



Still Curious: When Science Meets the Public

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Abstract

Humans are born curious, and that curiosity fuels our growth and development. For scientists and engineers that curiosity remains a way of life. Thus, curiosity is the bridge that can support interactions between scientists and the many non-scientist publics. But the relationship between science and society requires understanding of and attention to the needs of many different public audiences who support the enterprise as well as commitment and skills in reinforcing those relationships. The American Association for the Advancement of Science (AAAS) has been committed to supporting these interactions since its founding. The challenges of delivering on that commitment change over time with changing circumstances, societal values, and norms; so too has the organization evolved to meet these challenges. The lessons learned are instructive for the larger science community.

1 Science-Society Interactions

What happens “When Science Meets the Public?” I have reflected on this theme in writings and presentations multiple times over the past 30 years. This reflection has been stimulated in part by the organizational arrangement of my position at the American Association for the Advancement of Science (AAAS) whose education, diversity, and public engagement programs I headed for decades. The advisory committee that focused on science and society became a component aspect of the unit for which I had responsibility. In part, the reflection was also related to concerns about the many “marginalized” communities of color such as the one in which I was

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born and raised—a segregated community in Alabama that had not been a target for science engagement.

I find some irony in the fact that world events in science finally touched children even in the segregated schools of Birmingham. I came to science because of one of the most visible moments in the history of science and technology—the successful launch of Sputnik in 1957 by the then Soviet Union, and the United States’ response to being “scooped” by a social, political, and ideological rival country. News headlines and television programs about the satellite and the “Space Race” and attention to science and mathematics education in schools over the following years led many of us to careers in science and engineering, though we were probably considered unlikely “recruits.”

These experiences convinced me that there were opportunities for engagement with communities everywhere, beyond those whose members formed the mainstream of science representation and attention. But, for the most part, these opportunities had not been pursued, even when science reached into all of our lives and communities. There have always been (and still are) many science-interested audiences with whom we might engage. The story of science meeting the public is all too often a story of missed (or neglected) opportunities.

Since many people encounter science through technology or because of changing societal or environmental circumstances, my presentations over the decades have always been different as the times, the needs and the contexts have changed. The strategy for effective engagement with science has been (and continues to be) helping people see the connections to their personal, social, political, and economic lives, meeting different public audiences on their own terms, as recent events have clearly demonstrated.

2 Spotlight on a Pandemic

One of the more recent opportunities for engagement occurred in early 2020. As a novel coronavirus made its way across the globe, the word “pandemic” entered our lexicon. In 2020, both *Merriam-Webster* and *Dictionary.com* declared “pandemic” as the word of the year. *Merriam-Webster* noted that on March 11 when the World Health Organization (WHO) officially declared COVID-19 a “pandemic,” searches for the word spiked 115,806% compared with the same day in the previous year. Clearly that term and associated terms (as well as the opportunity to explain the science) were top of mind for public audiences [1]. As the pandemic wore on the challenges of getting the science right and getting the public health messaging right were of paramount importance. The science community achieved the first goal and stumbled badly on the second. But the other issue that was being confronted was the pervasiveness of disinformation such as that conveyed on social media. In the USA, all of these communications challenges were happening within a backdrop of politics and political messaging. The greatest danger emerged as the politics threw the announcement of the development of a vaccine effective with SARS-CoV-2 into a chaotic mix. What and whom to believe?

The earlier concerns I had when first confronting the idea of public engagement with science were all played out: the need to understand that there are many publics who needed appropriate messages; seeing that those publics likely needed different messengers and media strategies as well; developing partnerships with and enlisting and amplifying the voices of trusted messengers as many leading scientists and political leaders didn't know how to talk about the pandemic or vaccines and just added to the confusion. The science and public health messages were also caught in the "swirl" of political and social media messaging. How does one disentangle these as the death toll from COVID-19 continued to rise? And in the USA, how does one deal with health disparities that were laid bare, showing greater impacts on persons from minoritized communities?

The pandemic and the world's response to it underscored how woefully unprepared the science community was when facing a public in need of straight talk from trusted voices. Would that the science community have started "trust-building" efforts sooner. Would that the science community have conveyed not only the facts as they emerged but also information about how science works.

