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Making science communication inclusive: an exploratory study of choices, challenges and change mechanisms in the United States from an emerging movement

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Abstract

This qualitative study explores perspectives of U.S.A.-based science communication researchers and practitioners who attended a symposium focused on advancing inclusive science communication (ISC). ISC is a growing global movement that aims to center equity, inclusion, and marginalized perspectives in science communication. Findings underscore the complexity of systemic barriers to ISC, the critical need for resource sharing and network building, and the importance of evaluation frameworks. The authors also highlight critical dialogue as a strategic tool that might help support intentional, reciprocal, and reflexive practices in science communication.

Keywords

Representations of science and technology; Science communication: theory and models; Social inclusion

DOI

https://doi.org/10.22323/2.21050203

Submitted: 20th October 2021
Accepted: 21st May 2022
Published: 16th August 2022

Introduction

Science communication is a complex and interdisciplinary field with the potential for immense societal value. In a field that has experienced many evolutions in its framing, transitioning from deficit-based [Lewenstein, 2003] to asset-based and social justice [e.g., Calabrese Barton & Tan, 2019; Dawson, 2014; Honma, 2017; Landis et al., 2020], we feel it is important to begin by offering a working definition of science communication for the United States of America (U.S.) context of our study. Here we define science communication as "any information exchange designed to engage targeted audiences in conversations or activities related to [science, technology, engineering, mathematics, and medicine, or] STEMM topics" [K. N. Canfield et al., 2020], specifically to accommodate a range of STEMM engagement contexts.

This paper explores the perspectives of individuals who presumably seek to be, or are actively, engaged in "inclusive science communication" [K. N. Canfield et al.,

2020; Dawson, 2014; Massarani & Merzagora, 2014] and who attended an Inclusive Science Communication Symposium in the United States in 2019 as an indication of such active engagement. While science communication practices *can* foster social inclusion [Massarani & Merzagora, 2014; Streicher, Unterleitner & Schulze, 2014], they often do not. Indeed, this work is often conducted through a deficit-driven paradigm that either characterizes minoritized communities as lacking knowledge to offer or interest in STEMM [Dawson, 2014], or completely ignores these communities [Roberson & Orthia, 2021].

Yet, we are seeing a paradigm shift. A growing body of literature has explored science communication and publics through theories of social justice [e.g., Burris, 2019; Callwood, Weiss, Hendricks & Taylor, 2022; Dawson, 2014, 2017, 2018, 2019; Habibi Doroh & Streicher, 2021; Honma, 2017; Isler et al., 2021; Jones, 2021; Landis et al., 2020; Márquez & Porras, 2020; Nadkarni et al., 2019; Rasekoala & Orthia, 2020]. In fact, equitable, asset-based [Yosso, 2005] science communication has taken place in contexts well beyond the academy for generations [Finlay et al., 2021; Kankaria, Jarreau, Manna, Rasekoala & Bonea, 2022]. Helpfully, Finlay et al. [2021] define the work of science communication as a "journey of iterative, endless cycles of reflection and practice to co-develop inclusive, relevant, equitable and useful science communication, together" [p. 7]. Inclusive science communication (ISC), therefore, is not a static goal or outcome, but a continual examination of context, assumptions, norms, roles, values, and ultimately, ideologies. ISC can be considered an emerging movement that builds on decades of work across diverse fields [K. Canfield & Menezes, 2020; Judd & McKinnon, 2021].

Here we present insights from a small study conducted as part of the U.S.-based 2019 Inclusive Science Communication Symposium (ISCS), the second in an ongoing series of conferences launched in 2018. The conference was primarily attended by American academics, where mainstream science communication practices are largely shaped by a dominantly white, Eurocentric culture. This self-selecting nature of symposium attendees and physical location of the in-person symposium significantly limits the generalizability of study findings, yet we hope this work offers a small contribution to important ongoing conversations about inclusive science communication initiatives in the U.S. and internationally. The layered forms of marginalization in U.S. society (e.g., racism, sexism, homophobia, transphobia, classism, ableism) underscore the urgency of acknowledging the inequities that inform perceptions of and interactions with STEMM and mainstreaming inclusive science communication methods.

As a relatively young and growing area of research, there is a need for exploratory research on ISC initiatives to help clarify the gaps in practice and scholarship and identify promising practices via evidence [Jensen & Gerber, 2020]. This study, funded by award number 1940463 from the U.S. National Science Foundation, is an effort to identify these gaps by documenting the experiences, challenges, and needs of ISCS attendees, who we presume hope to engage in and advance inclusive science communication in the U.S. context.

