OXFORD

BioScience, 2024, **74**, 747–769
https://doi.org/10.1093/biosci/biae080
Advance access publication date: 8 October 2024
Overview Article

Use your power for good: Collective action to overcome institutional injustices impeding ethical science communication in the academy

E. Dale Broder, Bethann Garramon Merkle, Meena M. Balgopal, Emily G. Weigel, Shannon M. Murphy, Joshua J. Caffrey, Eileen A. Hebets, Anna A. Sher, Jennifer M. Gumm, Jennifer Lee, Chris J. Schell and Robin M. Tinghitella

E. Dale Broder was affiliated with the Department of Biological Sciences at the University of Denver, in Denver, Colorado, in the United States when this work was completed and is now affiliated with the Department of Biology at American University, in Washington D.C. in the United States. Bethann Garramon Merkle (bmerkle@uwyo.edu) is affiliated with the Department of Zoology and Physiology at the University of Wyoming, in Laramie, Wyoming, in the United States. Meena M. Balgopal is affiliated with the Department of Biology at Colorado State University, in Fort Collins, Colorado, in the United States. Emily G. Weigel is affiliated with the School of Biological Sciences at the Georgia Institute of Technology, in Atlanta, Georgia, in the United States. Shannon M. Murphy is affiliated with the Department of Biological Sciences at the University of Denver, in Denver, Colorado, in the United States. Joshua J. Caffrey is affiliated with the Department of Sociology at the University of Minnesota, in Minneapolis, Minnesota, in the United States. Eileen A. Hebets is affiliated with the School of Biological Sciences at the University of Nebraska-Lincoln, in Lincoln, Nebraska, in the United States. Anna A. Sher is affiliated with the Department of Biological Sciences at the University of Denver, in Denver, Colorado, in the United States. Jennifer M. Gumm is affiliated with the Branch of Hatchery Operations and Applied Science, Fish and Aquatic Conservation, at the US Fish and Wildlife Service, in Fairfax, Virginia, in the United States. Jennifer Lee is affiliated with the Forestry, Wildlife and Natural Resources, at Front Range Community College, in Fort Collins, Colorado, in the United States. Chris J. Schell is affiliated with the Department of Environmental Science, Policy, and Management at the University of California Berkeley, in Berkeley, California, in the United States. Robin M. Tinghitella (robin.tinghitella@du.edu) is affiliated with the Department of Biological Sciences at the University of Denver, in Denver, Colorado, in the United States.

Abstract

Science communication (*scicomm*) shapes our world by helping people use science to make societal and personal decisions. Supporting and doing ethical scicomm requires valuing diverse perspectives and the people who do scicomm. Unfortunately, institutional hurdles ingrained in academia impede and undermine ethical scicomm. The injustices impeding scicomm stem from the prestige paradigm of academia (articulated in the present article), which reinforces hierarchical relationships in an exclusionary and exploitative system. To move academia forward, we name and review these injustices through the lens of five realms of scicomm (scientific communication, teaching scicomm, academics engaging in scicomm, scicomm research, and scicomm careers beyond academia). We then provide a novel framework, helping readers identify axes of influence and how they can leverage their intersectional, academic capital to take concrete action to remove the hurdles impeding ethical scicomm in academia.

Keywords: scicomm, equity, higher education, academic metrics, academic reform, prestige

Ethical science communication (table 1) is vital, given that we hope society will use science to make policy, civic, and personal decisions. Briefly, ethical science communication (hereafter, *scicomm*; table 1 and see box 1) requires valuing people who engage in scicomm and ensuring that scicomm values diverse perspectives and approaches. Throughout the present article, we advocate for this ethical framework for scicomm, and, therefore, we use *scicomm* to mean *ethical scicomm* hereafter. Unfortunately, institutional and systemic hurdles in academia complicate, constrain, and undervalue efforts to share science effectively and ethically. *Prestige* (table 1) underlies a lot of these problems, so we recognize and organize the present article around an *academic prestige paradigm* (table 1, box 2; Mutisya and Osler 2017, Cook 2022). Using the prestige paradigm concept, academics can understand and work to mitigate how central issues of tension and injustice (table 1) affect most people who do scicomm and their efforts. Critically, scicomm and the people who do it are not valued in the prestige paradigm (Bell and Lewis 2022, Wróblewska et al. 2024). We have written the present article to provide a flexible framework to support such action and have therefore provided a set of actionable tools throughout.

To create an academic system where ethical scicomm is actually valued and incentivized, academics must collectively engage in the discomfort of naming complex and pervasive systemic issues and must then identify means of working together to overcome them. Numerous injustices affecting scicomm stem from academia's origins. Academia in the Global North (for brevity, hereafter, *academia*; table 1; Collyer 2018, Moosavi 2020) was developed by specific socioeconomic classes to provide specific mechanisms and benefits of access, assets, credibility, and shared values only for certain people (Hull et al. 1982, MacFarlane 2007, McMillan Cottom 2016, Oluo 2020, Baker 2021, Singh 2022). These people codified the scientific process as the one "right" way of understanding the world. Even now, most training in the physical and life sciences assumes that the (singular) scientific method is universal and neutral. Such constructs of universality or rationality enable certain people to marginalize other people and knowledge constructs (e.g., Indigenous ways of knowing; see Barsh 2001, Hernandez 2022, Sidik 2022), coding these latter people as lacking credibility or the ability to create valid knowledge (*misrecognition*, table 1; *sensu* Fraser and Honneth 2003). All of these exclusions and *biases* (table 1; see box 3 for more on bias) hinge on perceived

Received: January 16, 2023. **Accepted:** July 17, 2024

Table 1. Relevant definitions and concepts in alphabetical order.

Term	Definition
Academia, academic, academy, higher education	These terms encompass post-PK–12 instructors and scholars as academics and all such education as part of higher ed, the *academy*, or *academia*. Our framework in the present article is focused primarily on 4-year institutions in *higher education* in the United States; however, some issues we address have parallels in 2-year institutions. (We also note that we speak primarily to constructs of *academia* in the *Global North*, defined below.)
Audience, stakeholder	Previous scicomm discourse distinguished between *audiences* (passive, being talked at) and *stakeholders*, ideally actively engaged with multiple stages of a research and scicomm process (Merkle et al. 2022). However, contemporary understanding of the harm and erasure implicit in *stakeholder* shows neither *stakeholder* nor *audience* are adequate catchall words (Sharfstein 2016, Joseph 2018, Kappel and Holmen 2019, Reed et al. 2024). Terminology is ideally informed by the nature of scicomm in and with communities, so we do not suggest a single term as a replacement.
Bias, biases	*Bias* describes a preference for one person or thing over another and can be explicit or implicit. *Implicit bias* means that "human beings are not neutral in their judgement and behaviour" (Gvozdanović et al. 2018). When *biases* are normalized and rationalized into policies and practices that confer advantage to some and disadvantage others, they become *structural biases*. (See box 3 for more.)
Capital	Perhaps most familiar, *economic capital* describes access to and control of money. *Social capital* is one's network or social connections (i.e., trust, expectations, partnerships, friendships) that can be leveraged to achieve specific actions (Lin 2001, Liou and Canrinus 2020, Diaz-Clark et al. 2024). In some situations, *social capital* can be converted into *economic capital* (e.g., money and resources) (Bourdieu 2010). In the present article, we define *academic capital* as a subset of intellectual capital that we think of as CV items that make one seem established or esteemed in academia (e.g., degrees, publications, leadership roles)
Credentialism	*Credentialism* occurs when "affiliation with institutions of historic privilege (e.g., academia, big-name companies and nonprofits, etc.) [perpetuates] the prestige paradigm. For example, social media-based careers, YouTube-focused scicomm, and the like can be disdained or not recognized as substantive careers by scicomm practitioners who work with academics, agencies, or name-brand companies" (Schutte and Merkle 2022).
DEIJ (diversity, equity, inclusion and justice)	Similar acronyms include DEI, JEDI, and IDEA (where A refers to access). Some debate exists about which acronym should be used (Hammond et al. 2021). We opted for *DEIJ* while respecting that some people prefer other acronyms.
Gatekeeper, gatekeeping	*Gatekeepers* "influence entry or access to a particular arena, allocation of resources and information flows, the setting of standards, development of the field and the agenda, or the external image of that arena" (Husu 2004). See also Merton (1973) on *gatekeeping* as a fundamental role of scientists and Dancy and Hodary (2022) on how self-identified allies remain complicit.
Global North	Academia is not a White space, but one that people conflate with White spaces. *Global North* is a designation that recognizes spaces of economic and educational power specifically manifest in the academic prestige paradigm we discuss in the present article, rather than a specific, geographic region. For example, the *Global North* includes Australia and also recognizes that Indigenous nations in the West are excluded from the privileges of the academic prestige paradigm (Collyer 2018, Moosavi 2020).
Identity, identities	People have both avowed (how they see themselves) and ascribed (how others see them) *identities*. In other words, *identity* can be superimposed on people or groups, or people can self-categorize (Spears 2021). Individual and group experience affects and informs *identity* (Tajfel and Turner 2001). Terms and social constructs about *identity* with relevance to scicomm include but are not limited to sociocultural *identities* such as Black, BIPOC, Indigenous, LGBTQIA2S+, marginalized, minoritized, POC, and White, along with ability, age, citizenship, cultural background, gender, sexual orientation, and socioeconomic status. These terms have been extensively addressed elsewhere in the literature and public discourses. We capitalize all *identity* terms (per Kanigel 2019b).
Injustice, justice	If *justice*, simply put, is the concept that individuals are to be treated in a manner that is equitable and fair, then *injustice* is the inequitable treatment of individuals. In the academy, when only certain kinds of knowledge are valued, we privilege and support only certain people or identities to do certain work. These biases fuel injustices.
Intersectional, intersectionality	Crenshaw (2013) coined *intersectionality* first as a legal theory. "*Intersectionality* starts from the premise that people have multiple identities, and being members of more than one 'group,' they can simultaneously experience oppression and privilege" (Center for Intersectionality and Social Policy Studies 2024). Furthermore, Crenshaw (2017) stated, "*Intersectionality* is a lens through which you can see where power comes and collides, where it interlocks and intersects. It's not simply that there's a race problem here, a gender problem here, and a class or LBGTQ problem there. Many times that framework erases what happens to people who are subject to these things." See also Coaston (2019).
Jargon	*Jargon* encompasses terms that are specific to a field or a group of people. *Jargon* can be exclusionary, provide a sense of belonging, or be used to perform competence or validity (Merkle et al. 2022).

Table 1. Continued

Term	Definition
Misrecognize, misrecognition	*Recognition* is the mutual recognition between two people of some positive quality or characteristic—for example, being human or possessing and producing knowledge (aka epistemic authority), and our social norms toward one another (e.g., not using a condescending tone when communicating; Hegel 2018). *Misrecognition*, then, is a lack of respect for others' knowledge, ability, etc. The academic prestige paradigm (box 2) is an example of *misrecognition* of others' knowledge, among other issues (Taylor 1992; Fraser and Honneth 2003).
Modes of communication: Deficit versus dialogue and coproduction or coproduced	The *deficit model* is a long-standing notion that people will change their minds or their behavior if they just have, or are given, enough information (a "talking at" approach to scicomm; Simis et al. 2016). Extensive research indicates this approach rarely works (e.g., Simis et al. 2016). Models of *dialogue* encompass consultation and engagement ("talking with"), and *coproduction* models center on deliberation, critique, and cogenerated research questions and methods (working together; Trench 2008, Cicchino et al. 2022). These latter two modes tend to facilitate more ethical approaches to scicomm.
Performativity	*Performativity* is the interdependent relationship between language and action. It's not a mere performance, which is a conscious act. It is a way for a person to constitute themself (e.g., having a certain look and doing certain things to *perform* a gender, Butler 2006). *Performativity* extends to the construction of social institutions and structures (e.g., the economy, Callon 1998). For example, people *perform* actions that they assume legitimize them as faculty or as an expert. When people *perform* the academic prestige paradigm and perpetuate gatekeeping and other exclusion and injustice, this *performativity* ultimately constructs and reinforces hierarchies.
Prestige, academic prestige paradigm	*Prestige* refers to a "notoriety, reputation or influence arising from success, achievement, rank, or other favorable attributes" (Mutisya and Osler 2017). We further define (and organize the present article around) what we call the *academic prestige paradigm*, which reinforces hierarchical relationships and results in the academic system being exclusionary and exploitative (Cook 2022).
Privilege	Individuals experience systemic and individual advantages on the basis of intersectional dimensions of their life experience and identities; these are known as *privilege*. "Advantages can be economic, social or educational. One kind of *privilege* is freedom from barriers, suspicions or expectations that non-White people experience daily. Another can be freedom from judgment or denial surrounding success or aspirations" (Kanigel 2019a).
Scientific communication	*Scientific communication* is internal, technical communication done by scientists communicating with peers, students, administrators, and colleagues across professional sectors (e.g., industry, agencies; Brownell et al. 2013). As such, it is distinct from *science communication* (aka scicomm; Merkle et al. 2022).
Science communication (aka scicomm), ethical scicomm	*Science communication* is sharing science beyond the academy (not internally). "*Scicomm* is the exchange of information and viewpoints about science to achieve a goal or objective such as fostering greater understanding of science and scientific methods or gaining greater insight into diverse public views and concerns about the science related to a contentious issue" (National Academies 2017). See box 1 for our definition of *ethical scicomm*.

and real identity (table 1). Indeed, within this paradigm, we all face myriad opportunities to decide which work and whose work is valued. When people perpetuate the devaluation of certain identities and work within academia, they reinforce the hierarchies of the prestige paradigm (*performativity*, table 1; Callon 1998), such that certain identities continue to benefit more than others (e.g., Pell 1996, Zuroski 2018). Worse, proximity to these advantages compels all of us within the academy to maintain these biases. (Classism, racism, and heteronormativity are familiar manifestations of this problem; Wingfield 2020.) If justice is the concept that individuals are to be treated in a manner that is equitable and fair, the *injustice* (table 1) within this system is that academics may support only certain people or identities to do certain work when only certain kinds of knowledge and dissemination are valued (again, see box 2). Therefore, perpetuating the prestige paradigm prevents many researchers from having the societal impacts they want to have (Royal Society 2006, Pew 2009, Pew 2015, Hernandez and Lopez 2019, Wróblewska et al. 2024) and incentivizes damaging approaches that are in direct conflict with ethical scicomm (box 1). Likewise, when people do not do scicomm ethically, it can be ineffective, exclusionary, exploitative, or even outright dangerous (e.g., Dawson 2014b, Dawson 2018, Warren et al. 2020, Razai et al. 2021).

To create an academic system where scicomm is legitimately valued and practiced ethically, we academics must acknowledge that we *are,* in fact, the system and, therefore, have the obligation to help improve it (Callon 1998). Although we each have varying degrees of agency within this system, that does not mean we can individually and immediately make radical change (Goldberg 2022a, 2022b, 2022c). Rather, we must reckon with the degrees of influence we have, in order to work toward change individually and collectively. Therefore, academics must collectively identify and acknowledge complex and pervasive systemic issues and then work and advocate together for an academic system in which scicomm is valued.

To support this collective work, in the present article (figure 2), we authors clarify why ethical scicomm matters in academia (box 1) and introduce how the prestige paradigm at the core of the academy (box 2) perpetuates injustices (many related to identities; see box 3 for more on these biases). Then, we propose a novel framing of how *intersectional* (table 1) injustices manifest in five realms of the academy where scicomm is practiced or taught. We also provide a novel framework for visualizing individuals' own potential to influence changes in academia (axes of influence). Ultimately, we call on readers to use their positions within academic hierarchies to redress and eliminate barriers to ethical scicomm. Naming injustices and reckoning with one's role in them is daunting, but academics have agency to advocate for change (see Callon 1998). Therefore, we write from a position of hope: Informed analysis can drive change, especially at the individual level (e.g., Solnit 2016).

Box 1. Why ethical scicomm is important.

"Science communication (*scicomm*; table 1) is the exchange of information and viewpoints about science to achieve a goal or objective such as fostering greater understanding of science and scientific methods or gaining greater insight into diverse public views and concerns about the science related to a contentious issue" (National Academies 2017). Scicomm takes many forms (e.g., Rowe and Frewer 2005, Kappel and Holmen 2019) and is different from *scientific communication* (table 1), which is technical and often academic (see table 1 and Merkle et al. 2022). Scicomm shapes the world in which we live (e.g., why we know to wash our hands, why most people understand that we should not feed bears; Biel 2006, Spencer 2018, Matta 2020). Scicomm also plays a fundamental role in our future: creating engaged citizens, shaping the next generation of scientists, informing policymakers and lawyers, and guiding individuals' behaviors. Therefore, there is a need for *ethical scicomm* (table 1), which requires valuing people who engage in scicomm and ensuring that scicomm values diverse perspectives and approaches.

We advocate specifically for ethical scicomm because the practice of science can be exclusionary or anti-Indigenous and is a cultural construct that is a process of indoctrination (e.g., Barsh 2001, Sismondo 2010, Graeber and Wengrow 2021, Graves et al. 2022). Ideally, science is much more expansive, inclusive, and *coproduced* (table 1). Harms and barriers can sometimes be rectified when concerns are acknowledged and meaningfully addressed (Ekezie et al. 2021). We rely on the Merkle and colleagues' (2022) definition of *ethical scicomm* as evidence based and "rooted in principles of full inclusion and access to science at all stages, grounded in equity, and *intersectionality* (table 1; Canfield and Menezes 2020, Canfield et al. 2020), and fundamentally effective, and behaviors of those doing, sharing, and using science, and impacts and outcomes are tracked and assessed." In other words, when scicomm is done well and ethically, it is tailored to, resonates with, and respects all people. Relatedly, ethical scicomm assumes that the science being communicated is accurate (broadly supported by peer-reviewed literature). When people are trained in scicomm, there are many benefits (see figure 1 for examples of benefits).

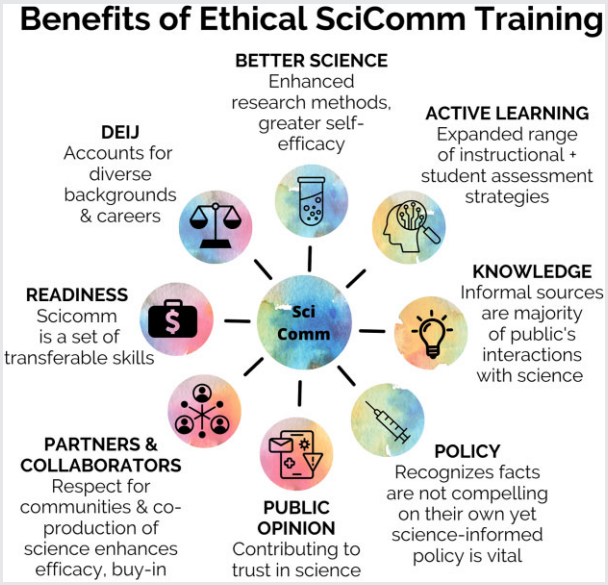


Figure 1. Training in ethical scicomm offers numerous, integrated benefits to students, academia, and society.

