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Reimagining Science Culture in Canada

Discussion Paper 1

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Actua Asks: What is Science Culture?

Actua is creating a Canada where every child has the skills and confidence they need to achieve their full potential. As a leading science, technology, engineering and mathematics (STEM) outreach organization, Actua includes over 40 universities and colleges, engaging 500,000 youth in 600 communities each year. For 25 years, Actua has focused on identifying and removing the barriers for entry into STEM and now has national programs dedicated to engaging Indigenous youth, girls and young women, Black youth, those facing economic barriers and youth in Northern and remote communities.

Actua plays an active role in shaping Canada's science and technology landscape. We do this by delivering hands-on STEM outreach to youth across the country, supporting educators in creating inclusive learning environments, partnering with Indigenous organizations and communities, and mobilizing a national network of university and college members. We also relentlessly advocate for equitable STEM policies and practices that remove barriers for equity-deserving youth.

As part of our ongoing commitment to inclusion and impact, we set out to better understand the concept of science culture and how Actua's programs and activities can help shape a stronger science culture. This is especially important at a time when public trust and perceptions of science are vulnerable.. We believe that reexamining and reinforcing science culture in Canada are powerful ways to improve how science shapes society and how society, in turn, helps shape science to benefit all.

Introduction: Science Culture in an Age of Uncertainty

A strong science culture is widely held to be a key contributor to innovation, economic growth, and societal well-being. Scientific literacy and trust in institutions and experts are viewed as bulwarks against mis- and dis-information and contributors to health, social cohesion and democratic integrity.[1] Societies with advanced science skills, and curious and critical citizens, are on the leading edge of discovery and prosperity. Science culture matters. But what is science culture, exactly? What is a strong science culture? How does a strong science culture actually contribute to positive outcomes?

[1] This discussion paper was prepared by Daniel Munro, Director of Research and Innovation at Actua, with substantial contributions from Bissy Waariyo. For constructive reactions and discussions, we thank Doug Dokis, Jennifer Flanagan, Alison Gareau, Virginia Hall, Val Iannitti, Creig Lamb, Suzi Loney, Rhonda Moore and Tracy Ross.

Achieving clarity on science culture is important given recent changes in public attitudes. While science and technology continue to generate improvements in transportation, communication, health and other areas, many people in liberal democracies distrust science. Amplified during the COVID-19 pandemic but stretching back decades to skepticism about climate change, vaccines, genetically modified foods, and other issues, doubt has made science vulnerable to populist attacks, with negative implications for funding, participation and use.[2]

Repairing the relationship between science and society depends on improving science culture. A first step is to better understand what it is, why it matters, and how it can be reimagined in the current age of skepticism and uncertainty.

In parallel, despite much-needed equity, diversity and inclusion (EDI) initiatives, science struggles to include and empower women, gender diverse people, racialized and Indigenous people, and people with disabilities. EDI initiatives have achieved some progress, but they are now highly politicized. Many who have benefitted from them face resistance to their accomplishments. Moreover, there are persistent barriers to Indigenous participation and knowledge in science.[3] As a result, many people who might be sympathetic to science maintain a guarded distance.

Repairing the relationship between science and society depends on improving science culture. A first step is to better understand what it is, why it matters, and how it can be reimagined in the current age of skepticism and uncertainty.

KEY QUESTIONS

This discussion paper shares insights and aims to spur discussion on the meaning and value of science culture. The hope is that with a renewed and reimagined understanding, science culture can help frame and guide efforts to enhance the relationship between science and society. To do so, it focuses on a few key questions:

- *Why does science culture matter?*
    - What is science culture expected to do?
- *What is science culture?*
    - How is it defined by different organizations and in different contexts?

[2] M. Mills and P. St. Clair (2025) "The Strange New Politics of Science" *Issues in Science & Tech XLI* (3).

[3] E. Anderson, et al (2021) "Policy Memo: Decolonization of STEM in the Public Education System in Québec, Canada." *Journal of Science Policy and Governance* 18 (4).

- What are their strengths and weaknesses?

- *How should science culture be reimagined?*

  - How should science culture incorporate insights about equity, diversity and inclusion, as well as Indigenous science and ways of knowing?

  - How should it recognize the importance of institutions and systems?

  - Should it embrace a more democratic approach to science communication?

