Changing the Culture of Science Communication Training for Junior Scientists

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Being successful in an academic environment places many demands on junior scientists. Science communication currently may not be adequately valued and rewarded, and yet communication to multiple audiences is critical for ensuring that it remains a priority in today's society. Due to the potential for science communication to produce better scientists, facilitate scientific progress, and influence decision-making at multiple levels, training junior scientists in both effective and ethical science communication practices is imperative, and can benefit scientists regardless of their chosen career path. However, many challenges exist in addressing specific aspects of this training. Principally, science communication training and resources should be made readily available to junior scientists at institutions, and there is a need to scale up existing science communication training programs and standardize core aspects of these programs across universities, while also allowing for experimentation with training. We propose a comprehensive core training program be adopted by universities, utilizing a centralized online resource with science communication information from multiple stakeholders. In addition, the culture of science must shift toward greater acceptance of science communication as an essential part of training. For this purpose, the science communication field itself needs to be developed, researched and better understood at multiple levels. Ultimately, this may result in a larger cultural change toward acceptance of professional development activities as valuable for training scientists.

THE IMPORTANCE OF SCIENCE COMMUNICATION FOR JUNIOR SCIENTISTS

Striving for success in an academic environment places many demands on junior scientists in terms of obtaining grant funding and publishing papers, which are overly emphasized metrics for career advancement (1). However, becoming a well-rounded and successful scientist requires engaging in many other activities that can lead to the development of various skills of benefit to scientists (see The Whole Scientist at Jackson Laboratory (http://bit.ly/2nmcUdg and 2). Currently, these types of professional training activities may not be adequately valued and rewarded (3, 4). As a result, junior scientists, who are in the best position to effect future change in science, may lack the necessary support and resources to promote and benefit from these activities.

Communicating science to multiple audiences is critical for ensuring that it remains a priority in today's society (5). The 2017 National Academies of Sciences, Engineering and Medicine report entitled “Communicating Science Effectively” (6) highlights multiple goals for science communication, which can be grouped into five broad categories:

1. Share the findings and excitement of science
2. Increase appreciation for science
3. Increase knowledge and understanding of science related to a specific issue that requires a decision
4. Influence people's opinions, behavior, and policy preferences
5. Engage with and consider the perspectives of diverse groups when seeking solutions to societal problems.

Other motivations for science communication include debunking misinformation and restoring public trust in scientists (6). Science communication can therefore be used by junior scientists as a tool for effecting change in society (7) and ultimately expand their impact (Table 1).

Because science communication has the potential to produce better scientists, facilitate scientific progress, and influence decision-making at multiple levels, training junior scientists in both effective and ethical science communication practices is imperative. Training is necessary to ensure that junior scientists deliver both accurate and truthful scientific evidence tailored to specific audiences, and do so in a culturally relevant way (see [8] for further discussion). In addition, as junior scientists may have different motivations...
for communicating science, they must acquire career-specific science communication training.

The communication of science is imperative to its progression and is therefore an essential part of a scientist’s training (9). The type of science communication taught, however, may differ based on career goals, and may thus influence the extent of engagement in related practical experiences. For example, scientific presentations, grantsmanship, and paper-writing are prioritized in academe; personal communication skills are highly prized in policy and industry; and the ability to communicate science to a breadth of audiences is key to engaging public audiences in the scientific process.

**CHALLENGES AND RECOMMENDATIONS FOR TRAINING**

Many challenges exist in addressing specific aspects of science communication training, including public communication (10). These can be overarching challenges at the systemic level or challenges more easily addressed either prior to or during training. Evaluating the effectiveness of this training over the short term (e.g., surveys to determine the usefulness of training programs for career advancement, putting skills into practice in a real-life situation) and the long term (e.g., longitudinal assessments of science communication abilities over time), and devising methods to determine the value of this training for career advancement, are critical points of assessment (Table 2).

Some universities have specific programs to train junior scientists in communicating their science to other scientists, or to audiences outside of academia. However, while individual principal investigators or institutions may offer science communication training for junior scientists informally (through scientific presentations, journal clubs, writing papers and grants), these opportunities are still very limited and highly variable across laboratories and institutions. No formal universal training mechanism for communicating science to particular audiences currently exists across universities. While devising such a universal standard will be difficult, it is a necessary endeavor to undertake for training the next generation of scientists.

