

All STEM students should learn inclusive science communication

Nicole C. Kelp, Ashley A. Anderson & Joy C. Enyinnaya



Science communication often assumes a ‘deficit’ in knowledge on behalf of the recipient, but this deficit-based approach is inequitable and ineffective. We must train all STEM (science, technology, engineering and mathematics) students in inclusive science communication, which uses collaboration with diverse people to address misinformation and solve socioscientific issues.

During the COVID-19 pandemic, the scientific community recognized growing issues with misinformation and distrust in science. Similarly, elections highlight the spread of political misinformation, especially about policies regarding socioscientific issues such as climate change. Many studies have analysed sources of misinformation, ways to curb its spread online and reasons for public distrust in science. But instead of only looking at problems with the non-scientist public and their opinions of science, we must also examine how we in the scientific community may be contributing to this misinformation and distrust. We should ask how our approaches towards communication about complex scientific issues contribute to these poor science communication outcomes; how STEM students and scientists are trained to communicate about science and its connection with social forces; and how we can do better.

The problem with the deficit approach

The deficit model of science communication assumes that Western science is the best way of knowing and posits that the public suffers from a deficit of information about science. Although this is still the most commonly used approach for science communication by many scientists, journalists and governmental entities, this model is both ineffective and inequitable¹. The deficit model focuses on delivering settled scientific facts, but this does not facilitate the collaboration between people of diverse disciplines and backgrounds that is necessary to solve complex and evolving socioscientific issues such as pandemics or climate change². This focus on settled scientific facts rather than the evolving nature of the scientific process may stem from a desire of scientists to prove the strengths of science and reject claims of uncertainty, but this can be interpreted as epistemic hubris by audiences or lead to anxiety when audiences face emerging socioscientific issues. Finally, the deficit approach fails to value cultural funds of knowledge and ways of knowing outside of the Western science paradigm, such as traditional ecological knowledge held by Indigenous communities. This not only perpetuates colonial attitudes but also limits the potential for interdisciplinary innovation.

There are a number of ramifications of scientists’ continued use of a deficit approach to communicating science. For one, scientists lose the benefit of gaining critical ideas and perspectives from non-scientist experts². Additionally, people may develop distrust in scientists who lack disciplinary humility and fail to be transparent about the uncertainties and limitations in science³. Also, scientists who hold a high deficit view of the public – assuming the public to be ignorant of science – are less willing to engage in conversations to address misinformation⁴. Finally, scientists may ignore the ways in which the scientific enterprise has harmed people of colour and other marginalized groups, and continue to perpetrate these problems. In short, scientists who hold deficit mindsets towards the public stall the collaborative conversations among various communities – within and outside of the scientific paradigm – that could drive scientific research forward.

Moving to an asset-based approach

Several alternative models of science communication have been developed, such as the contextual model that recognizes the need for cultural competence and the tailoring of messages based on complex social psychological schemas of diverse audiences. However, this model still often relies on a unidirectional sharing of information. The lay expertise, dialogic and participation models of science communication encourage input from people with diverse forms of knowledge, and some approaches directly involve citizens in decision-making processes related to science. Importantly, all of these models of science communication can be based on a foundation of deficit model perspectives, in which communicators aim to provide scientific knowledge.

Conversely, inclusive approaches to science communication shift the focus from assuming the deficits of the public to appreciating the assets held by diverse publics (Table 1, Fig. 1). Inclusive approaches to science communication are grounded in building relationships and highlight the value of a diversity of identities and disciplines in conversations about science⁵. Inclusive approaches to science communication facilitate collaborative conversations between scientists and diverse publics from outside of the traditional scientific domain at all stages of the research process – from development of research questions and experimental designs, to equitable methods of data collection and analysis, and to creative solutions for use of scientific findings. Such approaches to science communication promote transparency about uncertainties in science and lead to collaboration about the evolving scientific process that facilitates both understanding for diverse audiences as well as collaborations with multiple interested parties that can help to guide science as it is in process.

Inclusive science communication recognizes that people have diverse knowledge, interests, values and background experiences related to science. Inclusive science communication also values the importance of cultural, historical, sociological, regulatory, ethical, economic and other factors that influence science and society. Scientists with inclusive mindsets recognize what they need to learn from their

Table 1 | Comparison of different models of science communication

	Deficit model of science communication	Inclusive science communication
Visual depiction	Unidirectional information sharing from a scientific expert to a general lay public audience	Network of communication among people of diverse expertise in STEM fields, social sciences, humanities, communities and cultures, education, technical fields, and more
Ideological associations	Scientism	Relativism
How the scientist considers the public	As lacking in knowledge and requiring top-down education and delivery of facts to correct this lack	As diverse people, both in terms of identities and in terms of their expertise and experience (that are applicable to solving socioscientific challenges)
What the public is doing	Public understanding of scientific facts	Public understanding of and participation in the scientific process
Skills used by scientists and STEM students, especially regarding misinformation and complex socioscientific issues	Sharing settled scientific facts 'Debunking' misinformation Removing jargon to simplify messages to a general lay public Persuading the audience to believe science	Being transparent about uncertainties in the scientific process Listening with empathy to people's values and reasons for concerns about science Adjusting messaging to diverse audiences with different knowledge and interests Learning from audiences to adjust scientific practice Working with diverse groups for the design, execution and application of co-created solutions to socioscientific issues and misinformation

Although other models exist along this spectrum, this table highlights key mindset and skillset differences between deficit approaches and inclusive approaches to science communication.