In addition, this study aimed to understand the degree to which attendees of the 2019 ISCS use critical dialogue as a tool for advancing the aforementioned paradigm shift and for achieving the value-driven communication practices that can shift attitudes and behaviors on contentious STEMM topics [Dietz, 2013].

Critical dialogue is broadly defined as potentially difficult conversations, often between individuals of different backgrounds or identities, aimed at identifying and challenging oppression [Laman, Jewett, Jennings, Wilson & Souto-Manning, 2012]. The authors of this paper are especially interested in the use of critical dialogue as a way to foster social justice [Zúñiga, Lopez & Ford, 2012]. Also described in literature as intergroup dialogue, critical conversations, or dialogue across difference, the concept has been studied in formal education settings related to, for example, gender studies [Zúñiga et al., 2012], disability studies [Woiak & Lang, 2014], queer theory [Gunckel, 2009], writing [Knaus, 2009], social work [Lopez-Humphreys & Dawson, 2014], diversity studies [Gurin-Sands, Gurin, Nagda & Osuna, 2012], and sociology [Valiente-Neighbours, 2015], as well as in community contexts such as interfaith groups [Garfinkel, 2004] and leadership programs [Saloma & Price, 2019].

The 2019 ISCS was designed to both model critical dialogue and encourage its broader use among participants, thus providing an opportunity to gather data on whether and how ISCS attendees apply critical dialogue in their own work.

Finally, the timing of the symposium and our data collection is worth noting. The event was held in person at a higher education campus in the Northeastern United States in September 2019, months before several important events had a significant impact on the U.S. national context: the highly contentious 2020 U.S. presidential election, critical conversations about racial and social justice that entered mainstream conversation in the United States, and the COVID-19 pandemic that swept the globe. The COVID-19 pandemic, in particular, changed every aspect of life for many across the world — including bringing to the forefront many assumptions, applications, and complexities of science communication.

Literature overview

Mainstream paradigms of science communication and the emergence of inclusive science communication

The importance of science communication in a wider range of settings cannot be overstated; it informs decision-making on critical issues of health, climate change, and artificial intelligence, among many other topics [Fischhoff & Scheufele, 2013; Fontaine, Lavallée, Maheu-Cadotte, Bouix-Picasso & Bourbonnais, 2018; Nisbet & Scheufele, 2009]. Unfortunately, many approaches to science communication fail to account for diverse forms of expertise, individuals' autonomy, and the value of trust [Bevan, Calabrese Barton & Garibay, 2020; Dawson, 2014; Feinstein, 2017; Wynne, 1992].

Inclusive science communication is an approach that moves beyond mainstream models of science communication. ISC aims to acknowledge historical oppression, inequities, and biases to foster a sense of belonging for marginalized communities in STEMM and to center the perspectives of these communities [K. N. Canfield et al., 2020]. ISC builds on the most participatory models of science communication [Lewenstein, 2003], with a focus on naming systemic oppression and marginalization as central to the communication/engagement/dialogic process [Polk & Diver, 2020; Roberson & Orthia, 2021]. ISC aims to bring together previously siloed conversations (e.g., those within the disciplines of science communication, formal education, informal science learning, critical theory,

philanthropy, etc.) into a transdisciplinary space [Bevan, Calabrese Barton & Garibay, 2018; Calabrese Barton & Tan, 2019; K. Canfield & Menezes, 2020]. Addressing the structural problems that underlie many science communication practices, however, is not simply a matter of bringing literatures into conversation with one another or acknowledging past inequities. As Dawson [2018] notes, "Overlapping normative assumptions about dominant culture, politics and science can… frame inclusion in science communication as a form of crusade, one that seeks to generate larger publics for science, while remaining fundamentally uncritical of science communication practices or how publics are constructed" [p. 775]. Indeed, the act of reflexivity by ISC scholars and practitioners is essential if this movement is to develop more fully.

The term "socially inclusive science communication" first appeared in the literature in 2014 as part of a collection in the Journal of Science Communication following the 13th International Public Communication of Science and Technology Conference [Massarani & Merzagora, 2014]. We refer readers to a recent systematic review by Judd and McKinnon [2021] for a thorough examination of the growth and topical range of ISC literature.

Based on a small landscape study of early ISC leaders, K. Canfield and Menezes [2020] described ISC as a movement whose work is defined by three key traits that work together to create equitable interactions: intentionality, reciprocity, and reflexivity. These concepts, of course, are not novel, as they have been held up as goals and studied extensively by scholars and practitioners across a wide range of disciplines [Acker-Verney, 2016; Chilvers, 2013; Dewsbury, 2020; Grimpe et al., 2020; Marchel, 2007; Schön, 1983; Trench, 2008]. K. Canfield and Menezes [2020] argued that the range of disciplinary contributions to what we know about how these key traits can inform science communication, specifically, is important to the continued growth of the ISC movement — an argument buttressed by the findings of Judd & McKinnon's [2021] review.

