CHAPTER

19 Science Communication at Scientific Institutions

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Abstract

This chapter presents communication perspectives on two reputable science institutions in the United States, each with historic and modern roles in shaping the enterprise of science, as well as practice in communicating science: the American Association for the Advancement of Science and the National Academies of Sciences, Engineering, and Medicine. The discussion includes an overview of how these institutions synthesize and communicate scientific knowledge and an examination of their efforts not only to convey scientific information to the broader public but also to serve as a respected voice for the scientific community. It reveals tensions that occur when institutions dedicated to the advancement of science interface with the complex world of public perception and public policy. The chapter concludes by advocating for better connecting the theory and practice of science communication and calls for encouraging increased interaction and collaboration between science communication researchers and practitioners.

Key Words: science communication, public perception, public policy, science communication researchers, public policy, synthesizing scientific knowledge, American Association for the Advancement of Science, National Academies of Sciences, Engineering, and Medicine

In the midst of the 2014 Ebola outbreak in West Africa, media sources in the United States reported concerns about medical personnel exposure to the infectious disease. On October 24, 2014, Dr. Anthony Fauci, head of the National Institute for Allergies and Infectious Disease, addressed journalists gathered for a press conference at the National Institute of Health (NIH) headquarters in Bethesda, Maryland. A respected infectious disease scientist, experienced spokesperson, and compelling communicator, he announced the successful treatment and discharge from NIH of a nurse who had been infected with Ebola while treating a patient at a Texas hospital.

During subsequent questioning by journalists at the press conference, Fauci struggled to communicate to different stakeholders seeking different information. On one end of the spectrum were those who needed the most current and most scientifically defensible perspective on the risk of Ebola for healthcare providers, first responders, and public health officials. On the other were reporters with an interest in the narrative aspects of the nurse's story and the potential risks to the public of Ebola in the United States. The episode crystallizes a conundrum in science communication: How can scientific community leaders effectively both communicate clear public health (or science) messages, for instance to the public, and also deliver research-based messages, for instance to relevant researchers and healthcare providers?

Fauci said,

> It's important to point out: You must separate the issue of risk to the general public from the risk to brave people like [this nurse] and her colleagues. They are two different things. . . . I think it's important for people to understand that there's the public health issue and there's the scientific issue of

understanding what's going on. And that's essentially what we do here. Primarily, it's the care of the patient first. But together with that is to learn information that might help others . . . who are taking care of patients.[1]

The attempt to inform journalists ("you must separate the issue") illustrates significant challenges facing science-based organizations, particularly when communicating complex and potentially controversial science to various publics. Effective communication of issues that includes scientific information to multiple audiences and with diverse goals presents challenges that are not unique to federal agencies such as the NIH, the National Science Foundation, the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, or the Environmental Protection Agency; rather, these are shared challenges for many scientific institutions. Because modern democracies that invest in scientific research and technological development are in need of practical ways to inform and involve citizens, this chapter poses questions that include the following: How does science-based communication best reach public audiences and potential stakeholders? What are the opportunities and limitations of science communication to facilitate interaction and decision-making on the science-society issues of the day? How can scientific organizations work to advance science and serve society in a diversified communication landscape?

The Fauci example illustrates another salient challenge for science-based organizations: the need to represent science accurately while communicating it in such a way that various lay or nonexpert audiences will grasp the intended meaning. The former is important since federal agencies and science-based organizations play a special role in speaking on behalf of science and its connections to societal issues. The latter is primarily concerned with representing scientific ideas in ways that nonscientists can understand and make relevant to their own lives.

This chapter presents communication perspectives on two reputable institutions in the United States, each with historic and modern roles in science communication: the American Association for the Advancement of Science (AAAS) and the National Academies of Sciences, Engineering, and Medicine (NASEM). The discussion includes an overview of how these institutions synthesize and communicate scientific knowledge and an examination of their efforts not only to convey scientific information to the broader public but also to serve as a respected voice for the scientific community. It concludes with recommendations for further research and calls for finding ways to encourage increased interaction and collaboration between science communication researchers and practitioners.