Science communication and public outreach aren’t currently valued and rewarded in academia the way other aspects of a scientist’s training are (4). In 2016, a subcommittee of the American Sociological Association published a report looking at the impact of social media and other public communications with regard to tenure and promotion. The report indicated the need to recognize and reward public engagement either within, or as an additional criterion to, traditional categories (teaching, research, and service) and sought to “fill the vacuum” in standards for assessing the work of public communication (11).

At the university level, multiple groups (including faculty members, senior scientists, and academic administrators) must encourage and support the participation of junior scientists in existing science communication training outside the laboratory. While many scientists within the university may lack formal science communication training, connecting junior scientists with science communication trainers outside the university may be beneficial to devising novel programs or improving existing ones. Trainers should focus on objectives related to the science communication goals of scientists (12), as well as highlight the need for engagement activities to be effective and ethical (13). Professional organizations can help scientists think about communication goals beyond the traditional focus on message comprehension (13). Partnerships between science communication researchers and practitioners (14) can also be an effective way to help scientists communicate their work to various audiences. Including multiple stakeholders in this effort would allow for a breadth of expertise to improve the landscape of science communication.

Junior scientists may not be aware of existing science communication training opportunities, may not appreciate the value of participating in them, may be reluctant to engage in them given the time commitment away from the bench, or may already participate in such activities and not be rewarded for them, particularly in a culture where most professional development activities outside of the laboratory are discouraged (15, 16). Multiple stakeholders should empower junior scientists to seek necessary science communication training, encourage them to consider the impact and value of public engagement on their academic work and careers, and support those who already carry out this work (9, 17). In turn, junior scientists must seek to understand what society wants and needs and ensure the relevance of their work to general audiences and to society at large (18).
Junior scientists should be made aware of the science communication training and resources available to them prior to accepting a position, enabling them to make better informed career decisions. Some groups have devised a list of skills and competencies for science communication (10, 18). However, there is a need to scale-up existing science communication training programs at universities and to devise a uniform training program by establishing a universal standard across universities. To allow for the sustainability of science communication training in universities as a whole, this comprehensive program needs to include multiple branches for different careers that junior scientists may pursue.

Science communication training could be improved by working with other stakeholders with different expertise, and by providing courses and workshops for science communication (6). Below we include a non-exhaustive list of examples of relevant programs and resources:

- **Scientific societies**: American Society for Biochemistry and Molecular Biology (ASBMB) Art of Science Communication online course (www.asbmb.org/Outreach/Training/ASC/), American Society for Cell Biology (ASCB) COMPASS Communications Subcommittee (www.ascb.org/communications-subcommittee/), American Association for the Advancement of Science (AAAS) Center for Public Engagement with Science and Technology (www.aaas.org/pes)
- **Organizations**: Union of Concerned Scientists’ The Center for Science and Democracy (www.ucusa.org/our-work/center-science-and-democracy), Alan Alda Center for Communicating Science (www.aldacenter.org/training), iBiology (www.ibiology.org/), Science Open (www.scienceopen.com/ and 19), Future of Research Twitter chat (20)
- **Science communication trainers**: Alaina G. Levine, Quantum Success Solutions (www.alainalevine.com), Mónica Feliú-Mójer (monicafeliu.strikingly.com)
- **Efforts by junior scientists**: storytelling strategies (21), Science Soapbox podcast (www.sciencesoapbox.org/about-us/)
This list is far from comprehensive, highlighting the need to create a centralized online source of science communication information (including how-to guides for particular training programs). This resource would be free, comprehensive, accessible, and regularly updated. It would list efforts from multiple stakeholders in one place to allow sharing of science communication resources and information with junior scientists, faculty members, science communication trainers, and other professionals in this field. This resource would be an integral part of a comprehensive program in which multiple stakeholders participate to improve science communication training in a broader sense than previously discussed (22).

We envision such a program to be specifically geared toward junior scientists (but adaptable and accessible also for both early-stage and late-stage investigators), and to contain multiple elements necessary for training in universities (Table 3, Phase 1), including the centralized online resource, open to public input, described above. Importantly, this program would involve longitudinal tracking of participants and generate openly available data on science communication requirements and learning outcomes (Table 3, Phase 2). Finally, it would generate publications contributing to the scholarly literature on science communication, materials that can be used to implement training or improve existing training at universities, program completion certificates, and the opportunity for participants to research particular science communication issues. Overall, the program would aim to become a comprehensive training program to be adopted by universities, and a platform for junior scientists and other stakeholders to discuss barriers, incentives, and rewards in science communication training (Table 3, Phase 3).