3 What Scientists Get Wrong About Science-Public Interactions

My interest in scientist-public interactions as an object of research dates back to that AAAS committee and the proceedings of a 1991 workshop they had held that bore the title, *When Science Meets the Public* [2]. The volume was largely complete when I was asked to add some thoughts. I had previously shared some thoughts verbally with the committee based on more than a decade of experiences focused on sharing science with persons from marginalized communities, especially communities of color. As I read the manuscript, I saw the need to "unpack" the idea of who those public audiences might include and how they might be engaged.

Too often the challenge of engagement as seen from the lenses of those from the science community emerges from assumptions about different publics that are not borne out by experience or which do not hold up under scrutiny. Concerns about funding levels for science and support for research have often prompted many of these conversations. In a 1997 interview, physicist Neal Lane, then director of the US National Science Foundation (and later science advisor to President Clinton and head of the White House Office of Science and Technology Policy) spoke of the "reservoir of public goodwill" that science enjoyed across the public. Surveys supported by the foundation indicated that over 40 percent of the public indicated strong interest in science and technology, but he continued, "...only one in 10 surveyed believes that he or she is well informed about science and technology, and only one in four has some knowledge of science. And the vast majority of people have no understanding of the scientific process--98 percent of them don't know what research means. To me this gap is very troubling: two thirds laud the value of science, but very few understand the enterprise."

Lane emphasized the importance of genuine dialogue with public audiences as an aspect of scientists' professional responsibility. He noted, "The climate for science has changed forever. While it is necessary to increase public understanding of science and technology, it is equally important for scientists to deepen their understanding of the public" (Interview with Neal F. Lane—*Scientific American* [3]).

Surveys of public and science audiences conducted by the Pew Research Center and published in 2015 showed incredible agreement on the part of both these groups as to the importance of science in the society and the economy and the need for broad support of science. But there were strong differences of opinion between these populations on a number of science-related issues (e.g., the relationship between climate change and human activity, requirements for vaccines), indicating that they are seeing these issues through very different lenses [4].

Results from Pew Research Center studies published in 2020 continued to show strong support for science, but with some science-related issues, differences based on education, family income and party affiliation emerged. While most people see positive net benefits of science, the degree of agreement differed by race as well as by science knowledge, with Blacks and Hispanics showing lower levels of enthusiasm, along with persons with less science knowledge [5].

Scientists are, for the most part, viewed favorably by different publics, especially when compared with other sectors of society (e.g., political leaders, journalists). But too often these publics are not viewed positively by scientists who approach engagement with many non-scientist audiences from deficit models.

Outside of the school or college classroom or lab, when most people encounter the ideas of science, they are often bound around or embedded in technology. While those inside the science community make a big deal of saying this is not the same as science, most "regular" people don't distinguish between these two. Occasionally people will be put into a position of having to deal with science directly, such as if placed in the circumstances that arise where they might be considering DNA evidence (not just in a trial, but, e.g., when they are looking at genealogy) or when exploring specific treatment options for a health condition. But much of the time science is just part of the background noise of our lives until something happens. There may be a "blip" in attention for stunning pictures of a black hole, return pictures from a space mission, a volcanic eruption, a severe weather event, or the outbreak of a pandemic. But otherwise, no.

A focus of the AAAS committee's discussions had been largely on the communication of science and the places where people encounter it—the media of engagement. Unfortunately, while noting audience differences and needs, we still see a focus on facts and media rather than experiences and dialogue. That focus too often disrespects the audiences and the curiosity and knowledge they can bring. We must reshape the who, how, when, where, and why science meets the public. And on whose terms do these encounters occur.

4 Exploring One's World

Every human's relationship with science begins with incredible promise—curiosity and exploration as a fundamental human trait. That idea is reflected in the title of one of my favorite books, *The Scientist in the Crib* [6]. The book explores cognitive development and focuses on early learning by pointing out the ways in which infants and children explore and learn about themselves and their environments as they engage with “everyday physics,” “everyday biology,” and “everyday psychology.” And if we are really lucky to be born into the “right” family and in the “right” country and at the “right” time, that good early start can be maintained! A FaceTime call from one of my daughters was made on behalf of our three-year-old grandson who wanted to know “how do magnets work.” Walking through the house he can explore where magnets “stick” and where they do not. He does not yet want or need a deep scientific explanation of dipoles. So, the content is only part of the story; the other part is the audience, the context, and the opportunity for and experience of exploring [7].