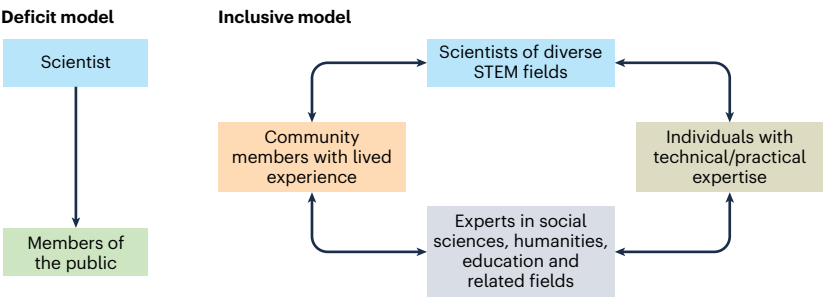


Fig. 1 | Deficit versus inclusive models of science communication. The deficit model of science communication focuses on unidirectional communication from the scientist to a monolithic public. Conversely, the inclusive model promotes a network of communication between scientists and experts in community lived experiences, practical and technical work in socioscientific issues, the social sciences and humanities, and more.

audiences, instead of just focusing on what they want to communicate to their audiences. Although scientists certainly have expertise in their particular area of research, this does not give them expertise in community experiences, historical considerations or other scientific fields. When scientists recognize this rightful place of their own skills, they are better able to use their expertise to contribute to shared solutions rather than promoting inequitable hierarchies. An excellent example of this mindset is [Robin Wall Kimmerer](#), a Potawatomi botanist and author whose work highlights the integration of Indigenous knowledge about the land and living things with newer scientific experimentation to provide new insights about ecological systems in the wake of climate change and other environmental challenges. Similarly, anthropologist [Richard Stoffle](#) recognizes the value of Native science for understanding changes in ecosystems over time, and he collaborates and publishes with Native experts to understand the effects of climate change.

How inclusive science communication works

The beginning of becoming an inclusive science communicator is mindset. Inclusive science communication is characterized by intentionality, reflexivity and reciprocity⁶. Scientists must intentionally plan how to make science communication more inclusive, while reflecting on how motives and identities affect their work, and focusing on reciprocal

interactions. In this shift, the scientific community must not maintain or develop an essentialist viewpoint towards communities – viewing them as monoliths in need of interventions – but rather develop an appreciative mindset towards diverse communities and their unique contributions.

Once an inclusive mindset is established, science communication practice can move towards inclusivity in several ways. For example, as scientists engage with diverse communities in participatory processes of science, they should have information about the scientific process available in terminology, language, cultural references and formats that hold meaning for those diverse individuals. Elizabeth Rasekoala, president of the African Gong network for science communication, discusses the importance of showcasing [sociocultural inclusion](#) in science communication. Another example is intentionally engaging with communities during the research process. For instance, Max Liboiron of the Civic Laboratory for Environmental Action Research ([CLEAR](#)) holds discussions with local Indigenous communities to receive guidance on where and how to collect environmental samples on local waters in Canada. Finally, scientists need to foreground empathy, humility and curiosity when discussing science with individuals who hold distrust towards science. For instance, scientists must recognize that root causes of misinformation among Black, Indigenous and

people of colour (BIPOC) communities often lie in systemic inequities that lend to mistrust of traditional sources of authority (for example, government or public health institutions) among minority communities. Scientists can practice inclusive science communication by letting [community members](#) in historically disadvantaged communities serve as [messengers](#) who guide conversations about topics such as vaccination and misinformation.

Science communication training for STEM students

Despite the plethora of evidence in the social science literature for the efficacy of inclusive science communication, scientists continue to use deficit approaches. The cycle continues with most science communication training for STEM students providing training only in deficit mindsets and skills⁷. Students may only be trained in how to talk about their science with fellow scientists via posters and talks or how to discuss science with a 'general lay public' via surface-level skills such as removing jargon. Students are rarely given the opportunity to reflect on their science communication mindset or develop skills in interdisciplinary collaboration with diverse community members. STEM students are thus not being prepared for a changing STEM workforce or for contributing to equitable, community-engaged solutions to complex socioscientific issues and misinformation.