In writing the present article, we were inspired by the many insightful criticisms and calls to action of academia writ large (e.g., the field of critical university studies and voices, including Todd 2012, Williams 2012, Wilder 2013, McMillan Cottom 2016, Tanner et al. 2021, Phillips et al. 2022). We authors build on this work by situating calls for a more just academy in scicomm itself. To do so, we relied on an expansive body of literature that draws from disciplines that biologists may not often read (e.g., critical university studies, organizational change management, behavioral economics, psychology, sociology), as well as fields that are gaining interest in biology circles (e.g., biology education research, the science of scicomm). We have also deliberately cited references well beyond the typical peer-reviewed literature to recognize the value and labor of diverse formats of science communication and contributions to social and academic change from individuals in and beyond academia (see, e.g., Ahmed 2017, Kim 2021). Furthermore, the venues where such contributions are made (e.g., social media, public intellectual work in podcasts, magazines, and newspapers) may be undervalued or dismissed by some disciplines (Kwon 2022).

As people commit to overcoming the academic prestige paradigm to make scicomm more just in the academy, academics will need different language. Rhetoric and vocabulary are structural, and the way academics use words drives conscious and subconscious behavior. Indeed, *jargon* (table 1) can be liberatory when it opens up new avenues for people to understand their social construction of the world and, therefore, how they are able to act in it. In this spirit, we authors provide a set of vocabulary and definitions (table 1) on which we have built the framework of the present article. We have also emphasized person-first

Box 2. The prestige paradigm of academia and science.

Prestige (table 1) refers to a "notoriety, reputation or influence arising from success, achievement, rank, or other favorable attributes" (Mutisya and Osler 2017). As such, "prestige is the insidious cultural value that has come to define the university" (Cook 2022). A *prestige paradigm* (table 1) reinforces hierarchical relationships, which results in the system being exclusionary and exploitative (Martinek 2021, Cook 2022). The *injustices* (table 1) impeding scicomm in *academia* (table 1) stem from this prestige paradigm.

The prestige paradigm in academia is not incidental; it is baked into the very fabric of higher education. European (hereafter, *Euro-colonial*) academia or science was developed for and by *privileged* (table 1), White, cisgender men of the upper classes and nobility to ensure leadership skills, social connections, and career preparation (e.g., military officers, high-ranking clergy, landed gentry; MacFarlane 2007). In both formal and informal settings, most rhetoric about science presents a dominantly Euro-colonial, White, straight, able-bodied, neurotypical, male perspective on the history of science (Hull et al. 1982, Ideland 2018). Essentially, "proper science" or "objectivity" is a social construction that asserts there is one right way to do science; this Euro-colonial *bias* (table 1) asserts problematic claims to universality and neutrality (Crenshaw 2013, Treves 2019). (We acknowledge that recognizing this issue does not automatically negate the benefits of empirically derived knowledge; e.g., Ho et al. 2019.) Academics then reinforced this framing by creating and perpetuating structures that are hierarchical and unequal (e.g., Hull et al. 1982, Buranyi 2017, Sharples 2017, Johnson et al. 2018, Ellemer 2020, Oluo 2020, Singh 2022). In other words, the prestige paradigm is "dependent on the nonprestige of others" (Cook 2022) and thereby creates unequal dynamics of access and entry, social and cultural *capital* (table 1), influence, hierarchies, and advancement (see Sismondo 2010, Todd 2012, Wilder 2013, Castleden et al. 2015,Halsey et al. 2020, Wingfield 2020, Baker 2021, Graeber and Wengrow 2021, Chen et al. 2022, Deanna et al. 2022, Docot 2022, Graves et al. 2022). This stereotypical framing of science persists despite the reality that the actual history of science is global, culturally and linguistically diverse, and only relatively recently driven by Euro-colonial paradigms (Barsh 2001, Janica 2018, Robson 2020, Sidik 2022).

Today, this paradigm enables or perpetuates *gatekeeping* (table 1). Gatekeepers define and evaluate success and subsequently determine who has access and control, mediating both exclusion and provision of opportunities and resources throughout academia and related sectors (Husu 2004, Hansson 2018). This is especially problematic when the metrics of success are based on accomplishments that are more accessible to some groups than others. For example, the NSF's funding review of proposals in the United States is not blind, and funding is awarded to White researchers at higher rates than to other demographics (Chen et al. 2022). When academics sustain the prestige paradigm, gatekeeping becomes a fundamental role, along with teaching, research, and administration (Merton 1973, Dancy and Hodary 2022).

When academics uphold the prestige paradigm, they dictate who enters and stays in science, often as a matter of *identity* (table 1). Worse, individuals, and consequently systems and institutions, *misrecognize* (table 1) people with minoritized identities, coding them as lacking knowledge and the ability to produce knowledge (e.g., do science; Taylor 1992, Fraser and Honneth 2003, Kim 2021, MacGregor et al. 2024). For instance, misrecognition of Indigenous people as engaging in "primitive," "mystical," and "irrational" ways of knowing was used to justify imposing "civilized," "scientific," and "rational" European ways of knowledge production and styles of reasoning (Quijano 2000). The relationship between the prestige paradigm and identity is complex and has roots in the colonial history of academia we described earlier; there is a rich literature on decolonizing academia that has bearing on efforts to make scicomm more just (e.g., Quijano 2000, Bhambra et al. 2018). Inherent, socially informed biases about people's *intersectional identities* (table 1; Crenshaw 2013) also affect how we engage with other people within and beyond academia (e.g., Liu et al. 2019, Davidson and Kelly 2020). See box 3 for further discussion on bias.

Furthermore, the prestige paradigm intersects with economic capital to perpetuate injustices associated with money and resources. Science operates within a broader capitalist system that exploits labor (Bousquet 2017), which, in turn, advantages those who are systemically privileged already (Templeton et al. 2016). This exploitation manifests in part by excluding those without enough privilege to undergo the low-paying, long-term training phases (Ahlgrim 2022, Sutter 2022, Van Dam 2022).

language throughout the present article, to underscore the relative agency and responsibility of people in academia.

Unpacking intersectional injustices in five realms of science-related communication

To organize our discussion of injustices affecting scicomm in the academy, we authors conceptualized five realms of science-related communication (table 2). These realms are characterized by the activities performed, the typical roles of people who engage in them, and the people they aim to reach or work with (table 2). The five realms are *scientific communication* (table 1); teaching scicomm; sharing science, technology, engineering, and mathematics (STEM) beyond academia (academics engaging in scicomm); scicomm research; and scicomm careers beyond academia. Similar injustices affect multiple realms, although there is variation in how these injustices manifest. An individual can be engaged in multiple realms and may therefore experience (and perpetuate) injustices in multiple realms.

To change this system to support and foster ethical scicomm, awareness of the overarching problems isn't sufficient. Each academic shapes academia as a whole. To foster ethical scicomm, academics must understand the *specific* ways in which injustices manifest in each realm of scicomm, then plan for and take corrective action. Therefore, we next provide examples to illustrate and contextualize these complex issues. Ultimately, we invite readers to consider their roles in each of these realms and then work to resolve these issues. To support readers' efforts, we provide a framework and recommendations to do so toward the end of the present article.

Scientific communication

Academic, scientific communication includes intradisciplinary communication among scientists, interdisciplinary

Box 3. Bias and identity.

Bias describes a preference for one person or thing over another and can be explicit or implicit. People do not perceive each other neutrally, and the implicit bias with which we interact with each other can be unconsciously driven by our own past experiences and preferences (table 2; Gvozdanovic et al. 2018). We all have implicit biases, and it can be informative to explore your own (https://implicit.harvard.edu/implicit/takeatest.html). Because institutions comprise people, the policies, practices, and structures we encounter in academia are also shaped by these people's biases. Importantly, when people's biases are normalized and rationalized into policies and practices that confer advantage to some and disadvantage to others, people then create structural biases that are often perpetuated by, invisible to, or resisted by individuals (McAdam et al. 1996, McGee 2020, Lincoln and Stanley 2021).

Extensive research has explored the manifestations of biases (e.g., in health care, Hall et al. 2015; related to women at all career stages, Llorens et al. 2021; with respect to race, Leshin et al. 2022; for LGBTQ+ people, Cooper and Brownell 2016, Cech and Waidzunas 2021; and regarding neurodiversity, Mellifont 2021, Grandin 2022). Sometimes, bias is manifested as exclusion or dismissal of credibility, such as when one person reacts negatively to another person's ideas on the basis of that person's visible differences (Ruffle and Shtudiner 2015). For example, people think a scientist only looks certain ways (e.g., Chambers 1983, Miele 2014). In reality, anyone can be a scientist, including a 2-year-old girl who identified a new tree-hopper species (Li 2019); a 69-year-old women who documented that snails have a homing instinct in her garden (Ghosh 2010); and low-income, racial- and ethnic-minority middle schoolers who studied the effect of urban light on an invasive grass (Murphy et al. 2021).

At other times, bias is based on nonvisual cues of difference, such as someone reacting negatively to an unfamiliar name (McConahay 1983, Kang et al. 2016) or perceiving someone as "old" (Zaniboni et al. 2019). In both cases, it can be easy to dismiss these interactions as the unfortunate ignorance or bias of an individual. However, substantial evidence from history, contemporary social dynamics and policy, and interdisciplinary research clarifies that these reactions are deeply rooted in culture, social norms, and one's construction of reality (see Davison and Kelly 2020). Indeed, hierarchies and who has access to resources are often systems-level manifestations of bias. For instance, tenure-track professors from the United States are much more likely to come from higher socioeconomic status families (e.g., education level of parents and childhood wealth) than the rest of the US population (Morgan et al. 2022).

There are myriad ways that bias compromises or constrains scicomm, illustrated by the following examples: Scicomm researchers may administer surveys that require Internet access to complete or that only include binary gender demographic options. University communications personnel may feature photographs of minoritized students doing public engagement on academic websites for recruitment efforts, when the photographs do not reflect the actual diversity of the student population. Scicomm instructors are evaluated by colleagues who rely in part on teaching evaluations known to reflect students' biases against certain demographics (ethnicity, Chávez and Mitchell 2020, Murray et al. 2020; female presenting, Mengel et al. 2017, Murray et al. 2020; international, Ghosh and Barber 2021; queer, Russ et al. 2002).

communication between scientists and nonscientists (e.g., administrators, funders), and communication with students in and out of the classroom (table 1). Although this realm does not include scicomm, this realm clearly embodies the prestige paradigm in ways that will be familiar to most readers (box 2).

The values and social classes that formed the academic prestige paradigm also established journals, professional societies, awards, etc., especially in the Global North. All of these aspects of academia are likewise rooted in that problematic paradigm. Academics adhering to the prestige paradigm prioritize research-related publications in high-impact journals, large grants, keynote invitations, and expensive conferences and explicitly reward these through the rituals of academic promotion and tenure (Youn and Price 2009, Buranyi 2017). The implication, then, is that nothing else counts or that it does not count as much. The sophistication and skill required to distill complex science are too often disregarded as lower-value (e.g., Merkle et al. 2022). Individuals adhering to the prestige paradigm drive a set of injustices (biased resourcing and valuation of people and their work). For instance, mentoring and service often don't count, but such work is vital to academia, and marginalized and intersectional academics experience a heavier mentoring and service burden (Massé and Hogan 2012, Jimenez et al. 2019, Deanna et al. 2022). Indeed, doing this work well requires attention, commitment, and expertise (Steffen 2009).

The injustices described above are exacerbated when we consider *whose* work is valued, given particular identities are disadvantaged or considered less qualified (e.g., women and racial minorities, Yap and Konrad 2009, Llorens et al. 2021; and LGBTQIA+ people, Cech and Waidzunas 2021). Academic publishing is exclusionary because of standard practices such as single-blind review (in which the author's identity is known), which enables elitist, racist, and sexist discrimination (we all have biases; see box 3; Crane 1967, Buranyi 2017, Brainard 2022, Hengel 2022) and which requires global scientists to assimilate to Euro-colonial writing and speaking styles (Rose 1985, Hull and Rose 1989, Trachtenberg et al. 2018, Docot 2022, Rassim et al. 2022; figure 3). Likewise, the credibility of a science expert or messenger can be at risk of judgment or even harassment in numerous settings (e.g., interviews, conferences, public talks), depending on gender presentation, speaking styles, and accents (e.g., dialects such as African American Vernacular English, Payne et al. 2000, Boucher et al. 2013; accents, Chen et al. 2013, Akomolafe 2020); age, appearance (Gilpin 2016, Seron et al. 2016, Bothwell et al. 2019); presentation style, and affiliation (Fitzgerald 2018 quoting Nussbaum 2018). In particular and despite much discussion to counter the issues, conference organizers continue to plan events that favor able-bodied (e.g., standing for hours at a poster session, a lack of accommodations for those with visual or hearing impairments), extroverted, and neurotypical people from cultures that value individual achievements, but these events are critical for networking and validating all scientists. Taken together, these issues create barriers to entry and success for historically marginalized academics and can exclude the ideas, interests, and skills of

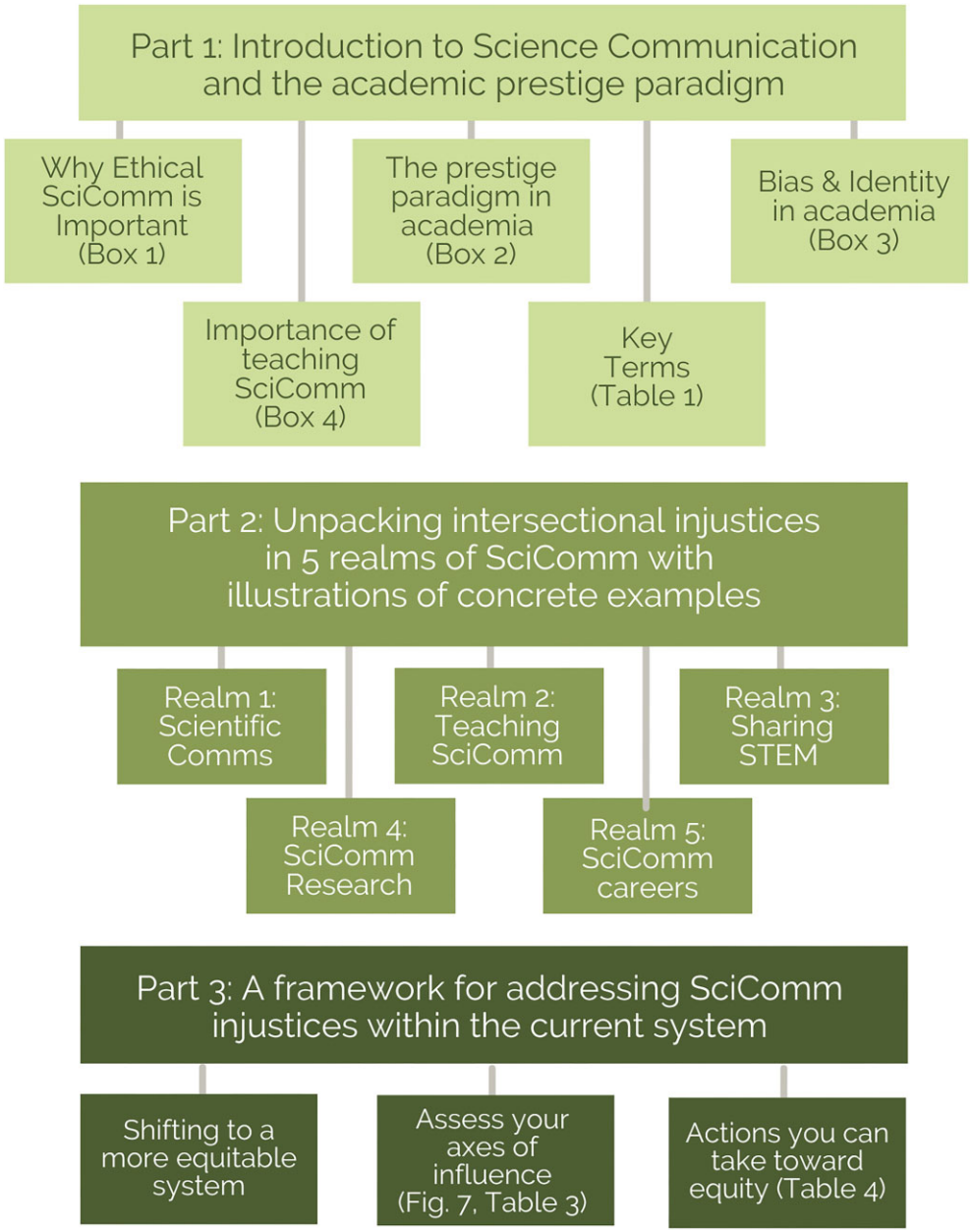


Figure 2. A map of this article to guide readers toward collective action. This article is organized to help readers understand the importance of ethical scicomm and the associated issues of the prestige paradigm (light colored boxes, part 1), recognize how intersectional injustices affect scicomm throughout the academy (medium colored boxes, part 2), and identify how they can use their axes of influence to make the system better (dark colored boxes, part 3).

scientists with diverse backgrounds and identities (Halsey et al. 2020). Imagine, instead, how much more accessible and inclusive a poster session at a conference might be (figure 3a) if we celebrated presenters with diverse identities and reconsidered our criteria for high-quality scientific communication (e.g., including community members in the work as coauthors or credible knowledge producers, using language that resonates with the community rather than stodgy science jargon, ensuring accessibility; figure 3b).

People adhering to the prestige paradigm also privilege certain identities in the context of science instruction (a type of scientific communication) and associated teacher evaluation. Most science textbook authors and designers of existing curricula present an exclusionary version of science history (Sirvisetty et al. 2020, Wood et al. 2020, but see Sher and Molles 2022), which can cause students to experience othering through a misalignment of cultural values and teaching methods (Brown 2008). For instance, the content authors emphasize in textbooks and exam questions perpetuate micro- and macroaggressions when they highlight only cis White (see identity and Kanigel 2019b in table 1) men as examples of "good science" (Wood et al. 2020) or require students to identify with a binary gender simply to generate a practice data set (e.g., comparing heights of men versus women in the class). Moreover, student biases about one another affect how they communicate during active learning discussions during class; when the biases are negative, these interactions can reinforce assumptions about who can succeed in the sciences (Bloodhart et al. 2020). Implicit and explicit biases also affect how students

Table 2. Realms of science-related communication.

