wrong, for instance someone else filling in on air as well as a private chat channel. Ask participants for their phone numbers – if your tech fails you will need some way to communicate with each other.
- For talk-based events, it is important to use non-specialist language; assume they have no knowledge of the area. The aim of science communication is to make science (and you) approachable. Focus on one key message and avoid jargon, abbreviations and cluttered slides. Instead use images or show props or a small piece of equipment or sample – I'm sure there are things you use every day that most people will have never seen.
- Show your personality and share your stories, hearing your journey will make you appear more approachable and human and will break up the science.
- Attention spans are short, so stick to your advertised time or segment your online event: introduce a break, activities, Q&A sessions. Pint of Science aims to create an informal feeling and we've found that in general talks mixed with something like a quiz or well-run activity creates a rounded and relaxed, fun event.
- Ethics, privacy and accessibility: be aware that some platforms may retain and use data especially if you are asking people to sign up to external platforms. Check with your participants that they are happy for the event to exist online afterwards (if applicable). Password-protect closed events. Can you do live captioning/ transcripts? Or add them afterwards? Can you get a sign-language interpreter?

Consider, prepare and embrace

To conclude, online events can give you some freedom to explore new ideas and audiences, but with everyone running online events it is not possible to stand out and there can be audience fatigue. Recognise this and consider your reasons and methods for running an online event. If you go with it, embrace the challenges and imperfections, you may very well muddle through it, but the experiences you create, skills you gain and the networks you become part of and the people you reach may go well beyond what you thought possible.

Attract more readers with a lay summary

James Bowers

Lay summaries increase visibility and scope of a research paper. What are they? And how can you write one well?

As a researcher, much of your career will be focused on publishing your work. But do you ever stop for a second to think about why you are publishing? Other than adding a line to a citations list on your next grant application, publications are about sharing your research findings with the world. Even better, you can use your publications to help the results of your research go further to really achieve what you were hoping for with your science.

To make the biggest impact possible with your paper, you can open it up to a wider audience by including a lay summary. That is to say a less-complicated, attention-grabbing outline of your study that will be published alongside your paper. Adding a lay summary can give people who may be unable to understand the complex nature of a scientific article, a glimpse into your research.

Moreover, some publishers have gone so far as to say that articles with lay summaries are read more. It has been reported that they attract a readership of over 20% more compared to publications without one. So, above the fact that people may talk more about your work based on your lay summary, they are actually also more likely to read it.

What is a lay summary?

Sometimes referred to as *"plain language"* or *"lay abstracts"*, a lay summary is basically a short description of a research paper that is written in a way that is accessible to a wider public. This includes students and researchers in other fields, but also journalists, writers or science communicators. Hence, your lay summary is generally still targeting a science-phile audience, even though they are likely to be far from specialists in your topic.

Some publishers will request a lay summary with the submission of your article. Whereas, for others it is completely optional, being requested only at the time of publishing once your article has been accepted and signed off. They vary in word count - from 100 to 1,000 words based on the guidelines of the publisher. As a ballpark figure, they are mostly found in the 400-500 word range. But some publishers ask for little more than a paragraph. Watch out

though, being shorter does not necessarily mean it is easier to write. Keeping your text concise can be tough.

How to write a good one

A common error when writing a lay abstract is to write it in the order that you would write a paper or a normal abstract: introduction, methods, results, and conclusion. Whilst this structure is standard for scientific publications, it is not ideal for facilitating understanding. For starters, it means that you are keeping the most interesting bit until the end. Try starting your lay abstract with your conclusion. It may not work every time, but it certainly helps to kick off with the juicy stuff.

Or why not try breaking the 'science' structure entirely. Instead, you could answer the following questions:

- What global problem do you want to solve?
- What did you find out?
- How did you do it?
- What impact will your new findings have on helping solve that original global problem?

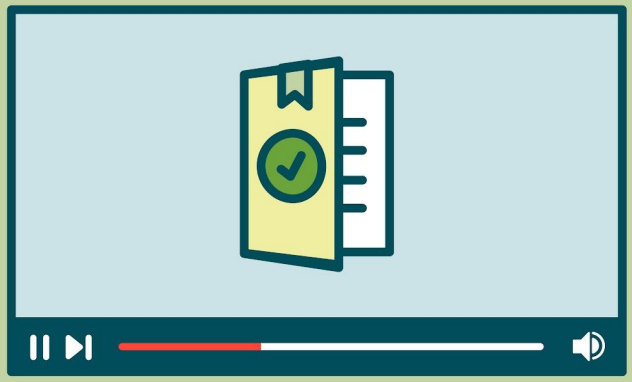
In doing so, you are following a simple 'cause and effect' or 'problem-solution' structure. With no more than a few sentences for each, you can give your readers a taste for what your study was about and why it is so important. This can also help you to break your topic down into a more digestible chunk. Unlike a scientific abstract, you do not have to mention the entire scope of your study either, just the important bits.

Getting it right

Your lay summary will not be read by your reviewers. More likely, it will be read by an editor before publication. With that in mind, you should expect them to come back with corrections. Don't take this the wrong way. They will have their idea about how to write a good lay abstract, will have their own style in mind and they know their readers. Take it as an opportunity to improve your writing skill set. Each publication or editor has different expectations, so the best thing to do is follow their lead and let them help you write a brilliant lay summary.

Lay out your research

By providing a lay summary, you are offering a window into your research paper, opening it up to those who may otherwise never read it. That means you do some of the leg work to bridge the gap between you and potential readers. And that helps you attract a whole new audience who can share, or even apply, your results to the real world.



Publishing: Make an impact with a video abstract

James Bowers

Statistics show that a video abstract can significantly increase engagement with scientific publications. What are the benefits and how can you go about making one?

You did it. You finally got your paper published. The long process of writing, preparing the figures and reaching a consensus with your co-authors, followed by the tedious edits, rejections, and rewrites, is finally over. Naturally, you want to just sit back, celebrate and bask in the success of your hard work.

Assuredly, you deserve it. But, once you've had your well-earned pat on the back, maybe it's time to think about how to make an impact by increasing the visibility of your article.

Video abstracts add value

Without a doubt, the most important aspect of your paper is the solid science inside it. However, it is easy to forget that much of the value of that science is down to the impact it makes on the scientific community. In short, impact comes from your work being seen and recognized; the more of your peers who know about it, the more likely they are to read it, cite it and consequently apply your methods, results and conclusions to their own research.
Over the years, video abstracts have proven very effective tools to improve visibility of scientific publications. One of the earliest studies, carried out in 2014, found that even though only 5% of articles in their sample had video abstracts, 25-30% of the most read articles had one. This meant that overall the small group of articles with videos associated were read significantly more than their video-less counterparts.

Others report similar trends, with international publishers stating that articles they publish with video abstracts can have 111% more views than those without. So, whilst they are far from obligatory, the data suggest that taking a little extra time to promote your paper with a video abstract can have a positive effect on impact.

Guidelines for video abstracts

Different journals will have their own rules around what kind of video abstracts they accept. These requirements include length, file size and the type of content. Therefore, the first thing

to do is to check out your publisher's guidelines. Often you can simply contact them to let them know your plans and get some advice about their expectations.

In terms of length, the Institute of Physics says the general rule is that videos should be limited to four minutes. Some other publishers have videos closer to seven minutes each. However long you decide to make it, your video needs to be straight to the point. Remember: you are drawing people in to read your article, not giving a seminar about it.

Also, be aware that journals often ask for transcripts to publish alongside your video. This means that you will need to write your script either before or after filming. My personal advice would be to write it before. It is almost impossible to deliver a short, concise explanation of an article without preparation so planning is essential. You don't have to stick to your pre-written speech word for word, but a good plan works wonders.

How to make a video abstract

Your audience here is your peers – other scientists – so you can set your *"popularization scale"* quite high. You probably don't need to explain well-known concepts, but anything specific to your research field or project should be defined. Also, your questioning or reasoning should be made obvious to viewers of any specialty; define key terms and subject-specific jargon.

What you also need is a good message that will pull people in. The temptation is to consider your article title as a message. This could work. but more often what you should tell people in a video abstract is closer to a simplified version of the conclusion of your paper. For example, what is the overall topic of the work? What do you hope to achieve with this research? What new information do your findings add to what we already knew?

In 2019, researcher Ni Feng and her team entitled their video *"How hibernating squirrels survive without water"*. Their topic is obvious and self-explanatory. Like they have done, a good video abstract will then detail the main points covered by the paper in a way that helps viewers know whether it is of interest to them.

Don't worry if you don't have a Hollywood budget. Video abstracts are often made using minimal equipment. Most recent smartphone cameras or webcams will be sufficient. Nevertheless, for a better-quality video you could ask the communication team at your institute or even your publisher to help you out.

If you do make a video yourself, take care to position the camera well, in a room with as little background noise as possible and a nice decor. That means staying away from whirring lab machines and finding a suitable backdrop with a soft, natural light source. Look into the camera, take your time and give it your all.

Make an impact

Publishing research can take years. It deserves to be seen and recognized. Giving people a sneak preview of what to expect by making a video abstract can improve the visibility of your paper and help your research make more of an impact.

Podcasting 101: that sounds like science

Izzie Clarke

Science podcasts are trending globally, with an audience of millions tuning in across the world. From interviews to marketing and finding a good story, podcast producer Izzie Clarke shares her top tips on the things you should know when making or taking part in a science podcast.

Science podcasts are popular. In 2019, Nielsen recorded an all-time high of 57.5 million US households who had listened to one over the year. That's a huge proportion of the American population and statistics show their popularity is still on the rise. Based on recent figures released in April 2020, Acast, a podcasting platform, also pointed to science and medicine as clear front runners in favored content.