While the paper addresses these questions, we don't claim to have all the answers. Our hope is that by posing the questions and spurring others to think about them, we can advance discussion about the value of science culture in navigating the relationship between science and society and supporting an inclusive and robust science and innovation ecosystem that generates benefits for all.

REIMAGINING SCIENCE CULTURE IN CANADA

Our efforts to rethink and reimagine science culture involve three related discussions: defining science culture, understanding systems and systemic change, and measuring science culture. To ensure that we give sufficient attention to each theme, we have prepared three discussion papers that explore the relevant dimensions and offer some preliminary thinking.

- Paper 1: Reimagining Science Culture in Canada
- Paper 2: From Pipelines to Systems: Thinking About Systemic Change
- Paper 3: Measuring Science Culture in Canada

The first two papers extend how we think about science culture and systemic change, while the third explores ways to measure both - including gaps in metrics and data - and offers a rough assessment on how Canada is doing.

Why Science Culture Matters

Why think about science culture at all? Why not simply focus on educating future scientists and advancing science literacy in the population more broadly? What does a science culture lens add to our understanding of science in society?

Consider a few ways science culture matters to broader social, economic and individual well-being:

- Science culture ***mediates how we understand and benefit from science*** and technology, including ***how benefits are distributed***. For example, a new pharmaceutical or insights about dietary patterns may have potential to improve health and well-being. But realizing that potential requires doctors and individuals to be open to science, to have the knowledge and skills to understand the potential and critically assess whether they are appropriate in one's particular circumstances, and to use the insights effectively.

- Science culture - understood (provisionally) as skills, attitudes, knowledge and behaviours across society - shapes the extent to which the benefits of science are absorbed by social actors.[4] How those skills, attitudes, knowledge and behaviours are distributed across gender, age, racial identity, Indigenous identity, socioeconomic status, (dis)ability, and intersecting and other identities shapes the distribution of the benefits of science.

- Relatedly, science culture may serve as a ***critical lens and bulwark against mis- and dis-information***.[5] Individuals alone are unable to stop a digital tsunami of ignorant and malicious messages about health, climate change, democratic integrity and other concerns. We need laws, institutions and social systems to support us. But individuals equipped with certain science "literacies" - such as health literacy, green literacy and digital literacy - may be better positioned to filter and evaluate junk information, and contribute to conversations about what laws, institutions and social systems are needed to combat mis- and dis-information.

> Science culture ***mediates how we understand and benefit from science and technology***, including how benefits are distributed.

[4] See, for example, Mills and St. Clair (2025) "The Strange New Politics of Science" *Issues in Science and Tech XLI* (3); G. Khoury, et al (2024) "Health Literacy and Health Care System Confidence as Determinants of Attitudes to Vaccines in France: Representative Cross-Sectional Study" *JMIR Public Health and Surveillance* 10.

[5] E. Greenspon and T. Owen (2018) *Democracy Divided: Countering Disinformation and Hate in the Digital Public Sphere* (Public Policy Forum) https://ppforum.ca/publications/social-marketing-hate-speech-disinformation-democracy/; T. Caufield (2020) "Misinformation, alternative medicine and the coronavirus." *Policy Options* https://policyoptions.irpp.org/magazines/march-2020/misinformation-alternative-medicine-and-the-coronavirus/; S. H. Ali and S. Chen (2025) "Better digital literacy could help reduce climate and disaster conspiracy theories" (York University) https://www.yorku.ca/news/2025/01/24/better-digital-literacy-could-help-reduce-climate-and-disaster-conspiracy-theories/.

- Societies with more advanced skills and more people with scientific skills and knowledge see ***better rates of innovation, economic growth and wages***.[6] To be sure, the effect of skills and knowledge on innovation and growth is mediated by institutions, regulations, market structures and other variables but, as a general matter, strong science cultures in this sense improve economic outcomes.

- Science culture affects ***who participates in science and what that participation looks like***. Norms about what a "scientist" looks like, what counts as "evidence" and "expertise", and the extent to which the priorities and practices of science should be shaped by values and democratic processes vary across societies. Science cultures with more inclusive norms and attitudes open the door for participation by historically excluded people and are receptive to other non-Western ways of thinking about knowledge, evidence and how to conduct science.

What is Science Culture?