Realms of science-related communication	Examples of activities	Typical roles doing this work	Example interest groups, partners, and audiences
Scientific communication	Peer-reviewed papers, conference talks and posters, grant proposals, textbooks, courses	STEM faculty (R1 through community college), postdocs, higher ed students, staff	Fellow academics, science students, administrators, funders, editors, and publishers
Teaching scicomm	Scicomm lessons, courses and workshops; trainings for peers at institutions and conferences; associated grants, assessment and curricular planning	STEM faculty, postdocs, graduate students, staff, and consultants	Fellow academics, science students, postdocs, faculty, staff, administrators, and funders
Sharing STEM beyond academia (academics engaging in scicomm)	Can range from deficit model (public talks) through dialog model (volunteering at science events) to coproduction (community-engaged science)	STEM faculty, postdocs, graduate students, staff (including public information officers and outreach staff), and consultants	Diverse publics including community, PK–12, service providers (e.g., health, business), journalists and the media, policymakers, science enthusiasts, and volunteers
Scicomm research	Peer-reviewed papers, conference talks and posters, academically situated scicomm trainings and classes.	Faculty, postdocs, graduate students, staff from diverse fields (e.g., social science research done by social scientists or scientists), and consultants	Fellow academics, students, administrators, funders, editors and publishers, and some practitioners outside the academy
Scicomm careers beyond academia	Can range from deficit model (documentaries) through dialogue model (summer camps) to coproduced, applied science (managing invasive plants)	Professional science communicators beyond higher ed (e.g., journalists, PK–12 STEM educators, museum educators, biologists, extension agents, and nonprofit personnel), science enthusiasts, and celebrity scientists	Shared practitioner community; diverse publics including community, PK–12, service providers (e.g., health, business), journalists and the media, policymakers, science enthusiasts, and participatory science volunteers

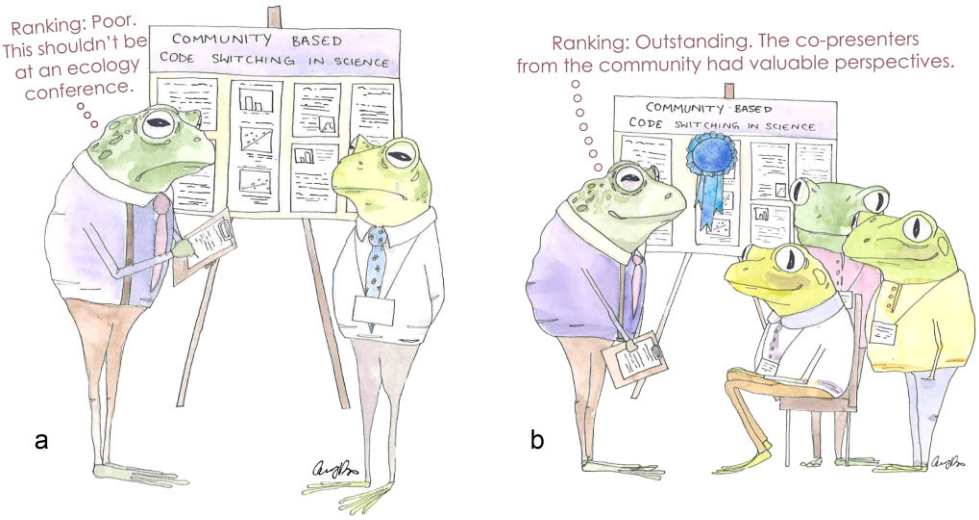


Figure 3. Injustice in the realm of scientific communication. (a) People planning, judging, and attending scientific conferences often exclude and undervalue scicomm, instead favoring longstanding norms (e.g., single presenter) that privilege those already favored by the prestige paradigm. (b) Alternatively, people involved with scientific conferences can enhance inclusivity and help remove barriers to entry and success of marginalized groups by formalizing appreciation of ethical scicomm practices such as including diverse community members in the work.

evaluate their instructors, but teaching evaluations often play a critical role in promotion decisions. Many studies have shown that teaching quality is not correlated with evaluations but, rather, with rapid subconscious judgements that favor the stereotypical scientist (straight, cisgender, White men; Ambady and Rosenthal 1992, Russ et al. 2002, Schmidt 2015, Mengel et al. 2017, Murray et al. 2020, Adams et al. 2022), unless cookies are provided on evaluation day (Hessler et al. 2018).

When academics adhere to the prestige paradigm, we also encounter issues of economic capital (table 1), thereby perpetuating

Box 4. Importance of teaching ethical scicomm.

Teaching scicomm is powerful and valuable for students and society. Students who practice scicomm have increased scientific self-efficacy (Broder et al. 2019) and have improved methodological research skills (Feldon et al. 2011); learn to tailor messages for their *audiences* (table 1; Weber and Schell Word 2001, Zia and Todd 2010, Brownell et al. 2013); and are, therefore, better prepared for a diverse array of jobs and postgraduation goals. Employers are clamoring for a workforce that is well versed in scicomm (e.g., Maehr et al. 2002, Atkins 2011, Mercer-Mapston and Kuchel 2017). Students want to influence social change (Jacoby 2017), and education in ethical scicomm builds student understanding of socioscientific issues (Medvecky and Leach 2019), prepares them to be effective scientists (e.g., Lubchenco 1998, Fallowfield and Jenkins 1999), and enhances student engagement with diverse community members (e.g., Goldina and Weeks 2014). Ethical scicomm education involves preparing students to increase their skills in communicating about emotionally charged socioscientific issues (e.g., Osseweijer 2006), to increase participation of diverse community members in decision-making (Heath et al. 2007, Rust et al. 2021), and to use guiding principles of ethical scicomm to inclusively or effectively communicate with diverse audiences (Georgiadis and Pescarelli Lagorio 2012, Medvecky and Leach 2019).

It is also important to recognize that teaching scicomm is nuanced and relies on expertise. To teach scicomm well, educators must be comfortable with different modes and media of communication, integrate different world views into assignments, equitably assess student work, be familiar with communication and discourse theories, and synthesize and convey the rich, multidisciplinary literature that informs inclusive, evidence-based scicomm and inclusive pedagogies (e.g., Mercer-Mapstone and Kuchel 2017, Gannon 2020, Zuroski 2020, Balgopal et al. 2021, Edlund and Balgopal 2021, Kulago et al. 2023). Effective teaching requires the rigor that we expect of good science, but most academics fail to value, expect, and train people on good teaching practices (Brownell and Tanner 2012).

the injustices associated with money and resources. Prohibitive page changes for publishing (especially for prestige and open access journals; Van Noorden 2013) and increasingly costly travel expenses for conferences (Hong 2018) prevent underresourced individuals and groups from submitting their work to these venues or participating in valuable networking. Grant writing, a requirement for participation and prestige in academia, also rests on inequitable, codified norms. Better-resourced institutions provide support and training for grantsmanship, which becomes heritable as certain labs or departments have access to these resources and cultivation (Wahls 2016, Sato et al. 2021; see also the National Science Foundation's racial inequities in funding, Chen et al. 2022). In essence, normative communication skills and insider grooming help researchers and institutions with *privilege* (table 1) to build their programs and careers.

Although we have outlined many grim issues, there is room for hope. First, action is possible because academics are trained to speak the language of science for reasons that are not entirely negative. Scientists use jargon to say things efficiently, and jargon signals belonging (Lave and Wenger 1991, Davies 2005). Although jargon can enable *gatekeeping* (table 1), if academics nurture authentic relationships across disciplines and beyond academia, we can build shared language. Shared language takes the focus off the messenger (you, the academic). Instead, we can become part of a mutual process of using and exchanging information. Because academics are already conditioned to use specific language to belong within our respective disciplines, it is not a stretch to leverage this conditioning toward better work beyond one's discipline. Second, people who host virtual scientific conferences reduce financial, geographic, and political barriers to participation. Anecdotally, we have seen creative conference presentations and posters that include community members being recognized and encouraged, especially at the regional and local level (figure 3b; Silvy 2016). Similarly, people involved with conferences and science instruction are increasingly highlighting speakers and examples addressing nonbinary aspects of nonhuman animal behavior, intersections between art and the history of science, and more.

Teaching scicomm

Teaching scicomm in higher education involves teaching students to communicate science with diverse *audiences* (table 1), in essence turning a biology degree into a transferable skill set (see box 4; e.g., Lubchenco 1998, Kuehne et al. 2014, Murphy and Kelp 2023). Scicomm is increasingly taught in higher education settings (Fischhoff and Scheufele 2014). Of the four of us who have taught stand-alone scicomm courses, all of us were the first to do so in our STEM departments, but the prevalence of scicomm courses in STEM departments is currently unknown (we are investigating this question in a separate study). How academics teach scicomm, what the learning goals and assessments should be, whether it should be taught in STEM departments or elsewhere on campus (e.g., journalism, technical writing), and even whether it can be taught are still debated (Baram-Tsabari and Lewenstein 2017, Rubega et al. 2021).

Nevertheless, when people are trained in ethical scicomm, there are many benefits, including enhanced diversity, equity, inclusion, and justice (*DEIJ*; table 1) elements of teaching and public engagement and repaired public trust in and use of science (per box 1 and Sumner et al. 2014; also see box 4 for more on the value of teaching ethical scicomm). Despite the importance of teaching scicomm in higher ed or science, there are significant hurdles posed by those who uphold the prestige paradigm. Systemically, STEM academics often undervalue teaching relative to research during promotion and merit decisions (Murray 2019). Teaching scicomm is further undervalued (Eise 2019) and basically considered service (Bell and Lewis 2022) by most STEM academics. Service and service-like teaching are disproportionately done by women, minoritized people, and those lower in the hierarchy (Hogan 2009, Steffen 2009, Massé and Hogan 2012, Jimenez et al. 2019). Teaching scicomm, like engaging in scicomm and other service work, is likely predominantly done by these same historically excluded demographics, a probability that warrants further research. Furthermore, three authors on the present article have even taught scicomm courses for no pay (figure 4a). Indeed, in most cases, scicomm courses are electives that are more likely

Figure 4. Injustice in the realm of teaching scicomm. (a) Teaching scicomm is currently undervalued by academics, and numerous barriers prevent these important courses from becoming established. (b) Support for teaching scicomm would signal that the field and expertise of scicomm researchers and practitioners is valued and respected not only by our students but by our peers and administrators.

to be taught by underpaid adjuncts in tenuous, short-term roles (Finkelstein et al. 2016). Other coauthors among us were also expected to first secure external grants for scicomm to justify teaching it. In such cases, administrators and faculty peers are tacitly or explicitly indicating that only subjects receiving external funding are worthy of being taught. These examples highlight the reality that STEM academics tend to systematically undervalue teaching scicomm.

Imagine, instead, if our administrators, peers, and students actively supported the benefits of teaching scicomm (see figure 1; e.g. better science, enhanced respect for community partners, more effective policy efforts). Such support requires valuing and respecting the expertise of scicomm researchers and practitioners (figure 4b) as well as compensating them. Recent changes in the teaching of scicomm give us authors hope. First, in our experience, focused scicomm courses are becoming more common at a diversity of institutions, and more people are now teaching scicomm formally and on load (getting credit for it) than in the past. For example, many of us began teaching the first scicomm courses at our institutions 5–10 years ago, and now such courses are regularly offered at our institutions, and some schools even offer a scicomm minor. In addition, human dimensions of science (which we authors see as related closely to scicomm) are increasingly being prioritized within courses and as stand-alone courses (e.g., structured decision-making, mediation). Perhaps most inspiring, students are demanding scicomm courses. The scicomm courses of which we are aware have waiting lists, and many of us authors have had students express interest in our STEM research groups because of our commitment to scicomm. Finally, academics are learning about scicomm from students and communities and hopefully incorporating this knowledge into their scicomm courses. For instance, many students are engaged in informal scicomm through popular social media efforts, filmmaking, podcasting, community-based science, social justice work, and even the launch of major engagement and training initiatives run by students.

Engaging in scicomm (academics sharing STEM beyond academia)

Most people think of scicomm as scientists sharing STEM beyond academia. In our discussion of this work, we authors concentrate on people *within* the academy who engage in scicomm (table 2). This work is distinct from *scientific communication* (table 1). Academic scientists are motivated to engage in scicomm for multiple reasons, including granting agencies' expectations, institutional priorities, and scientists' own complex, personal, or moral imperatives (Royal Society 2006, Pew 2015, AbiGhannam 2016).

Academics adhering to the prestige paradigm drive a set of injustices related to sharing STEM beyond the academy. Because scicomm itself is undervalued (Eise 2019, Singh et al. 2019, Bell and Lewis 2022, Wróblewska et al. 2024), academics who invest time and work in scicomm are sometimes perceived as lesser by their science peers (figure 5; Martinez-Conde 2016, Merkle et al. 2022). Furthermore, ethical scicomm is time intensive and does not automatically produce (or even distracts from) academically valued products such as grants and high-ranking publications (Tretkoff 2007). Academics who do scicomm are also disadvantaged in academic settings where the number of attendees or high-profile nature of events are default metrics of what counts (versus quality of engagement or long-term impacts, both of which are difficult to document; figure 5). Worse, in our experience, and as documented in the literature (Bell and Lewis 2022), administrators and communications offices may impede scicomm efforts, then brag about and claim responsibility for employees' and students' scicomm successes when it is politically or financially useful (e.g., student recruitment, donor courting, accreditation).

Together, these injustices can specifically discourage academics with certain identities from pursuing training in and engaging in scicomm. First, minoritized academics have less access and support for sharing STEM outside the academy, whereas established, senior scientists have relatively more social *capital* (table 1) and enhanced resourcing. These assets then enable more senior academics to deflect dismissive attitudes about scicomm (Bentley and Kyvik 2011). Conversely, junior academics risk career setbacks (e.g., Merkle et al. 2022) or assume the already disproportionate burden of scicomm perceived as service (e.g., Hogan 2009, Massé and Hogan 2012). Furthermore, some academics are perceived as less credible; for example, women scientists engaging in scicomm are frequently described as "bitchy," "emotional," "bossy," and "motherly" (McKinnon and O'Connell 2020).

Just as there is inequality in how identity affects those engaging in scicomm, academics adhering to the prestige paradigm recognize only certain people as credible knowledge producers; generally, audiences are relegated to receiving information, not

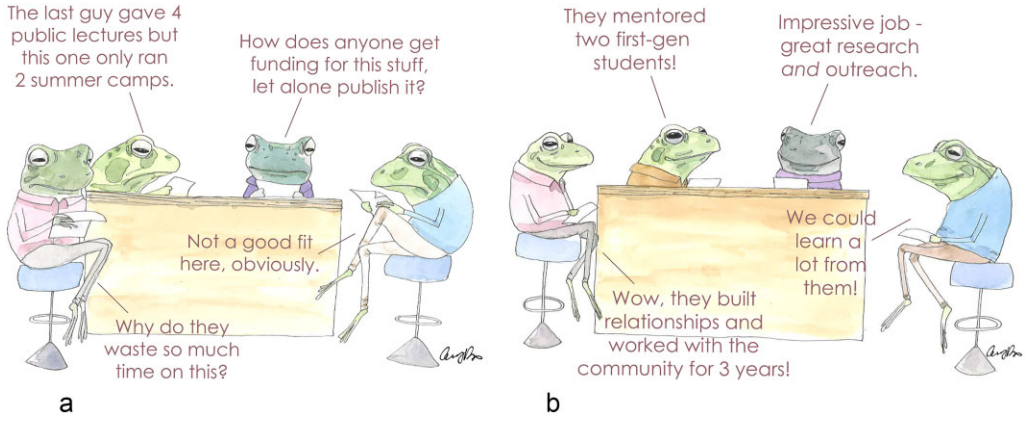


Figure 5. Injustice in the realm of scicomm engagement. (a) Academics working in scicomm are often perceived as lesser scientists (e.g., by hiring committees) by peers and administrators, and the assessment of scicomm work is often done by people who have little expertise in it. (b) Academics in power positions can facilitate and encourage positive reviews of colleagues who do ethical scicomm.

coproducing (table 1) knowledge and solutions. This attitude is known as the *deficit model* (table 1), and academics' reliance on it exacerbates inequalities (e.g., Razai et al. 2021). Recent, problematic examples of the deficit model include ineffective vaccine advocacy messages in BIPOC (Black, Indigenous, and people of color) communities that disregard religious issues (Razai et al. 2021) or poor personal experiences with the medical establishment and a history of medical exploitation (Warren et al. 2020). A long-term example of the deficit model is the North American Model of Wildlife Conservation, which has legitimized the exclusion of Indigenous peoples from their homelands in the name of preservation (e.g., Yellowstone, Yosemite; for an example of a better approach, see Poudyal et al. 2018). People who instead use *coproduction* (table 1), *dialogue* (table 1), and related approaches (e.g., interpretation; Tilden 2008) can reduce the imbalances associated with unidirectional scicomm. Such adjustments are especially important when academics are involved with creating public policy (Spafford 2019) and when scicomm could affect people historically disenfranchised by science or policy (box 1; e.g., Poudyal et al. 2018).

However, academics' adherence to the prestige paradigm confounds even good intentions. People using positive alternatives (e.g., citizen or community science, action research, coproduction) try to make access to and participation in science more equitable, dialogic, and rooted in community or interest groups' needs and positionality (e.g., Polfus et al. 2017). However, these efforts can be exclusionary and narrow in scope (Reich et al. 2010, Dawson 2014a, 2014b, 2018, Varner 2014, Lin Hunter et al. 2020), because of the resources (including time), connections (access), knowledge, and experience required of all involved. Furthermore, academics' situated privilege relative to communities we hope to work with can lead to centering oneself or one's goals instead of on the community (e.g., harmful land acknowledgments; see Vowel 2016), swooping in to "save" someone or someplace through parachute science (Asase et al. 2022), exclusion of knowledge bearers and contributors (e.g., undergraduates, community members, Indigenous researchers and consultants) from academic products (Asase et al. 2022), disregard or refusal to create meaningful products or outcomes for end users (Castleden et al. 2015, Merkle et al. 2019), and truncating community relationships in favor of moving frequently for career advancement. Fundamentally, the funding models academics rely on and sustain (scarcity mindset, novelty as priority) do not allow for sustained relationships outside academia. However, such relationships are fundamental to ethical scicomm.

Throughout academia, funding is a circular injustice: The way people allocate money manifests what is valued while also impeding what is not. In scicomm, academics' conflation of research quality with money (see Polster 2007) leads to specific, predictable injustices (Steinþórsdóttir et al. 2020). Even when funding mechanisms at universities and granting agencies exist for scicomm projects (e.g., the NSF Broader Impacts framework; Caballe and Bardelli 2021), funding decisions are made by scientists who are rarely scicomm experts and likely unfamiliar with ethical scicomm (Tretkoff 2007, Bozeman and Boardman 2009, Sarewitz 2011). Too often, scicomm is treated as a supplement rather than considered central to the science proposed (e.g., Sarewitz 2011, Nadkarni and Stasch 2013). Worse, reviewers tend to favor narrow, exclusionary notions of what works (Reich et al. 2010, Nadkarni and Stasch 2013, Dawson 2014a, 2014b, 2018), and scicomm experts are regularly recruited for their expertise or time without receiving appropriate compensation (see Wilkinson et al. 2022). After all that, successful scicomm efforts that receive attention are also sometimes poached (i.e., credit for them is stolen) by faculty or administrators for the purposes of securing donations, grants, or public recognition (trespasses that some coauthors have experienced firsthand). All these injustices can lead to ineffective, low-quality, and harmful scicomm efforts led by academics lacking the expertise, coaching, or accountability to carry out rigorous, ethical scicomm (Ziegler et al. 2021).

Although academics engaging in scicomm face many challenges, there is reason to be hopeful. First, scientists who do ethical scicomm actually have higher research productivity (Jensen et al. 2008, Russo 2010). In part, this productivity boost relates to improved academic writing (Martinez-Conde 2016), a skill academics can hone by effectively connecting diverse people to science. In addition, there are many examples of successful, coproduced science (e.g., Polfus et al. 2017, Risien and Storksdiek 2018). Such research can and should inform training, funding, and support programs, so academics can ensure scientists are prepared to meaningfully engage with marginalized communities. Furthermore, members of scientific societies are leveraging the credibility and prestige of their societies to emphasize the importance of scicomm and provide resources, awards, and training.