Having started my career as a physicist turned science radio producer, I now exclusively make science podcasts. What I find most exciting is hearing a researcher's personal insight on their subject. For me, it's about demystifying their work in an accessible way, revealing the stories that would not make the published study. In my opinion, if you have an authentic idea and people passionate enough to convey that message, then you will find your audience.
I previously produced popular science podcasts for The Naked Scientists and the Nature Podcast, where we would interview authors of the biggest research papers every week, transforming the most complex of reads into a thoroughly enjoyable listen. My latest series, The Supermassive Podcast, for the Royal Astronomical Society launched in January 2020 and we already have listeners as far apart as New Zealand and Brazil. Amongst podcasters, we are seeing that there is a loyal audience out there for this type of content. If you are thinking about whether to embark on your own podcast adventure, or wondering how it all works, here are my top tips to bear in mind.

Prepare your team

First up, the team. Some people are natural organizers and writers who make good producers. Others ask great questions and can talk for days – these tend to be presenters. Some are both. Decide what roles each person will have. Then, once your team is established, you can find yourself some guests who can talk about their subject with clarity and passion.

Before you hit that record button, write a script. You need a precise beginning, middle and end. However, the rest of the episode can be bullet points, including any interview questions, because this helps your podcast sound natural and spontaneous. Be conscious of keeping your tone engaging whilst not patronizing your audience.

It is best to brief your guests about what you want to discuss with them and the key points you would like the listener to understand. Start with the broader topic and why it's important, then explore the finer details as the conversation progresses. And don't be afraid to interrupt, if there is something you don't understand then it is likely your listeners will feel the same. Remember: it's not live so if you feel you need to stop and start again, then you can, and should.

Produce your piece

When you are ready, you next need to record your episode. Audio quality is best obtained with professional external microphones. But these can be expensive. Alternatively, handheld recorders from Zoom, Tascam or similar have reliable in-built microphones; as do most smartphones.

When recording, remember that location is important. Finding a silent room is the golden ticket to success. If you are taping next to a building site or in a chatty office, it is unlikely your listeners will stick around with a noisy end-product. Soft furnishings can help reduce echo in closed spaces; so the more pillows and sofas, the better.

Another thing to watch out for is microphone technique. Be careful not to hold the recording device too close to your mouth as that can distort the audio. Hold it about a hand span away and point it towards your chin to avoid "pops". If you can't be in the same room as your guest, you can ask them to record their side of the conversation on their own using a smartphone. As for editing your clips into a polished piece, there are various software depending on your level of editing skill. Audacity is free and best for beginners. Whereas, for those who have more challenging or creative ideas, you might want to explore trickier tools like Reaper or Adobe Audition. Regardless of the software, if you are new to audio editing then online tutorials from these software hosts as well as YouTube can help.

Publish your episode

When you are ready, you need to get your piece out to the rest of the world. To do so, there are a range of podcast-hosting websites. SoundCloud and iTunes are free, for example, but that only keeps your podcast in one place. Platforms like Audioboom and Podbean will take your audio file and send it to multiple websites including iTunes, Spotify and Google Podcasts with the click of a button. This means you can cater to a variety of devices and listening habits without multiple uploads.

Once your podcast is online, it is also your job to promote it. For social media, 'audiograms' are a great way to offer a sneak preview of your content. These short videos play an excerpt of your episode and help point potential listeners in the direction of your podcast. Also, think about generating a twitter account or a unique hashtag that your listeners can engage with.

This helps to create an online community whilst also allowing you to keep track of specific content, such as conversations that you might want to include in a future episode.

To sum up, you can succeed without the need to spend much money on recording equipment or editing software. Just be sure to always keep the listener in mind when planning an episode, or interviewing guests. Possessing these vital communication skills and bringing science to a range of audiences, whatever your role in the podcast team, will only benefit you as a researcher. Podcasts are flourishing in the world of Sci Comm, there has never been a better time to start.

Communicate well with the media, or someone else will

James Bowers

The media can be a gateway to a wide audience. What can you do to make the most of such opportunities?

A 2013 study published in PNAS stated that *"Most scientists consider visibility in the media important and responding to journalists a professional duty…"*[1]. And rightly so. Nobody can replace a genuine expert in a given field. Hence, the media need people like you to help them get the facts right. If you don't stand up for science, then who will? Potentially, people less qualified.

As a person who has worked across both web and TV, I am strongly of the opinion that if the media have sought you out for your expertise then their goal is not to trip you up. In a recent scicomm webinar for Science Magazine, Laura Helmuth, editor-in-chief of Scientific American, said the same thing about the press. She stated that *"Scientists sometimes think of journalists as snakes, dangerous and difficult to predict. But as with real snakes, they are more scared of you than you are of them."*[2]

When the media call, they are usually looking for insight, facts and a better understanding. You can get your message out to the world through them and you can also use the opportunity to ensure that the information they broadcast is accurate. All you have to do is share a few moments of your time and trust that good journalism will prevail.

Help your journalist

A good journalist or production researcher should have done their bit by exploring their topic sufficiently before contacting you. You should not have to give them all the background info. However, to get the best out of interactions with the media, there are certain things that you can do to make the whole thing run smoother. As a media trainer I always give this advice: *"Before meeting a journalist, anticipate or ask for their questions before speaking to them."* [3] That way you can prepare your responses. Where possible, take a few minutes to jot down important info and chew over the topic at hand.

Be ready to explain things simply. Science writer, Ed Yong warns in his blog to *"bear in mind that if something is riddled with jargon, I can paraphrase it, but I can't really quote it [4]. That's a little riskier for you, because maybe I might inadvertently misinterpret something you say."* If you do some of the leg work, then you can meet in the middle with your media contact. And that's the best place to be for everybody.

Speak with certainty

As a respectable scientist, you probably believe that you should not talk in certainties. In research circles we all use terms like *"our data suggest…", "these results defend our hypothesis,"* and so forth. And, yes, that is all well and good when you're dealing with people from the scientific community. Unfortunately, however, this ambiguity can leave you open to be misunderstood because the outside world tends to work in a manner that is much more precise. Hence being clear and straightforward leaves less room for interpretation.

In the same way, flowery language doesn't help people working in media translate your science easily into a story either. Science communicator Richard Berks even says not to use terms like *"ground-breaking or game-changing", [5]* that don't really mean anything. I agree. Instead, it is much better to say, *"this medication will improve lives for many over 65's"* or *"this technology will lead to better protection of personal data"*.

Assert your authority

You are an expert in your field, so you know what other experts in your field think too. People in the media don't have the same comprehensive vision of the research landscape that you do. Media contacts may ask you about possible counterarguments and misconceptions. Put them straight. Make sure that your voice as an expert is heard and become a spokesperson for the scientific community.

This was the message of a recent publication in Nature Communications, which called for climate change scientists to *"exert their authority in scientific and public discourse"*[6]. In their paper they state that an "*overwhelming majority*" of scientific experts agree that human activity is responsible for climate change. Yet, according to their recent analysis, a whopping 49% more media articles featured experts vouching against this theory. It appears that, somehow, the idea of a consensus is being diluted by a few voices with a disproportionate amount of coverage. Be assertive enough to pierce through.

Conclusion

Media outlets are great ways to get research findings out to the wider world. By giving them a hand as an expert, you are contributing to the pool of true knowledge out there. Be a media pro: respond promptly, keeping your answers clear and concise. That way, the journalist will call you first again next time, which is great because if it's not you they are talking to, then it could be someone else who is less rigorous - and nobody wants that.

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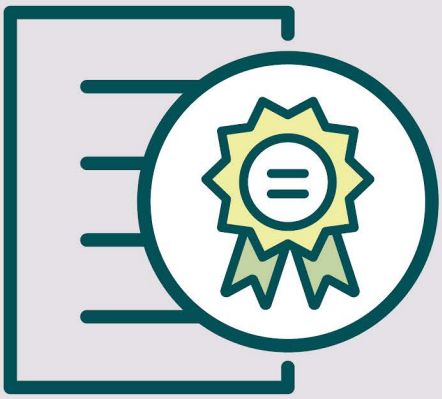


The merits of getting help with your scicomm

Catherine Deeprose

Why and when to work with a scicomm consultant

Most universities and companies have a media department to take care of scicomm related matters. However, the skill set required is often quite different. This means it is often better carried out by someone with experience, actively working in the scicomm arena.

For this reason, some scientists recruit the help of a scicomm consultant or specialist to help them with their dissemination and outreach efforts. There is a lot of merit in approaching these types of organizations. For one thing, they have time and know-how that can be invested into communicating your science well.

They have already laid a solid foundation in scicomm, often with the social media presence and professional contacts needed to increase the impact of your outreach. Some also have the publishing infrastructure to get your work into print, audio, and video expeditiously, which you can then use personally as a dissemination tool at community events, workshops or conferences. And most importantly, they will have access to an experienced set of writers, editors, designers and marketing specialists who know the ropes of scicomm. These teams with varied skills can transform your science into something palatable and engaging for a broad audience.

From a professional point of view, many groups are actively being encouraged by their university or funding agency to engage and showcase their work beyond their own niche communities. Particularly when it comes to research funded by the taxpayer. If you think about it, the taxpayer has already funded the research, and is then expected to pay again to subscribe and read a journal article they are unlikely to understand. That's really quite unfair. So, it's vital to transform the work carried out by scientists into something enjoyable, understandable and impactful that everyone can understand.

But isn't employing someone else classed as 'vanity publishing'? I hear you ask.
Whilst some may refer to scicomm consultants and publishers as 'vanity publishers', it isn't quite the case. A vanity publisher is a publishing company to which authors pay money to have their books published. As such, vanity publishing is often associated with profiteering

and bullying tactics. But not all vanity publishers are the devil. And in any case, it's really quite a stretch to suggest scicomm specialists are vanity publishers in the first place.

Here are some of the key differences:

- While scientists do pay for dissemination by scicomm specialists, they are also having someone transform their work into a form appropriate for the public. So it is more than the dissemination of a scientist's own original, creative work or their research papers.
- Most scicomm consultancy companies are standalone publishers with no foundation support or institutional funding, so they strive to keep the work they publish completely free and open for anyone to read. As such decision-making is not driven by profits.
- Many scicomm consultancy firms and their publications are free from advertising. Hence, again, they are focused on the science,s notfinancial gain.
- Good scicomm consultants will be in constant contact with the scientists to achieve the desired result. They don't just take your papers and never speak to you again. They want your feedback, they are working FOR and WITH you.