Science culture matters. But what is it?

In recent decades, thinkers and practitioners have offered various understandings of science culture and its features.[7] These have evolved from measures of science literacy and levels of trust in science, to mapping and assessing the institutions that embody and operationalize scientific values, as well as to examining the trustworthiness of institutions and experts leading science and technology.[8] While it is beyond the scope of this paper to canvas all accounts of science culture, we focus on a few representative examples to illustrate features and gaps worth discussing.

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[6] C. Goldin and L. Katz (1995) *The Race Between Education and Technology* (Harvard University Press); S. Coulombe et al (2004). "Literacy scores, human capital and growth across fourteen OECD countries" *Statistics Canada* https://www150.statcan.gc.ca/n1/pub/89-552-m/89-552-m2004011-eng.pdf

[7] Prominent contributions in the Canadian context include Council of Canadian Academies (2014) *Science Culture: Where Canada Stands*. Ottawa: The Expert Panel on the State of Canada's Science Culture, Council of Canadian Academies; and B. Godin and Y. Gingras (2000) "What is scientific and technological culture and how is it measured? A multidimensional model." *Public Understanding of Science* 9 (1). In 2022, the Institute on Governance released a suite of papers which, among other topics, explore the relationship between science and society, public attitudes to science, science literacy and inclusion as part of its Government Science and Innovation in the New Normal initiative. https://iog.ca/resource/government-science-and-innovation-in-the-new-normal-gsinn/

[8] On the distinction between trust and trustworthiness, see O. O'Neill (2018) "Linking Trust to Trustworthiness." *International Journal of Philosophical Studies* 26 (2). https://www.tandfonline.com/doi/full/10.1080/09672559.2018.1454637. O'Neill writes, "Trust is valuable when placed in trustworthy agents and activities, but damaging or costly when (mis)placed in untrustworthy agents and activities.... Information about others' generic attitudes of trust or mistrust that take no account of evidence whether those attitudes are well or ill placed can offer little or no help for those who aim to place or refuse trust well."

UK ROYAL SOCIETY OF CHEMISTRY

A rich definition of science culture was developed by the UK Royal Society of Chemistry in the early 2000s. Science culture, on their view:

> *encompass[es] the behaviours, values, expectations, attitudes and norms of science communities. It influences career paths and affects the way that science, innovation and associated services are designed and delivered. It is defined by the conduct, practices and approaches of individuals, groups and organisations and the extent to which they are empowered to do what is best for science and for society.*[9]

Moreover, the Royal Society of Chemistry asserts that a positive science culture has five qualities: It is *rigorous, safe and supportive, ethical and responsible, open and collaborative*, and *accessible and inclusive*.

This definition is valuable in that it emphasizes key components of *culture* - i.e., behaviours, values, expectations, attitudes and norms - and acknowledges how cultures shape or "affect" how science is pursued and shared. Taking a closer look, however, the definition exhibits three weaknesses that a renewed or reimagined conceptualization of science culture ought to address:

- *Definition of Science*. While we recognize that what counts as "science" is itself contested terrain, the lack of an account or definition of what "science" is in the Royal Society's account - even provisionally - leaves a gap.[10] One is left wondering what the object or focus of the culture is in science culture.

- *Narrow Focus*. The Royal Society is focused on the culture of science narrowly understood as what scientists and students of science know, believe and do, to the exclusion of what the broader public knows, believes and thinks about science and how they participate. It offers little help in understanding how science culture mediates the interface between science and society. A robust account of science culture should move beyond the culture of science, narrowly defined.

- *Limited Dimensions*. Finally, the Royal Society's account largely omits science literacy, knowledge and skills. While "behaviours, values, expectations, attitudes and norms" are certainly key elements of culture, recognition and measurement of what people know about science and their skills to contribute to and/or use science and technology are equally important.