The work we present here attempts to make a small contribution to ongoing conversations about how to shift the paradigm of science communication as it is typically viewed in U.S. contexts toward a model that centers equity.

Methods

Theoretical framework

In conceptualizing this exploratory study, we employed social constructivism as a guiding paradigm. As a frame or paradigm often associated with qualitative designs, social constructivism implies knowledge construction is highly dependent on human interaction. Constructivist research aims to understand a phenomenon and, at its heart, includes a concern for lived experience, or the world as it is felt and understood by social actors [Schwandt, 1994]. Because the ISC movement is still nascent in the U.S., and the symposium setting of the study was designed to encourage critical dialogue and interaction, applying a constructivist framework to exploratory work was the most meaningful approach for understanding emerging views, perspectives and nuances that influenced the worldviews of our participants. With social constructivism "people create meaning through their interactions with each other and the objects in the environment" [Kim, 2010]. We highlight the meaningful ways in which constructivism might help ISC scholarship efforts move forward in our conclusion.

Study context: the 2019 Inclusive SciComm Symposium

Practitioners and researchers engaging and/or interested in inclusive science communication registered to attend the 2nd Inclusive SciComm Symposium in September 2019 at the University of Rhode Island, Rhode Island, U.S.A. This convening brought together individuals from the United States (2% of the 196 registrants worked outside of the U.S.) and from a variety of sectors, including academia, non-profits, government, and the private sector. The goal was to share perspectives, techniques, and lessons learned while engaging in discussions on how to prioritize ISC across the many disciplines, sectors, and approaches of science communication. The symposium's primary themes were: critical dialogue; changing structures and systems through inclusive science communication; and social responsibility and ethics of inclusive science communication.

The qualitative research presented here is part of a larger mixed methods research effort, which included pre- and post-symposium surveys, focus groups during the symposium, and a 2020 follow-up survey, to better understand the lived experiences of participants in their roles. Demographic information was only collected during the pre-survey.

We undertook this study to identify the motivations, challenges, and opportunities for ISC among symposium participants. The study uses data from open-ended survey questions and two focus groups to address one central research question:

What are Inclusive SciComm Symposium participants' perceptions of future directions for ISC as an emerging field?

Participants received pre- and post-event surveys, with closed- and open-ended questions about their experiences relative to ISC and critical dialogue. Symposium attendees participated in the online surveys distributed via Qualtrics, with 94 respondents for the pre-event survey and 93 respondents for the post-event survey, yielding participation rates of 48% and 47%, respectively. In addition, 17 individuals participated in one of two small in-person focus groups about future directions for ISC during the symposium. Focus group participants were identified during the pre-event survey, based on their responses to the call for voluntary study participation. Anonymized open-ended survey and focus group data were analyzed using an inductive approach. Inductive analysis allows the data to guide the questions, in contrast to a deductive approach in which prior assumptions are directly tested [Thomas, 2006]. Given the relatively recent emergence of ISC as an area of study and the dearth of existing data regarding ISC motivations to guide hypotheses, an inductive approach was deemed appropriate for this qualitative data set.

The research team first coded the open-ended survey responses individually through an iterative process. Two initial rounds of coding used *in vivo* and descriptive coding techniques [Thomas, 2006]. Analytical memos were generated during each round to record meaningful findings in the data or coding process [Charmaz, 2006]. The team met biweekly for three weeks to discuss the data and emergent questions and ensure credibility of individual findings [Creswell & Miller, 2000]. Once a consensus had been reached on the relevance of preliminary codes to the broader research questions, the team completed a third round of

coding, with the aim of unearthing categories, then overarching themes. The research team used similar coding techniques to derive patterns and themes from focus group transcripts. Again, they met to establish details of the process, engaged in several rounds of coding to identify and share prominent findings, and collaboratively reviewed synthesized themes. Focus group data analysis yielded patterns that reinforced themes from the post-survey as well as novel results.

Findings

Demographic information provided by survey respondents is listed in Table 1. Most respondents self-identified as white (65%), women (76%), and held advanced

Table 1. Summary of demographic data from pre-event survey.