Remember that scicomm specialists set out to achieve very different goals and the work they do should not be compared to traditional publishing. It's more about the 'outreach' or broader communication element of science publishing. They want to speak in a new, easy-to-understand language to help researchers communicate their work to the broader scientific community and beyond.

They do this with the dual aims of establishing future research collaborations and funding, as well as developing direct stakeholder participation. Moreover, they tend not to focus on specific scientific data, methodologies and results, but rather the goals, objectives and implications of the research. Scicomm should be viewed as a complement to traditional publishing that will not only help bring attention to the original paper but help bridge the gap between science and society.

Part C

Conversations with science communication experts

Mia Rozenbaum sat down with science communication experts, public engagement professionals and scientists leading science communication initiatives that make a real impact on society.

Jump In2science

In an effort to encourage and facilitate STEM vocations for underprivileged students, In2science is taking them directly to the scientists. Breaking the social wall and bridging new links for future budding scientists to build their career on, the initiative is giving young people a chance.

Around the world, poverty and social background remain huge barriers in scientific careers. Science, technology, engineering and mathematics (STEM) are the most closed careers to young people from low income and working class backgrounds. A 2016 study found that only 15% of scientists, fewer than 10% of life science professionals and just 6% of doctors come from working-class households, which represent 35% of the general population.

In an urge to fight that tendency, Rebecca McKelvey started inviting underprivileged young people into her lab while studying for her PhD in Neuroscience in the UCL Division of Biosciences. *"As a former science teacher for disadvantaged high school students, I realised that there was no way the very bright young people that I had been teaching science to, regardless of how very smart and interested in science they were, were ever going to become a researcher,"* she admits. *"There were too many barriers. So I decided to start a program in my research lab."*

By leveraging the passion of researchers to engage young people in a research setting, Rebecca was hoping to mentor pupils from disadvantaged backgrounds into believing science careers were more accessible. *"Researchers find it really difficult to engage local communities with their work because of their experimental constraints and the pressure to publish. Public engagement isn't necessarily high up on their list of things to do,"* she explains. The In2scienceUK non-profit program hones the skills and passion of researchers to engage and support young people from poor, working class backgrounds on the off chance that it would power a budding STEM career.

All students get to take part in three different activities. The first is a two-week work placement to engage in science and develop technical skills in a lab. The second aspect involves public engagement. The organization runs a public engagement competition for the students and researchers that includes a blog competition and a photo competition. And finally, the students get to engage with workshops looking at science research and writing about science, presenting about science, and thinking about science. *"And we try to engage researchers in all*

aspects. They deliver the work placements, the workshops, and encourage students in the competitions. The key is making things easy for the scientists," adds Rebecca.
To encourage the researchers, everything is made to be as simple as possible for them. Signing up is effortless and engaging is straightforward. The students come to their lab as opposed to researchers taking a huge amount of time preparing new materials and going out into the community to engage. *"The impact clearly wouldn't be the same if the researchers were going out to classrooms,"* explains Rebecca.

The program has been wonderfully successful. *"A huge number of our students have gotten Masters and applied to PhD programs, and some are even working in research now!"*, is joyed to announce Rebecca. Numbers show that in2scienceUK has significantly increased the science capital of the young people they work with and hence raised the probability that students go to top universities and study research intensive degrees. Indeed, 75% of in2scienceUK participants have progressed to University, 58% of which to a top university. The initiative has now been running for 9 years and Rebecca hopes that by 2020 in2scienceUK will have spread from London to the south east, the south west and the midlands and have outposts in every city in the UK in hopes of one day going international. *"I think there is a huge appetite for supporting people from working class backgrounds and there has been a definite move by researchers to engage more with local communities about their work. Faced with the statistics, most scientists feel compelled to make the difference. And we help them!"*

I’m a scientist get me out of here

Funded by the Wellcome Trust, ‘I'm a scientist, get me out of here’ is an outreach program that connects students with scientists online, so they can ask them whatever comes to mind. The online media breaks geographic barriers and nurtures boldness in students, to encourage students to see scientists in a more friendly and human manner. In doing so, the organizers hope to spur up some budding science careers.

Small, bushy haired man with glasses, brainy, socially awkward with a lab coat over his shoulders… picture a scientist yet? Yet, you have it all wrong, and I’m a scientist, get me out of here is proving it to young students by connecting them with real life scientists so they can ask all the questions they want. A unique way for live online myth busting and encouraging science careers.

Born from a democratic engagement project with a sprinkle of science, I’m a scientist, get me out of here breaks all stereotypes around researchers. Funded by the Wellcome trust, this online student stem enrichment activity connects, year after year, in real time students with scientists across the UK and the globe. Victim of its success, the project has spread worldwide to Vietnam, USA, Kenya, Ireland, Spain, and Australia.

Each scientist fills out a profile about their work, their background and, most importantly, about more personal queries - what is their favorite color, their favorite food, or music? And although these questions might seem trivial, their impact is quite astonishing on children. The students are taken online by their teachers to read these profiles and they are invited to ask each scientist any question they want and vote for the one they prefer. At the end of the two-week long interactions, the most popular scientist earns £500 to spend on a stem communication project.

“The experience is special and unique,” explains Shane McCracken, the founder and initiator of the project. *“The key to its success is accessibility and equality that the online media facilitates. Being online means that geography isn’t creating a barrier to participation, which is an issue, in the UK at least.”* Indeed, students are twice as likely to be visited by university scientists if their school is less than 15 mins away from a university. *“So half the kids, get half the scholar visits, just because of physical distances. It is not fair.”*

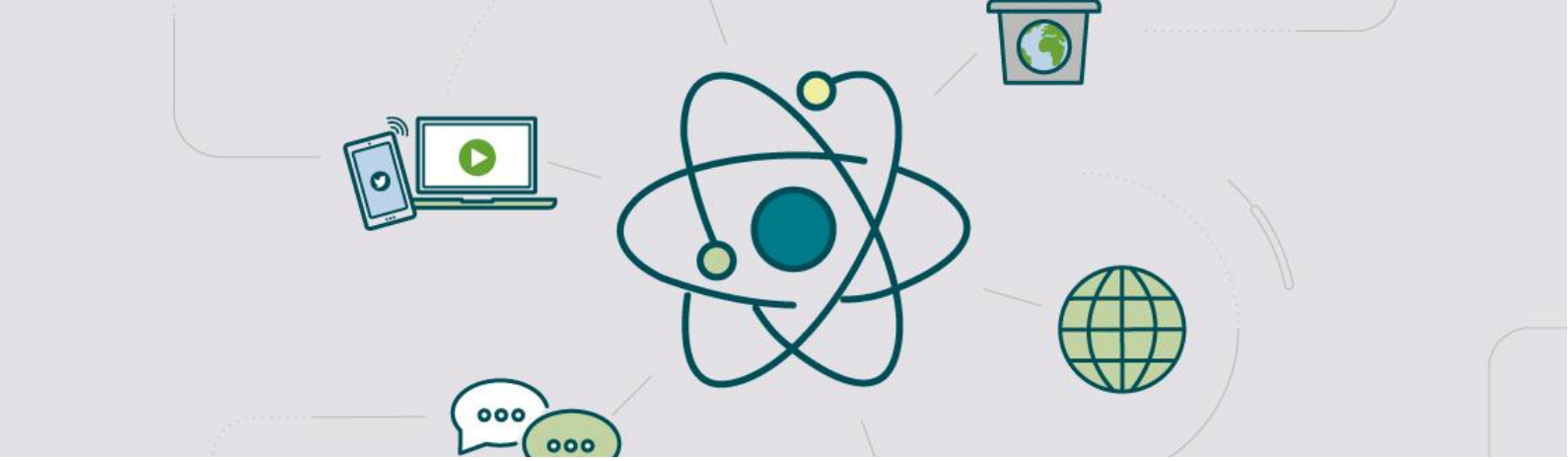
Online activity not only creates geographic equality, it also establishes equality within the classroom. Generally, the same 10 to 15% of students ask questions and interact in school engagement programs. Often those that are most confident and eloquent tend to ask questions that the context demands. *"Being online and student led, every kid gets an equal voice."* Explains Shane McCracken. *"We usually find that 90% of the kids in the class end up participating. And all of them get a response from a scientist."*

Because the students get to ask questions that are personally relevant to them, and vote for their favorite scientist, I'm a scientist turns the brainy, inaccessible, researcher into a normal person. *"We encourage the scientists to talk about things they like and about themselves as people rather than about their work. It is all about showing them as average humans,"* added Shane McCracken. *"If the students see them as people, it breaks the invisible pedestal that might exist, and they are more likely to feel that they can be a scientist too"*.

However, the children are not the only benefactors from this interaction. *"We hadn't realized how much the scientists were going to take away personally by engaging in that way with the students. It was a massive and pleasant surprise,"* is thrilled to say Shane McCracken. This was true for all the volunteers. Again, because of the online factor, the participating scientist doesn't have to be a performer to take part. So even the most introverted scientists can share without feeling exposed, worried about stuttering or how they look. *"It is wonderful to see people that are not natural performers take part and just connect with the young people so well."* All in all, both scientists and students experience a lovely time.

Starting your own science communication project can be challenging, but Shane McCracken offers three major tips. The first, is to make sure that there is purpose for the audience. *"So much science communication is all about the scientist or the science and the audience are just expected to participate because it is science and it is great. That is not enough, unless you really want to reach people that are already engaged."* It is also important your activity is designed for all the people involved so that it is easy, enjoyable and has a purpose for everyone. *"For I'm a scientist, we make sure things are easy for the students and schools, but also for the scientists. We do everything for them and we provide them with everything, so they are spending all their time with engagement, not logistics, traveling, waiting."*

And lastly, don't belittle online engagement. *"There is a tendency to think that being there in person, helps you better connect, but in reality, online interactions have got strengths which go beyond that. Kids are really comfortable online, they don't have to worry about talking face to face. It builds confidence. Elements of online are actually better than face to face engagement."* Good luck with the adventure.