Social justice issues have also prompted individuals and organizations to critically examine their own scicomm efforts.

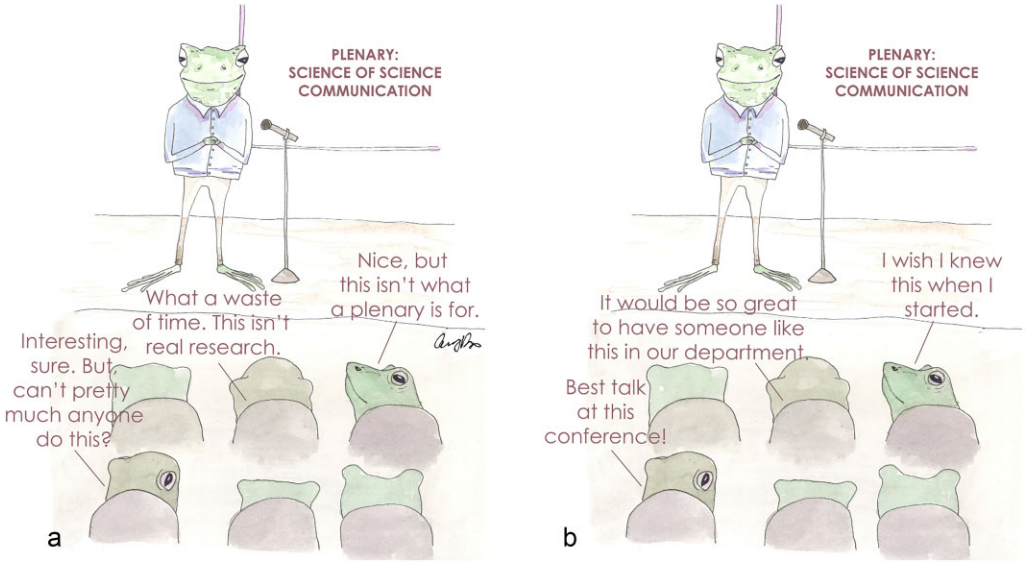


Figure 6. Injustice in the realm of scicomm research. (a) Academics often devalue scicomm research. It is even assumed that this work can be done by anyone, despite the science of scicomm being an expert domain. (b) Scientists can learn and improve their own efforts by inviting scicomm researchers to share their work through seminars and other professional development fora.

In other words, people are increasingly recognizing that not all scicomm efforts are effective and that some may even do harm. As individuals get better at ethical scicomm, they increasingly advocate for scicomm to be included in retention, tenure, promotion, and hiring decisions (figure 6), and some institutions are therefore exploring how to include scicomm metrics. There is a great proof of concept already: extension roles in agriculture and forestry (Gornish and Roche 2017) and civic spheres. Because extension roles are so effective and valued, academics can use them as a model to create similar positions in other areas of STEM such as biology or engineering. Although scicomm is primarily done by people in roles given less prestige in academia, growing recognition of its importance may also inspire more academics to reimagine prestige and hierarchies for those who do scicomm. Ironically, as staff and non-tenure-track faculty increasingly model alternatives to the publish or perish approach, they also stimulate discussion of how to expand the privilege of scicomm-heavy roles to tenure-track faculty. Ideally, these shifts will drive the reciprocal stability, compensation, and perceived value of all employee types who do scicomm.

Scicomm research

Scicomm research from within the academy, sometimes called the *science of science communication*, refers to the explicit study of any aspect of scicomm (Fischhoff and Scheufele 2014). This growing field requires skills from numerous disciplines. In practice, it can involve quantitative, qualitative, and mixed-methods research to inform science pedagogy, organizational management, community engagement, etc. (e.g., Rust et al. 2021, Vickery et al. 2023). In academia, scicomm research involves recognizable scholarly activity, including peer-reviewed publications, talks, and conferences. Because scicomm research is multidisciplinary and done by diverse scholars across numerous fields, it is not disseminated exclusively in communication or scicomm journals (National Academies 2017, Gerber et al. 2020). Furthermore, scicomm research and evidence-based training is conducted by communications and behavior scholars (often within the social sciences), as well as by scientists examining their own scicomm efficacy (Scheufele 2013, National Academies 2017). We coauthors are a blend of scicomm and social science scholars and natural scientists practicing scicomm; our goal with this article was to publish where scientists and science instructors would most likely encounter these ideas and use them. We increasingly see similar, deliberate cross-pollination of scicomm research into science journals (Davis et al. 2022).

Given the prestige paradigm, it is predictable that scicomm research is undervalued—and, at times, devalued—by the academic community, despite being an expert domain (figure 6). Scientists pay relatively little attention to research-informed insights in scicomm, and such work is too often dismissed as "anyone can do that" (figure 7; Fischhoff and Scheufele 2014, Jensen and Gerber 2020). For related reasons, the field has not been established in disciplinary structures; relevant scholars and literature are often siloed within diverse fields with greater credence in the prestige paradigm, such as psychology or marketing, each with their own discipline-specific jargon and conventions (National Academies 2017, Gerber et al. 2020, Navarro and McKinnon 2020). This isolation complicates scientists' efforts to find and apply scicomm research insights.

As with other realms of communication and research, it is critical that scicomm research be done ethically, with respect for and in communication and collaboration with relevant scholars and audiences, end users, communities, etc. (Banks et al. 2007, Reich et al. 2010, Dawson 2014a and 2014b, Dawson 2018, Canfield et al. 2020). As such, the identities of people who are research subjects, collaborators, and users are of vital importance. Regardless of scicomm's relative value within academia, members of academic institutions still benefit from the prestige and privilege of academia broadly, when contrasted with individuals and communities outside the academy. Therefore, academics of all identities are responsible for acting in right relations with people they seek to understand, support, and inform through scicomm research.

As is true for academics who do scicomm, scicomm researchers are also not sufficiently valued or compensated. Many scicomm researchers are frequently exploited by fellow academics and administrators for their expertise (e.g., for grant writing, project

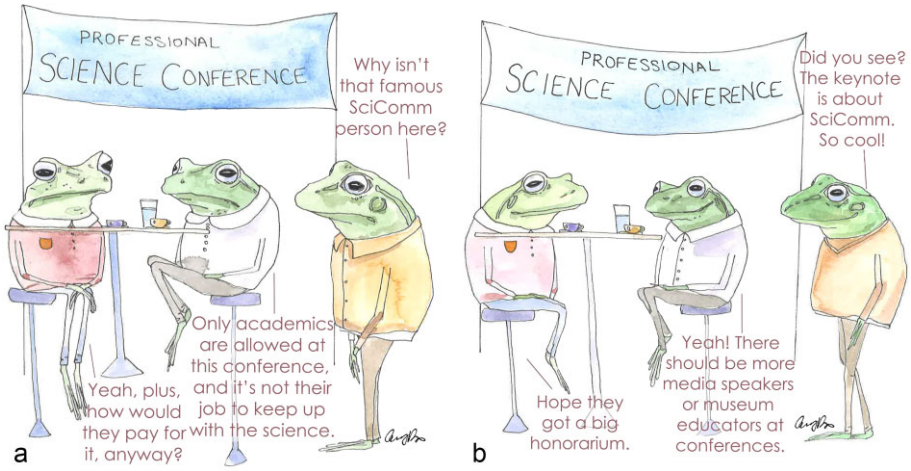


Figure 7. Injustice in the realm of scicomm careers beyond academia. (a) Organizers of academic conferences often exclude people with valuable scicomm expertise. (b) Conference organizers can platform scicomm practitioners by inviting them to present at and even keynote such events.

scoping and justifications, and providing training). Frequently, in some coauthors' experience, scicomm researchers are asked to perform the broader impact portion of a research project (per NSF lingo; ARIS 2021) without compensation (e.g., funding or coprincipal-investigator roles). Furthermore, academics wanting to partner with scicomm researchers must support the implementation and assessment of the scicomm components at a level that can be meaningful to scicomm scholarship, including adequately funding the work. For example, longitudinal scicomm scholarship, which has increased capacity to understand behavior and attitudinal changes, remains a major research gap because long-term research projects in this domain are rarely funded (Gerber et al. 2020). Meanwhile, short-term projects impede ethical relationships, particularly in community settings. All these challenges render the transferable, actionable conclusions of scicomm scholarship less accessible to scientists and scicomm practitioners (National Academies 2017, Gerber et al. 2020).

Despite these realities, recent changes are heartening. First, more people are engaging in scicomm from diverse backgrounds, and individuals are recognizing the need to educate themselves in evidence-based practices. Therefore, the work of scicomm scholars and practitioners is being read and implemented more widely. Academically situated scicomm trainings and classes are also arising alongside relevant scholarship. Finally, more inclusive and contemporary approaches to scholarship are gaining traction within STEM; these have positive influence on valuing and using scicomm research.

Scicomm careers beyond academia

Although, in the present article, we emphasize the injustices of the prestige paradigm in scicomm, there is an extra-academic realm of scicomm that intersects consistently with academia. Science communicators who are not employed in higher education (hereafter, *scicomm practitioners*) often share other researchers' work to broad audiences (e.g., in roles such as museum educator, freelancer, journalist). This practitioner realm is crucial, because many science-trained professionals have careers beyond academia. Many scicomm practitioners have or receive specialized training to tailor messages to specific audiences (e.g., Schweizer et al. 2009), because scicomm practitioners must navigate broader societal constraints, institutional barriers, and opportunities present in a vast diversity of scicomm careers. In essence, scicomm practitioners possess the communications expertise and professional experience often lacking in STEM academics (Spoel et al. 2008, Knapp et al. 2013, Bolsen et al. 2019, Goldberg et al. 2019). In the present section, we focus on interactions between this realm and academia.

People who do not have academic or institutional affiliations tend to experience even more exclusionary attitudes about themselves and their work. This gatekeeping is typically conducted by academics resorting to *credentialism* (table 1) related to training, type of education, and affiliation (Treise and Weingold 2002); scicomm practitioners are thereby excluded from prestigious settings (figure 7). This exclusivity is counterproductive: Although scientific training may be considered more prestigious, many scicomm practitioners have more relevant and robust training in scicomm (which we hope we have convinced you is equally valuable; e.g., journalism, interpretation, informal education, social media, policy and public affairs; Pew 2009, Besley and Tanner 2011). Meanwhile, academics and others trained in science—but not scicomm—set impossible standards for scicomm practitioners (Stern and Powell 2013, Hicks et al. 2020, Prescod-Weinstein 2022a, 2022b), even though scientific credentials alone are inadequate for assessing the effectiveness or quality of scicomm. Often, credentialism is a screen for the convergence of both the academic prestige paradigm and broader biases and structural injustices in our society. In particular, credentialism is weaponized against women (e.g., Rossiter 1993), marginalized people, nonnative English speakers, and those engaging in scicomm in nontraditional ways (e.g., attacks on Greta Thunberg's climate advocacy emphasize her age and lack of science credentials; Judd and McKinnon 2021, Park et al. 2021).

Next, academics who perpetuate the prestige paradigm create barriers for trainees who may pursue scicomm careers beyond academia. Although becoming a scicomm practitioner is a meaningful and increasingly viable way for many people to use their science training, academics tied to the prestige paradigm may not see it that way. As a result, mentors may teach students (either directly or implicitly) that scicomm careers are less prestigious than science positions. STEM academics also largely fail to provide students with training that facilitates pursuing or transitioning into scicomm careers. Of course, academics' and funders' devaluation of scicomm also makes money a central issue for scicomm practitioners. Most obviously, a lack of money

limits scicomm practitioners' abilities to engage in these careers and do ethical scicomm.

Even so, there are hopeful developments in this realm. There are increasing instances of scicomm practitioners being invited and paid to consult and give keynotes and seminars in academic spaces (figure 7b). In addition, some academics are learning about ethical scicomm, and professionals experienced in a particular context, such as museum educators (Alpert 2016), are increasingly recognized as valuable collaborators.

Shifting to a more equitable system for scicomm within academia

Now for the exciting part: Academics can collectively change the system for the better! In this section, we authors first describe the ideal academic scicomm system; doing so enables us to collectively visualize the changes we want to see. We acknowledge the roles of individuals in performing and enacting the prestige paradigm, but we highlight that individual changes, through collective action, can become systemic changes that improve scicomm in the academy. Next, we help readers identify their position in the prestige paradigm hierarchy to guide them in determining the levers they can pull to affect change. Finally, we offer guidance on some of the actions that readers can take. We make suggestions about how to improve the system while working in it, because we value the potential of academia and have experienced the impact possible in academic work. We therefore want to see academia improved, not merely abandoned or—worse—dismantled.

The ideal academic scicomm system

We authors would like to live and work in an academic system where the injustices we have highlighted are resolved. What would this future look like? At a minimum, we ask readers to envision that they have access to all the resources and training they could ever want to do, teach, or study scicomm. Imagine that peers, students, mentees, and supervisors respect, appreciate, and reward work in scicomm that is equitable and inclusive, thereby helping make the world a better place. In this scenario, scicomm research, teaching, and practice contribute to public trust in science, help bridge tech-transfer gaps, and science graduates are better equipped to contribute to science and society.

Individual responsibility

Hopefully, you also want to make this vision a reality at your institutions. Nurturing and respecting scicomm from within academia is only a radical premise until enough of us agree and shift to working this way (e.g., Solnit 2016). Because the system is actually just individuals performing the prestige paradigm (e.g., Peterso 2022, Goldberg 2022a), changing our actions changes the system. Of course, for many of us who want to stay employed in the academy, there are also limits to the change one individual can implement (Robbins 2007, Holdren 2021, Goldberg 2022d, Pardo-Guerra 2023). Even so, individual changes, through collective action, become systemic changes that can improve scicomm in the academy.

Change for the better is possible

In changing for the better, there is an important corollary to universal design for learning (Capp 2017). That is, adjustments to improve individuals' experiences often enhance the environment for everyone. If the changes we authors call for (to improve the situation for scicomm in academia) are actually enacted, other dimensions of academia will likely also be improved. Moreover, effective change has been made in academia before: Foremost is academia itself shifting from theology and philosophy to the myriad disciplines academics recognize today. More recent examples include desegregation, shifts to learner-centered teaching, and creating promotion mechanisms for instructional and clinical track faculty members. Responses to the onset of COVID-19 also drove a rethinking of "normal" that proved society-wide and institutional change can happen quickly. Positive examples include more virtual accessibility, wider permission to work remotely, and enhanced teaching practices. It is also helpful to consider successful examples of rethinking academia entirely (e.g., the Ferrer School, Avrich 2014; folk schools, Eiben 2015; the Brooklyn Institute for Social Research, https://thebrooklyninstitute.com). At the same time, pragmatism is essential: Decades of tension and conflict around efforts to name, address, and change issues in education demonstrate just how much resistance can be expected (e.g., violent resistance to desegregation of US schools; Clotfelter 2011).

Change requires us to assess our axes of influence in the academic prestige paradigm

Academics can affect change in two ways: changing our behavior and influencing other people's behavior. In both cases, our impact and actions will depend on where we each fit into the prestige paradigm's hierarchies. For instance, academics can use their prestige or that of their institution to initiate new programs, allocate funding, or make space for those who hold less prestige (Cook 2022). To help you, as a fellow academic, reflect on your individual potential to influence change in scicomm in the academy, we authors developed the figure below (figure 8). Our work to visualize the many intersecting axes of influence within academia is informed by Sword's visualization of the multiple dimensions of writing habits (https://writersdiet.com/base/base/).

In essence, academics' influence in the academy is shaped by our economic capital (access to and control of money), academic capital (a subset of intellectual capital that encompasses CV [curriculum vitae] items that make one seem established in academia), social capital (one's social networks), and prestige or identity (figure 8). As figure 8 shows, academics' influence can be visualized as a polygon that summarizes the extent to which each academic holds these types of capital. The polygon's shape and size (hereafter, *influence potential*) will vary among people, even people with the same job title, which means that different individuals will be able to affect different types of change. Below, we provide examples of what the influence potential may look like for a hypothetical graduate student, a new faculty member, a senior faculty member, and an administrator (figure 8).

Readers who want to identify their own potential to effect change can use table 3 to determine where they sit on each of the axes of academic influence. We recommend that you complete the exercise for at least two or three scenarios, because everyone's influence potential will differ by context (e.g., in a classroom versus in a meeting with a dean).

Actions you can take

Now that you have identified your axes of influence in the academy, we provide concrete recommendations about what you can do. These recommendations are informed by the authors' collective experience, expertise, and engagement with scholarship and discourse in scicomm, sociology, and social justice.

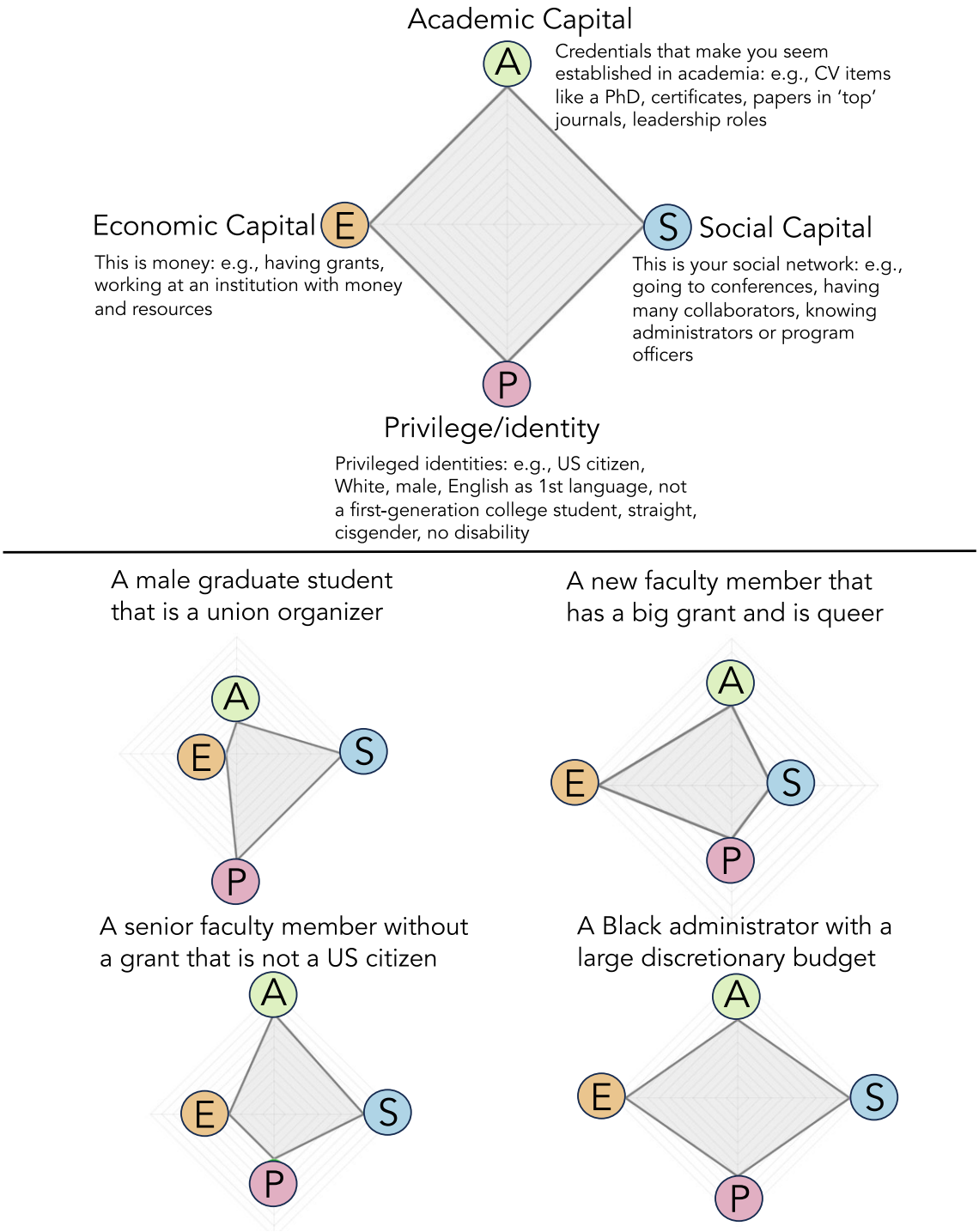


Figure 8. Intersecting axes of influence in academia. The top panel presents the primary axes of influence, which can be visualized as a polygon that summarizes the extent to which an individual holds each of these types of capital. The bottom panel shows sample polygon shapes for four hypothetical individuals. These examples illustrate how one's influence potential may vary, depending on where influence is situated on these axes.