** table 3.**

| Phase 1: Specific Training Program Elements |
|--------------------------------------------|
| Seminars and invited speakers              |
| Hands-on workshops and courses             |
| Writing opportunities (blogging, op/ed pieces, nonspecialist summaries) |
| Online resources and events (courses, webinars, Twitter chats) |
| Public outreach events (science festivals) |
| Opportunities to meet with policymakers   |
| Centralized online resource for science communication |

| Phase 2: Program Evaluation and Tracking |
|-----------------------------------------|
| Longitudinal tracking of participants   |
| Generate data on effectiveness of training |
| Assess learning outcomes for participants |

| Phase 3: Products of Training Program   |
|-----------------------------------------|
| Open access journal article             |
| Materials to implement/improve training in universities |
| Completion certificates for participants |
| Opportunity to research a science communication issue |
| Platform to discuss science communication training |

**Achieving Culture Change**

The culture of science must shift toward greater acceptance of science communication as an essential part of training scientists and as a scientific contribution meriting reward and recognition. For a graduate student, this could involve incorporating science communication elements into mandatory degree courses, taking into account science communication activities in a training grant application and toward PhD graduation (including rewards for participation in these activities), and adapting grant funding mechanisms to make it mandatory that a particular amount be allocated specifically for training activities within the university. For a faculty member, science communication activities also need to be recognized in grants, tenure, and promotion and used as means for career advancement.

In order to make science communication an integral part of scientific training, the field of science communication itself needs to be developed, researched, and better understood at multiple levels. Very few publications address the development of science communication in a historical sense, which is critical to addressing the broader issues and challenges in this field (23). “The Science of Science Communication” was the topic of three National Academy of Sciences Arthur M. Sackler Colloquia (2012, 2013, and 2017). The 2012 Colloquium surveyed the art of empirical social science research in science communication and focused on research in multiple areas surrounding issues in science, engineering, technology, and medicine (24). It addressed the need for science communicators to perform four interrelated tasks: identify the science most relevant to the decisions that people face, determine what people already know, design communications to fill the critical gaps between what people know and need to know, and evaluate the adequacy of those communications (25).

The 2013 Colloquium highlighted particular challenges in communicating science that involves controversy and conflicting perceptions (26), which can hamper understanding and action moving forward (27), leading to the 2017 consensus study report (6). The report discusses goals, challenges, and questions in science communication, including the need for more study of the discipline. Notable ideas for change include: the need for comprehensive reviews of factors affecting the communication of science; the need to
grow research capacity and research methods for science communication; and the need to integrate science communication into a broader societal context (6). In discussing the communication of science in a highly charged, politicized environment, the report considered the role of individual beliefs and attitudes toward specific issues and how these can influence decisions and behaviors. An additional point of discussion was how information is disseminated and received via social networks (27).

The 2017 Colloquium focused on the consensus study as a framework to advance both research and practice in science communication. It explored ways to build capacity and foster the use of evidence-based strategies for engaging the public with science and ensuring its appropriate use (28). For this purpose, the National Academy of Sciences offered two awards with the Rita Allen Foundation to support the formation and development of partnerships between science communication researchers and practitioner (14) that would lead to collaborative projects with shared research interests aligned with the report (28).

The two winning projects were “Evaluating New Approaches to Promoting Vaccination” (a field experiment to study the effect of messages about immunization on parents’ beliefs and vaccination decisions) and “Evidence-Based Science Communication to Policymakers” (examining the communication and use of science within the policymaking arena, in order to propose a set of best practices for presenting science to policymakers). The latter relates to the best way to engage scientists with the public and the need to increase public trust in scientists, and suggests that efforts to “inform the public, share opinions, and motivate behavior change” have the potential to succeed on a larger scale. Ultimately, having “amplified voices of organized interests and influential individuals” is a potential strategy to alter the perceptions both within and about the field of science communication in general (6).

PERSPECTIVES AND CONCLUSIONS

Training junior scientists to communicate their science to various audiences is critical for many aspects of science and society. Studying how to provide science communication training to junior scientists is imperative for ensuring that they are well-trained, competent, and rigorous. This knowledge can aid universities and other stakeholders in devising appropriate training programs to address the career needs and larger societal challenges faced by junior scientists. In a broader sense, the current lack of resources for, and training of, junior scientists in science communication is an example of a systemic problem. A proposed solution is to centralize information in an online resource as part of a comprehensive science communication program to be adopted by universities. Future work should seek to test whether this type of program can be generalizable to different institutions, in different contexts, and within different disciplines. Ultimately, increasing recognition of science communication training as necessary for career advancement and societal impact may lead to a larger cultural change toward acceptance of professional development activities as valuable for training scientists.

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