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[9] Royal Society of Chemistry (2025) "A Vision for Science Culture." https://www.rsc.org/policy-evidence-campaigns/inclusion-diversity/surveys-reports-campaigns/a-vision-for-science-culture/

[10] The UK's Science Council defines science as "the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence." https://sciencecouncil.org/about-science/our-definition-of-science/. The Understanding Science initiative at the University of California, Berkeley, defines science as "both a body of knowledge and a process...a way of discovering what's in the universe and how things work today, how they worked in the past, and how they are likely to work in the future." https://undsci.berkeley.edu/understanding-science-101/what-is-science/

DEFINING SCIENCE CULTURE IN CANADA

Arguably, the most important contribution to Canadian discussion about science culture of the past few decades - and one that addresses some of the deficits of the Royal Society account - is the Council of Canadian Academies' (CCA) 2014 assessment, *Science Culture: Where Canada Stands*.[11] The expert panel convened by the CCA developed an account of science culture as the sum of population performance on four key dimensions (see exhibit 1):

- Public *attitudes* towards science and technology;
- Public *engagement* in science;
- Public science *knowledge*; and
- Science and technology *skills*.

In effect, the CCA conceptualizes science culture as a set of beliefs, behaviours, knowledge and skills related to science, and measures its strength as the extent individuals in society exhibit the relevant beliefs, behaviours, knowledge and skills. The approach has much value. How well citizens relate to science and how science relates to citizens depends on a shared language (i.e., knowledge and skills), and a willingness and interest to participate (i.e., attitudes and engagement).

ATTITUDES	ENGAGEMENT
• What are Canadian attitudes towards science and technology? • What are their views about the promise of science or their reservations about science and technology? • To what degree does the Canadian public support public investment in scientific research, or believe in the value of scientific education and careers? • What are Canadian attitudes on specific scientific issues such as biotechnology or climate change?	• How interested are Canadians in scientific issues, ideas, and developments? • How do they seek out information about new developments in science? • How engaged are Canadians in scientific activities or pursuits? • To what degree do they participate in scientifically oriented events or visit or contribute to scientific institutions?
KNOWLEDGE	**SKILLS**
• What is the general level of knowledge about science among Canadians? • How well do Canadians understand core scientific constructs such as what a molecule is or what a DNA is? • To what extent do Canadians understand what it means to study something scientifically?	• To what extent are Canadians developing professional science and technology skills? • Are Canadian youth pursuing educational opportunities in the sciences? • To what extent are Canadians seeking out advanced training in the sciences or employed in scientific careers?

Source: Council of Canadian Academies (2014) Science Culture: Where Canada Stands.

[11] Council of Canadian Academies (2014) *Science Culture: Where Canada Stands.* Ottawa: The Expert Panel on the State of Canada's Science Culture, Council of Canadian Academies. https://cca-reports.ca/reports/science-culture-where-canada-stands/

With the benefit of a decade's hindsight - including a global pandemic that laid bare deep deficits in science literacy and communication and accelerated pockets of public skepticism about science - we can point to two important areas of the CCA's approach that could use fresh thinking.

- *Equity, diversity and inclusion (EDI)*. The CCA's report has little to say about how science culture should be understood in the context of a diverse society. While it examines the distribution of science literacy, attitudes and skills through a few demographic lenses - notably gender, age, income and, to some extent, Indigenous identity - it has less to say about the relationship science culture has with racialized people, people with disabilities, gender diverse people, and intersecting identities. More importantly, the assessment lacks an explicit conceptual framework for analyzing EDI and distributive considerations in science culture.

- *Institutions, Structures and Systems*. The CCA considers "institutional and social support for science culture in Canada" but does not fully engage with the systemic dimensions of science and science culture. Science culture is treated mainly as the *aggregated skills*, attitudes and behaviours of individual agents with less attention to the ways institutions and systems carry and perpetuate norms, patterns of inclusion and exclusion, status, priorities and other features of science culture. Laws, rules, funding criteria, the physical spaces where science is done, and other features of institutions and systems play a substantial role in shaping science culture and how science culture, in turn, shapes the nature and distribution of its outcomes.

The CCA's assessment is an exceptional resource that offers much value to our understanding of science culture, why it matters and how Canada is doing. In pointing out omissions, our aim is not to diminish the CCA's contribution, but merely to point towards areas where we can build on that strong foundation.

Reimagining the Definition of Science Culture

To make the idea of science culture more relevant and useful in our current context, there arethree areas where it would be helpful to reimagine what it means and why it matters. By incorporating lenses related to equity, diversity and inclusion (EDI); institutions and systems; and more democratic science communication, science culture can play a more vital role in improving key outcomes for Canada.