All of us can take time to ask *How am I perpetuating hierarchy or marginalization, and how can I do better?* Because we academics are indeed "the system," this simple but challenging action is perhaps the most important thing we each can do. For example, does your scicomm rely on the deficit model? If so, how could you do a better job respecting, learning from, and working with relevant communities? How much credit are you taking for collaborative scicomm work or work that you supervise or contract (whose thunder is being celebrated or stolen)? Who do you work with that you can lift up, to ensure they get credit and support for their scicomm work?

Building on this self-reflection, you can strive to actively improve the situation by holding doors open, advocating for, and funding nontraditional approaches to science and scicomm, especially those done by historically excluded people, expanding promotion beyond your networks or familiar demographics, and collaborating ethically (Chaudhary and Berhe 2020, Halsey

Table 3. Reflective prompts to identify your influence potential in the academic scicomm influence framework.

Academic capital	Social capital	Economic capital	Privilege or identity
Do you have a PhD?	Do you have lots of collaborators?	Do you have a grant as principal investigator?	Are you straight and cisgender?
Have you ever held a leadership position in a scientific society or in your university?	Do you regularly attend conferences where you network?	Do you allocate funds to other people or projects?	Are you a US citizen, and is English your first language?
Have you published papers in top journals?	Do you know administrators or program officers?	Is your institution well resourced?	Did your parents go to college?
Have you won awards or honors?	Are you at a prestigious institution with more networking opportunities?	Do you have professional development funds?	Are you White?

Note: Start by answering each of the questions on the table for yourself. These questions are not exhaustive but, rather, provide examples of how to think about academic axes of influence. Your answers to these questions will help you determine whether you have high or low capital in each of the four axes depicted in figure 8. For instance, if you answer no to all of the questions in the academic capital column (0 out of 4), place your A point in the center of the gray grid. If you answer yes to all of the questions in the social capital column (4 out of 4), place your S point far to the right on the social capital axis. When complete, you will have a polygon representing your axes of influence in the academy, which you can then use to determine which actions you can most readily take to improve scicomm in academia.

Table 4. Examples of actions that leverage high capital along the four axes of academic influence.

Axes of influence	High capital action examples
Academic capital	Recognize and set policies to affirm scicomm as meaningful for hiring, retention, and promotion; mentor students toward scicomm opportunities and careers; prioritize and approve scicomm courses taught in your department
Social capital	Leverage your access to administrators (including institutions and professional societies) to advocate for support for scicomm; encourage and mentor people learning and doing scicomm
Economic capital	Reprioritize budgets to fully fund scicomm; embed scicomm fully in proposals; pay honoraria and travel costs for scicomm experts speaking in seminars; create permanent positions for people to teach, research, and do scicomm
Privilege or identity	Model and invest in more respectful relationships with the communities and people you do scicomm with; leverage your privilege or identity to sponsor minoritized people doing scicomm

Note: Individuals may have high capital in multiple areas, and this is not an exhaustive list of possible actions (see supplement S1 for a more comprehensive list of actions).

et al. 2020, Gewin 2021, Liboiron 2021, Grandin 2022) while also knowing when to stand aside and respect sovereignty and self-determination (e.g., Fox and Prescod-Weinstein 2019). Notably, many concrete actions can be taken by anyone, regardless of what axes of influence they possess. For example, we can affirm great work in scicomm (congratulate, read, and recommend others' work), push to pay people for scicomm work (e.g., honoraria and salary top-ups for faculty, postdocs, staff, and students, not just external consultants), and model and invest in more respectful relationships with nonacademic scicomm practitioners (e.g., partnerships, paid consulting, and coproduction). However, substantial change is needed, and people who possess high levels of influence have particular capacity to make these changes. Therefore, we provide a few illustrative suggestions (table 4), along with an extensive list of possible actions for individuals and organizations looking for tangible ideas (supplement S1).

Conclusions

As we authors look ahead to being the change we want to see, we acknowledge that we are not the first to attempt to name and suggest solutions to issues of inequality in academia. We hope you take away from this work a desire to interrogate their own role in perpetuating the injustices we describe above and concrete ideas about what you can do to change the way academia values, rewards, funds, and assesses scicomm. This is a call to action. It is well past time for us all to manifest the infrastructure that mitigates the scicomm-related inequities we have discussed and experienced. As the Lorax exclaimed in Dr. Seuss's book, "Unless someone like you cares a whole awful lot, nothing is going to get better. It's not." We hope the suggestions in the present article, coupled with system-level critique, help you recognize where you can contribute to a better system.

Supplemental material

Supplemental material is: Supplement 1: Potential action items, calibrated to axes of influence.

Acknowledgments

The ideas in this article were initially generated through an RCN Incubator on Science Communication in Undergraduate Education, which was funded by the US National Science Foundation (Undergraduate Biology Education grant no. 1920054 awarded to SMM, RMT, and AAS). We thank Avery Davis for creating the illustrations used as figures in this article, which were supported by RMT's NSF CAREER grant (Integrative Organismal Systems grant no. 1846520). The findings and conclusions in this article are those of the authors and do not necessarily represent the views of the US Fish and Wildlife Service. We also thank two anonymous reviewers and editor-in-chief Charles Fenster for their valuable

suggestions, which helped us greatly improve this article. Personnel were supported by NSF IOS grant no. 2240950, NSF IOS grant no. 1846520, NSF DEB grant no. 2012041 and the Wyoming Agricultural Experiment Station's Global Perspectives fund.

Author contributions

E. Dale Broder (Conceptualization, Data curation, Investigation, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing), Bethann Garramon Merkle (Conceptualization, Data curation, Investigation, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing), Meena M. Balgopal (Conceptualization, Writing – original draft, Writing – review & editing), Emily G. Weigel (Conceptualization, Writing – original draft, Writing – review & editing), Shannon M. Murphy (Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing), Joshua J. Caffrey (Conceptualization, Writing – original draft, Writing – review & editing), Eileen A. Hebets (Conceptualization, Writing – original draft, Writing – review & editing), Anna A. Sher (Conceptualization, Funding acquisition, Writing – original draft, Writing – review & editing), Jennifer M. Gumm (Conceptualization, Writing – original draft, Writing – review & editing), Jennifer Lee (Conceptualization, Writing – original draft, Writing – review & editing), Chris J. Schell (Conceptualization, Writing – original draft, Writing – review & editing), and Robin M. Tinghitella (Conceptualization, Data curation, Funding acquisition, Investigation, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing).

Positionality statement

The issues we discuss affect who wants to and can participate in, lead, and share science. Indeed, some of the coauthors have actively considered leaving academia because of these issues. We are academics in STEM, scicomm, and sociology, as well as scicomm practitioners, who have experienced many of the issues described in the article. Drawing on our diverse experiences and employment, we clarify (unless otherwise stated) that *we* and *we authors* refer to the coauthors of the present article collectively. However, not all coauthors have experienced every issue or share every stated opinion. We also clarify that, although we represent many dimensions of diversity (e.g., ability, gender identity, ethnicity, neurodiversity, sexual orientation, social background, societal privilege, and nature and category of employment beyond and within higher education—including 2-year and 4-year, and non-tenure-track, tenure-track, and academic staff), the authors do not fully reflect the identities of all those affected by scicomm injustices.

References cited

AbiGhannam N. 2016. Madam science communicator: A typology of women's experiences in online science communication. *Science Communication* 38: 468–494.

Adams S, Bekker S, Fan Y, Gordon T, Shepherd LJ, Slavich E, Waters D. 2022. Gender bias in student evaluations of teaching: "Punish[ing] those who fail to do their gender right." *Higher Education* 83: 787–807.

Ahlgrim A (@adamahlgrim) 2022. I am devastated, but I have to leave my PhD program. my family and I are simply too poor to continue on an embarrassing stipend with no benefits. the space on credit cards has run out, so the method we've been using to survive so far has run its course. 1/5. Twitter (12 July 2022). https://x.com/AdamAllGrim/status/1547011336940490752

Ahmed S. 2017. *Living a Feminist Life*. Duke University Press.

Akomolafe O. 2020. African-born scholars and accent discrimination: The last acceptable form of prejudice. Page 199–226 in Abidde SO, ed. *African Scholars and Intellectuals in North American Academies: Reflections on Exile and Migration*. Routledge.

Alpert CL. 2016. The research communication continuum: Linking public engagement skills to the advancement of cross-disciplinary research. *Journal of Museum Education* 41: 315–328.

Ambady N, Rosenthal R. 1992. Thin slices of expressive behavior as predictors of interpersonal consequences: A meta-analysis. *Psychological Bulletin* 111: 256.

[ARIS] Center for Advancing Research Impact in Society. 2021. What are broader impacts? Center for Advancing Research Impacts in Society (March 2021). https://researchinsociety.org/broader-impacts

Asase A, Mzumara-Gawa TI, Owino JO, Peterson AT, Saupe E. 2022. Replacing "parachute science" with "global science" in ecology and conservation biology. *Conservation Science and Practice* 4: e517.

Atkins N. 2011. *The Wildlife Society Blue Ribbon Panel Final Report: The Future of the Wildlife Profession and Its Implications for Training the Next Generation of Wildlife Professionals*. Wildlife Society.

Avrich P. 2014. *The Modern School Movement: Anarchism and Education in the United States*, vol. 309. Princeton University Press.

Baker DJ. 2021. *Postsecondary Education's Role in Promoting Justice: Institutions Must Consider Race and Class*. Postsecondary Value Commission.

Balgopal MM, Gerardo NM, Topden J, Gyatso K. 2021. Moving past postcolonial hybrid spaces: How Buddhist monks make meaning of biology. *Science Education* 105: 473–497.

Banks JA, et al. 2007. *Learning in and out of School in Diverse Environments: The LIFE Center and Center for Multicultural Education: Life-Long, Life-Wide, Life-Deep* University of Washington.

Baram-Tsabari A, Lewenstein BV. 2017. Science communication training: What are we trying to teach? *International Journal of Science Education B* 7: 285–300.

Barsh RL. 2001. Who steals indigenous knowledge? Pages 153–161 in Lovall E, ed. *Proceedings of the ASIL Annual Meeting*, vol. 95. Cambridge University Press.

Bell M, Lewis N. 2022. Universities claim to value community-engaged scholarship: So why do they discourage it? *Public Understanding of Science* 32: 304–321.

Bentley P, Kyvik S. 2011. Academic staff and public communication: A survey of popular science publishing across 13 countries. *Public Understanding of Science* 20: 48–63.

Besley JC, Tanner AH. 2011. What science communication scholars think about training scientists to communicate. *Science Communication* 33: 239–263.

Bhambra GK, Gebrial D, Nişancıoğlu K, eds. 2018. *Decolonising the University*. Pluto Press.

Biel AW. 2006. *Do (Not) Feed the Bears: The Fitful History of Wildlife and Tourists in Yellowstone*. University of Kansas Press.

Bloodhart B, Balgopal MM, Casper AMA, Sample McMeeking LB, Fischer EV. 2020. Outperforming yet undervalued: Undergraduate women in STEM. *PLOS ONE* 15: e0234685.

Bolsen T, Palm R, Kingsland JT. 2019. The impact of message source on the effectiveness of communications about climate change. *Science Communication* 41: 464–487.

Bothwell E, Grove J, Pells R, Reisz M. 2019. Twitter responses show sexual harassment is rife at academic conferences. Times Higher Education (21 May 2019). www.timeshighereducation.com/blog/twitter-responses-show-sexual-harassment-rife-academic-conferences

Boucher CJ, Hammock GS, McLaughlin SD, Henry KN. 2013. Perceptions of competency as a function of accent. *Psi Chi Journal of Psychological Research* 18: 27–32.

Bourdieu P. 2010. *Distinction: A Social Critique of the Judgment of Taste*. Routledge.

Bousquet M. 2017. How the university works: Higher education and the low-wage nation. Pages 299–314 in Aronowitz S Roberts MJ, eds. *Class: The Anthology*. New York University Press.

Bozeman B, Boardman C. 2009. Broad impacts and narrow perspectives: Passing the buck on science and social impacts. *Social Epistemology* 23: 183–198.

Brainard J. 2022. Reviewers award higher marks when a paper's author is famous. *Science* 377: 1251–1251.

Broder ED, Guilbert KE, Tinghitella RM, Murphy SM, Ghalambor CK, Angeloni LM. 2019. Authentic science with dissemination increases self-efficacy of middle school students. *Integrative and Comparative Biology* 59: 1497–1508.

Brown AV. 2008. Effectively educating Latino/a students: A comparative study of participation patterns of Hispanic American and Anglo-American university students. *Journal of Hispanic Higher Education* 7: 97–118.

Brownell SE, Tanner KD. 2012. Barriers to faculty pedagogical change: Lack of training, time, incentives, and… tensions with professional identity? *CBE—Life Sciences Education* 11: 339.

Brownell SE, Price JV, Steinman L. 2013. Science communication to the general public: Why we need to teach undergraduate and graduate students this skill as part of their formal scientific training. *Journal of Undergraduate Neuroscience Education* 12: E6–E10.

Buranyi S. 2017. Is the staggeringly profitable business of scientific publishing bad for science? The Guardian (27 June 2017). www.theguardian.com/science/2017/jun/27/profitable-business-scientific-publishing-bad-for-science?

Butler J. 2006. *Gender Trouble: Feminism and the Subversion of Identity*. Routledge.

Caballe A, Bardelli M. 2021. Building blocks of virtuous science communication: Grant funding, policy making, and public engagement. *DNA Cell Biology* 41: 6–10.

Callon M. 1998. *The Laws of the Markets*. Blackwell/Sociological Review.

Canfield K, Menezes S. 2020. *The State of Inclusive Science Communication: a Landscape Study*. Metcalf Institute, University of Rhode Island. www.informalscience.org/state-inclusive-science-communication-landscape-study

Canfield KN, et al. 2020. Science communication demands a critical approach that centers inclusion, equity, and intersectionality. *Frontiers in Communication* 5: 2.

Capp MJ. 2017. The effectiveness of universal design for learning: A meta-analysis of literature between 2013 and 2016. *International Journal of Inclusive Education* 21: 791–807.

Castleden H, Sylvestre P, Martin D, McNally M. 2015. "I don't think that any peer review committee…would ever 'get' what I currently do": How institutional metrics for success and merit risk perpetuating the (re)production of colonial relationships in community-based participatory research involving indigenous peoples in Canada. *International Indigenous Policy Journal* 6: 48767194.

Cech EA, Waidzunas TJ. 2021. Systemic inequalities for LGBTQ professionals in STEM. *Science Advances* 7: eabe0933.

Center for Intersectionality and Social Policy Studies. 2024. *Center for Intersectionality and Social Policy Studies*. Columbia Law School. https://intersectionality.law.columbia.edu

Chambers DW. 1983. Stereotypic images of the scientist: The draw-a-scientist test. *Science Education* 67: 255–265.

Chaudhary VB, Berhe AA. 2020. Ten simple rules for building an antiracist lab. *PLOS Computational Biology* 16: e1008210.

Chávez K, Mitchell KM. 2020. Exploring bias in student evaluations: Gender, race, and ethnicity. *PS: Political Science and Politics* 53: 270–274.

Chen CC, Rao A, Ren IY. 2013. Glass ceiling for the foreign born: Perspectives from Asian-born American R&D scientists. *Asian American Journal of Psychology* 4: 249.

Chen CY, Kahanamoku SS, Tripati A, Alegado RA, Morris VR, Andrade K, Hosbey J. 2022. Meta-research: Systemic racial disparities in funding rates at the National Science Foundation. *Elife* 11: e83071.

Cicchino A, Weinberg AE, Sample McMeeking LB, Balgopal MM. 2022. Critical pedagogy of place to enhance ecological engagement activities. *Conservation Biology* 37: e14023.

Clotfelter CT. 2011. *After Brown: The Rise and Retreat of School Desegregation*. Princeton University Press.

Coaston J. 2019. The intersectionality wars: When Kimberlé Crenshaw coined the term 30 years ago, it was a relatively obscure legal concept. Then it went viral. *Vox* (20 May 2019). www.vox.com/the-highlight/2019/5/20/18542843/intersectionality-conservatism-law-race-gender-discrimination

Collyer FM. 2018. Global patterns in the publishing of academic knowledge: Global North, global South. *Current Sociology* 66: 56–73.

Cook IM. 2022. Fuck prestige. Page 209 in Cantat C, Cook IM Rajaram PK, eds. *Opening up the University: Teaching and Learning with Refugees*. Berghahan Books.

Cooper KM, Brownell SE. 2016. Coming out in class: Challenges and benefits of active learning in a biology classroom for LGBTQIA students. *CBE—Life Sciences Education* 15: 3.

Crane D. 1967. The gatekeepers of science: Some factors affecting the selection of articles for scientific journals. *American Sociologist* 2: 195–201.

Crenshaw KW. 2013. Demarginalizing the intersection of race and sex: A black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. Pages 23–51 in Maschke K, ed. *Feminist Legal Theories*. Routledge.

Crenshaw KW. 2017. Kimberlé Crenshaw on intersectionality, more than two decades later. News From Columbia Law (8 June 2017). www.law.columbia.edu/news/archive/kimberle-crenshaw-intersectionality-more-two-decades-later

Dancy M, Hodary A. 2022. How well-intentioned white male physicists maintain ignorance of inequity and justify inaction. *International Journal of STEM Education* 10: 1–29.

Davidson LJ, Kelly D. 2020. Minding the gap: Bias, soft structures, and the double life of social norms. *Journal of Applied Philosophy* 37: 190–210.