A career between science and society: interview with Imran Khan

Imran Khan's life's work has been at the intersection of science and the rest of society. According to him, science is one of those things that can improve society and change lives for people but only if it is put in perspective with the world of politics, media, civil society, among other things. Science needs to be connected.

Imran Khan, Head of Public Engagement at the Wellcome Trust, started as a budding scientist, with a bachelors' degree in biology but rapidly realized he needed something more than research. *"I think part of the reason I wanted to get into science communication was that I really am interested in all forms of research and I couldn't quite bring myself to focus on one specific project,"* he said. He hence took a master's degree in science communication which resulted in an impressive career in science engagement.

With hindsight, Imran acknowledges that having a science background definitely helps in a science engagement and communication career but is far from necessary. *"It didn't bring anything special except the love of science."* However, it does help understand what scientists care about, what is important to scientific institutions and what kind of challenges scientists face when engaging with the rest of society. *"But equally, I've worked with a lot of people that don't have a science background and are perhaps more interested in different but as interesting topics - like how society, volunteering organizations or the media work,"* explains Imran. Coming from science can also, in some ways, be a barrier. "*Engaging the public only thinking like a scientist, might hinder your capacity to appreciate the angle a politician or a journalist needs. I think you have to be able to see science from other people's perspectives. Only thinking like a scientist can be challenging."*

"Personally I wouldn't have gone into science engagement if I didn't have a science background. It was my passion and my interest in science that got me started. Initially my plan was to become a science writer, and I did a bit of writing and freelancing for a while, but ended up working in politics." However, Imran never strayed too far from science. He worked for a member of parliament in the UK, *"and got to see first-hand how science is used in politics, in policy and how it is often misused and abused as well. That gave me a real passion to try and improve that relationship and make sure evidence is used in policy making."*

From running an organization called the Campaign for Science and Engineering, which tries to promote the profile of science and engineering amongst the political and the media world, to heading the British Science Association, which promotes science as part of culture, Imran was driven by the idea that science is just too important to be left to scientists alone. For him, everyone needs to be able to appreciate science and have a role in science. *"You don't need to be a professional politician or musician or footballer to appreciate politics, music or sports. But somehow, with science, there is the assumption that unless you did a science degree, or worked as a scientist, science is not something you can engage with. I'd like to change that by working with policy makers, schools and festivals."* This spark resulted in Imran becoming the Head of engagement at the Wellcome Trust three years ago, where every day he tried to address the role of the public in the Wellcome trust's journey to turn research into better health.

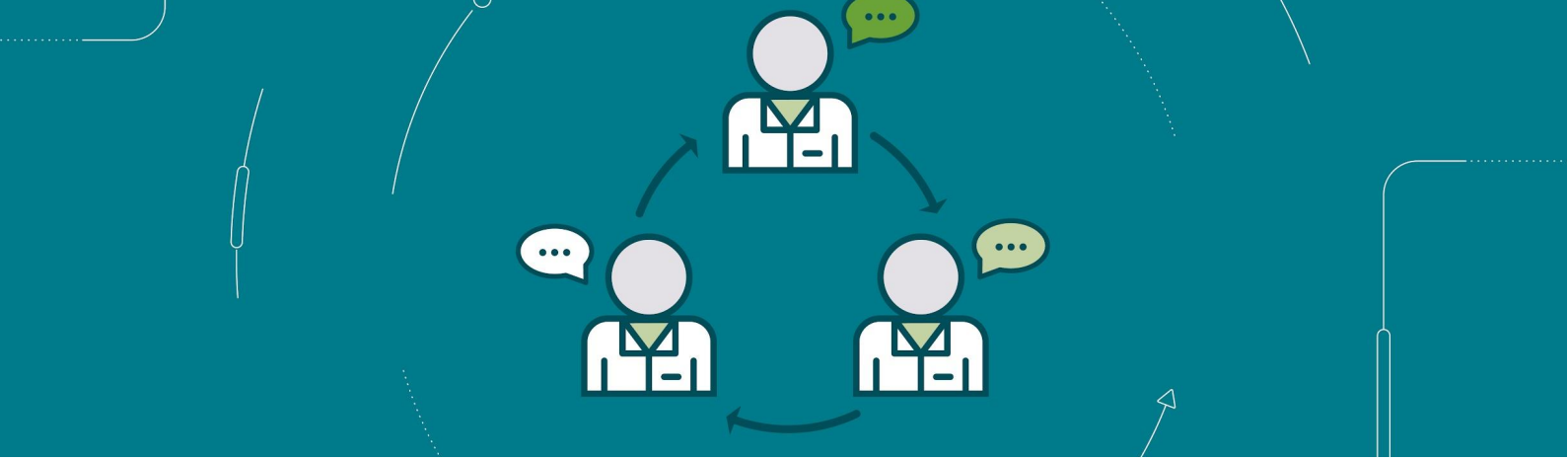
But the path to working in science engagement and communication can also be quite tricky, according to the specialist. There are no defined career pathways to follow. *"It is not like becoming a doctor or a lawyer, or being in a large organization, where you kind of always know what is your next step or opportunity. Science communication and public engagement are much more messy. One of the hurdles is trying to figure out, of all the ways to improve things, which one to focus on, and which one feels most important and most likely to have an impact given that there is no guide book."* But that messiness also helps brew opportunities to shape new ideas and the future, and do things differently. *"I was really privileged to build organizations and work on creating new narratives on how the relationship between science and society can work."* The key is staying open, thinking outside the box and academia. *"There are lots of different touch points between science and society. Only focusing on getting science in the news, as important as it might be, means staying closed to all the different ways society connects to science."*

According to Imran, science engagement is increasingly being approached from the perspective of the public. There used to be the assumption that the goal was to tell people how amazing and important science is *"but for a working parent with a full schedule, learning about antibiotic resistance or genetics isn't going to be on the top of their list."* Science professionals need to understand what is important to the public and start from there; make engagement more people centered. *"Science communication and engagement hasn't become any less or more important over the years but people are being much more deliberate about engagement. It's not about doing engagement just for engagement's sake but because there is something to change or improve."*

However, one of the outstanding challenges that remains, is that researchers, and professionals, don't really get rewarded for science engagement projects. They get recognized for publishing academic papers, getting funding or doing things that give them visibility in the academic community but they rarely get praised for their work engaging the public and improving things in society that stem from research. *"I don't think we celebrate that enough, and that is something we need to fix,"* comments Imran.

"I think scholarly publishers have a role to play in that direction. I'd be interested in hearing from publishers about what they can do to raise a profile or celebrate work that doesn't necessarily revolve around traditional academic papers." The job of a researcher goes beyond just

publishing papers, it is about playing a full role in society which includes engaging with the public and engaging with policy makers. That needs to be more recognized and celebrated.



Where science engagement and communication meet: interview with Ivvet Abdullah-Modinou

An interview with Ivvet Abdullah-Modinou, Head of Engagement for the British Science Association and Director of the British Science Festival.

If science communication and engagement clearly benefit the general public, researchers also gain from seeing the world outside their lab instead of down their microscope. The era of the one-sided speech by scientists has evolved into a more sharing environment that elevates all parties according to the science engagement specialist Ivvet Abdullah-Modinou.

"I never really tell people I'm a scientist because I don't feel I am one. It was such a long time ago", states Ivvet Abdullah-Modinou. Ivvet has been Head of Engagement for the British Science Association for the last five years now, and sharpens her skills managing public programs across the UK, such as the British Science Festival and British Science Week.

Although Ivvet started out working as a budding geologist in Hawaii, she rapidly moved away from lab work with a masters in science communication. Since, she's worked in journalism, in radio, in newspapers and spent a decade working at the Natural History Museum in London, hand in hand with scientists to help them develop narratives for the general public. *"My time working in science engagement at the museum really taught me to see what works and what doesn't while engaging the public; and that practice carried through with me,"* she explains.

And although being a scientist didn't shape Ivvet's career, it did help in some ways. She explains: *"having a science background made a difference in how scientists view me. They see me as an ally, but actually if you think about it, public engagement or science communication practitioners are always the audience's advocate."*

According to Ivvet, science engagement is about what the audience needs or wants, what content best suits them and interests them: "So I actually don't think you need a science background. I think you need an interest in the subject, as you would in any job. Controversially, I don't think you need the knowledge of everything. You need knowledge if you think science communication is telling people stuff but I don't think that is what science communication should be about."

So what is science communication? The answer probably varies slightly from one professional to another and each one's work experience. But according to Ivvet, it is more about conveying an idea around science that you know or you are passionate about; whether that is on the television, doing a talk, or presenting at a festival. Not to be mixed with science public engagement which doesn't necessarily have an outcome set beforehand. "Say you are organizing a debate around a scientific topic, you need to think about equity in that conversation. It is not about the scientist being elevated above the audience. You need to make sure all voices are equal, everyone is heard and being engaged in the way they want to be. It is a nuance but an important one", explains the specialist.

Although slightly different, both occupations help scientists see the world outside their lab. "It is important that scientists communicate and engage with people who are not like them, that they be put in situations that are slightly uncomfortable or outside of their area of expertise, because that is where the real learning happens," points out Ivvet.

"Doing public engagement might never change the way a scientist looks down the microscope but it may change the way they see the world around them and understand more how other people see their work and research. They may never have had that realization before so it is a really nice opportunity to understand more about the public."