EQUITY, DIVERSITY AND INCLUSION

When thinking about science culture, we should think about aggregate patterns of skills, attitudes, behaviours and engagement, as well as who participates in and benefits from science. In short, we should think about the distribution of the dimensions of science culture across identities and intersecting identities.

A strong science culture, we might say, is one that ensures equitable participation in and distribution of benefits from science. This matters for both normative and practical reasons.

- From a normative point of view, ensuring that all people have opportunities to participate in and benefit from science is a matter of justice. No one ought to be excluded from the benefits that science can offer, and those benefits should be distributed equitably - especially when science is funded with public resources.

> By incorporating lenses related to equity, diversity and inclusion (EDI); institutions and systems; and more democratic science communication, ***science culture can play a more vital role in improving key outcomes for Canada.***

- From a practical point of view, ensuring more diversity and inclusion in science can contribute to better science by opening doors to different ideas, perspectives, knowledge and skills. Having diverse teams with multiple perspectives prompts researchers to look at things in new ways and consider a broader range of consequences. As one observer notes, "people think and behave differently when they interact with more diverse groups, leading to more open-mindedness, more deliberate consideration of possible outcomes, and more effective problem-solving."[12] Racially and gender diverse teams consistently outperform homogenous teams in problem-solving, critical thinking and innovation. "Diversity jolts us into cognitive action in ways that homogeneity simply does not."[13]

In that case, we can say that a strong science culture is one that embraces equity, diversity and inclusion in opportunities to participate and distribution of outcomes. Progress towards incorporating EDI considerations into science culture - and recognizing its link to scientific excellence - has been made by a number of institutions, including NSERC, the American Association for the Advancement of Science, and the National Science Foundation.[14] While there has been unfortunate and substantial backsliding in the U.S. on EDI - including by the National Science Foundation - it is clear that thinking about the place of EDI in science culture is critically important.

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[12] Sekuler (2017) "Because it's almost 2018: Inclusivity enhances our excellence," *Globe and Mail*. https://www.theglobeandmail.com/opinion/because-its-almost-2018-inclusivity-enhances-our-excellence/article36941996/

[13] K. Phillips (2014) "How Diversity Makes Us Smarter." *Scientific American* (October). https://www.scientificamerican.com/article/how-diversity-makes-us-smarter/. See also the discussion in C. Clearfield and A. Tilcsik (2018) *Meltdown: Why Our Systems Fail and What We Can Do About It*.

[14] S. Villeneuve and A. Webb (2017). *Strengthening Research Excellence through Equity, Diversity and Inclusion* (NSERC) https://www.nserc-crsng.gc.ca/_doc/EDI/EDIpresentation_EN.pdf; American Association for the Advancement of Science (2024). Inclusivity for Excellence https://www.aaas.org/focus-areas/inclusivity-for-excellence; National Science Foundation (2024) About Equity for Excellence in STEM [Link removed by current administration].

INDIGENOUS SCIENCE

Embracing diversity is not about ticking demographic boxes, but about ensuring meaningful opportunities for people to contribute to and benefit from science. Part of that involves being open to different kinds of knowledge, ways of thinking and evidence that "Western" science has tended to ignore or actively discount. The growing awareness of the contributions of Indigenous ways of knowing to our understanding of the world strongly recommends that science culture be defined and measured in ways that ensures these contributions are invited into and respected in science.

As part of ongoing Truth and Reconciliation efforts, some steps are being made to better recognize and value Indigenous ways of knowing and seeing in science. For example:

- In 2019, the Deputy Ministers Task Force on Indigenous Reconciliation recommended a Federal Indigenous STEM (I-STEM) Cluster be formed to bring together multiple federal departments and Indigenous scholars to bridge Western and Indigenous knowledge systems, focusing on equitable, inclusive STEM engagement.[15]

- In 2022, an Indigenous Science Division was formed within Environment and Climate Change Canada with a mandate to bridge, braid, and weave Indigenous science with western science approaches to inform and enhance decision-making.[16]

Still, there is substantial work to be done in recognizing and embracing Indigenous knowledge and ways of thinking in science and science culture. Significant openness and humility is needed on the part of scientists and others shaped by "Western" and colonial understandings of science to recognize that Indigenous science is science, with intrinsically valuable aims and methods, and not a resource to exploit.