Davies B. 2005. Communities of practice: Legitimacy not choice. *Journal of Sociolinguistics* 9: 557–581.

Davis C, Weber C, Nadkarni NM. 2022. Prevalence of discourse on public engagement with science in ecology literature. *Frontiers in Ecology and the Environment* 20: 524–530.

Dawson E. 2014a. Equity in informal science education: Developing an access and equity framework for science museums and science centres. *Studies in Science Education* 50: 209–247.

Dawson E. 2014b. "Not designed for us:" How science museums and science centers socially exclude low-income, minority ethnic groups. *Science Education* 98: 981–1008.

Dawson E. 2018. Reimagining publics and (non) participation: Exploring exclusion from science communication through the experiences of low-income, minority ethnic groups. *Public Understanding of Science* 27: 772–786.

Deanna R, et al. 2022. It takes a village: The importance of diverse networks in academic mentorship. *Nature Communication* 13: 1–7.

Diaz-Clark ED, Otto JL, Wright DS, Lin Hunter DE, Sample McMeeking LB, Weinberg AE, Balgopal MM. 2024. Under pressure: How do science teachers use capital to achieve agency during turbulent times? *Science Education* 108: 1–24.

Docot D. 2022. Dispirited away: The peer review process. *PoLAR* 45: 124–128.

Edlund AF, Balgopal MM. 2021. Drawing-to-learn: Active and culturally relevant pedagogy for biology. *Frontiers in Communication* 6: 739813.

Eiben V. 2015. *A Brief History of Folk Schools*. Folk Education Association of America. www.folkschoolalliance.org/a-brief-history-of-folk-schools

Eise J. 2019. What institutions can do to improve science communication. *Nature* (13 December 2019). www.nature.com/articles/d41586-019-03869-7

Ekezie W, Czyznikowska BM, Rohit S, Harrison J, Miah N, Campbell-Morris P, Khunti K. 2021. The views of ethnic minority and vulnerable communities towards participation in COVID-19 vaccine trials. *Journal of Public Health* 43: e258–e260.

Ellemer N. 2020. Science as collaborative knowledge generation. *British Journal of Social Psychology* 60: 1–28.

Fallowfield L, Jenkins V. 1999. Effective communication skills are the key to good cancer care. *European Journal of Cancer* 35: 1592–1597.

Feldon DF, Peugh J, Timmerman BE, Maher MA, Hurst M, Strickland D, Gilmore JA, Stiegelmeyer C. 2011. Graduate students' teaching experiences improve their methodological research skills. *Science* 333: 1037–1039.

Finkelstein MJ, Conley VM, Schuster JH. 2016. Taking the measure of faculty diversity. *Advancing Higher Education (April 2016)*. Teachers Insurance and Annuity Association of America Institute. www.tiaa.org/content/dam/tiaa/institute/pdf/full-report/2017-02/taking-the-measure-of-faculty-diversity.pdf

Fischhoff B, Scheufele DA. 2014. The science of science communication II. *Proceedings of the National Academy of Sciences* 111: 13583–13584.

Fitzgerald H (@helfitzgerald). 2018. also ditto the scatterbrained absentminded professor /genius who can't tie his shoelaces, an archetype wholly & cruelly only available to men. brilliant men are expected to require project managers; women are expected to be them. Twitter (5 January 2018).

Fox K, Prescod-Weinstein C. 2019. The fight for Mauna Kea is a fight against colonial science. Nation (24 July 2019). www.thenation.com/article/archive/mauna-kea-tmt-colonial-science

Fraser N, Honneth A. 2003. *Redistribution or Recognition? A Political-Philosophical Exchange*. Verso.

Gannon K. 2020. *Radical Hope: A Teaching Manifesto*. West Virginia University Press.

Georgiadis T, Pescerelli Lagorio P. 2012. The communication of science as an ethical issue: The case of Raffaele Bendandi. *Annals of Geophysics* 55: 409–412.

Gerber A, Metcalfe J, Broks P, Lorke J, Gabriel M, Lorenz L. 2020. *Science Communication Research: an Empirical Field Analysis*. German Federal Ministry of Education and Research. https://sciencecomm.science/app/uploads/2020/05/Research_Field_Analysis__Science_Communication__2020__public.pdf

Gewin V. 2021. How to include indigenous researchers and their knowledge. Nature News (12 January 2021). www.nature.com/articles/d41586-021-00022-1

Ghosh P. 2010. Snails "have a homing instinct." BBC News (3 August 2010). www.bbc.com/news/science-environment-10856523

Ghosh D, Barber K. 2021. The gender of multiculturalism: Cultural tokenism and the institutional isolation of immigrant women faculty. *Sociological Perspectives* 64: 1063–1080.

Gilpin L. 2016. How the National Park Service is failing women. High Country News: Know the West (12 December 2016). www.hcn.org/issues/48.21/how-the-park-service-is-failing-women

Goldberg JA (@KempoJesse). 2022a. So I wanted to redirect the student's question from the absolutist premise that we either do reproduce injustice or we don't while doing our academic work, because the "we don't" is a self-congratulatory fantasy. Instead, how do we act ethically knowing we cause harm? Twitter (23 September 2022). https://x.com/KempoJesse/status/1573066400142442498

Goldberg JA (@KempoJesse). 2022b. One of the ways, I think, to do good work as an academic is to refuse the academy's attempt to monopolize our time. Refuse to even ask the question, "how will X fit into my tenure file?" Refuse to have our political speech preemptively (self-?)censored. Twitter (23 September 2022). https://x.com/KempoJesse/status/1573066404730904577

Goldberg JA (@KempoJesse). 2022c. And then, do some work beyond the academy's boundaries instead of giving all of your free time to your employer. Be accountable to communities that don't write your paychecks. Twitter (23 September 2022). https://x.com/KempoJesse/status/1573326166999863297

Goldberg JA (@kempojesse). 2022d. What I am arguing against is purity or the notion that actual revolutionary work can be done inside the academy. There's lots of good work that falls short of revolutionary or radical in its scope! Do that good work! But don't be fooled into thinking it's more than it is, is all." Twitter (23 September 2022). https://x.com/KempoJesse/status/1573326164349034496

Goldberg MH, van der Linden S, Ballew MT, Rosenthal SA, Gustafson A, Leiserowitz A. 2019. The experience of consensus: Video as an effective medium to communicate scientific agreement on climate change. *Science Communication* 41: 659–673.

Goldina A, Weeks OI. 2014. Science café course: An innovative means of improving communication skills of undergraduate biology majors. *Journal of Microbiology and Biology Education* 15: 13–17.

Gornish ES, Roche LM. 2017. Cooperative extension is key to unlocking public engagement with science. *Frontiers in Ecology and the Environment* 15: 487–488.

Graeber D, Wengrow D. 2021. *The Dawn of Everything: A New History of Humanity*. Farrar, Straus and Giroux.

Grandin T. 2022. *Visual Thinking: The Hidden Gifts of People Who Think in Pictures, Patterns, and Abstractions*. Riverhead Books.

Graves JL, Kearney M, Barabino G, Malcom S. 2022. Inequality in science and the case for a new agenda. *Proceedings of the National Academy of Sciences* 119: e2117831119.

Gvozdanović J, Maes K, Brage T, Gilland-Lutz K, Mantilleri B, Norman J. 2018. *Implicit Bias in Academia: A Challenge to the Meritocratic Principle and to Women's Careers—and What to Do about It*. League of European Research Universities. *Advice Paper no. 23*. www.leru.org/files/implicit-bias-in-academia-full-paper.pdf

Hall WJ, Chapman MV, Lee KM, Merino YM, Thomas TW, Payne BK, Eng E, Day SH, Coyne-Beasley T. 2015. Implicit racial/ethnic bias among health care professionals and its influence on health care outcomes: A systematic review. *American Journal of Public Health* 105: e60–e76.

Halsey SJ, Strickland LR, Scott-Richardson M, Perrin-Stowe T, Massenburg L. 2020. Elevate, don't assimilate, to revolutionize the experience of scientists who are black, Indigenous and people of colour. *Nature Ecology and Evolution* 4: 1291–1293.

Hammond JW, Brownell SE, Kedharnath NA, Cheng SJ, Byrd WC. 2021. Why the term "JEDI" is problematic for describing programs that promote justice, equity, diversity, and inclusion. Scientific American (23 September 2021). www.scientificamerican.com/article/why-the-term-jedi-is-problematic-for-describing-programs-that-promote-justice-equity-diversity-and-inclusion

Hansson L. 2018. Science education, indoctrination, and the hidden curriculum. Pages 283–306 in Matthews MR, ed. *History, Philosophy, and Science Teaching*. Springer.

Heath S, Fuller A, Paton K. 2007. Life Course, Generation and Educational Decision-Making within Networks of Intimacy. *Paper presented at the British Educational Research Association; 4–7 September 2017*, London, United Kingdom.

Hegel GWF. 2018. *The Phenomenology of Spirit*. Cambridge Hegel Translations.

Hengel E. 2022. Publishing while female: Are women held to higher standards? Evidence from peer review. *Economic Journal* 132: 2951–2991.

Hernandez J. 2022. *Fresh Banana Leaves: Healing Indigenous Landscapes through Indigenous Science*. Penguin Random House.

Hernandez JC, Lopez MA. 2019. Leaking pipeline: Issues impacting Latino/a college student retention. Pages 99–122 in Seidman A, ed. *Minority Student Retention: The Best of the Journal of College Student Retention: Research, Theory, and Practice*. Taylor and Francis.

Hessler M, Pöpping DM, Hollstein H, Ohlenburg H, Arnemann PH, Massoth C, Seidel LM, Zarbock A, Wenk M. 2018. Availability of cookies during an academic course session affects evaluation of teaching. *Medical Education* 52: 1064–1072.

Hicks AS, Mirza S, Rice WL, Richards JC, Alarab MR. 2020. When green is blue: Perspectives on inclusivity and recommendations towards reforming and demilitarizing law enforcement in US national parks. *Parks Stewardship Forum* 36: 502–509.

Ho K, et al. 2019. What happened to social facts? *American Anthropologist* 121: 160–204.

Hogan K. 2009. What is criticism on academic labor for? *Minnesota Review* 71/72: 191–199.

Holdren N. 2021. Faculty moral distress about pandemic teaching. Academe Blog (11 Ma7 2021). https://academeblog.org/2021/05/11/faculty-moral-distress-about-pandemic-teaching

Hong J. 2018. The high cost of opportunity: Paying for academic conferences. Diverse Issues in Higher Education (15 January 2018). www.diverseeducation.com/home/article/15101861/the-high-cost-of-opportunity-paying-for-academic-conferences

Hull G, Rose M. 1989. Rethinking remediation: Toward a social-cognitive understanding of problematic reading and writing. *Written Communication* 6: 139–154.

Hull AGT, Scott PB, Smith P. 1982. *But Some of Us Are Brave: All the Women Are White, all the Blacks Are Men*. Feminist Press.

Husu L. 2004. Gate-keeping, gender equality and scientific excellence. Pages 69–76 in Brouns M Addis E, eds. *Gender and Excellence in the Making*. European Commission, Directorate-General for Research. Report no. EUR 21222.

Ideland M. 2018. Science, coloniality, and "the great rationality divide." *Science and Education* 27: 783–803.

Jacoby B. 2017. The new student activism: Supporting students as agents of social change. *Journal of College and Character* 18: 1–8.

Janica EV. 2018. The wisdom of our Native American tribes: Advanced math, science and culture for the future. Pages 70–76 *2018 IEEE Integrated STEM Education Conference*. Institute of Electrical and Electronics Engineers. https://researchinsociety.org/broader-impacts/

Jensen EA, Gerber A. 2020. Evidence-based science communication. *Frontiers in Communication* 4: 78.

Jensen P, Rouquier J-B, Kreimer P, Croissant Y. 2008. Scientists who engage with society perform better academically. *Science and Public Policy* 35: 527–541.

Jimenez MF, Laverty TM, Bombaci SP, Wilkins K, Bennett DE, Pejchar L. 2019. Underrepresented faculty play a disproportionate role in advancing diversity and inclusion. *Nature Ecology and Evolution* 3: 1030–1033.

Johnson JM, Boss G, Mwangi CG, Garcia GA. 2018. Resisting, rejecting, and redefining normative pathways to the professoriate: Faculty of color in higher education. *The Urban Review* 50: 630–647.

Joseph B. 2018. 9 terms to avoid in communications with Indigenous peoples. Indigenous Corporate Training (11 May 2018). www.ictinc.ca/blog/9-terms-to-avoid-in-communications-with-indigenous-peoples

Judd K, McKinnon M. 2021. A systematic map of inclusion, equity and diversity in science communication research: Do we practice what we preach? *Frontiers in Communication* 6: 744365.

Kang SK, DeCelles KA, Tilcsik A, Jun S. 2016. Whitened résumés: Race and self-presentation in the labor market. *Administrative Science Quarterly* 61: 469–502.

Kanigel R. 2019a. White privilege. *Diversity Style Guide*. www.diversitystyleguide.com/glossary/white-privilege

Kanigel R. 2019b. White, white. *Diversity Style Guide*. www.diversitystyleguide.com/glossary/white-white

Kappel K, Holmen SJ. 2019. Why science communication, and does it work? A taxonomy of science communication aims and a survey of the empirical evidence. *Frontiers in Communication* 4: 55.

Kim SE. 2021. The paths we were told to follow: A citational practice worksheet for students. *Teaching Citational Practices: Critical Feminist Approaches* 1: 33–38.

Knapp CN, Cochran J, Sayre N, Kofinas G. 2013. Putting local knowledge and context to work for Gunnison sage-grouse conservation. *Wildlife–Human Interactions* 7: 195–213.

Kuehne LM, Twardochleb LA, Fritschie KJ, Mims MC, Lawrence DJ, Gibson PP, Steward-Koster B, Olden JD. 2014. Practical science communication strategies for graduate students. *Conservation Biology* 28: 1225–1235.

Kulago HA, Guernsey P, Wapeemukwa W. 2023. "It feels fake": Decolonizing curriculum and pedagogy in predominantly white institutions. *Occasional Paper Series* 49: 69–79.

Kwon D. 2022. The rise of citational justice: How scholars are making references fairer. *Nature* 604: 568–572.

Lave J, Wenger E. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press.

Leshin RA, Lei RF, Byrne M, Rhodes M. 2022. Who is a typical woman? Exploring variation in how race biases representations of gender across development. *Developmental Science* 25: e13175.

Li J. 2019. *Kentucky 2-year-old discovers new species of bug while gardening with mom. Inside Edition (14 August 2019)*. www.insideedition.com/2-year-old-discovers-new-species-bug-while-gardening-mom-55252

Liboiron M. 2021. *Pollution Is Colonialism*. Duke University Press.

Lin N. 2001. *Social Capital: A Theory of Social Structure and Action*. Cambridge University Press.

Lin Hunter DE, Newman GJ, Balgopal MM. 2020. Citizen scientist or citizen technician: A case study of communication on one citizen science platform. *Citizen Science: Theory and Practice* 5: 17.

Lincoln YS, Stanley CA. 2021. The faces of institutionalized discrimination and systemic oppression in higher education: Uncovering the lived experience of bias and procedural inequity. *Qualitative Inquiry* 27: 1233–1245.

Liou YH, Canrinus ET. 2020. A capital framework for professional learning and practice. *International Journal of Educational Research* 100: 101527.

Liu S-NC, Brown SEV, Sabat IE. 2019. Patching the "leaky pipeline": Interventions for women of color faculty in STEM academia. *Archives of Scientific Psychology* 7: 32–39.
Llorens A, et al. 2021. Gender bias in academia: A lifetime problem that needs solutions. *Neuron* 109: 2047–2074.
Lubchenco J. 1998. Entering the century of the environment: A new social contract for science. *Science* 279: 491–497.
MacFarlane B. 2007. Defining and rewarding academic citizenship: The implications for university promotions policy. *Journal of Higher Education Policy and Management* 29: 261–273.
MacGregor S, Ali N, Katz-Gerro T, Walker C, Ahmad Z 2024. Holding up a mirror: Researching symmetrically to explore exclusion, othering and whiteness in local environmental governance. *Local Environment* 29: 1–14.
Maehr DS, Thompson BC, Mattfeld GF, Montei K, Haufler JB, Kerns JD, Ramakka J. 2002. Directions in professionalism and certification in the Wildlife Society. *Wildlife Society Bulletin* 30: 1245–1252.
Martinek N. 2021. How to spot and protect against knowledge vampires: 10 red flags to spot the knowledge vampire. Hacking Narcissism (8 December 2021). https://www.hackingnarcissism.com/p/knowledgevampires
Martinez-Conde S. 2016. Has contemporary academia outgrown the Carl Sagan effect? *Journal of Neuroscience* 36: 2077–2082.
Massé MA, Hogan KJ, eds. 2012. *Over Ten Million Served: Gendered Service in Language and Literature Workplaces*. SUNY Press.
Matta G. 2020. Science communication as a preventative tool in the COVID19 pandemic. *Humanities and Social Sciences Communications* 7: 1–14.
McAdam D, McCarthy JD, Zald MN, eds. 1996. *Comparative Perspectives on Social Movements: Political Opportunities, Mobilizing Structures, and Cultural Framings*. Cambridge University Press.
McConahay JB. 1983. Modern racism and modern discrimination: The effects of race, racial attitudes, and context on simulated hiring decisions. *Personality and Social Psychology Bulletin* 9: 551–558.
McGee EO. 2020. Interrogating structural racism in STEM higher education. *Educational Researcher* 49: 633–644.
McKinnon M, O'Connell C. 2020. Perceptions of stereotypes applied to women who publicly communicate their STEM work. *Humanities and Social Sciences Communications* 7: 1–8.
McMillan Cottom T. 2016. *Lower Ed: How For-Profit Colleges Deepen Inequality in America*. New Press.
Medvecky F, Leach J. 2019. *An Ethics of Science Communication*. Palgrave MacMillan.
Mellifont D. 2021. Ableist ivory towers: A narrative review informing about the lived experiences of neurodivergent staff in contemporary higher education. *Disability and Society* 38: 865–886.
Mengel F, Sauermann J, Zoelitz U. 2017. Gender bias in teaching evaluations. *Journal of the European Economic Association* 17: 535–566.
Mercer-Mapstone L, Kuchel L. 2017. Core skills for effective science communication: A teaching resource for undergraduate science education. *International Journal of Science Education B* 7: 181–201.
Merkle JA, et al. 2019. A collaborative approach to bridging the gap between wildlife managers and researchers. *Journal of Wildlife Management* 83: 1644–1651.
Merkle BG, Bayer S, Shukla P, Valdez-Ward E. 2022. Sharing science through shared values, goals, and stories: An evidence-based approach to making science matter. *Human–Wildlife Interactions* 15: 27.
Merton RK. 1973. *The Sociology of Science: Theoretical and Empirical Investigations*. University of Chicago Press.
Miele E. 2014. Using the draw-a-scientist test for inquiry and evaluation. *Journal of College Science Teaching* 43: 36–40.
Moosavi L. 2020. The decolonial bandwagon and the dangers of intellectual decolonisation. *International Review of Sociology* 30: 332–354.
Morgan AC, LaBerge N, Larremore DB, Galesic M, Brand JE, Clauset A. 2022. Socioeconomic roots of academic faculty. *Nature Human Behaviour* 6: 1625–1633.
Murphy KM, Kelp NC. 2023. Undergraduate STEM students' science communication skills, science identity, and science self-efficacy influence their motivations and behaviors in STEM community engagement. *Journal of Microbiology and Biology Education* 24: e00182–22.
Murphy SM, et al. 2021. Streetlights positively affect the presence of an invasive grass species. *Ecology and Evolution* 11: 10320–10326.
Murray DS. 2019. The precarious new faculty majority: Communication and instruction research and contingent labor in higher education. *Communication Education* 68: 235–245.
Murray D, Boothby C, Zhao H, Minik V, Bérubé N, Larivière V, Sugimoto CR. 2020. Exploring the personal and professional factors associated with student evaluations of tenure-track faculty. *PLOS ONE* 15: e0233515.
Mutisya PM, Osler JE II. 2017. Academic freedom and shared governance: A framework to reclaim academic prestige in the academy. *Journal on School Educational Technology* 12: 35–48.
Nadkarni NM, Stasch AE. 2013. How broad are our broader impacts? An analysis of the National Science Foundation's Ecosystem Studies Program and the broader impacts requirement. *Frontiers in Ecology and the Environment* 11: 13–19.
National Academies of Sciences, Engineering, and Medicine. 2017. *Communicating Science Effectively: a Research Agenda*. National Academies Press.
Navarro K, McKinnon M. 2020. Challenges of communicating science: Perspectives from the Philippines. *Journal of Science Communication* 19: A03.
Nussbaum E (@emilynussbaum). 2018. Hey guys the "superauthentic messyhead from-the-heart, passionate, spontaneous upstart candidate" role *isn't available for women.* It's the Goldilocks Rule. We're eternally too cold (experienced, canny therefore ambitious & compromised) or too hot (rando, lightweight, no cred.) Twitter (5 January 2018). https://x.com/emilynussbaum/status/949381394043727874
Oluo I. 2020. *Mediocre: The Dangerous Legacy of White Male America*. Seal Press.
Osseweijer P. 2006. A new model for science communication that takes ethical considerations into account: The three-e model: Entertainment, emotion, and education. *Science and Engineering Ethics* 12: 591.
Pardo-Guerra JP. 2023. The problem of (management) knowledge in higher education. Juan Pablo Pardo Guerra (6 December 2023). https://pardoguerra.org/2023/12/06/the-problem-of-management-knowledge-in-higher-education
Park CS, Liu Q, Kaye BK. 2021. Analysis of ageism, sexism, and ableism in user comments on YouTube videos about climate activist Greta Thunberg. *Social Media and Society* 7: 20563051211036059.
Payne K, Downing J, Fleming JC. 2000. Speaking Ebonics in a professional context: The role of ethos/source credibility and perceived sociability of the speaker. *Journal of Technical Writing and Communication* 30: 367–383.
Pell AN. 1996. Fixing the leaky pipeline: Women scientists in academia. *Journal of Animal Science* 74: 2843–2848.
Peterso C (@christapeterso). 2022. if you have literally any substantive responsibility and don't get over the fear of people with more power being unhappy with you, you will do evil. Twitter