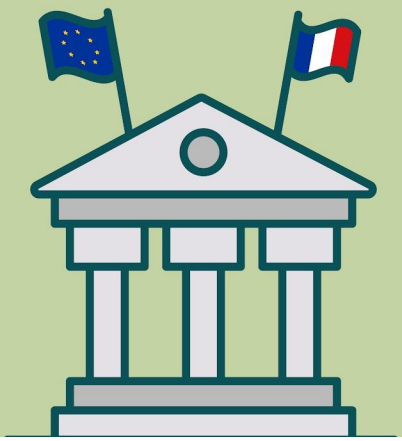
And over the years, public engagement has shifted from a one-sided speech to a two-way discussion, which has encouraged researchers to embrace art and social sciences to improve the way they communicate their work to the wider public. *"There has been great support from the research community in the UK. Scientists are really up to sharing what they do. They like being involved, they see the value and the importance."*

But unfortunately, this part of the scientist's work is rarely celebrated and recognized. *"I think there is still a lot that scholarly publishers could do in that direction,"* adds Ivvet. *"Promoting open science, for example, making sure abstracts are readable and engaging, so that when anyone does have access to it, they can actually read and understand the science, just like they would a news story. They are an intermediary. I don't think a journal necessarily needs to be the one engaging the public but in the same way, the public don't always need to know the ins and outs of science publishing. What they do need is to have an appreciation of it and the content in the journal."*

And although science might seem far from everyday life, some of the content in these journals could really help people make changes in their lives. The specialist is eager to share: *"There is nothing more rewarding than to see people use science to make their lives better, whether through their diet, or putting up an air pollution monitor. How science can make people have agency to change their lives is really exciting."*

One of the biggest hurdles of the sector is getting the public interested, when some don't immediately identify with science. To engage all members of society with science innovation, *"you need to accept that some people have full and happy lives and don't need to engage with science and that is ok,"* adds Ivvet. It is about creating opportunities and experiences for all people to engage with science on their own terms. *"But when you do find that space, when*

those groups, those communities, those audiences find some proximity to science or finally get how interesting or fun or unusual science can be, that is when it is all worth it," she concludes.



From the classroom to the French Ministry for Research: interview with Nicolas Ngo

An interview with Nicolas Ngo, Head of the Science and Society Relations Department at the Ministry of Higher Education, Research and Innovation in France.

Nicolas Ngo's goal is to build an outlook of science that works both with and for society, whilst keeping the field open to individuals from different backgrounds and skill-sets to increase collective intelligence.

Starting out as a math teacher, Nicolas Ngo has always had a passion for transmitting science. After inspiring his pupils with out-of-the-ordinary math puzzles, he dived into science communication at the *"Cité des Sciences et de l'Industrie"* museum in Paris. Whilst there, he imagined, uplifted and delivered public outreach of science exhibitions. He spent four years there, working with both the public and researchers to encourage curiosity for science in those eager to learn.

Further down the line, he is now Head of Department at the Ministry for Higher Education, Research and Innovation in France. *"They were looking for someone from both the education system and public outreach worlds. From my two previous experiences, I checked all the boxes. That's how I became 'Mr. Scientific Culture' at the Ministry of Education and then the Ministry for Research and Innovation,"* he discloses.

Coming from a scientific background seemed almost mandatory to him. Although, Nicolas also learnt to develop alternative skills and find the right mix of people to sit by his side. This means that, at the ministry, Nicolas surrounds himself with people from varying backgrounds. *"People from different fields add to the collective intelligence. I work in a very transversal department so if you find yourself surrounded by super specialists, you lose contact with society,"* he explains.

This assortment of profiles is particularly important when trying to implement and monitor frameworks for national public policies and long-term strategies. In France, around 1,300 players are involved in scientific culture, reaching a total of 17 million people each year.

Nicolas organizes the National Governance of Scientific Culture at both the national and regional scale, and on an individual level too.

"I make sure there is coherence between all projects, then support them and create favorable conditions so their actions are as efficient as possible at all levels," he adds. *"I am no longer in direct contact with the general public. Although I try to, whenever I have the chance. But, I have a position which allows me to do things that you can't do when you're a player on the ground."*

Either way, the goal remains ultimately the same. *"You hope to see that sparkle in the eyes of a child or an adult when they understand the magic of science. You want the encounter between a citizen and a scientist to be a memorable turning point that inspires astonishment and curiosity, and pushes them to want to know more. You've won if you've managed to do that,"* Nicolas says.

He adds, *"This feeling of working for the common good is very rewarding. Working for research in the service of advancing knowledge within society is a very noble mission, I find."*
So how do you get to be that person? Quite simply *"stay curious"* and find new ways to communicate.

Since the 1970s, there has been a push to open the door to scientific knowledge for citizens as we move forward in a vastly technological world. *"There used to be this very top-down perspective of the all-knowing scientist explaining to the average person,"* Nicolas describes. *"But, in recent years, we are becoming increasingly concerned with dialogue, listening to the general public and trying to install an interchange between science and society. We want citizens to participate, contribute and get involved in research activity. But that assumes researchers are trained, informed, and motivated by the stakes at play."*

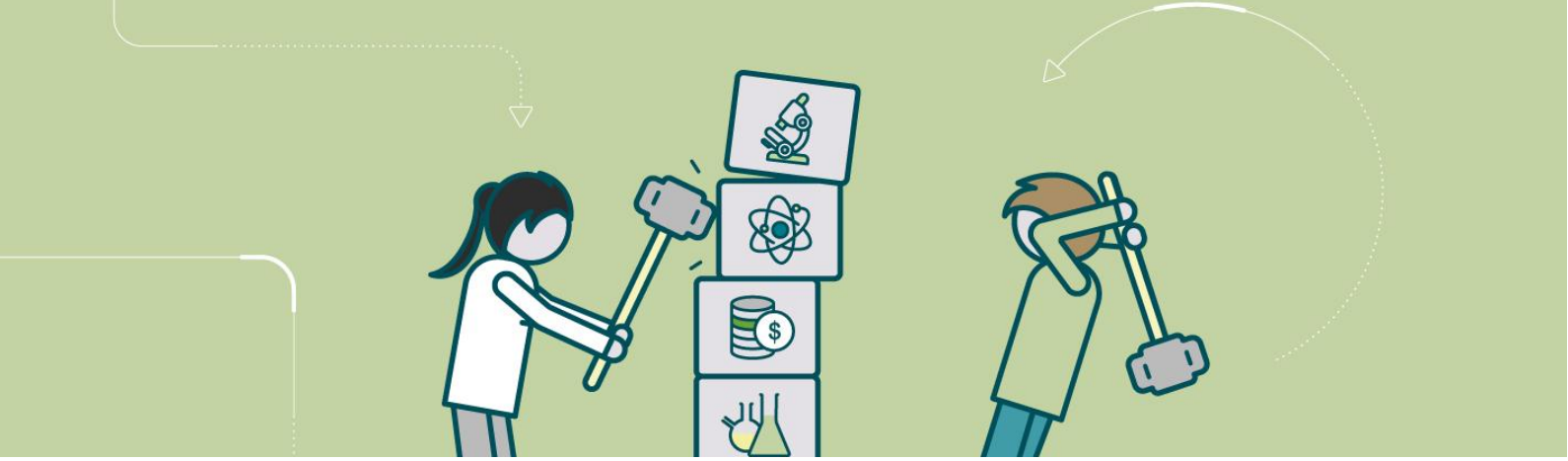
Science communication is not only useful for the public. Researchers get a lot out of it too. *"Clearly explaining the complexity of your thoughts and your science can help put research into context and understand the power of the science,"* he explains.

Scientists are a prime target to improve the outreach of scientific knowledge. And not only for themselves. *"Scientific interest aside, researchers have a social responsibility to raise awareness. Sharing their expertise with the general public and decision-makers ensures that knowledgeable and factual decisions are made,"* adds Nicolas. *"A media like Hindawi has a duty, from this point of view, to promote this awareness by sensitizing researchers to this issue."*

Initiatives such as the Hindawi Science Communication Guide will help both scientists understand the issues at stake and inspire professionals. Promoting awareness is necessary to keep science open, accessible and woven into national policies.

"It is often hard to precisely reach those who need it the most. By improving the way science is communicated by scientists, you are increasing the number of people who have access to that information, and understand the message," explains Nicolas.

To conclude, science communication offers a powerful tool to promote research findings. That can happen when we work together. In the words of Nicolas Ngo, that can happen by taking the path of a science that is both *"with and for society"*.



Breaking walls between science engagement and the public: interview with Marie Mulhmann

In the current context, the need for engaging science and trust in men and women in white coats is ever more present. Marie Mühlmann, Head of the Falling Walls Engage program, explains how improving science engagement helps solve today's most pressing challenges.

Built in the image of the fall of the Berlin wall in 1989, Falling Walls Engage has tackled for the last two years the immense challenge of bringing down the fence between science and society. « *We want to support science engagers and communicators by giving them a platform to exchange and meet in different parts of the world*, » keenly presents Marie Mühlmann, Head of the Falling Walls Science Engagement program.

Every year, an event welcomes pioneering initiatives who have successfully implemented concepts of engaging people with science topics. It is an opportunity to soak in ideas and learn from the experiences and developments of others.

"*We want to show that science engagement is relevant for science and scientists*," explains Marie Mühlmann. "*It is not just a nice add-on to the work in the lab. It really benefits research. Integrating non-scientists to discuss questions, problematics and challenges helps grasp different aspects of your project.*"

And as a non-STEM scientist herself, Marie Mühlmann is particularly receptive to the issue. "*I'm not a scientist so to speak. I studied cultural studies and religion. Science topics often focus on STEM subjects, but there is a growing interest also in social sciences. In the future we would like to bring these together to see what they can learn from each other, and give social sciences a bigger platform in the science world*." For Marie, being a scientist might have made things easier in her daily work, but she wouldn't have it any other way. She explains: "*I don't always get where scientists are coming from, because of the different background knowledge, education or even character that they develop as a scientist*."

"*Sometimes when we have discussions or we're planning events I don't really grasp what they want. Maybe if I knew a bit more about the research word, I would know how they work and it would be easier to tailor everything for them*." But the plurality of thought also adds to the stake of the program. Having another train of reflection has enriched the program and helped it grow and become the success it is today.

However, most of the accomplishment comes from the science engagers themselves, their ideas, motivations and inspirations. And part of what makes them successful is getting what their target audiences want, need, are interested in - and find ways they can engage with scientific topics. "*I am always surprised at how well they know their audience*," adds Marie Mühlmann. "*There are so many ways to be involved and science engagers are creative in so many ways. They come up with new ideas every day*."