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[15] Government of Canada (2025) *Interdepartmental Indigenous Science, Technology, Engineering and Mathematics (I-STEM) Cluster.* https://science.gc.ca/site/science/en/interdepartmental-indigenous-science-technology-engineering-and-mathematics-i-stem-cluster

[16] Government of Canada (2024) *Indigenous Science* https://www.canada.ca/en/environment-climate-change/services/science-technology/indigenous-science.html

SCIENCE CULTURE(S): SINGULAR OR PLURAL?

In thinking about the relationship between Indigenous ways of knowing and current scientific practice, a question arises about whether science culture ought to be conceived of as a single, holistic and shared culture, or whether we should think about many science cultures co-existing in the same society. The latter was raised in the Canadian context by Godin and Gingras who emphasized a plurality of values around science culture, recognizing the diversity of ways individuals might attach value to and participate in science and scientific knowledge.[17]

A pluralistic approach has the benefit of bringing many ways of knowing into science without seeking to impose a single, rigid way of understanding or engaging with science. One risk of a pluralistic approach is that as different standards of knowledge and evidence proliferate, ordinary citizens might have difficulty distinguishing between reliable and unreliable conclusions, especially if science skeptics see pluralism as a way to weaponize uncertainty and spread misinformation.

INSTITUTIONS AND SYSTEMS

Organizations working to improve EDI in STEM are increasingly recognizing that real change requires as much effort to reshape the systems in which people live, learn, and work as it does on *equipping individuals* with skills, knowledge and confidence to succeed within those systems. Systemic change to achieve equity and empowerment entails transformation of the institutions, policies, practices, norms and other structural features that comprise science ecosystems. It aims to bend systems to serve people rather than bending people to fit into outdated, ineffective and unjust systems.

Structural barriers exist for many groups that cannot be overcome simply by further upskilling and empowering the people facing those barriers. Despite efforts to improve outcomes in science for historically underrepresented groups, substantial gaps persist.[18]

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[17] B. Godin and Y. Gingras (2000) "What is scientific and technological culture and how is it measured? A multidimensional model" *Public Understanding of Science* 9.

[18] For example, women in Canada hold 34 percent of STEM degrees but represent only 23 percent of the STEM workforce, and earn an average of $20,000 less annually than male counterparts in technology jobs. Participation and graduation rates among Black university students in STEM continue to lag those of other racialized people. Among Indigenous graduates with bachelors' degrees, 14 percent majored in STEM (versus 19 percent among non-Indigenous non-minority graduates and 35 percent of minority graduates), and Indigenous tech workers earn on average $14,000 less annually than non-Indigenous tech workers. D. Maclatchey and S. Ghose (2024). *Achieving equity in STEM benefits us all*. https://www.wlu.ca/about/governance/senior-leadership/president/news/2024/winter/international-day-for-women-and-girls-in-science.html; A. Lockhart and V. Vu (2024). *Canada's Got Tech Talent: Diversity of Canada's Tech Workers* (DAIS) https://dais.ca/reports/canadas-got-tech-talent-chapter-2/; T. Handler, et al. (2024) *Pathways of Black, Latin American and other population groups in bachelor's degree programs* (Statistics Canada) https://www150.statcan.gc.ca/n1/pub/36-28-0001/2024005/article/00003-eng.htm; A. Usher (2022). *A First Look at 2021 Education Census Data*. https://higheredstrategy.com/a-first-look-at-2021-education-census-data/;

Part of the challenge is that many solutions (and many conceptions of science culture) focus on improving individuals' skills, attitudes, confidence and behaviours without tackling the gendered, racial and other structural barriers that impede even the most skilled, talented and motivated individuals. Solutions and science cultures that prepare individuals for science pathways by raising awareness, spurring interest, and developing skills, knowledge and confidence help to close some of the gaps. But more is needed.

To get a better handle on how to improve EDI in science, science culture needs to move beyond its conventional focus on the aggregated skills, attitudes and behaviours of individuals to consider the structures that constitute and shape the environments and contexts of science. Simply put, systems, structures and institutions ought to be considered part of science culture and not merely background supporting conditions.

We elaborate on the ideas of systems and systemic change in STEM in our second discussion paper, Pipelines to Systems: Thinking About Systemic Change in STEM.