Characteristic	*Percent of respondents* ($n = 94$)
Race/Ethnicity	
American Indian or Native Alaskan	1
Asian	4
Black or African American	10
Hispanic or Latinx	11
Middle Eastern	1
Multiple races and ethnicities	7
Unspecified	1
White	65
Total	100
Gender	
Gender non-conforming or non-binary	2
Men	22
Women	76
Total	100
Degree	
Bachelor's degree in college (4-year)	22
Doctoral degree	35
High school graduate (or GED)	1
Master's degree	40
Professional degree (JD, MD)	1
Some college but no degree	1
Total	100
Sector	
Government	11
Higher education	51
Non-profits	22
Other (K-12 education, philanthropy, private sector)	16
Total	100
*Primary science communication role**	
Another role (e.g., funders)	18
Practitioner and/or trainer	60
Researcher	22
Total	100

* The surveys were designed to allow for a single role selection, but many people noted that they serve more than one of these roles.

degrees (75%). Respondents represented a range of sectors, led by higher education (51%). Most identified as practitioners and/or trainers (60%). The surveys were designed to allow for a single role selection, but many people noted that they inhabit more than one of these roles.

Survey and focus group responses yielded three dominant themes related to future directions for ISC: (1) frustration with systemic cultures and practices; (2) need for connections and resource-sharing across contexts; and (3) need for evaluative mechanisms. Despite the fact that questions specifically probed future directions for ISC, both survey and focus group participants primarily described the barriers to their ISC work *first*. This pattern is evident in all three themes. In addition, coded responses relevant to the use of critical dialogue as part of future ISC initiatives are also reported here.

Theme 1: frustration with systemic cultures and practices

Respondents described frustration with various systemic issues — largely cultures and practices that inhibit the exploration or adoption of inclusive approaches. Systemic issues named by participants included funding, timelines, power structures, and ways of thinking and operating that were unsupportive and/or "exclusive" in nature. Respondents considered these issues inherent and embedded within their institutions over time.

Across the board, attendees expressed concerns that the institutions involved in their work (universities, science centers, funding entities, etc.) do not sufficiently support inclusive efforts. This lack of support includes both inadequate funding and a failure to provide encouragement or emotional backing. In large part, survey respondents held higher-ranking institutional figures responsible; as one participant noted: "Some people are in power and just don't prioritize inclusive practices, or outright ban them or put communicators at risk if a particular inclusive practice feels 'risky' to them".

Several survey respondents attributed the institutional "inertia" and failure to adopt more equitable practices to a white supremacy culture where culturally diverse influences are notably lacking [Callwood et al., 2022]. Others drew connections between white dominance in STEMM and the educational "STEMM pipeline", [National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007] which is full of obstacles to inclusion [Berhe et al., 2022]. One participant noted curiosity about "whether it's possible to build alternate pathways to science engagement on a large scale, and what those could look like".

Participants noted the precedence of Western, Eurocentric conceptions of science over other ways of knowing as further perpetuating a culture of systemic exclusion that creates a barrier for ISC. For example, one respondent noted a "lack of awareness about what 'STEM' is [beyond the Western conception], and who does 'STEM'… leads to limited perspective, conversations, and actions because of the homogeneity of [organizational] decision-makers". Participants also shared fundamental concerns about how institutional practices and dominant definitions of science systematically exclude marginalized groups and individuals.

Participants lamented that projects focused on inclusivity were difficult to get funded and were only funded for short periods of time. For example, focus group participants described and agreed on the need to seek different sources of funding for ISC efforts (e.g., from city-level funders, such as city councils, instead of traditional funding agencies). Several noted that funding for community-oriented programs needs to be long-term, as short-term funding inhibits project scope and potential project sustainability.

One description of short-term project consequences significantly illuminated this concern: "All these projects happen that are wonderful and fantastic, and in two years it's done… there's no [more] connection and no relationships and those communities get abandoned again". Survey respondents offered solutions to the issue of short-term funding, for example, "funding pre-work such as engaging communities to see what THEY want rather than not figuring that out until after we've written and gotten the grant". In general, participants stressed a need for earlier engagement, suggesting that practitioners, audiences, partners, and/or community members need to be involved with the co-production and sustainability of ISC programs.

Theme two: need for connections and resource-sharing across contexts

The need for stronger connections and relationships among ISC researchers and practitioners emerged repeatedly across participant responses. Symposium attendees described looking forward to building an authentic community of ISC practitioners and researchers. Silos were frequently mentioned as a barrier to more collaborative and transdisciplinary ISC practice. For example, focus group participants suggested further examination of how K-12 teachers are excluded within broader discussions of science communication practice:

> "We're really interested in understanding more about how teachers have become a marginalized group within the science communication industry… I'm like regularly blown away by how frequently they're absent from conversations related to science communication, particularly at the academic level, but especially at the funding level."