American Association for the Advancement of Science

Founded in 1848 during the emergence of a scientific community in the United States, AAAS is a nonprofit, nonpartisan membership organization based in Washington, DC. Its broad mission is to "advance science, engineering, and innovation throughout the world for the benefit of all people." AAAS has long been described and sees itself as a "voice for science" within the broader society, with mission-based efforts and impacts in communication, education, and policy.

AAAS has grown into an international organization with many functions, employing approximately 440 staff active in diverse yet interconnected and mission-based activities, including scientific publishing and science–society interaction in the United States and globally. Its audiences are varied—including, but not limited to, researchers, professionals, and educators in science, technology, engineering, and math (STEM) fields, policymakers and policy specialists, industry and religious community leaders, journalists and science communicators, and interested members of the public. Affiliated organizations of AAAS include 252 societies and academies of science with more than 10 million members, representing the world's largest federation of scientific and engineering societies. In 2015, approximately 70% of individual AAAS members held a PhD in science, technology, engineering, or mathematics or an advanced medical degree. From its founding, AAAS welcomed all members, regardless of scientific attainment. A historical perspective on AAAS states: "Inevitably, AAAS became a forum not only for presentation of new scientific knowledge but also for debate about how science should establish and maintain itself in American life" (Kohlstedt et al. 1999).

As a complex organization, AAAS follows a set of diverse goals. The current ones, adopted by its board of directors in 2007, include enhancing communication among scientists, engineers, and the public; promoting and defending the integrity of science and its use; strengthening support for the science and technology enterprise; providing a voice for science on societal issues; promoting the responsible use of science in public policy; strengthening and diversifying the science and technology workforce; fostering education in science and technology for everyone; increasing public engagement with science and technology; and advancing international cooperation in science. Clearly, AAAS is an organization working in the intersection of science and society.

A key mechanism for the organization's science communication is publication of cutting-edge science, accompanied by translation of peer-reviewed research and dissemination to key stakeholders. AAAS publishes the multidisciplinary journals *Science, Science Advances, Science Translational Medicine*, and *Science Signaling*. Two additional journals launched in 2016: *Science Robotics* and *Science Immunology*. Through news, editorials, perspectives, policy forums, and research publications and correspondence, these journals involve and serve scientists in a range of STEM disciplines, as well as policymakers and others interested in scientific information. The media outreach operation for the *Science* family of journals extends beyond these communities to journalists in the United States and around the world, as well as interested members of the public. Historically, the underlying model of science communication was linear and hierarchical: Publication in one of the most respected science journals provided saliency and urgency following peer review, and deliberate and sophisticated outreach to journalists and science communicators ensured that an interested and news-consuming public would stay abreast about newsworthy developments in science and implicitly about the value of scientific research itself.

This model of communication from the scientific community to a science-attentive public is being challenged by technological and social changes in the communication environment over the past decade, including increasing levels of public access to specialized content presented and/or consumed by audiences through sociopolitical filters (Storksdieck 2015). These recent developments have a profound effect on the distribution of information, including messages about science. The ongoing evolution of communication mechanisms in the digital age contributes to individual (or algorithmic) filtering of information; at the same time, content distribution and participation by "the audience" are diversifying (i.e., online social networks, cable and digital streaming, digital news and opinion). Many of the audiences that scientific institutions reach, either directly or through mediation by journalists and others, likely overlap; audiences are often motivated to find and embrace information that confirms their ideology, politics, or other group identity (Scheufele 2013). Under the growing significance of "filter bubbles" and "echo chambers," a scientist or scientific institution emitting a steady stream of research-based information on a website, or even a focused and targeted set of sophisticated communication tools, may not connect with an audience that will find, read, or engage with the information. At the same time, the relatively recent ability of consumers of information to share widely with others via online social media platforms exposes science communication to new audiences and might reinforce or even magnify participation.

In addition to direct media outreach for journal publications, AAAS has varied communication mechanisms and products to reach different audiences with targeted messages. Reflecting its mission, primary foci of AAAS programmatic and communication outreach include science policy, international diplomacy, and public engagement. Challenges include a diversity of goals that are at times competing and vary in priority across the scientific community and between the scientific community and public audiences. The need for multidirectional communication among scientists and with the broader public vastly increases as scientific inquiry and technological development move into areas that may confront social values, benefits, and risk—namely, climate change, gene editing, and artificial intelligence, to name a few (McCallie et al. 2009). Science communication is a featured component of the AAAS annual meeting, which includes a very active newsroom, public engagement activities, and peer-reviewed sessions highlighting recent research and practice.