Additionally, the current training paradigms harm our STEM students themselves. If STEM educators focus on the deficits of an 'ignorant' public who are not scientific experts, they communicate to students from historically disadvantaged and excluded backgrounds that their unique cultural funds of knowledge are irrelevant to conversations about science. Conversely, when students learn inclusive science communication and the value of multiple ways of knowing in developing creative solutions to complex scientific problems, they also learn that their unique backgrounds are valuable. In fact, training in inclusive science communication has been shown to increase students' science identity and science self-efficacy, which are factors that are known to support persistence in STEM for students from diverse backgrounds⁸. This matches a plethora of science education research that highlights that when educators switch from problematizing marginalized students (a deficit approach) to focusing on how to change the systems that marginalize students to value these students and their existing strengths (an asset approach), students are better able to succeed. Just as educators should focus on the assets instead of deficits of diverse STEM students in the classroom, they should focus on educational perspectives that acknowledge the assets instead of deficits of diverse publics in science communication.

A vision for a better future

All STEM students should receive training in inclusive science communication. This requires both institutional and individual commitments (Box 1). Academic institutions and departments must create space and resources for advancing inclusive science communication training. This training must go beyond standalone workshops and instead be incorporated early and often throughout degree programmes to avoid the persistence of deficit-model thinking at formative points in the career trajectories of the next generation of scientists.

Scientists must design, implement and evaluate inclusive science communication training carefully. Although such training could be integrated in disciplinary STEM courses or in standalone science communication courses, the training should be grounded in evidence-based science communication theory, research and

BOX 1

How STEM educators can train STEM students in inclusive science communication

Institutional responsibilities

- Create space throughout the undergraduate and graduate STEM curriculum for inclusive science communication training
- Recognize community-engaged and participatory research in tenure and promotion processes so that faculty members and student researchers can practice inclusive science communication
- Provide stable financial resources for inclusive science communication training and practice

Individual responsibilities

- Design inclusive science communication training that relies on evidence from the science communication research literature
- Develop collaborations between STEM and social science scholars and educators
- Learn from a diversity of community members and organizations to develop case studies and community engagement experiences for science communication trainees

practice. STEM faculty members must learn from current social science research in science communication training⁹. Collaboration between STEM researchers and science communication researchers to coteach science communication courses can be an effective approach. The training should focus on helping students to develop both an inclusive mindset towards diverse audiences as well as a skill-set in having collaborative conversations and learning from people who are different from them. This training could involve analysis of case studies, active engagement with the community, building conflict-management skills, the cultivation of boundary-spanning and reflexive practices in identity development, a focus on humanism in science communication, and professional practice in inclusive science communication.

Institutions should support not only training in, but also the practice of, inclusive science communication. They can facilitate community-engaged and equity-based scientific research through recognition in the promotion and tenure process and via provision of time and resources for these endeavours. When faculty members can themselves practice inclusive approaches for engaging with communities in the scientific process, they will also train their students in inclusive science communication via authentic application.

Overall, STEM faculties must not continue the status quo. Training STEM students in only deficit mindsets and approaches to science communication will leave them struggling to address misinformation and engage in productive dialogues about science with diverse people. Conversely, training STEM students in inclusive science communication will help students by empowering them to recognize the assets that they bring to science and will help society by developing a new STEM workforce that is better equipped to codevelop creative

and innovative solutions to socioscientific issues along with diverse communities. These STEM students and future scientists can become individuals who span boundaries between the scientific community and their own home communities¹⁰, and engage with diverse people with curiosity and shared values. This new generation of scientists can promote mutual trust and collaboration around tricky socioscientific issues that have been historically plagued with misinformation and distrust.

Nicole C. Kelp ¹ , **Ashley A. Anderson** ² & **Joy C. Enyinnaya** ³

¹Department of Microbiology, Immunology, and Pathology, Colorado State University, Fort Collins, CO, USA. ²Department of Journalism and Media Communication, Colorado State University, Fort Collins, CO, USA. ³School of Communication, University of the Fraser Valley, Abbotsford, British Columbia, Canada.

 e-mail: nicole.kelp@colostate.edu

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References

1. Simis, M. J., Madden, H., Cacciatore, M. A. & Yeo, S. K. *Public Underst. Sci.* **25**, 400–414 (2016).
2. Nogueira, L. A., Björkan, M. & Dale, B. *Front. Environ. Sci.* **9**, 699397 (2021).
3. Covitt, B. A. & Anderson, C. W. *Sci. Educ.* **31**, 1155–1180 (2022).
4. Choi, S., Anderson, A. A., Cagle, S., Long, M. & Kelp, N. *PLoS ONE* **18**, e0287870 (2023).
5. Judd, K. & McKinnon, M. *Front. Comm.* **6**, 744365 (2021).
6. Canfield, K. et al. *Front. Comm.* **5**, 2 (2020).
7. Vickery, R. et al. *CBE Life Sci. Educ.* **22**, ar8 (2023).
8. Alderfer, S., McMillan, R., Murphy, K. & Kelp, N. *Front. Educ.* **8**, 1173661 (2023).
9. Besley, J. C. & Tanner, A. H. *Sci. Commun.* **33**, 239–263 (2011).
10. Shah, H., Simeon, J., Fisher, K. Q. & Eddy, S. L. *CBE Life Sci. Educ.* **21**, ar12 (2022).

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Competing interests

The authors declare no competing interests.