Participants also described a sense of elitism and hierarchy, particularly between researchers and practitioners. As one noted:

> "For some time, I and others have perceived the existence of a Scicomm 'cool kids' club that is very hard to gain entry to. I also believe there is still room to include more practitioners… to broaden our definition of who engages in sci comm/engagement."

Solutions to the disconnects, particularly the chasm between practitioners and researchers, were evident in both focus groups and the survey responses. Numerous attendees called for tools to connect, such as through the use of online hubs, where people can both share resources and build networks. Others called for a shift toward paradigms, theories and methods that emphasize collaboration, suggesting the same asset-based, equitable, and community-focused approach to

building relationships between researchers and practitioners (e.g., honoring different types of expertise and knowledge) as ISC advocates between science communicators and their audiences or partners.

Focus group participants also discussed audience-driven approaches to dialogue across science communication research and practice, and the significance of listening and finding commonalities to develop more meaningful partnerships. They shared hope for building and sustaining these relationships, emphasizing that care is needed to make collaborations just and equitable for all involved: "People need to work together in a collaborative environment around a common goal to move from conversation to connection, and from 'making for' to 'making with,'" one explained.

In addition to stronger relationships, participants expressed a need for shared resources on critical dialogue and other inclusive practices. Despite attendees feeling motivated to center inclusion, equity, and intersectionality in their work, many felt unsure of *how* to do it. Suggestions included guidance on how to start difficult conversations, common language for engaging in the conversations, and practical advice on how to apply ISC methods across various communication channels (e.g., social media). Beyond the practical utility of shared guidance for critical dialogue and other ISC methods, having shared resources was presented as an opportunity to build community and reduce isolation. As one participant noted, "I would love to have a running list of [the barriers]… to making Inclusive SciCom happen, and all the hiccups along the way. Because I know I'm not the only one".

Finally, and as a sub-theme relative to shared connections and resources, one focus group probed issues around shared language. Specifically, there were concerns that the term "inclusive science communication" is not representative of their work:

> "The things that I feel are most inclusive are community partnership building work and full on engagement. Whereas scientific communication I tend to think of more as one directional, not necessarily bi-directional… it does make me think whether or not you can actually truly have fully inclusive sci-comm versus inclusive engagement with science, or inclusive science…"

For example, the group discussed the silos that prevent public health, international aid, and health care workers from engaging in cross-discipline dialogues and attending conferences together: "I think in part calling it sci-comm makes it sound less related to a lot of what those people do than just talking about it as inclusive science".

Theme three: need for evaluative mechanisms

Respondents consistently indicated a demand for more systematic (that is, standardized and/or accessible) evaluation of ISC and critical dialogue. Participants discussed evaluation at length in both survey and focus group data sets. Between the survey responses and focus group transcripts, the words "evaluate" and "evaluation" were found 27 times. Words related to evaluation such as "analyze", "measure", or "assess" were used an additional 48 times.

Participants described evaluation as critical, not only for identifying more and less effective approaches, but also for achieving more widespread integration of this paradigm shift in science communication. Numerous participants noted the difficulty in scaling up ISC projects or implementing successful strategies in new settings. One respondent explained,

> "The methodologies for different types of environments… what works in one environment is not necessarily going to work in another environment; informal versus formal science communication, digital versus in-person environment, all those methods of evaluation still need to be worked out."

The call for evaluation was also presented as a way to lobby for institutional support, or "figuring out how to get leadership at the major public engagement organizations to take this stuff seriously… finding the metrics that will get their attention". Findings like this also underscore the deep concern among ISC researchers and practitioners that current funding and reward systems are not designed to support this work, and that their efforts are not prioritized by leaders at their institutions, per theme one.

Another significant finding related to evaluation was the desire for non-traditional approaches. There was a call to spend time reflecting on the goals and what is considered "success" in the early stages of project planning through dialogue with communities and practitioners. The goals of ISC may differ significantly from most institutions' expectations because this work is so nuanced and takes place in the affective domain. One focus group participant put it this way:

> "[W]ith the evaluation, it depends on what we want to see. So for me it's like how many people come to an event, and I don't care. It's like the experience of the one person who is now sparked to do something in their community or to change their career path… I guess it depends on, on what we're evaluating, and what is the goal. And I know my goal is very against the grain for most people, when it comes to that. A lot of people are very linear when they're thinking about evaluation."

Two terms were suggested for new forms of evaluation — "co-evaluation creation" and "inclusive evaluation". The way participants described these ideas parallels the key traits of ISC [K. Canfield & Menezes, 2020] placing intentionality, reciprocity, and reflexivity at the center of evaluation by developing participant-driven and community-focused assessments. As one respondent noted,

> "It makes no sense to me that we change one part of the system without changing all parts. I really am keen to understand how we might better perform evaluation from a fresh point of view — how do traditional expectations of outcomes stifle and warp our work?"