With the founding of the AAAS Center for Public Engagement with Science and Technology in 2004, engagement between the public and the US scientific community was prioritized by Alan I. Leshner, CEO emeritus and former executive publisher of *Science*. Announcing the initiative in a *Science* editorial, Leshner (2003) wrote,

> We need to move beyond what too often has been seen as a paternalistic stance. We need to engage the public in a more open and honest bidirectional dialogue about science and technology and their products, including not only their benefits but also their limits, perils, and pitfalls. We need to respect the public's perspective and concerns even when we do not fully share them, and we need to develop a partnership that can respond to them.

The AAAS Center for Public Engagement employs mechanisms to convene, connect, and encourage collaboration among science communication and public engagement researchers, practitioners, and scientists actively engaging with public audiences. It also facilitates Communicating Science workshops, a skills-development program that trains scientists in communication practice. In late 2015, the Center announced its first Public Engagement Fellows of the Leshner Leadership Institute, providing leadership development, training, networking, planning, and evaluation of public engagement for fifteen fellows, with a stated goal to implement positive change within institutions, not just for their individual practice. Each year, a cohort focuses on a topic of societal relevance connected to fellows' individual areas of research, evaluates the success of their efforts in public engagement, and builds capacity in their home institutions and disciplinary fields. The underlying model for improving scientist involvement in public engagement is one of individual actors influencing a growing network, reinforced by empirical evidence and reputation. An in-process evaluation of the fellows program will determine whether this model has traction as a means to spread successful public engagement methods through in-person and online connections within a growing network.

In recent years, the Center for Public Engagement has worked with science communication researchers and the Pew Research Center, a nonpartisan public opinion think-tank, to better understand AAAS member attitudes about and activities in public engagement (Pew Reseach Center 2015). The resulting data, and that from others (Wellcome Trust 2015), make clear that scientist attitudes can be similar or diverge from those of the public on science-society issues (Besley and Nisbet 2011) and also begin to answer questions such as: What are the qualities of issues that are (or may become) publicly contentious? As scientific advances become ever more intertwined with ethical, legal, and social issues, can scientists and the scientific enterprise better anticipate areas of public concern, develop proactive ways to involve public stakeholders, and utilize information from the public to democratize research and development? Moreover, are scientists willing to engage in this discourse, and for what purpose? The results of these investigations will provide much-needed empirical evidence for framing science engagement for scientists themselves (Besley, Dudo, and Storksdieck 2015).

As a result of growing research and best practices in effective science communication (Davis 2008), AAAS is beginning to more closely define and evaluate its own communication activities beyond traditional measures such as media metrics and web analytics. The organization has struggled with the challenges of audience(s) and how they are reached or influenced by AAAS: it aims to represent, inform, and engage with the broad scientific community, while at the same time informing and engaging audiences beyond the science community. Recognizing divergent goals, messages, and mechanisms provides the foundation for effective ways to reach more targeted audiences. While important for practical application within science communication and public engagement, addressing this type of complexity makes it difficult to study and evaluate success in a complicated communications environment.

More broadly, AAAS regularly convenes discussion on ways to evaluate science communication for institutions, groups, and individuals—including AAAS and the scientists with whom it works. Traditional habits and behaviors die hard, and there is still much to be done in educating (or, more appropriately, engaging with) scientists, communication professionals, and institutions in how to interpret, use, and further inform the field of science communication. At the same time, scholars of science communication and public engagement would benefit from practical applications (and empirical testing) of their theoretical work. AAAS is actively seeding research–practice connections through its Center for Public Engagement; challenges include sustained funding and institutional infrastructures that may not adequately recognize the needs and long-term value of such collaborations.