With such promising beginnings—curiosity as a foundation to science engagement—what can be done to encourage and support that? How do we enhance science's interactions and engagement with the larger society and society's interactions and engagement with science? Not only are humans curious; so too are many animals. My own research related to imprinting in birds and showed how, over time after hatching, those birds move beyond the mother to explore and learn the larger environment as they grow and develop.

Gopnik et al. [6] argue in their book that scientists provide an example of a group that maintains that curiosity that human babies display as they grow and develop. Science helps us make sense of the things around us, and scientists are not just seekers but also have opportunities to be guides.

5 AAAS and the Challenge of Public Science Literacy

There is a rich history to the AAAS role in public science literacy, one that threads through the stories of the Association and its journals, ever seeking new and better ways to support connections among science and people.

AAAS was established as a professional society in 1848 around some central ideas: to be a forum of science across disciplines and to support democratic principles by advancing knowledge and connecting science to people. At the time of its founding there was strong interest in science among the educated public. This was driven in part by the westward expansion of the United States. The history of the Association that was published for the organization's sesquicentennial in 1998, *The Establishment of Science in America: 150 Years of the American Association for the Advancement of Science*, [8] records some of this history, including public response to science during those early years. It should be noted that this response was largely that of the educated non-scientist public whose enthusiasm for science led them to attendance at lecture halls and purchase of periodicals, pamphlets, and texts. Science

was an aspect of “culture,” and it attracted that small but fervent audience. Small colleges that sprang up expanded their curricula to include science, including women’s colleges such as Mt. Holyoke and Vassar. As the Annual Meeting of the organization moved each year from town to town, it attracted not only the scientists but also the community elite who enjoyed scientific talks as well as the interaction with scientist attendees [9].

Science and the association were affected by the larger socio-political forces in the communities and in the nation. Just as education in the 1850s and 1860s was not accessible to all, based on economic status, class, race, and gender, neither was access to the formal study of science available to all. AAAS, unlike some other societies, never restricted participation, for example, by women, but women’s lack of greater access to science due to restricted educational and career opportunity meant that they were less prominent in the life of the organization for the first 120 years of its history. The significant population of Black Americans who were enslaved in the country did not have access to any education. But stories suggest a strong interest in and use of local science knowledge such as in navigation (e.g., the Underground Railroad used by enslaved people to escape to the North and into Canada) and invention. After emancipation many historically Black colleges were established for the education of Blacks. Though most provided education starting at a very basic level, the curricula eventually moved beyond applied areas such as agriculture and mechanics to include study of the basic sciences. Howard University, for example, became the home of basic researchers such as developmental biologist, Ernest Everett Just. While they had received doctorates from white research universities, they were not hired by any of them. And while some free Blacks had access to formal education, even before emancipation, they were unable to pursue careers in science also because of lack of employment opportunities. Edward Bouchet was the first African American to earn a Ph.D. from any American university, completing his doctorate in physics from Yale University in 1876. But his employment prospects were quite different from the White graduates in his class.

So which scientists and which publics were able to engage with an organization like AAAS was based, not only on the willingness and openness of the association, but also on the socio-historical context of the times. As it weathered the period before, during, and after the Civil War, the organization tried to do so in a way that welcomed all, a real challenge of “science diplomacy!” Some socio-political events were just too monumental to be navigated, however. AAAS did not hold Annual Meetings during the Civil War or during WWII. Negative encounters at the 1955 Annual Meeting in Atlanta with the reality of “Jim Crow” laws that enforced racial segregation led to a resolution not to meet in the segregated South—this, at a time when other professional societies continued the practice. Differences in perspectives and values related to interactions with society are reflected in these different choices—whether science is open to all or if societal or regional “norms” are allowed to trump openness in science.

The challenges for engagement during that time were significant:

- How does an organization maintain an open yet focused forum for scientists to exchange information about their research?
- How does it foster communication among disparate scientific disciplines and promote interdisciplinarity?
- How does it embody principles for democracy and popular access while advancing scientific knowledge that seemed increasingly esoteric to many people and where others did not have access or the background to understand its connection to their lives?