"*They put their heart in this work and I admire them for that. They work really hard, it's something that our society should support more."* And particularly in these hard times. The current worldwide situation has confronted the general public to the importance of science and research. "*And the need for trust right now is immense. People need to trust what scientists say*," discloses Marie Mühlmann.

But, from the reactions across the globe, it has become clear that there is a lack of confidence in science at the moment. There is still a lot of work to be done. But if one thing, the pandemic has nudged the interest of the general public in the direction of science. It is an opportunity for scientists to ease scientific knowledge, make it more accessible and rebuild faith in science.

"*It shows that the work of science engagers is really important and will become even more important in the next couple years*," according to Marie Mühlmann. "*And we want to inspire more and more scientists to engage*."

According to the professional, the most important thing is finding your own way of engaging, your own interests, hobbies, or things you like to do. "*Not every scientist likes to stand on stage or speak on the radio, but there are many other ways to engage," she adds. "We want to encourage scientists to find their own way, everyone has something to share and their own approach to do so*."

By showing everyone that science engagement is a relevant part of science, we will be able to win over governing bodies and institutions. And initiatives like the Hindawi science coms guide will help in that direction. It is important that scientists are mindful of the stakes and understand the importance of sharing their science. Reading about it is part of the challenge. "*The more people and scientists are aware and interested in science engagement, the closer we get to that goal*," adds Marie Mühlmann.

We don't only want walls to fall, but borders to be crossed. Science engagement is part of proving how science can help solve today's most pressing challenges.

Building a future on science: an Interview with Laurent Chicoineau

Moving towards a better world together, is science communication the key? Laurent Chicoineau, Director of Quai des Savoirs, believes so. Here, he tells us how he thinks we can do it. And how, with a little guidance, all scientists can and should participate in making a difference.

"Building a future together," is the goal of Quai des Savoirs, a French science engagement project based in Toulouse, France. The association encourages interactions between communities and groups with stakeholders in STEM. As such, they hope to enable them to find ways of working together towards a brighter future for all.

"[Quai des Savoirs] is not a political program - but almost!" jokes Laurent Chicoineau. *"When you think about it, both science communication and culture are about imagining the future. They are at the heart of society and its challenges. Environment, health, technology, energy, and so many more concerns involve science. It is part of common culture. Therefore, it is important to share if we wish to progress and build a united future together."*

We are surrounded by science and technology; mathematical algorithms and health paradigms, for example, govern our daily lives in a certain way. But we often lack perspective. It is important to understand the influences steering our future if we are to step back from their grip.

At Quai des Savoirs, researchers, engineers, companies, associations, artists and public outreach specialists can meet one another. There, they conceive and nurture a wide range of public engagement and collaborative projects with the objective of sharing science. "At Quai des Savoirs, we are not experts in science but we work with people who are," explains Laurent. *"The project offers an interface between scientific disciplines and communities. I am a facilitator - a creator of opportunities. I reunite people, ideas and new situations. This is how I see public engagement with science. It is not only about popularising and making it more accessible. But it also involves working towards a common goal with societal impact."*
Quai des Savoirs is a gold mine for new, multi-dimensional ideas to help explain the latest advances in science and technology. And each new concept brings with it new ways to communicate. According to Laurent, you cannot communicate science these days without the involvement of "new media" and "new information systems". The current climate is one of post-mass-media where social media sit at the forefront, changing the face of how we learn and educate.

Laurent says that from the earliest age, it is vital for individuals to find the tools required to grow; acquiring knowledge, expertise, and skills, while arousing curiosity and imagination. It is up to everybody to find their own way to innovate and shape the world. For him, the answers are not only found in the experimental sciences. He also believes that literature, philosophy, and other such topics should be equally as accessible to everyone.

Quai des Savoirs is particularly attentive to audiences who do not immediately feel concerned by science. *"We are not just doing science communication for those who like science,"* adds Chicoineau. *"Those who enjoy it are those who have already been in contact with initiatives like ours. We try to reach out to those who don't naturally feel attracted to science. We want to make them aware of important issues and to feel connected to them. They have a say, just as much as anyone else."*

Over time, Laurent Chicoineau came to realise that people always enjoy science if you bring it to them in the right way. *"People don't just not care about science. The interest and fascination is rooted in everyone. But, unfortunately, what often happens is the manner in which it is communicated is ill-adapted to the audience. And throughout the years, we have learnt how to better tailor the science to the public, in a way that interests them."*
Moreover, there is a flourishing new attitude in young researchers, who really grasp the importance of communicating their research. More and more, they are seeing this as part of their job. *"There have never been as many public speakers, podcasts, videos and so on…"* Laurent adds gleefully .

However, public engagement and communication are still not recognized as part of the role of being a scientist. So, most of the time, projects are born out of passion, away from the academic sphere. *"Scientists often speak up alone, create communities alone, work alone. Institutions have yet to see how beneficial these interactions can be,"* he says. Nevertheless, public engagement projects still need professional support if they are to flourish. Content needs to be refined and tailored. Feedback is required and projects need direction. *"Some scientists are convinced that they are the first to speak out to the public and that they can do it without any help or advice. But too often their passion is not enough,"* he says. But, with a little help, everybody's needs can be met.

Communicating science is a professional field that needs much thought and experience. There is history to science communication that is interesting to know and take on board before jumping in. This is where scientific journals can help; by sharing more information about best practices in science communication, supporting programs and offering a platform for expression and dissemination.

Funding research: an insurance policy for a better future: an interview with Isabelle Bergeron

Rather than fixing the world's problems, Isabelle Bergeron hopes they can be prevented altogether. Head of Communications for the AXA Research Fund, she believes that science and research hold the key to anticipating and mitigating the impact of the greatest hurdles of our time. The challenge lies in making scientific knowledge accessible – both visible and comprehensible – to non-scientists.

Many are familiar with the often-used aphorism *"knowledge is power."* But is the power of knowledge enough to save the world? According to Isabelle Bergeron, Head of Communications for the AXA Research Fund, scientific breakthroughs could in fact help solve the problems we will face in the coming century. Supporting and leveraging science that focuses on anticipating and mitigating major risks is probably our best insurance policy for a brighter future, she says.

"Rather than just cover the damage caused by human activities or natural catastrophes, AXA is working to prevent, anticipate and limit our society's current and future points of vulnerability by supporting scientific research," explains Isabelle. *"We believe that by funding risk research projects and accelerating innovation, we can help to ensure that there are fewer issues downstream, whether medical, technological, socio-economic, or environmental. As a global insurer, AXA already offers protection in all these major areas. Supporting risk science goes hand in hand with managing risks."*

AXA has already committed significant funding – 250 million euros - to over 650 research projects from leading institutions located all around the world. Yet the mission of the AXA Research Fund, a unique global scientific philanthropy initiative, is not just to accelerate scientific knowledge through funding but to get it out of the lab for the benefit of the majority, as Isabelle puts it.

The company is also an active communicator with respect to the research it supports.

"We are not only about giving grants. We actively help share the scientific knowledge obtained with the world, in the hope that it will make the biggest possible impact. We believe that if most

decision-makers, public figures, stakeholders, and even companies are made aware of the science, they will work together to limit the impact of future risks."

As part of the process, Isabelle encourages researchers to recognize the value of being a good communicator. Through media training, events, and media partnerships, the AXA Research Fund promotes dialogue between scientists, experts, and the media. *"We are facilitators more than organizers. We engage researchers and give them the means and opportunities to fuel the debate."*

She adds, *"We often work with science journalists so that the information comes across effectively. As a non-scientist myself, I recognize the limitations of not understanding the complexity of the science. To avoid confusion, we call upon specialized communicators."*

The ever-growing phenomenon of fake news is driving a clear need for real facts and solid research publications. In times of crisis, such as with the current global pandemic, there is often pressure on the scientific community to design and communicate rapidly public policies. However, assessing scientific knowledge requires an understanding of the rigors of scientific methodology and the time it takes for discoveries to happen. To reduce misunderstandings and manage expectations, Isabelle says that *"the media should increasingly refer to science but also contextualize scientific method, the evolving nature of scientific knowledge, and the foundations of conflicting ideologies."*

In a society that is force-fed information, expecting people to forage on their own through complicated words in order to understand the underlying concepts can be problematic. Sometimes information needs to be pre-digested for the audience so that the messages come across in a clear, concise way. The goal is to avoid confusion, not create more. In that sense, information on the scientific method should be shared more widely with the general public.

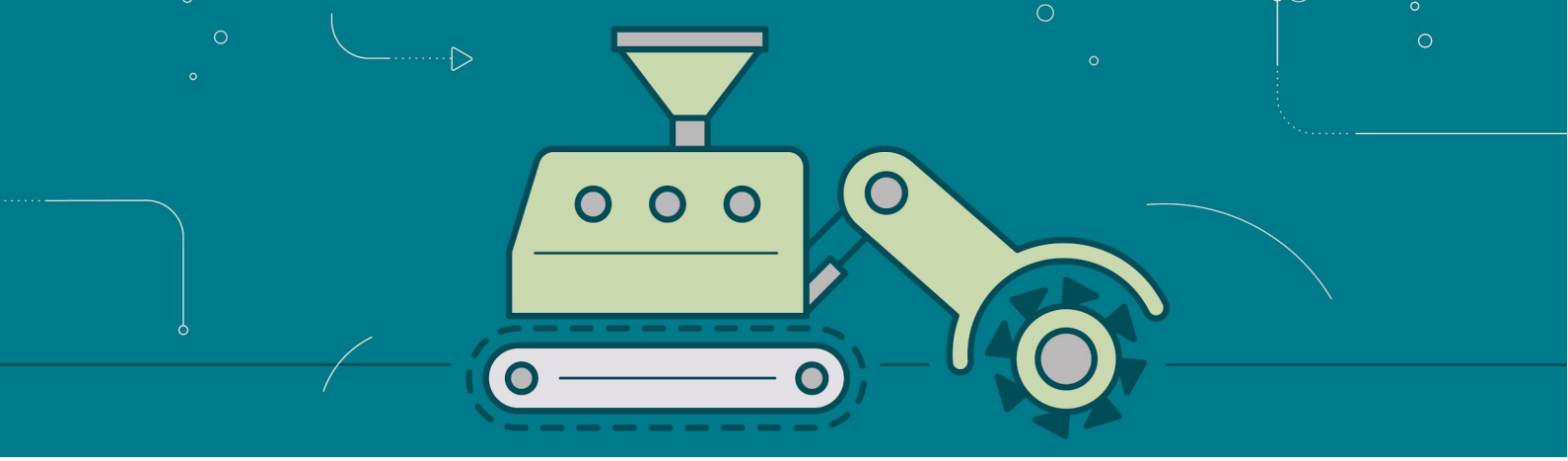
Without well-grounded context, science can quickly disappoint public opinion due to misconceptions. *"If we let science go beyond its intended scope and be more than what it can and should be, mistrust follows. And this can quickly become counterproductive,"* Isabelle says. The more importance given to communicating about science and the world of research, the more people will understand that science is most often a conundrum, with many pieces of the puzzle to take into account.