The National Academies of Sciences, Engineering and Medicine

Founded by an act of Congress on March 3, 1863, and signed into existence by President Lincoln the very same day through a congressional charter, the original mission of the (then) National Academy of Sciences (NAS) was to "whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art." The forming of the NAS during the Civil War represented a recognition not only that science and technology (which is what was referred to by the term "art") played a significant role in society but also that the federal government did not have the independent expertise to fully benefit from them. Again during wartime, in 1916 the NAS was further expanded with the establishment of the National Research Council (NRC) at the request of President Wilson to ensure access to the broader field of science (the NAS membership at the time stood at just around 150) and to provide a backbone of professional staff that would help volunteer scientists in their effort to advise the federal government. The expanding role of science, technology, engineering, and medicine in society finally led to a differentiation within the NAS through the founding of the National Academy of Engineering (NAE) in 1964 and the Institute of Medicine (IOM) in 1970, all under the authority of the original charter. The four institutions (NAS, NRC, NAE, and IOM) were united as the umbrella organization National Academies of Sciences, Engineering and Medicine (NASEM) in 2015, albeit with three relatively independent academies of sciences, engineering, and medicine, each with its own president and separate membership.

Initially founded as a relatively small organization of fifty scientists, the membership of NAS, NAE, and the newly renamed National Academy of Medicine has grown to a combined 5,700. In contrast to the AAAS, membership is restricted to a body of highly accomplished professionals who are nominated and elected from within the current membership, using internal criteria that stress research accomplishments and standing in the respective fields. The result of this process is a membership structure that is not representative of the individual fields overall. At the same time, its traditional norms on what constitutes an elite scientist systematically exclude entire areas of research (such as the learning sciences or education research) and some individuals of scientific accomplishment and stature who have translated scientific findings for the larger public. Famously, Carl Sagan was never inducted into the NAS, even though he was bestowed in 1994 with the NAS's most prestigious award, the Public Welfare Medal, for his significant contributions to the broader impact of science through effective science communication. In 2015, the same honor was given to Neil deGrasse Tyson, an astrophysicist who leads the Hayden Planetarium of the American Museum of Natural History in New York and who is arguably the most featured public intellectual of science today. Given his publication record, though, deGrasse Tyson is not likely to be elected into the membership ranks of the NAS.

This narrow focus on research excellence and scientific reputation serves one part of NASEM's core mission well: synthesizing what is currently known from research about a scientific subject, what is not known so far, what knowledge is still somewhat tentative, and concluding from the current state of knowledge what additional research is needed to close knowledge gaps or inform decision-makers. Arguably, NASEM's process that evolved over time to address these questions is highly sophisticated and designed to minimize bias and errors, leading to reports that are independent from outside influence (beyond the original framing in negotiation with the sponsor[s] of the study) and objective in their findings and conclusions (given the limitations of the study process).

The flagship "product" of NASEM is a consensus study. No matter the subject, all consensus studies go through a predetermined process:

- The study must be defined in collaboration with a sponsor or set of sponsors, ending in a clear "statement of task" for the committee that will later conduct the study.
- The statement of task, a work plan, and budget must then be approved by the institution's governing board. Review at this stage can lead to changes or even rejection of a study.
- Once a study is approved, the program unit of NASEM responsible for it establishes a committee that has the appropriate expertise for the task and has balanced perspectives and life experiences, is screened for conflicts of interest, and includes members of three academies. Oftentimes, a committee of twelve requires the screening of hundreds of experts and a careful selection to ensure that the committee's composition provides no or little reason to reject the findings and recommendations based on perceived or actual bias.
- The committee roster is subsequently reviewed and approved by the president of NAS, a (still) provisional roster published on NASEM's website for public comment, and finally officially approved after conflict of interest discussions.
- The committee then begins its task of fact-finding and synthesis in order to address the statement of task. Deliberations are closed to the public to ensure frank and open debate and to protect committee members from potential outside influence; nonetheless, committees tend to conduct public meetings and workshops during which additional experts discuss the state of research.
- Based on public discussions, syntheses of existing research and other evidence, and internal deliberations, the committee drafts a consensus

report (all members of the committee agree on the report and count as its authors).

• This draft report is then reviewed for its objectivity, its adherence to the statement of task, its rigor in basing findings and conclusions on stated evidence, and the defensibleness of its recommendations by a comparably sized group of expert reviewers that shadows the committee but is often chosen to represent potentially different viewpoints. The review process is overseen by an independent unit of NASEM, and all reviewer comments must be addressed to the satisfaction of two review leads who are independently appointed.