(18 September 2022). https://x.com/christapeterso/status/1571672432964149260

Pew Research Center. 2009. *Public praises science; scientists fault public, media*. Pew Research Center (9 July 2009). www.pewresearch.org/politics/2009/07/09/public-praises-science-scientists-fault-public-media

Pew Research Center. 2015. *How scientists engage the public*. Pew Research Center (15 February 2015). www.pewinternet.org/2015/02/15/how-scientists-engage-public

Phillips MJ, Dzidic PL, Castell EL. 2022. Exploring and critiquing women's academic identity in higher education: A narrative review. *SAGE Open* 12: 21582440221096145.

Polfus JL, Simmons D, Neyelle M, Bayha W, Andrew F, Andrew L, Merkle BG, Rice K, Manseau M. 2017. Creative convergence: Exploring bicultural diversity through art. *Ecology and Society* 22: 4.

Polster C. 2007. The nature and implications of the growing importance of research grants to Canadian universities and academics. *Higher Education* 53: 599–622.

Poudyal M, et al. 2018. Who bears the cost of forest conservation? *PeerJ* 6: e5106.

Prescod-Weinstein C. (@IBJIYONGI). 2022a. And it's important to recognize that these are skills that people have to develop and are so important that people get paid for them! It's not "any random person on Twitter can do this just as well." Twitter (12 July 2022). https://x.com/IBJIYONGI/status/1547040202912399360

Prescod-Weinstein C (@IBJIYONGI). 2022b. Setting the bar at "be as good at this as a paid expert at a multibillion dollar federal agency" might not be the encouragement that it looks like on the surface. Twitter (12 July 2022). https://x.com/IBJIYONGI/status/1547040202912399360

Quijano A. 2000. Coloniality of power and eurocentrism in Latin America. *International Sociology* 15: 215–232.

Rassim K, Mahdjoub H, Baaloudj A, Chaib S. 2022. Language of citation and publishing performance of graduate students in French-speaking countries with different economic and linguistic advantages. *Facets* 7: 71–81.

Razai MS, Osama T, McKechnie DG, Majeed A. 2021. Covid-19 vaccine hesitancy among ethnic minority groups. *BMJ* 372: n513.

Reed MS, et al. 2024. Reimagining the language of engagement in a post-stakeholder world. *Sustainability Science* 19: 1481–1490.

Reich C, Price J, Rubin E, Steiner M. 2010. *Inclusion, Disabilities, and Informal Science Learning. A CAISE Inquiry Group Report*. Center for Advancement of Informal Science Education.

Risien R, Storksdieck M. 2018. Unveiling impact identities: A path for connecting science and society. *Integrative and Comparative Biology* 58: 58–66.

Robbins B. 2007. Coerced confessions. *Minnesota Review* 71/72: 236–243.

Robson E. 2020. *Mathematics in Ancient Iraq: A Social History*. Princeton University Press.

Rose M. 1985. The language of exclusion: Writing instruction at the university. *College English* 47: 341–359.

Rossiter W. 1993. The Matthew Matilda effect in science. *Social Studies of Science* 23: 325–341.

Rowe G, Frewer LJ. 2005. A typology of public engagement mechanisms. *Science, Technology, and Human Values* 30: 251–290.

Royal Society. 2006. *Science communication: Survey of factors affecting science communication by scientists and engineers*. Royal Society (1 June 2006). https://royalsociety.org/-/media/policy/publications/2006/1111111395.pdf

Rubega MA, Burgio KR, MacDonald AAM, Oeldorf-Hirsch A, Capers RS, Wyss R. 2021. Assessment by audiences shows little effect of science communication training. *Science Communication* 43: 139–169.

Ruffle BJ, Shtudiner ZE. 2015. Are good-looking people more employable? *Management Science* 61: 1760–1776.

Russ T, Simonds C, Hunt S. 2002. Coming out in the classroom… an occupational hazard? The influence of sexual orientation on teacher credibility and perceived student learning. *Communication Education* 51: 311–324.

Russo G. 2010. Outreach: Meet the press. *Nature* 468: 465–467.

Rust NA, Rehackova L, Naab F, Abrams A, Hughes C, Merkle BG, Clark B, Tindale S. 2021. What does the UK public want farmland to look like? *Land Use Policy* 106: 105445.

Sarewitz D. 2011. The dubious benefits of broader impact. *Nature* 475: 141.

Sato S, Gygax PM, Randall J, Schmid Mast M. 2021. The leaky pipeline in research grant peer review and funding decisions: Challenges and future directions. *Higher Education* 82: 145–162.

Scheufele DA. 2013. Communicating science in social settings. *Proceedings of the National Academy of Sciences* 110: 14040–14047.

Schmidt B. 2015. Gendered language in teacher reviews. Ben Schmidt (February 2015). http://benschmidt.org/profGender

Schutte V, Merkle BG. 2022. The visibility monster (no. 15). *Meteor SciComm: The Honest Podcast about SciComm with Impact*. www.buzzsprout.com/1862324/11027665-the-visibility-monster

Schweizer S, Thompson JL, Teel T, Bruyere B. 2009. Strategies for communicating about climate change impacts on public lands. *Science Communication* 31: 266–274.

Seron C, Silbey SS, Cech E, Rubineau B. 2016. Persistence is cultural: Professional socialization and the reproduction of sex segregation. *Work and Occupations* 43: 178–214.

Sharfstein JM. 2016. Banishing "stakeholders." *Milbank Quarterly* 94: 476–479.

Sharples C. 2017. Why the white explorer trope is outdated and dangerous. Gal-Dem (18 November 2017). https://gal-dem.com/white-explorer-trope-outdated-dangerous

Sher AA, Molles MC. 2022. *Ecology: Concepts and Applications*. McGraw Hill.

Sidik SM. 2022. Weaving indigenous knowledge into the scientific method. Nature (11 January 2022). www.nature.com/articles/d41586-022-00029-2

Silvy T. 2016. Bella Romero 8th-graders win collegiate-level science competition, gaining inspiration in the process. Greely Tribune (3 December 2016). www.greeleytribune.com/2016/03/12/bella-romero-8th-graders-win-collegiate-level-science-competition-gaining-inspiration-in-the-process

Simis MJ, Madden H, Cacciatore MA, Yeo SK. 2016. The lure of rationality: Why does the deficit model persist in science communication? *Public Understanding of Science* 25: 400–414.

Singh GG. 2022. Prestige risks homogenizing and hampering academia. *Nature* 610: 630.

Singh GG, et al. 2019. Researcher engagement in policy deemed societally beneficial yet unrewarded. *Frontiers in Ecology and the Environment* 17: 375–382.

Sirvisetty H, King RK, Fuselier LC. 2020. Seen in science: LGBTQ+ inclusivity in anatomy and physiology texts. Undergraduate Arts and Research Showcase 19. https://ir.library.louisville.edu/uars/19

Sismondo S. 2010. *An Introduction to Science and Technology Studies*. Wiley-Blackwell.

Solnit R. 2016. *Hope in the Dark: Untold Histories, Wild Possibilities*. Haymarket Books.

Spafford H. 2019. Scientists in the politicoscientific community: Beyond the Lorax. *Annals of the Entomological Society of America* 112: 57–61.

Spears R. 2021. Social influence and group identity. *Annual Review of Psychology* 72: 367–390.

Spencer E. 2018. *The Bear Necessities of Conservation Messaging: Exploring How to Effectively Communicate Safety Information to People Visiting bear Country*. Memorial University of Newfoundland.
Spoel P, Goforth D, Cheu H, Pearson D. 2008. Public communication of climate change science: Engaging citizens through apocalyptic narrative explanation. *Technical Communication Quarterly* 18: 49–81.
Steffen H. 2009. Pack consciousness. *Minnesota Review* 71/72: 248–254.
Steinþórsdóttir FS, Einarsdóttir, Pétursdóttir GM, Himmelweit S. 2020. Gendered inequalities in competitive grant funding: An overlooked dimension of gendered power relations in academia. *Higher Education Research and Development* 39: 362–375.
Stern MJ, Powell RB. 2013. What leads to better visitor outcomes in live interpretation?. *Journal of Interpretation Research* 18: 9–43.
Sumner P, et al. 2014. The association between exaggeration in health related science news and academic press releases: Retrospective observational study. *BMJ* 349: g7015.
Sutter PM. 2022. Universities are failing the next generation of scientists. Undark (24 March 2022). https://undark.org/2022/03/24/universities-are-failing-the-next-generation-of-scientists
Tajfel H, Turner JC. 2001. An integrative theory of intergroup conflict. Pages 94–109 in Hogg MA, Abrams D, eds. *Intergroup Relations: Essential Readings*. Psychology Press.
Tanner RL, et al. 2021. Examining cultural structures and functions in biology. *Integrative and Comparative Biology* 61: 2282–2293.
Taylor C. 1992. The politics of recognition. Pages 25–75 in Gutmann A, ed. *Multiculturalism: Examining the Politics of Recognition*. Princeton University Press.
Templeton E, Love B, Davis BH, Davis M. 2016. Illusion of inclusion. *Journal Committed to Social Change on Race and Ethnicity* 2: 88–115.
Tilden F. 2008. *Interpreting Our Heritage*, 4th ed. The University of North Carolina Press.
Todd Z. 2012. Should I stay or should I go? Anthrodendum (12 May 2018). https://anthrodendum.org/2018/05/12/should-i-stay-or-should-i-go
Trachtenberg J, Lee HY, Anderson C, Chang S, Cameron C. 2018. Do you speak science? Dialect and its role in research training. *Understanding Interventions* 9: 3729.
Treise D, Weingold MF. 2002. Advancing science communication: A survey of science communicators. *Science Communication* 23: 310–322.
Trench B. 2008. Towards an analytical framework of science communication models. Pages 119–135 in Cheng D, Claessens M, Gascoigne T, Metcalfe J, Schiele B Shi S, eds. *Communicating Science in Social Contexts: New Models, New Practices*. Springer.
Tretkoff E. 2007. NSF's "broader impacts" Criterion gets mixed reviews. *APS125* (n.d.). www.aps.org/publications/apsnews/200706/nsf.cfm
Treves A. 2019. Scientific ethics and the illusion of naïve objectivity. *Frontiers in Ecology and the Environment* 17: 1540–9295.
Van Dam A. 2022. People from elite backgrounds increasingly dominate academia, data shows. Washington Post (8 July 2022). www.washingtonpost.com/business/2022/07/08/dept-of-data-academia-elite
Van Noorden R. 2013. Open access: The true cost of science publishing. *Nature* 495: 426–429.
Varner J. 2014. Scientific outreach: Toward effective public engagement with biological science. *BioScience* 64: 333–340.
Vickery R, Murphy K, McMillan R, Alderfer S, Donkoh J, Kelp N. 2023. Analysis of inclusivity of published science communication curricula for scientists and STEM students. *CBE—Life Sciences Education* 22: 8.
Vowel C. 2016. Beyond territorial acknowledgments. Âpihtawikosisân (23 September 2016). https://apihtawikosisan.com/2016/09/beyond-territorial-acknowledgments/
Wahls WP. 2016. Biases in grant proposal success rates, funding rates and award sizes affect the geographical distribution of funding for biomedical research. *PeerJ* 4: e1917.
Warren RC, Forrow L, Hodge DA, Sr, Truog RD. 2020. Trustworthiness before trust: Covid-19 vaccine trials and the black community. *New England Journal of Medicine* 383: e121.
Weber JR, Word CS. 2001. The communication process as evaluative context: What do nonscientists hear when scientists speak? Scientists and nonscientists benefit by recognizing that attempts at mutual influence, multiple frames of reference, and "objective" information in science communication are not neutral but evaluated with other social influences. *BioScience* 51: 487–495.
Wilder CS. 2013. *Ebony and Ivy: Race, Slavery, and the Troubled History of America's Universities*. Bloomsbury.
Wilkinson C, Milani E, Ridgway A, Weitkamp E. 2022. Roles, incentives, training, and audiences for science communication: Perspectives from female science communicators. *Journal of Science Communication* 21: A04.
Williams JJ. 2012. Deconstructing academe: The birth of critical university studies. Chronicle of Higher Education (19 February 2012). www.chronicle.com/article/deconstructing-academe
Wingfield AH. 2020. Systemic racism persists in the sciences. *Science* 369: 351–351.
Wood S, Henning JA, Chen L, McKibben T, Smith ML, Weber M, Zemenick A, Ballen CJ. 2020. A scientist like me: Demographic analysis of biology textbooks reveals both progress and long-term lags. *Proceedings of the Royal Society B* 287: 20200877.
Wróblewska MN, Balaban C, Derrick G, Benneworth P. 2024. The conflict of impact for early career researchers planning for a future in the academy. *Research Evaluation* 33: rvad024. https://doi.org/10.1093/reseval/rvad024.
Yap M, Konrad AM. 2009. Gender and racial differentials in promotions: Is there a sticky floor, a mid-level bottleneck, or a glass ceiling? *Relations Industrielles (Industrial Relations)* 64: 593–619.
Youn TI, Price TM. 2009. Learning from the experience of others: The evolution of faculty tenure and promotion rules in comprehensive institutions. *Journal of Higher Education* 80: 204–237.
Zaniboni S, Kmicinska M, Truxillo DM, Kahn K, Paladino MP, Fraccaroli F. 2019. Will you still hire me when I am over 50? The effects of implicit and explicit age stereotyping on resume evaluations. *European Journal of Work and Organizational Psychology* 28: 453–467.
Zia A, Todd AM. 2010. Evaluating the effects of ideology on public understanding of climate change science: How to improve communication across ideological divides? *Public Understanding of Science* 19: 743–761.
Ziegler R, Hedder IR, Fischer L. 2021. Evaluation of science communication: Current practices, challenges, and future implications. *Frontiers in Communication* 6: 669744.
Zuroski E. 2018. Holding patterns: On academic knowledge and labor. Medium (5 April 2018). https://medium.com/@zugenia/holding-patterns-on-academic-knowledge-and-labor-3e5a6000ecbf
Zuroski E. 2020. Where do you know from? An exercise in placing ourselves together in the classroom. MAI: Feminism and Visual Culture (27 January 2020). https://maifeminism.com/where-do-you-know-from-an-exercise-in-placing-ourselves-together-in-the-classroom

Received: January 16, 2023. **Accepted:** July 17, 2024

Author Contributions

EDB, BGM, and RMT are equal co-first authors. EDB: Conceptualization (lead), Data Curation (lead), Project Administration (lead), Visualization (lead), Writing – Original Draft Preparation (lead), Writing – Review & Editing (lead); BGM: Conceptualization (lead), Data Curation (lead), Project Administration (lead), Visualization (lead), Writing – Original Draft Preparation (lead), Writing – Review & Editing (lead); MMB: Conceptualization (equal), Data Curation (leadlead), Writing – Original Draft Preparation (equal), Writing – Review & Editing (equal); EGW: Conceptualization (equal), Data Curation (supporting), Writing – Original Draft Preparation (equal), Writing – Review & Editing (equal); SMM: Conceptualization (equal), Data Curation (supporting), Writing – Original Draft Preparation (equal), Writing – Review & Editing (equal); JJC: Conceptualization (equal), Writing – Review & Editing (supporting), Visualization (supporting); EAH: Conceptualization (equal), Data Curation (supporting), Writing – Original Draft Preparation (supporting), Writing – Review & Editing (supporting); AAS: Conceptualization (equal), Data Curation (supporting), Writing – Original Draft Preparation (supporting), Writing – Review & Editing (supporting); JMG: Conceptualization (equal), Data Curation (supporting), Writing – Original Draft Preparation (supporting), Writing – Review & Editing (supporting); JJL: orting), Writing – Original Draft Preparation (supporting), Writing – Review & Editing (supporting); CS: Conceptualization (equal), Data Curation (supporting); RMT: Conceptualization (lead), Data Curation (lead), Project Administration (lead), Visualization (lead), Writing – Original Draft Preparation (lead), Writing – Review & Editing (lead).