SCIENCE COMMUNICATION AND DEMOCRATIC DELIBERATION

Finally, science culture should continue to grapple with the way science is communicated and governed. Most science communicators have moved past a one-way model of communication which aims to simplify and disseminate scientific knowledge to a receptive public. In its place, many have embraced more two-way communication that connects with people and communities on their terms and from their starting points. Yet, there is a lingering habit of viewing the general public through a "deficit" lens which emphasizes the gap between what people "need to know" and what they "currently know." In that case, part of our thinking about science culture should involve how science interacts and engages with the public.

In a report on nanotechnologies that predates its science culture report, the CCA explored much richer, democratic conceptions of how to guide science for society. In that report, the expert panel wrote:

> *It is increasingly recognized that not only are public perceptions of the benefits and risks of new products critical to the acceptance of those products in the marketplace, but more importantly, that the public has a legitimate claim to democratic participation in the formulation of public policies related to the governance of these products and their underlying technologies.*[19]

[19] Expert Panel on Nanotechnology (2008). *Small is different: a science perspective on the regulatory challenges of the nanoscale*. Ottawa: Council of Canadian Academies.

For the panel, the issue is in part about engaging the public to increase its acceptance of science and technology, but more importantly a matter of giving space to citizens who have a legitimate democratic claim to steer the nature, direction and pace of science and technology. The panel recommended exploring institutions that move beyond one-way communication and consultation as mere listening and towards those that empower the public to articulate goals and values and make decisions to shape and steer science and its application.

As the science, technology and society scholar Sheila Jasanoff reminds us, science and technology are "neither self-propelling nor value-free." They are political in the sense of both challenging and reinforcing power relations, offering different possibilities for the distribution of benefits and harms, and raising questions about what priorities we should have about the direction and pace of scientific and technological activity. Critically, because science is political, it should be open to democratic deliberation and decision-making.[20]

Institutionalizing a more democratic approach to science governance is no easy task. While citizens ought to have power to shape the direction and pace of science and technology in their societies, too many lack the knowledge and expertise needed to understand science, leaving them exposed to influence by narrow economic and political interests. What this means for science culture is an open question. More democratic engagement is valuable, but how a conception of science culture should build that in and how it can and should be institutionalized require more thinking.

Advancing Science Culture

Where does all of this leave us on rethinking and advancing science culture? In light of our review of why science culture matters, prominent understandings of science culture, and issues that deserve more consideration, it might be worth offering a provisional, reimagined working definition of science culture. We might say that a strong science culture:

> values diverse norms, attitudes, behaviours, and knowledge systems, and equips people with basic and advanced skills, in order to practice *constant inquiry*, engage in *public dialogue* on science, support *evidence-informed decision making*, and *champion discovery and responsible innovation*.

Pulling the various strands together, the following table offers a picture of the elements that we think need careful consideration and possible incorporation into a reimagined conception of science culture.

[20] S. Jasanoff (2016) The Ethics of Invention: *Technology and the Human Future* (New York: Norton): 266.

DIMENSIONS OF SCIENCE CULTURE

CCA SCIENCE CULTURE DIMENSIONS	Public attitudes towards science and technology	Attitudes to science generally, and specific issues/technologies
		CCA Science Culture Dimensions
		Support for public investment in science; value of science education & careers
	Public engagement in science	Interest in scientific issues, ideas, developments
		Ways of seeking information
		Engagement in science activities/pursuits
		Participation in science events; visits to scientific institutions
	Public science knowledge	General scientific literacy
		Knowledge of core scientific constructs
		Understanding of scientific study/process
	Science and technology skills	Development of professional science and technology skills
		Pursuit of educational opportunities in the sciences
		Advanced training in sciences; employment in science careers
ACTUA'S ADDITIONAL DIMENSIONS	Equity, diversity and inclusion	Distribution of attitudes to and knowledge about science
		Distribution of opportunities to participate in science, and educational and career achievement
		Actua's Additional Dimensions
		Plural science culture(s) and links among science culture(s)
	Institutions and Systems	State and inclusiveness of scientific institutions
		Laws, policies, funding mechanisms, access to resources
		Formal and informal practices, norms and language
	Science Communication and Democratic Deliberation	Opportunities to learn about/from science
		Opportunities to share views and values about science & tech
		Opportunities to shape priorities, direction & pace of science & tech

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