6 **Science: A New Tool to Support Engagement**

The journal *Science* was founded in 1880 by John Michels with support from Thomas Edison and later from Alexander Graham Bell. The journal was not formally connected to AAAS until 1900, but clearly this connection was good for both: expanding the journal's reach and enhancing the organization's ability to attract members and fulfill its mission: to advance science and support the exchange of research information across all fields of science. *Science*, editorially independent though published by AAAS, could also serve to amplify the stories of science discovery. Over the years as the journal matured and grew in prestige and circulation, it could also become a source for news of scientific discoveries that could reach non-scientists through the popular press and other media. As it enjoyed the stewardship of capable editors and publishers, it too evolved to address the needs of the time, for example, improvement of peer review processes; developing a strong news component; becoming a digital as well as a print product; expanding its titles to become the *Science* family of journals; adding digital media and other enhancements to support expanded audiences and different preferences for engagement and more.

Science is a "big megaphone," and editors, publishers, and leaders have used this voice over the years to speak to concerns about and needs of the science enterprise, including the need for openness and inclusion in science.

7 **Science Meets the Public: Imagining a Perfect World**

While we can outline the deficiencies of today's current environment for science interactions with our many publics, it is important as well to articulate and work toward establishing the conditions in which these interactions can thrive.

What might be considered "heaven" in terms of promoting the interaction between science and its many publics?

Such a goal might include conditions where:

- *The curiosity that children are born with is encouraged and strengthened over time.* This means that within the home and larger community, there are opportunities to promote curiosity as a natural part of healthy growth, development, and learning.

- *Science is an everyday part of people's lives (like sports and music).* Science has become a part of the larger social and cultural landscape of people's lives, not a compartmentalized section reserved for experts and elites. In some ways, weather forecasting and reporting have already reached this level of acceptance and integration into people's lives.
- *Children have rich instruction in science throughout their formal schooling and often engage (along with their families) in science activities informally.* Science experiences are available from the earliest point of formal education, including pre-school, and quality education in science includes both school and out of school experiences in community places of science. This also assumes having schools available to all where science is valued and taught well by highly qualified teachers in ways that support learning by all and cultural connection for all.
- *There are many opportunities to engage with science at all stages of life.* Completion of formal education is not the end of opportunities for engagement. While there are books, online videos, articles, museums, science centers, and more, engagement is a two-way street. Science is accessible in ways that you can find it, and it can find you through the everyday activities in which you participate.
- *Scientists are active partners with members of the public and comfortable interacting with them.* There are no barriers between scientists and public audiences. There is comfort and pride to be found in these interactions. Scientists are appreciated and recognized for this work as an aspect of fulfilling their professional and civic responsibilities.
- *Scientists are visible members of communities as citizens and as scientists.* Scientists are seen in their roles as citizens such as when they use their knowledge in support of evidence-based decision-making, serve in advisory roles where their knowledge and perspectives can add value, or participate as elected or appointed officials, office seekers, and office holders.
- *Science is broadly representative—with talent that includes all demographics; not just the domain of the well-off (accessible and egalitarian) or of those who have historically participated.* The science and engineering communities look a lot like the communities around them and actively engage with and build trust with those communities, bringing scientific and technical knowledge to help address the challenges of those communities. Their lived experiences and personal identities inform their work, and they add value to the work and support excellence in the enterprise.
- *Science is well supported as a public investment, and people are fully engaged with and curious about the science, the enterprise, and its impact.* Research and development continue to be supported as a public investment because people see the contributions that science and technology make to them as individuals, as communities, to countries and to the health of the planet. They support the investment because they are strongly vested in the payoff.
- *Scientists are respected in the roles they play in the larger society—from working to understand the way the world works, to addressing problems that emerge.*

While there is currently strong support for scientists and the work they do, these views expand to communities that have been less supportive because of the increasing diversity of the science community, improved engagement with these publics, greater openness and transparency about the science, and willingness to discuss and resolve historical barriers across these communities.