In considering evaluation as a critical next step for ISC's future directions, participants also focused on the realistic challenges involved: "Evaluation is expensive. It's time consuming. Getting the wording right to get it so it's not leading. And if you're a practitioner with zero, little to zero, support, that makes it

near impossible". Participants indicated a desire for flexible, modular, and more accessible approaches to evaluation that might include, for example, partnerships between researchers and practitioners to create "evaluation kits" that could be used in a variety of contexts.

Discussion and implications

The process of selecting specific science communication methods has significant potential to either reinforce or reduce historical inequities. One of the methods that deserves more attention is critical dialogue. The 2019 ISCS organizers specifically incorporated this technique into the symposium design, in an effort to socialize its use among participants and to investigate attitudes about these difficult conversations.

The following discussion highlights key implications arising from each of the three thematic responses for the ISC movement and, where possible, for advancing the use of critical dialogue as a powerful ISC technique.

Shifting systemic cultures and practices

Our findings offer a reminder that structural issues and barriers are layered; in other words, those who wish to pursue ISC will have to grapple with the hindrances posed by organizational culture as much as (or perhaps more than) with the specifics of our practice — a finding that corresponds with previous work [Bevan et al., 2018; K. Canfield & Menezes, 2020]. The question, for example, of how to obtain authentic buy-in from organizational decision makers looms large as a priority item. We offer several recommendations for addressing these systemic challenges.

First, ISC practitioners might consider the strategy of building capacity for social justice work and reform. Education research offers a helpful model because the field has wrestled with similar problems for decades. Thought leaders of this challenging work in educational settings have emphasized the importance of being realistic and strategic, networking, and starting with volunteers or like-minded individuals [Guerra, Nelson, Jacobs & Yamamura, 2013; Robertson & Guerra, 2016]. Participants in the present study indicated disillusionment and discouragement because of the lack of support "from the top". To this point, education researchers have proposed that starting with individuals (even a few) who demonstrate a willingness to learn about equity, inclusion, and social justice will yield useful alliances over time. They argue that the isolation often experienced by social justice leaders is decreased through this network-building, ultimately creating capacity for institution-wide change [Guerra & Nelson, 2009; Ritchie, 2012; Theoharis, 2009]. Research/practice partnerships may also play a helpful role in this capacity building effort, including in the context of "thinking partners" as described by Peterman et al. [2021]. Importantly, we must not overlook the invaluable insights of community organizers whose methods, while not necessarily part of the academic literature, offer hard-won lessons about how to build and sustain social justice movements.

Second, our study participants noted that evaluation could become a mechanism used to lobby for institutional support, including funding and resources. Indeed,

evaluation is used similarly in higher education and other fields; staff at philanthropic foundations, for example, claimed evaluation is largely used to justify efforts and maintain support from board members [Patrizi & McMullan, 1998]. Funders and institutional leaders can facilitate experimentation with novel evaluative mechanisms.

Finally, the challenges of transforming systemic barriers offer an excellent opportunity to engage in critical dialogue. Yet, as our findings show, many of the 2019 ISCS attendees feel uncertainty about how to initiate these difficult conversations. This intersection of critical dialogue and science communication is a rich area for further research.

More connections and resource sharing across contexts

The call for more connections and resource-sharing across contexts echoes a pressing need: more training and practical tools to move the field forward, especially for practitioners who want to embrace inclusivity and equity through dialogic approaches to science communication [DiCenzo et al., 2021; Judd & McKinnon, 2021; Kearns, 2021; YESTEM Project Team, 2021].

Participant comments about silos, hierarchies, elitism, and language barriers within science communication reflect an especially salient implication of this theme: science communication must grapple with the challenges of inclusion, equity, intersectionality, and critical dialogue *internally* (amongst those in the field) as much as it seeks to counter issues of exclusion that may be present *externally* — that is, among intended audiences. Finlay et al. [2021] highlighted one critical aspect of this internal reflection: the need for those working in the global North and West to consider a more globally and historically expansive suite of science communication contexts and practices to inform their own. Similarly, the silos and tensions between scholars and practitioners noted in our study are well known [David-Chavez, 2019; Kearns, 2021; Peterman et al., 2021; Salmon, Priestley & Goven, 2017; Salmon & Roop, 2019; Smith et al., 2020]; these persistent concerns require more equitable exchanges [Harris et al., 2021] within the community of practice and scholarship that acknowledge the value of different knowledges and experiences.