• Only after passing of review can a consensus report be released to the sponsor, relevant entities of the federal government, and the public. To ensure maximum transparency, all reviewers' names are made public in the final version of the report.

While far from perfect in preventing bias or avoiding error, this process of scientific review is unparalleled in its careful effort to create objective and neutral research syntheses. It works best when it stays within the bounds of science, engineering, or medicine itself but is challenged when topics of broader societal concern are addressed that require a careful weighing of factors that lie outside the purview of science, including norms and values, or considerations of fairness and equity. In general, statements of task are written to limit a committee to areas that can be addressed with evidence from research, but that might not always be the case. Overall, however, academies' consensus reports shy away from advocating or demanding particular action; instead, the reports make recommendations that are based on explicit findings or well-supported conclusions.

Another problem can occur when committee reports speak to an audience outside of science, engineering, or medicine, for instance, decision-makers who need to weigh scientific aspects against others (e.g., economic considerations) or communities that need guidance but may not have cultures and institutional structures that make it easy to appreciate and incorporate a scientific perspective. However, the study process that creates consensus reports is not necessarily designed to create broader societal "buy-in" for its findings and recommendations, which can limit a report's potential impact. From the perspective of the study process, the end point is the report rather than the action that a report is meant to trigger. In the language of logic models, the study process ends with an output, which leaves poorly addressed many steps that would help turn the output into outcomes and impact.

The multistep process that led to the creation of the Next Generation Science Standards in the United States is illustrative. The NAS started this process with a consensus study that created the foundational framework for the science education standards (NRC, 2012). The designated client for the report was the educational nonprofit Achieve, which managed a highly complex process that involved twenty-six states in translating the findings and recommendations from the report into so-called performance expectations that represented the education standards. On the surface, this was a straightforward process of separating the process of "getting the science right" in terms of the scientific content and the foundational knowledge in learning and education, provided in a NASEM report, from the messier translation of the report findings and recommendations into standards, which required considerations of existing laws, capacities, norms, values, and interests and perspectives by many stakeholders in the vast K–12 education sector. In fact, the reality of NAS's involvement in complex societal and political domains required NASEM to alter the typical study process. Unheard of before, the staff of the Board on Science Education and the committee inserted a public feedback process: halfway through the study a draft of the framework was placed online for public feedback, and focus groups with key stakeholder groups were conducted throughout the country to better understand how the proposed ideas about future science teaching and learning in K–12 might "resonate." Dozens of focus groups and more than 2,000 individual responses, as well as dozens of official statements by key stakeholder groups, were taken into account by the committee in the drafting of the final report.

Given sensitivities surrounding K–12 education standards, this feedback process served multiple key objectives that included (a) improving the final report, particularly its acceptability and alignment with the current K–12 education system; (b) creating stakeholder engagement and providing opportunities for voice and ownership; and (c) creating early excitement and thus preparation for the subsequent process of developing standards. While going public with a draft was valuable, the need to keep the remaining study process confidential complicated committee and staff public communication. As a result, NAS was seen by some as an organization unwilling to cooperate or collaborate for the larger good of developing new standards. The process that protected the committee's ability to provide objective and unbiased advice conflicted with the equally important need of a larger team of organizations to carefully and prudently shepherd the political process of creating standards.

This example represents an extreme case for balancing the need to be objective, independent, and scientifically correct and the mission-related need to help decision-makers. Traditionally, the NASEM has erred on the side of independence and objectivity, and that has protected its valuable "brand." However, there are ongoing efforts to try to bridge the two needs. For one, committees are experimenting with shorter and faster reports, or supplementing reports with executive summaries or derivative products that build on the extensive and rigorous discussion of a traditional consensus report, but extract only the information needed for key target audiences. NASEM is also experimenting with new models of reaching a wider public, from webinars and online screening of meetings to extensive stakeholder engagement at the beginning and at the end of the study process. The anecdote of Anthony Fauci's attempt to satisfy the information interests of various stakeholders can play out in similar ways when NASEM reports are communicated to various stakeholder groups within and outside of government. Consequently, NASEM is investing in more thoughtful preparation of committee chairs and committee members to increase the likelihood that these scientists, engineers, and physicians will become effective communicators of study findings and address the needs of their audiences, rather than simply communicating results in a standardized format that may not speak to all audiences.