According to Isabelle, scientists have a genuine role to play in the making of future policies; as guardians of knowledge, they have a unique ability to drive the evolution in hypotheses and provide basis for decision making. *"I believe there should be more long-term, permanent scientific advisers in governments, rather than scattered, ad hoc solicitations, which can cause confusion."*

"Once I invited key figures of the GIEC (IPCC) to raise awareness of climate change among key AXA leaders. It was definitely a trigger in the design of AXA's climate policy, which blocked particularly adverse investments," she shares enthusiastically. *"It was a fantastic example of how scientists can make an impact on the real world. By inviting science to a dialogue with*

industry, it was possible to raise awareness of the reality of climate change and get our business leaders to play a more active role in making a difference."

This is just one example of how powerful and impactful scientific truths can be – as long as the communication channels are transparent and rigorous. We can all make a difference in our own way. For scientists, it lies in both doing and sharing their research. *"And there is still so much to discover,"* concludes Isabelle. *"I find it fascinating there are still so many unknowns we don't even suspect, just waiting to be discovered."*



An interview with deep-sea biologist Diva Amon

Marine biologist and science communicator, Diva Amon, is a fellow at NHM London and Director of SpeSeas and Co-lead of the Deep-Ocean Stewardship Initiative (DOSI). She tells us why sharing her research with the world is so important to her.

Diva Amon studies the deep ocean. She regularly embarks on trips around the world to study undiscovered habitats in the unknown depths below. Dedicated to her work, she has travelled as far down as 2.7 km below sea level to collect samples. She once even spent over a year of her life on a ship for her research. Yet, somehow she still finds time to raise public awareness of her field. An advocate for science communication, she has conquered both marine ecosystems and the hearts of the public alike. Like much of the rest of the planet, the habitats she studies are under threat. She feels a duty to communicate her research and be a role model for younger generations.

Diva believes that the worlds of academia and research haven't always been great at communicating science. "Especially in the world that I work in, the deep sea is incredibly out of sight and out of mind. It has a really bad PR problem," she says. "As a result, the public is not only misinformed, but also unaware of much of the research going on behind the scenes. I think we have a moral obligation to communicate about what we do, especially if our work is publicly funded." She wants to share her passion too, "I get the privilege of experiencing this incredible place and I feel the need to share it with as many people as possible in the hope that maybe it may spark curiosity for this very unique place."

According to Diva, communication of deep sea research is largely unsuccessful because of subscription-based academic publishing. Knowledge is locked behind paywalls and research findings are simply unreadable to the average person. She says that science can't make an impact on the world if we keep it locked up in this way, *"…the people making the laws and regulations that govern our oceans can't access the research they need to make informed decisions. And even if they could access it, they usually can't understand it."*

She wants this to change. *"I believe academic publishing is broken and needs a huge reform. We need to change the model somehow and make science available to everyone."* Open access is one way to go. But could more journals help publicize research? There are many other

communication channels that can be used: blogs, books, social media, press releases or illustration. Diva even suggests that editorial policies should be more accessible to the public and other members of the community, not just scientists.

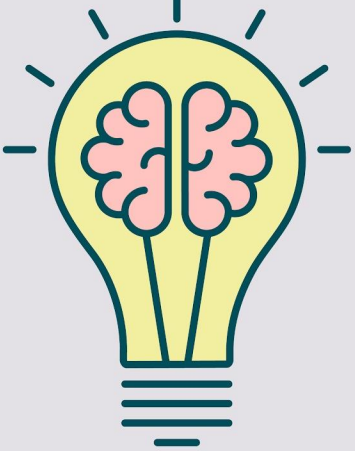
Coming from Trinidad and Tobago, Diva Amon has a unique experience of how science communication has evolved over the last decade. *"Back then, because I was interested in science, I would seek out information in any way I could, reading popular science novels, science news and magazines, and watching documentaries. Today the information is accessible in so many more ways and there is so much more being produced."* For one thing, social media has completely changed the landscape in science communication, everything has become more rapidly available.

Diva says that it helps to have someone who can show you where to begin. She was lucky enough to have two PhD supervisors willing to help, encourage and nourish her interest in science communication. For anyone hoping to start out, her advice is *"…if public speaking isn't something you feel extremely comfortable doing, start with schools, because you usually always get great feedback and it is rewarding. You can also find fantastic programs which allow you to talk to schools around the world even from the comfort of your home or lab. My advice: don't start small, start comfortable. Avoid, for instance, the high-profile events at first. Even now they are not always easy for me."*

Still, science communication isn't for everyone. And that's OK. Diva has produced a huge amount of content. She has published in CNN International, National Geographic, BBC World, ABC Australia, NHK, Los Angeles Times and more. She has spoken at a great number of important events, too. But, even now, she gets cold feet. *"I still get impostor syndrome. The way I deal with it is essentially by telling myself: 'fake it until you make it'. Even if you feel you don't have the confidence or the ability, if you pretend, then others will believe it as well. So often when I'm nervous, I say to myself: 'You can do this, you have the ability, but if you feel you don't, pretend you do.'"* Regardless, Diva still finds the time and the strength to put herself and her research out to the wider world.

For her, it's not all about the research, though. "*Growing up, the lack of diversity in science communication and especially among those advocating environmental issues was profound. It was important for me that I become a role model for younger generations,"* she adds. *"Having that diversity of voices is part of the reasons why I do science communication… I didn't have a face, a voice, or someone from a similar background as a role model. So, it is important that I am potentially that role model for future generations. If I can get people from where I'm from, or similar, to care about the ocean, its environment and even potentially think about careers in science, I think I will have succeeded."*

Diva continues to strive to inspire others with her research. Whether it be kilometers under the surface of the ocean, or the energy to overcome nerves at a public talk; she is prepared to go the distance.



Spreading knowledge: How progress stays visible: interview with Selina wray

Selina Wray hopes to help break down misconceptions around Alzheimer's research. As a Senior Research Fellow at UCL Institute of Neurology, she invests much of her time in sharing her research findings with the world. Even though scientists are tirelessly working towards a cure, the clinical impact is not always so obvious. Spreading knowledge is a vital way for patients to see progress in the field.

According to Selina Wray, being a scientist nowadays is about more than just sitting in a lab doing experiments. A cell biologist at UCL, Dr. Wray is researching Alzheimer's disease. She investigates how the tau protein starts building up in the brain as the disease and dementia progress, causing damage to nerve cells. Yet, somewhere between the brain cells and microscopes, she finds time to share her findings with the wider world.

Throughout her career, Selina has woven her scientific work together with public engagement and communication projects, aimed at various audiences. Her adventure started during her PhD with 'open lab' events for the public, which then later evolved into coordinating engagement projects with Alzheimer's research UK. Her involvement in public engagement cannot be overstated. She ran the Science Museum Day at the Science Museum which attracted 4,000 attendees and has taken part in many other events, including Pint of Science. Selina believes that it is important for scientists to engage with the public. She says that, first and foremost, it helps distill many of the misconceptions around research, which is particularly important for Alzheimer's and dementia. Scientists have been working on figuring out the disease and finding potential treatments for several decades. But applied solutions are still lacking, so patients are waiting to feel the impact of the research on prognostics and day-to-day life.

"Without information on ongoing research, people could easily think that nothing is being done, no progress is being made," explains Selina. *"Talking about what we do can help explain the progress that has been made even if it hasn't reached the clinic yet. We can tell them why that is, why progress might be slower than in other areas, what work we are doing and how that will eventually translate to benefits in clinics."*

Talking about the research also empowers patients. Over the last five years, there has been an increase in funding for dementia research *"…because patients and family members have felt informed enough and confident enough in the research, and the work that is being done in the field to give money to accelerate the process,"* she adds. In addition, since the work is funded by the public, via the government or charities, *"it is really important that we tell people what we are using their money for and why."*

According to the researcher, there is also an opportunity here for science journals to make information more accessible. *"It would be nice if whenever a paper is published, a short commentary, an interview or a podcast is published alongside it for a lay audience. Anyone interested, scientist or not, could access the information. This would also push scientists to think about the general interest of their work, why it is relevant and important. It would help both scientists and the audience place the work in the bigger picture."*

Over the last decade, science communication platforms and events have flourished. There are now a plethora of ways to participate in communication, both as scientists and as somebody simply hoping to find out more on a subject. *"For me, it is something I do alongside my research. But being a science communicator has become a full-on career,"* explains Selina. *"The landscape is very different now. The charities we work with have dedicated people working in sci comm. Their role is to think about what we scientists need to communicate and how to do that in the most efficient manner."* They are there to help, offering training, support and guidance on how best to communicate science with different audiences.