This theme suggests the critical importance of helping ISC practitioners and researchers find networking spaces (in-person or online) that might yield more common ground or shared knowledge in terms of how intentionality, reciprocity, and reflexivity are defined, supported, and, especially, practiced [K. Canfield & Menezes, 2020; Peterman et al., 2021]. The processes, descriptions, and applications of ISC will not be the same for all science communication contexts. Nonetheless, greater connectivity among the individuals and organizations doing this work can accelerate the movement in numerous ways.

An important tenet of inclusion and equity work, regardless of communication setting, is community. Building or developing authentic community amongst individuals who are intentional about inclusion helps them navigate critical dialogues successfully, while minimizing intangibles like burnout and maintaining emotional wellness for dialogues that can be very difficult, risky, and challenging

[e.g., Murray-Johnson & Ross-Gordon, 2018]. This study's identification of so much common ground across participant contexts in terms of challenges faced in pursuit of ISC indicates that reflexive, ongoing discussion across fields could foster transparency, outline the many intersections across fields and methods so people can more easily see how their work fits in the movement, provide relevant learning opportunities, and promote a culture of continued collaboration that might reduce silos and perceived hierarchies, where only some people are in the know.

Collaboration might occur in a range of communal spaces that are developed *ad hoc* or via more formally structured events like the Inclusive SciComm Symposium. Either way, creating more of these spaces may yield equitable, innovative research/practice partnerships (e.g., highlighting the work of community partners in development of communication or engagement strategies and research design/inquiry; amplifying and actualizing practitioners' perspectives as part of funding decisions). Additionally, like the ISCS itself, these communal spaces may themselves become sites for research and evaluation.

Grappling with the evaluation conundrum

This study underscores a persistent conundrum in science communication evaluation: the desire for straightforward, accessible evaluation techniques vs. the limitations of streamlined evaluation measures for substantive assessment and equitable outcomes. As Jensen [2014] noted, "poor-quality evaluation has been feeding questionable data and conclusions into the science communication system for years" [p. 1]. Evaluation, like the practice of ISC, requires strategy, intentionality, reciprocity, and reflexivity.

Our findings show a desire among ISCS participants for both the development of evaluation protocols and tools specific to inclusive practice (including critical dialogue) and studies to assess the value of these new protocols and tools. Rigorous and co-created evaluation focused on building evidence for ISC related to substantive outcomes (e.g., building trust, sustaining relationships, changing behaviors) will also lead to critical reflections on researchers' and practitioners' own biases and mistakes, which is essential for the ISC movement to grow and improve [Garibay & Teasdale, 2019]. Jensen and Gerber [2020] offered a range of considerations and recommendations for how to achieve these more meaningful evaluations, as well as the "transfer mechanisms" that facilitate applicable, collaborative, and mutually appreciative exchange between science communication researchers and practitioners.

But evaluation also needs to be considered in the context of systemic cultures and practices; as one respondent noted, "The STEM enterprise itself is largely unwilling to reflect on and change its own paradigms and practice". This paradox reflects the need for evaluative work that is reflexive in its attempts to change the *culture* of evaluation in science communication. A small number of evaluative frameworks explicitly connect critical dialogue and science communication, even if they use different terms [e.g., Bandy et al., 2018; Brighton et al., 2018; Lehr et al., 2007; Salmon & Roop, 2019]. Lehr et al. [2007] applied education research to propose three frameworks for evaluating STEM "dialogue events as sites of learning" [p. 1467]. They suggested that organizers of dialogue events frame evaluations

around: (1) collaboration and equity; (2) symmetrical individual learning through social processes; and (3) social justice. These frameworks, along with Bandy et al.'s [2018] concept of "democratically engaged assessment", emphasize many of the concepts that are essential to ISC (e.g., relationship building, interrogating power dynamics, examining the concept of "expertise") and are well matched to ISC key traits.

Certainly, there is no one-size-fits-all approach to evaluation for ISC. Nonetheless, practitioners raise equally reasonable concerns about the challenge of finding and implementing meaningful evaluation measures that can be achieved within their timelines and budgets. Practitioners, then, face the significant hurdles of knowing which evaluation protocol or framework to use in a given ISC context that captures substantive outcomes (especially related to critical dialogue), contributes to future evidence-based practice, and can be implemented within their programmatic constraints.