- *People consume scientific knowledge and ideas and understand and value the role of science in their lives.* There is strong demand for science, and members of the public seek to determine the attitudes toward and positions related to support of science by those seeking public office.
- *People use scientific findings and scientific ways of thinking to help them make personal decisions.* There is demand for scientific information around issues such as vaccine uptake; and where questions remain, people actively seek science-based explanations rather than mindlessly embracing misinformation/disinformation found on social media.
- *People can contribute to science (citizen science).* People are actively invited to assist in the work that scientists do, such as in data collection. And because of increased trust and appropriate engagement, people are willing to participate in clinical trials and to become partners in the research enterprise.
- *People are attracted to and interested in studying science and engineering and following scientific and technical progress much as they do sports.* As with those who anxiously followed the pace of testing during clinical trials of COVID vaccines and those who follow release of stunning pictures from the recently launched Space Telescope, people are excited to see science advances and to learn about the processes and people behind them.
- *The public endorses and policymakers seek science informed-solutions to policy challenges.* While acutely aware that science cannot be the only consideration when developing policies, there is increasing expectation that it should inform those policy decisions.

While my list may not mirror that of the reader, I have tried to offer a vision of what I consider important goals to discuss. I urge anyone interested in the challenges of science-society interactions to devote some time thinking about what you might want those interactions to be and to accomplish.

8 Science Meets the Public: Facing the Realities

The biggest problem with my list is that it does *not* reflect real-world findings.

- Science is NOT universally encouraged for and taught to young children, in spite of the role of S&T in our world and the natural curiosity that children display.
- While some children have access to rich instruction in science in their schooling, most do not. Often disparities are related to budgets for education; other times these might be related to the educational and income levels of families. In other cases, they relate to cultural expectations of who can and cannot do science.

Historic barriers still exist for girls and women and for those from countries' minoritized populations.

- Scientists are not necessarily active partners with their communities nor comfortable interacting with them. And science is often poorly communicated, even when it is a matter of life and death. Communication and engagement strategies are not generally included in the education and training that scientists receive; and too often, those who undertake these efforts are marginalized among their peers.
- The demographics of the science communities are not especially reflective of the communities in which they live or the publics that support their work.
- And increasingly there is an erosion of trust in science and scientists overall, but more by marginalized communities than by others.
- Publics are increasingly distanced from science and from those who create it.
- Too often science does not factor into either personal or public policy decision-making.

We have all too many recent examples of these failures of the science-public connection.

These challenges have not just developed. They have been around for a very long time. Perhaps the gravity of the pandemic made them more visible and made it more urgent that we address them.

So given all of this, what do we DO?

9 Advancing Science, Serving Society

An organization such as AAAS can only remain vibrant for 175 years if it continues to consider its relevance and re-set its role within the scientific enterprise. AAAS has undergone such discussions and actions over the years, often in response to challenges emerging in the larger society. For example, the movement for civil rights, women's rights, and social justice led to a major re-set in the early 1970s as the Association established advisory structures and programs in support of diversity, equity, and inclusion which have been prominent in the organization for some 50 years. Also, the need for greater input for science within policymaking structures led to the establishment of the AAAS Science and Technology Policy Fellowship Program, again 50 years ago. *Science* expanded its engagement with media to amplify its reach to more public audiences.

But even with these key programs in place, circumstances within the larger society can create new or renewed urgency for action, such as the disruption caused by the pandemic, the murder of George Floyd, and the stark realization of societal inequities revealed in the population disparities of who contracted COVID-19, who died from COVID-19, and who did and did not have access to quality care and to vaccines. A hard look within the research enterprise revealed differential funding, where Black biomedical scientists were less likely to receive support for their research, especially where this research was focused on understanding disparities in their own communities, leaving dangerous knowledge lacuna. How could we

claim research excellence in our work when diverse perspectives and diverse voices were not being included?

This was the backdrop for an AAAS governance modernization process begun over 2 years ago. It represented the first time in over 70 years that the organization had considered its structure and processes to align them to the needs and issues of today, such as the increased role of interdisciplinarity and need for responsiveness and nimbleness in addressing current and future science-related challenges. The mission of AAAS remained the same: advance science, engineering, and innovation throughout the world for the benefit of all. But, in re-visiting our place in the scientific enterprise AAAS had also to consider the strategic goals that would take the organization into the future. It emerged with these:

- *Advance scientific excellence and achievement*
AAAS recognizes, inspires, and enables a robust research ecosystem that drives discovery and innovation and prepares future scientists and engineers.
- *Foster equity and inclusion for scientific excellence*
AAAS fosters the diverse, equitable, open, and inclusive scientific enterprise that is essential for scientific excellence.
- *Build trust among scientists and communities*
AAAS builds trust among scientists and engineers and broader communities and is a valued source of accurate scientific information that is foundational to countering misinformation.
- *Catalyze progress where science meets policy*
AAAS provides actionable evidence for public policy that serves society and promotes policies that enable quality science.