RELEVANT TO: Broder, E.D.♦, **B.G. Merkle♦**, M. Balgopal, E. Weigel, S. Murphy, J.J. Caffrey, E. Hebets, A. Sher, J. Gumm, J. Lee, C. Schell, and R. Tinghitella♦. 2024. Use your power for good: An applied framework for overcoming institutional injustices impeding SciComm in the academy. *BioScience* 74(11): 747-769. https://doi.org/10.1093/biosci/biae080

Supplement: action items, calibrated to axes of influence

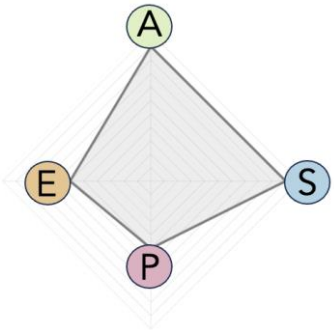
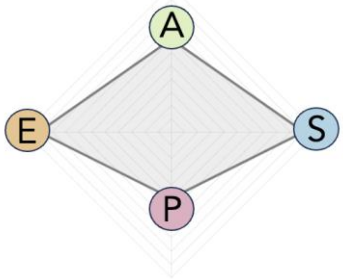
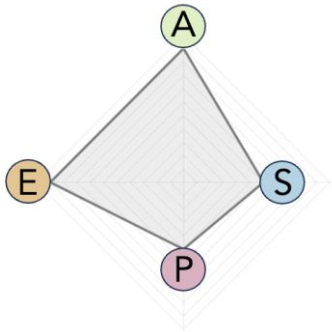
The good news is that there are innumerable actions you can take to make academia more equitable in the context of SciComm. However, having specific ideas will help you get started. To that end, we have provided an extensive but not exhaustive list of suggestions.

For nearly every one of the actions listed before, anyone can attempt to initiate or support these changes. In other words, most efforts to effect change are available to everyone. At the same time, in most situations and actions, having some capital will usually always help. Recognizing that responsibility and influence are major factors, below we distinguish among administrators and major funders, faculty and staff with more and less power, and postdocs and students. Thus, we begin with actions most feasible or impactful if implemented by those with extensive influence within academia (e.g., administrators). We end with actions that everyone can take. We also discuss opportunities and responsibilities at each hierarchical level below. We also include examples of polygons (from axes of influence introduced in Fig. 7; Fig. S1-4) for hypothetical individuals in each of the hierarchical levels, to illustrate how intersectional issues manifest at each level (see also Hogan 2009, Steffen 2009, Massé and Hogan 2012, Jimenez et al. 2019). Many of the suggested actions below have been inspired and informed by discussions within the SciComm community and in social justice discourse.

Administrative influence

Administrators often have the opportunity to change policy, implement new programs, and allocate significant financial, administrative, and personnel resources (Geschwind et al. 2019). These are system-shaping functions; thus, we focus on them first. Funders and professional societies also sit within the context of administrative power and obligation to enhance the state of SciComm in the academy. These include personnel working within funding agencies, professional society leadership roles, and major editorial positions. Thus, our administrator recommendations also encompass these academic-adjacent roles and entities. Because administrators have influence in so many different spheres, we organized the list of actions into four categories: re-define metrics of success and recognition, accountability, and funding (Royal Society 2006, Singh et al. 2019, Wellcome Trust 2020, Ocampo 2021).

Figure S1. Examples of administrative/funder-level influence potential

 A. Neurodivergent president of a scientific society	 B. Black administrator with a large discretionary budget	 C. Indigenous NSF program officer

- **Re-define metrics of success:**
    - Mid-level and upper-admin are typically accountable for metrics including: student enrollment and retention, graduation times, publications, grants received, budget use etc. Meaningful, measurable SciComm impacts (from their units) should be added to these metrics. When Deans and Provosts are accountable for these impacts, institutional encouragement isn't so hollow or appropriative, and institutional investment is more likely.
    - Consider SciComm efforts as positive aspects of an employee's record during hiring, tenure, promotion, and retention decisions (perhaps even formalize this).
    - Support and incentivize (rather than prohibit) co-teaching and cross-listing courses. Encourage interdisciplinary collaborations between natural and social scientists with expertise in communication.
    - Use analytics and surveys to assess the proportion of alumni that use SciComm in their careers. Then overhaul institution-level learning objectives and curriculum to prepare instructors, advisors, and students appropriately.
- **Recognition**:
    - Provide meaningful recognition and funding for SciComm initiatives, not just science research initiatives or SciComm as a tack-on to science research. Doing so helps counter the exploitative nature of much SciComm reporting by upper admin.
    - Actively promote the work of personnel that have expertise in this area (including many who are not on a tenure track). This includes suggesting them as an expert, putting forth their names for institute profiles, as well as expanding the scope of internal funding, fellowships, awards, and support systems..
    - Award and recognize alumni, community partners, and others who do ethical SciComm in their professional and civic work.
    - Avoid whitewashing and cannibalizing the SciComm efforts of your personnel - if you actively obstructed or passively didn't support the work, don't later poach it to brag about the institution's cultural awareness, social commitments, or community partnerships.
- **Accountability:**

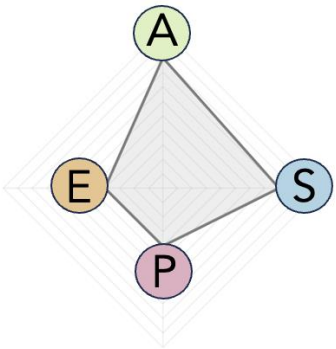
    - Establish accountability mechanisms to ensure personnel receiving funding for SciComm-style broader impacts are actually implementing ethical SciComm as part of larger funding packages.
    - Systematically audit claims of effective SciComm/broader impacts. Entrenched faculty often minimally complete (or fail to complete) funded SciComm aims and assessment, etc., while less-visible or valued personnel make significant impacts which are frequently overlooked.
    - Reward and incentivize personnel who actively pursue training in modern pedagogical good practices, DEIJ issues, SciComm, good mentoring practices, etc. Systematically review faculty at all career stages, and require re-training for personnel actively avoiding these areas of professional development.
    - Ensure classroom assignments and class times for SciComm courses are attractive to students and instructors.
- **Funding:**
    - Support SciComm efforts and practitioners with hard-money, not soft monies. Real impacts require sustained funding.
    - Change the way you evaluate/fund proposed work that includes SciComm to ensure expert, open-minded, evidence-based review and accountability.
    - Make science fully, affordably open access. Paywalls and page fees prevent efforts to publish, distribute, and implement SciComm research.
    - Incentivize proposals/programs that provide well-paid opportunities for students to engage in SciComm practice, research, and teaching.
    - Explicitly state what portion of a budget should be allocated to SciComm/broader impacts and prioritize proposals that appropriately and meaningfully can accomplish their claims within these financial limits.
    - Establish and enforce expectations for proposals and projects to (a) require relevant expertise from inception, (b) appropriately compensate expertise, and (c) operate in right relations with relevant communities (including but not limited to compensation).

Faculty & staff influence

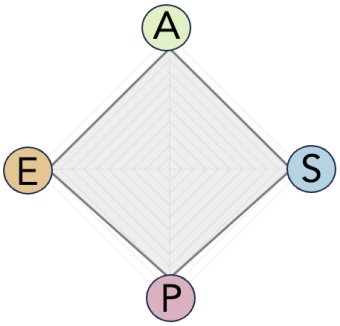
We next discuss (and distinguish between) faculty with more influence and faculty and staff with less influence. While people with and without tenure have distinct levels of influence, there are also entire tracks of faculty who explicitly have less prestige and influence (e.g., visiting faculty, non-tenure track faculty including lecturers and professors of practice, and certainly adjuncts). At the same time, staff positions range from janitors to directors of communication. This imbalance in prestige and hierarchy exists despite the reality that many people do not desire a tenure-track role and do not perceive their own work and roles as settling for a lesser career option.

Senior faculty & staff with more influence

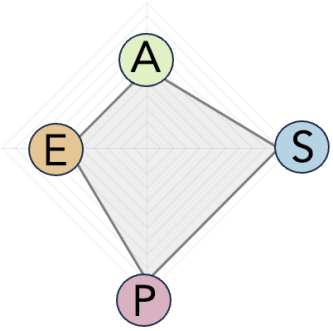
Figure S2. Examples of faculty and staff with more influence



A. Senior faculty member without a grant that is not a US citizen



B. Tenured faculty with a major, long-term grant

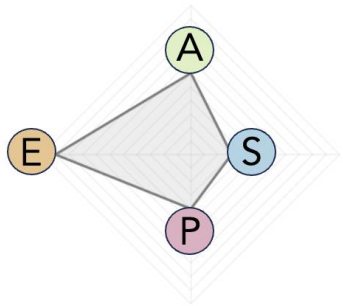
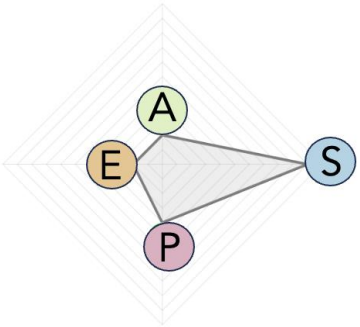
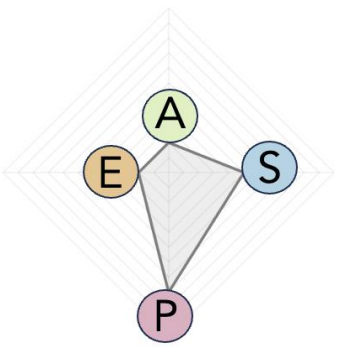


C. Director of the Office of Teaching and Learning

- Advocate for department and institutional investment in paid training/resources in SciComm.
- Hold space (in department planning, funding review panels, hiring processes, etc.) for SciComm-active people, even if they don't have "traditional" science PhDs and academic career paths.
- Vote to hire and promote people in all employment types who spend time on SciComm and/or teaching SciComm.
- Write excellent tenure letters for people who spend time on SciComm and teaching SciComm.
- Recognize and value more diverse modes of production besides peer-reviewed publications and funded grants.
- Call out injustice when you see it (e.g., when you see SciComm being devalued).
- Demand virtual/hybrid academic conference options; these facilitate participation of more diverse people.

Junior faculty & staff with less influence

Figure S3. Examples of administrative/funder-level influence potential

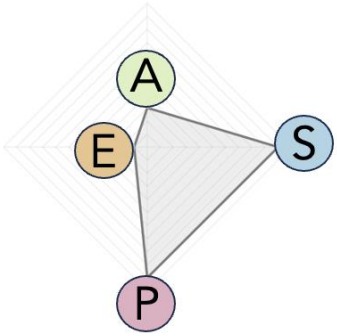
 A. New faculty member who has a big grant and is queer	 B. Ag extension agent who uses a wheelchair	 C. Social media manager for a STEM department

- Acknowledge and support the SciComm expertise of those with less power (e.g., staff, students, early-career academics, practitioners external to the academy).
- Nominate SciComm-active people for research and professional activity awards (not “just” teaching and outreach awards).
- Become familiar with SciComm career options and provide mentorship to connect and support individuals interested in them.
- Include SciComm as an explicit learning objective in your curriculum and courses.
- Value and support SciComm as a research output (not “just” service) in annual evaluations of peers, employees, and mentees (e.g., graduate students and postdocs).
- Coach students, early career people, etc., to translate their SciComm work into academically valued outputs (publications, data, using citations to substantiate the work, etc.) and vice versa (SciComm courses, integration of SciComm into discipline courses, workshops). Doing so makes SciComm more accessible, visible, and valuable in academia and beyond.
- Include salary for students and evaluators to do the SciComm parts of your grant proposals if you are not qualified to do so, and advocate that others do so, too.
- Budget for open access publication fees to ensure broader public access to science, a foundational element of sharing science

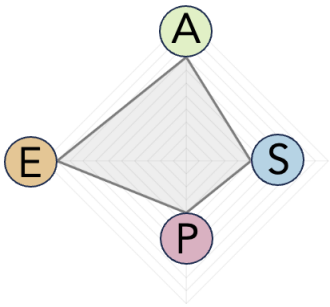
Students and postdocs

Undergraduate and graduate students and postdocs are lowest in the academic hierarchy, but are often the most passionate about systemic change and the urgency of doing ethical SciComm. Furthermore, individuals at these levels may still have influence, for instance a widely networked student volunteering on a President’s Office task force could have a lot of social capital. For people in these roles in the hierarchy, collective actions also have the potential to make big changes.

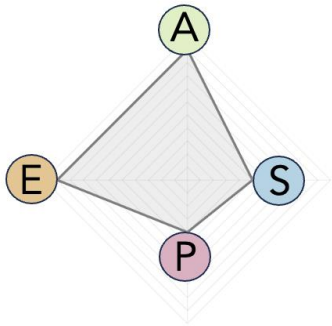
Figure S4. Examples of administrative/funder-level influence potential



A. Male graduate student that is a union organizer



B. First-generation NSF GRFP PhD fellow with a major outreach component to their GRFP



C. International, prolific postdoc on a big grant

- Seek out mentorship, employment, and professional opportunities, settings, and mentors who support your interest, efforts, and expertise in SciComm.
- Ask professors to include SciComm content in their courses, and/or leverage other feedback opportunities to advocate for SciComm training and courses.
- Mention in course evaluations if you feel you benefitted from SciComm course content.
- Explore SciComm careers or components of careers.

Everyone

As we noted, every member of the academy, regardless of axes of influence, can work to make academia more just for, and through, SciComm.

- Invest in and commit to working in right relations with the many collaborators, end-users, communities, and other people who may have influence over, interest in, or be impacted by your work.
- Prioritize addressing your biases. Take implicit bias tests regularly to become aware of gaps in knowledge and problematic attitudes and behaviors, and then track your growth as you work to address them.
- Do the hard, necessary work of discerning your relationship with your job, including any or all of the following:
    - Think hard about how much you want to identify with your job.
    - Take back time you're spending trying to get the institution to 'love' you since the perpetuity of any institution relies, in part, on individuals within it being replaceable (Daub and Goode 2020, Holdren 2021).
    - Allocate time to catalyze important changes in your community through ethical SciComm that aligns with your values, even if that work doesn't "count" within academia or your values are not always aligned with academia (Montgomery 2019).

    - TL;DR: you can potentially be more effective doing radical work outside academia (Goldberg 2022a-c).
- Learn more about SciComm by attending SciComm events, trainings, courses, and conferences and reading the literature and relevant public discourses to learn more about the important work being done in this area and how you can help.
- Affirm great work in SciComm (congratulate, read, cite, and recommend others' work).
- Acknowledge contributions to your work that are SciComm (e.g., a beautiful figure someone makes for your paper could go in author contributions; a social media post from a coauthor or colleague brings attention to your work).
- Invite speakers that have SciComm as a big part of their work.
- Budget and push to pay people for SciComm work (incl., honoraria and salary top-ups for faculty, postdocs, staff, and students, not just external consultants).
- Model and invest in more respectful relationships with non-academic SciComm practitioners (including partnership, co-production, supporting people pursuing careers in this realm, etc.).
- Become an active SciComm-engaged academic with a commitment to ethical SciComm as characterized in this paper.

References

Daub A, Goode L. (Hosts). (2020, June 17). Tressie McMillan Cottom (No. 2) [Audio podcast episode]. In *The Feminist Present*. Clayman Institute for Gender Research, Stanford University. https://gender.stanford.edu/podcast.

Geschwind, L., Aarrevaara, T., Berg, L.N. and Lind, J.K., 2019. The changing roles of academic leaders: Decision-making, power, and performance. Pages 181-210 in Pinheiro, R, Geschwind, L, Foss Hansen H, Pulkkinen, K., eds. *Reforms, Organizational Change and Performance in Higher Education: A Comparative Account from the Nordic Countries*. Springer Nature.

Goldberg JA. 2022a. [@KempoJesse] (2022, September 23). *So I wanted to redirect the student's question from the absolutist premise that we either do reproduce injustice or we don't while doing our academic work, because the "we don't" is a self-congratulatory fantasy. Instead, how do we act ethically knowing we cause harm?* [Tweet]. Twitter. https://twitter.com/KempoJesse/status/1573066400142442498.

Goldberg JA. 2022b. [@KempoJesse] (2022, September 23). *One of the ways, I think, to do good work as an academic is to refuse the academy's attempt to monopolize our time. Refuse to even ask the question, "how will X fit into my tenure file?" Refuse to have our political speech preemptively (self-?)censored.* [Tweet]. Twitter. https://twitter.com/KempoJesse/status/1573066404730904577.

Goldberg JA. 2022c. [@KempoJesse] (2022, September 23). *And then, do some work beyond the academy's boundaries instead of giving all of your free time to your employer. Be*

accountable to communities that don't write your paychecks. [Tweet]. Twitter. https://twitter.com/KempoJesse/status/1573326166999863297.

Hogan K. 2009. What is criticism on academic labor for? *Minnesota Review* 71/72: 191-199.

Holdren N. (2021, May 11). Faculty Moral Distress about Pandemic Teaching [web log]. Retrieved from https://academeblog.org/2021/05/11/faculty-moral-distress-about-pandemic-teaching/.

Jimenez MF, Laverty TM, Bombaci SP, Wilkins K, Bennett DE, Pejchar L. 2019. Underrepresented faculty play a disproportionate role in advancing diversity and inclusion. *Nature Ecology and Evolution* 3:1030–1033.

Massé MA, Hogan KJ. eds. 2012. *Over ten million served: Gendered service in language and literature workplaces*. SUNY Press.

Montgomery B. (2019, September 30). How I work and thrive in academia – From affirmation, not for affirmation [web log]. Being Lazy and Slowing Down. Kimine Mayuzumi and Riyad A. Shahjahan, eds. Retrieved from https://lazyslowdown.com/how-i-work-and-thrive-in-academia-from-affirmation-not-for-affirmation/.

Ocampo AC. (April 7, 2021). Junior faculty don't need more time, senior faculty need more imagination: A template for change. *Chronicle of Higher Education.* https://www.chronicle.com/article/the-future-of-tenure?bc_nonce=cju5bdc0qiftyw7bkry65&cid=reg_wall_signup#ocampo

Royal Society. 2006. *Science communication: Survey of factors affecting science communication by scientists and engineers*. Report. Retrieved from https://royalsociety.org/topics-policy/publications/2006/science-communication/.

Singh GG. 2022. Prestige risks homogenizing and hampering academia. *Nature* 610: 630.

Steffen H. 2009. Pack consciousness. *Minnesota Review* 71/72: 248-254.

Wellcome Trust. 2020. What researchers think about the culture they work in. Report Summary. Retrieved from https://wellcome.org/reports/what-researchers-think-about-research-culture.

Recommended citation: Broder et al. 2024. Supplement: Action items, calibrated to axes of influence. Supplement 1 in Broder, E.D.♦, B.G. Merkle♦, M. Balgopal, E. Weigel, S. Murphy, J.J. Caffrey, E. Hebets, A. Sher, J. Gumm, J. Lee, C. Schell, and R. Tinghitella♦. 2024. Use your power for good: An applied framework for overcoming institutional injustices impeding SciComm in the academy. *BioScience* 74(11): 747-769. https://doi.org/10.1093/biosci/biae080