"Having a professional by your side helps you feel more confident. They offer the support of someone with experience," says Selina. She also adds that you do not have to jump into science outreach with a big event. There are many more informal ways to communicate science, like social media. Online platforms help you to open up a dialog with the public in a more casual manner. *"You can also give it as much or as little time as you want."*

Her final advice: just jump in and give it a try. *"The first time is never going to be perfect, but eventually you will get better at it by trying out what works and what doesn't. Your skills will evolve and get better with practice."*

Science: Stars in Hervé Dole's Eyes

Professor at the Institute of Space Astrophysics at the Université Paris-Saclay, Hervé Dole studies the mysteries of the universe. Also vice-president of art, culture, science and society at the university, he aims to ignite curiosity about nature in others. For him, strength comes in numbers, so scientific discovery should be shared by all to help guide decisions made by society.

Up above us in the night sky, twinkling stars beckon our curiosity. Under the spray of diamonds, we are all equal and humbled. The universe, if only by its sheer size, has inspired and awed us since the dawn of humanity. What is it made of? Where do we come from? The desire for answers to these fundamental questions has drawn people and communities together, creating instant connections even to this day.

Hervé Dole, professor at Université Paris-Saclay, feeds his thirst for knowledge and discovery with astrophysics; a topic that he endeavors to open up to the wider community. *"I contribute to space missions to better understand the origin of the galaxies and the universe,"* he explains. His most notable achievement so far was building the coldest instrument in the universe. It was sent into space to measure cosmic background and the first light to ever exist.

Passionate about astronomy, he has always wanted to share his enthusiasm for science with others. *"There are many ways to study the universe. And many more to talk about it… I recognized an interest in people that I talked to. This pushed me to share, exchange and get involved in science communication."* His enthusiasm has led him to the role of vice-president of a Université Paris-Saclay, specifically in charge of public engagement, art and culture in society.

Hervé believes that engaging and reaching out to the general public has and will always be important for scientists. His first argument for such is that science is, by and large, publicly funded. Therefore, it is only fair that citizens get a glance of what they are contributing towards.

Science inspires curiosity. And everyone is equal in the face of curiosity, a lever to equal opportunity. *"Outside of the common school setting, this inquisitiveness helps build confidence in students with difficulties… and gives meaning to teaching,"* Hervé adds. And as science communication evolves over time, it becomes ever more relevant to society.

"Science helps humanity forge its own vision of the world," he states. *"All the knowledge that helps fuel the engines of human activity and shape public opinion. Learning allows you to make informed decisions."* This particularly resonates in today's society of manipulation and fake news. But it goes beyond that, too.

Another important aspect of public engagement is that it helps scientists stay aware of society's expectations. It helps them stay in touch with the real world and adds meaning to their work. *"It helps us see just how great our jobs are. And it keeps us motivated,"* adds Hervé Dole. "It is really enriching."

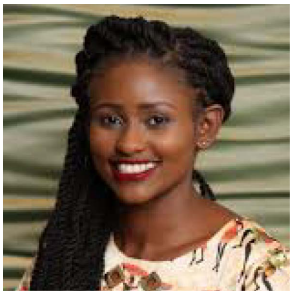
Over the years, the way science is passed on has changed. Transmission has moved from top-down, institutional approach, to a more participative, exchange-driven one. This welcome change encourages engagement and favors access to science for the wider public. *"The science world is becoming aware that dialogue with society is neither unnecessary nor uninteresting,"* explains Prof. Dole. *"Taking the questions and attitudes of the community into account is very important because science is part of society."*

Science communication has played a vital role in this shift in mindset and general practice. And innovations in the way science reaches out to the public have been crucial in driving change. Unfortunately, however, innovative science communication sparsely originates from academic ranks. This is where specialized scientific journals could have a role to play. There is increasing debate over an overhaul of the lucrative publication system, which will help make all scientific findings open to all. *"Journals should be a vehicle of science and scientific knowledge, not a business model based on making money and turning profit from discoveries that could profit all,"* Hervé believes. *"Part of the issues around fake news and the lack of faith in science is that people question the origins of the funds and actions carried out - even when the research is publicly funded. I reckon having independent journals could be a first step to changing that."*

"But communication, in general, is very difficult. You are often either very institutional or very business driven. For me, a balanced ecosystem should involve multiple payers: different journals, more feedback to universities or organizations but also journalists who are trained to counterbalance the information. We need more scientific communication, with more channels, more actors, and more independent spokespeople. The more sectors and people are involved, the less suspicion surrounds the science. No single voice or pressure group takes control. A balanced system reassures."

In this context, Hervé says that scientists are not the only ones who need to speak up. Now, there are associations and foundations that take that role on building a new form of synergy. Hence, engagement and communication are varied. *"There is at least one type of activity for everyone,"* he encourages. *"Each researcher can find their own way of communicating. There is no one mold to follow. On the contrary. There are so many possibilities that at least one will suit you."* And every scientist has something interesting to share - technicians, professors and students alike

What does Science communication mean to you and why is it important?



It is evident that science plays a pivotal role in sustainable development. As years go by, the challenges people and this planet face are more complex. Since we are beneficiaries of the work(s) of science; its effective communication is paramount. However, I want to emphasize the need of a new era of science communication that is diverse, inclusive and open-minded; one that is more engaging. A shift from treating the public as recipients of scientific knowledge but rather as co-authors/co-creators. Looking at our current world and building a prosperous future, we all need this. Not only to advance science and improve scientific literacy but to have a society that safe guard's scientific integrity as we continue this scientific journey of exploring and evolving.

Stephanie Ajwan'g Okeyo
https://twitter.com/ajwangokeyo

The extent of global challenges are driving conflicts around the world to become increasingly embedded into societies. Nurturing creative collaborations between scientists, communities, artists and media professionals could help push back the tide of misinformation, encourage and facilitate public engagement with science, and allow us to reach out to new audiences.

Irem Couchouron
https://twitter.com/IremCouchouron

"Effective science communication can begin to address some of the stereotypes that surround science; not just who can be a scientist, but how it is constantly questioning and moving forward. SciComm unlocks inspiring stories about human endeavour that go beyond what we learnt in the classroom, that spark curiosity and wonder in us all."

Ivvet Modinou
https://twitter.com/IvvetM

Engagement with different stakeholders is a fundamental activity underpinning good research; in informing the research that we carry out, in sense-checking that the research being conducted and solutions being discovered are useful to society, and in gaining feedback on how effective the end results of this research are. Without it, there can be a growing disconnect between those that do research, and those that they are trying to help. Effective science communication can create a platform for this two-way dialogue, resulting in better-considered research that will hopefully benefit the widest range of people in the most impactful way.

Dr Suze Kundu
https://twitter.com/FunSizeSuze

Science communication is so important in today's society for many. It's often the seed for young budding scientists and reignites the excitement in science for the older generation who may have lost touch with their curious side. Everyone benefits from good science communication.

Kirsten Banks
https://twitter.com/AstroKirsten

“For anyone who wasn’t already on board with recognising the importance and value of accurate, timely, understandable information about complex scientific topics, the COVID-19 pandemic has made it inescapable. I think it’s fantastic that more and more researchers are understanding the importance of communicating effectively – not just to the public but to colleagues, peers, funding organisations, policymakers and more. But this isn’t as simple as it might seem and involves a skill set that needs practising over time, as well as a good eye for what makes a story. Done well, it can be a rewarding partnership between researchers and professional communicators – writers, podcasters, artists, animators and videographers, PR and social media experts… – seeking out the stories that really matter and telling them in a compelling way to help people understand and engage with their own life and the world around them in a deeper way.”

Dr Kat Arney is an award-winning science writer and broadcaster. She is the founder and Creative Director of First Create The Media - a communications strategy and content agency working with clients in the life sciences.

Dr Kat Arney
https://twitter.com/Kat_Arney

Scicomm is the bridge that links researchers and their science to the rest of the world. Science takes place in echo chambers and the only way to interact with and be empowered by that fascinating world, is via engagement. A public that is engaged with its science creates more future scientists with better ideas, greater discoveries, and a more symbiotic way of experiencing life. Communication indicates a two-way street; a dialogue. Which means then, room for feedback, intriguing questions, and energised discussions, which is vital to mature into a better informed, more engaged society.

Mahinn Ali Khan
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https://falling-walls.com/engage/finalists/science-and-the-city/

The world is facing some huge challenges*, Science & Technology offer the best solutions, but we can't improve anything unless we communicate those well, invite and empower our audience to join in the conversations, regain trust in experts and evidence, and inspire and celebrate the next generation of scientists and engineers.

(*from the challenges of COVID to food & water insecurity, continued climate change, and decreasing vaccination rates, to the increasing rise of misinformation and 'fake news' around scientific stories and ideas)

Greg Foot
https://twitter.com/gregfoot
https://www.youtube.com/user/gregfoot08

It's important to communicate science because that's the first step towards sharing it. The processes, mistakes and wonders of the way we have done and still do science lie behind so much of our world, and it's wrong to exclude people from that because they haven't had the opportunity to learn the "language." Science is a story that is still being written– everyone can pick up the pen.

Helen Craig
https://twitter.com/helenfcraig
https://twitter.com/UCLEngage

To master the challenges that lie ahead for our planet and ourselves, we will need to collectively adopt a science mindset that is deeply interwoven with all aspects of society and popular culture. We need to move towards a global paradigm shift to fact-based decision making on all levels, from personal to political. In my view, a world-spanning effort to boost science engagement is key to achieving this ambitious next level – a new enlightenment that will allow us to exist within our planetary boundaries.

Felix Rundel
Executive Director at the Falling Walls Foundation
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As citizens and voters, we are called on more and more to have opinions on scientific and technological matters, on topics ranging from Climate Change, Genetically Modified Organisms, Nanotechnology, and Vaccines. There are many voices vying for the public's attention, and it can be challenging to distinguish the technically sound from those that merely sound technical.Outreach efforts by scientists can play an important role. Scientists, of course, do not have all the answers, but they can help in posing the right questions.

Jim Kakalios
https://twitter.com/JimKakalios

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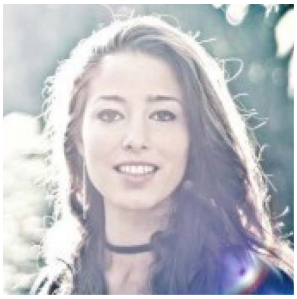

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