To address the link between output (a report) and outcomes and impacts (how the report and the process that created it makes a difference), the effectiveness of the study process involved in creating a consensus report on communicating chemistry to the public will itself be evaluated. In this collaboration between the Board on Chemical Science and Technology and the Board on Science Education, and with funding from the National Science Foundation, an outside research group will conduct a summative evaluation of the impact of the combined effect of consensus report and stakeholder engagement, allowing NASEM to better understand its value in advising the nation.

In addition, the NASEM has recently developed an interest in understanding the science of science communication itself. It convened two Sackler Colloquia on the topic, published two special issues of the *Proceedings of the National Academy of Sciences*, developed an active research project using local scientists as ambassadors for science within a community in Pittsburgh, and created the Science and Entertainment Exchange in Hollywood, where scientists and film producers come together to improve the representation of science in movies. Each of these activities provides NASEM with opportunities to learn through research and practice what effective science communication and science engagement looks like.

Bridging Theory and Practice

AAAS and NASEM represent the scientific enterprise and the concept of science itself. Both will likely have to appeal to the theoretical and empirical foundations of the science of science communication when trying to change some of the fundamental approaches toward engaging various publics. However, communication theory is "useful" only inasmuch as it informs practice. An overreliance on theory, without consideration of practical conditions in the field (the "wisdom of practice"), is not particularly helpful to those seeking to use the products of communication research. Science communication needs more and better examples of successful collaboration between research and practice at multiple time, funding, and institutional scales and active discussion of how theory and practice inform each other in order to be perceived as helpful. Both practitioners and researchers should engage in collaboration, recognizing that there will not be a perfect or one-size-fits-all solution to the problem(s) inherent in science communication—after all, perfect is the enemy of good. More work is needed on convening the kind of discussion in research and practice that leads to experimentation and broader dissemination and uptake of best practices. Funding is needed to find adequate rewards and opportunities to support collaboration and iterative development, and AAAS and NASEM might be ideal test beds to study ways in which theoretical and practical considerations of the science of science communication can be infused into processes that successfully communicate scientific findings with nonexpert audiences.

Understanding Impact

How should organizations determine the value and success of their communication activities? Some may be able to be evaluated (e.g., use of science to inform policy, science communication skills gained and utilized, the immediate impact of a consensus report on key stakeholders), while others are harder to assess (e.g., health of science–society interaction, societal value of science, scientific value of society). Currently there is precious little empirical evidence beyond output and anecdotal stories on how much value added is created in the outreach, communication, and engagement efforts of AAAS and NASEM. Fortunately, efforts are now underway at both institutions to create empirical evidence about the value of science communication and science engagement and to use evidence to guide and improve the quality of activities in that arena, even as it remains an open question as to how this information can best be disseminated to and used by the organizations and individuals who need it.

AAAS and NASEM represent organizations that experience tension between the desire and the essential need to defend scientific reputation on the one hand and the increasing demand to play a stronger and more prominent role in translating scientific findings to a broad spectrum of stakeholders and audiences on the other (where debates can be messy and institutions can become more easily embroiled in the politics of conflict). This is indeed a tension, since different groups within the two organizations prioritize one over the other, or represent institutional roles that stress one over the other, and might have little incentive to find workable solutions to ease this tension without clear mandates from leadership. Fortunately, the leaders of both AAAS and NASEM have spoken out in favor of resolving those tensions, and we might expect more leadership in encouraging all scientists to identify an appropriate balance for themselves.

The scientific endeavor has been, and will remain, a valued component of societal need and function. While it is unlikely that one would design modern institutions in the likeness of AAAS or NASEM if starting from scratch, these scientific institutions and other scientific societies serve an essential role as trusted sources of unbiased and objective information. The scientific community should commit to improving and better equipping its institutions to become more effective in science communication and engagement with public audiences and other key stakeholders who maneuver the intersection of science and society; in fact, it is time that key scientific institutions invest in evidence-based science communication and engagement with the same fervor, rigor, and commitment to excellence that they bring to curating scientific research itself.

Note

1. https://www.c-span.org/video/?322324-1/national-institutes-health-press-conference-ebola

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