The organization arrived at these goals through broad consultation and discussions that incorporated diverse member voices, guided by diversity in board and staff leadership. It is critical to note the alignment of these strategic goals with the concerns of and need to repair structural weaknesses in current science-society interactions [10].

10 Programming to Support Strategic Goals

While it is important to have goals, it is equally important to align goals and actions, to measure impact and effectiveness, and to hold ourselves accountable for meeting the goals. A few recent and historical examples are relevant here:

- In response to the pandemic, *Science* committed itself to publishing the best research and to making that research freely available to all as quickly as possible. Review and editorial processes were accelerated to achieve that.
- The news presented through *Science* was amplified to help counter misinformation.

- SciLine identified a diverse group of scientists who made themselves available to speak with reporters who were not specifically trained in or responsible for covering science.
- Established in 1975 the AAAS Mass Media Science and Engineering Fellows has offered 10-week summer media internships to some 800 advanced science, engineering, and medical students and postdoctoral scholars. While not designed to promote career transition to science journalism, the program has played that role for many and enriched the pool of skilled science and technology communicators among journalists and scientists.
- Awards have been effective tools to give more visibility to policymakers to the importance and impact of basic research (Golden Goose Award championed by Representative Jim Cooper); they also recognize the work and value to the science enterprise of active scientists and engineers who carry out excellent work in engaging with public audiences (AAAS Mani L. Bhaumik Award for Public Engagement with Science and AAAS Early Career Award for Public Engagement with Science).

Over the years, AAAS programs have reached out specifically and served to engage Members of Congress, agencies and departments of government (AAAS Science and Technology Policy Fellows); clergy (Dialogue on Science, Ethics and Religion); members of minoritized communities, especially through organizations based in communities (Black Churches, Historically Black Colleges and Universities, community-based organizations); youth-serving groups and much more.

11 “Advance Science, Engineering, and Innovation Throughout the World for the Benefit of All.”

In the USA and indeed in many of the countries of the globe, the challenge is not just about doing excellent science; it is also about whether the science that gets done is accessible to all, so that they can both use science knowledge and contribute to science knowledge.

A final story highlights the need for diverse inputs into the science and the need also to engage with diverse communities in respectful ways. The AAAS Early Career Award for Public Engagement with Science was established in 2010, to recognize early-career scientists and engineers who demonstrate excellence in their contribution to public engagement with science activities. In 2022 the awardee was Dr. Kizzmekia Corbett who was honored for her engagement about SARS-CoV-2 vaccinations and for her particular focus on underserved, higher-risk Black communities. She has been described as a model for how scientists, whose research touches upon important and timely social issues, can engage the public in effective and impactful ways. As a postdoctoral researcher at the National Institutes of Health, Dr. Corbett was instrumental in developing the lifesaving Moderna mRNA vaccine

against SARS-CoV-2, the infection that leads to COVID-19. She also played a central role in the effort to address vaccine inquisitiveness in communities of color.

In a nationally televised Town Hall meeting during the pandemic, Kizzy Corbett engaged with a young African American man who had not yet been vaccinated. Her interactions with him were respectful and non-judgmental. She re-defined the descriptive terminology that was being used for persons like him—from “vaccine hesitant” to “vaccine questioning.” And she was prepared to engage with him until all of his questions were answered. It was later revealed that she met him and his mother at the pharmacy where they received their vaccines. It is likely that this was not all about questions asked and answered, but also about building trust, where scientists, who are members of affected populations, are very visible, are willing to engage on the terms of the audiences, and open to being transparent. These are scientists who are open to accepting and responding to people who are *curious*.

United in our shared curiosity about ourselves and our world, there is an opportunity to support positive interactions between science and society.

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