Our findings demonstrate the desire among practitioners for clarity on the range of evaluative mechanisms they might use, the guiding principles or frameworks they might apply [e.g., those of Garibay & Teasdale, 2019; Lehr et al., 2007; Jensen & Gerber, 2020; Murray-Johnson, 2019, or others], and, especially, new evaluation models that are far more collaboratively designed. These models require attention and sensitivity to ISC's many moving contexts, and a transdisciplinary approach that builds on learning from other fields that, for example, can offer insights about critical dialogue [Calabrese Barton & Tan, 2020; Cordero & Davis, 2020; Mauldin, 2014; Garfinkel, 2004; Zúñiga et al., 2012]. There is also a clear need for longitudinal studies that follow ISC efforts — in specific contexts and with specific goals over time — rather than the typical model that has relied on one-time efforts with time-bound funding. In ISC as in so many other approaches to science communication, the practical realities of time, funding limitations, and uncertainty about how to apply research frameworks to their practice often complicate practitioners' intentions to plan for evaluation *from the start* as part of their overall strategy [Jensen & Gerber, 2020; Martin, 2015; Salmon & Roop, 2019; Storksdieck, Bevan, Risien, Nilson & Wills, 2018].

Limitations of the study

This study examines a specific community (participants at the Inclusive SciComm Symposium) within a specific timeframe (2019, pre-pandemic), in a specific context (the U.S.). The majority of participants worked in higher education, had previous engagement with ISC, and were from and/or residing within the United States. While these study attributes may limit the broader application of our findings, we note the value of studies like this for identifying constraints and opportunities that may accelerate or inhibit ISC research and practice. The virtual 2021 ISC Symposium had a significant increase in international participation [S. Menezes, personal communication]; we aim to use research from the 2021 symposium to assess the applicability of these findings with more globally diverse respondents in a future study.

Conclusion

This study adds to the growing body of literature that aims to clarify the aims and outcomes of social justice-driven, inclusive science communication. While we do

not claim the study's qualitative data are universally generalizable, they nonetheless offer a valuable perspective on motivations and challenges for ISC practice and scholarship within U.S. contexts. Our findings demonstrate a desire for greater structural/institutional support mechanisms and for greater connectivity among ISC scholars and practitioners. Finally, the study contributes to the arguments for more meaningful and contextual evaluation of science communication, generally, [Dawson & Jensen, 2011; Garibay & Teasdale, 2019; Jensen, 2014; Jensen & Gerber, 2020], and for more accessible forms of evaluation, specifically [Grand & Sardo, 2017].

Inclusive science communication holds much promise as a transdisciplinary framework for science communication. This study sought to explore the future directions of ISC; we found that the evolution of this movement will depend on addressing several current challenges. Nonetheless, our findings demonstrate that professional learning opportunities are a meaningful way of exploring current needs while developing shared understandings and identifying promising practices across contexts. As science communication practitioners and scholars pursue this shared learning, several larger questions arise.

How might the languages of this movement (with regard to definitions, disciplinary jargon, and the current publication record being overwhelmingly English based) limit or expand the opportunities for the paradigm shift it seeks? Judd & McKinnon's [2021] systematic review of ISC literature to date "does not show a coherent and comprehensive body of work" at this point [p. 14], and many of the publications they identified focused on formal educational settings. Indeed, the silos and language barriers noted in our study and others [Bevan & Smith, 2020; K. Canfield & Menezes, 2020; Guenther & Joubert, 2017; Márquez & Porras, 2020; Rasekoala & Orthia, 2020; Smith et al., 2020; Trench & Bucchi, 2015] could affect the longevity of ISC and the movement's ability to embrace globally informed scholarship and transdisciplinarity.

As ISC researchers and practitioners confront internal communication issues amongst themselves, while working to build individual and collective capacities for intentional, reciprocal, reflexive practice, they will require increased relationship-building and collaboration across settings. How can institutions and networks facilitate these collaborations? There are promising examples [e.g., Peterman et al., 2021], but more experimentation is needed.

Evaluation remains an urgent need — and at the same time presents a valuable opportunity. In our study, effective, inclusive, and accessible evaluation mechanisms emerged as, perhaps, the most critical link between the themes of building institutional support and creating more connections across ISC contexts. Despite the absence and inapplicability of a unified evaluative framework, common tools and resources can help connect isolated groups [Storksdieck et al., 2018]. In solidarity with this finding, we see the overwhelming call for assistance with evaluation as an opportunity to break down disciplinary and sectoral barriers, improve institutional support, and experiment with co-created strategies for varied contexts. Such significant opportunities may enable ISC not only to survive, but to thrive sustainably across community, practitioner, training, research, and funding contexts.

Finally, we highlight the importance of constructivist paradigms and frames to probe research-based solutions around silos and the need for connectivity. At its core, social constructivism perceives knowledge making as an interactive social process and views knowledge as produced within and through social discourse. In our study, participants made meaning of their lived experiences and co-constructed knowledge through rich discourse. To obtain a wider scope of perspectives around the questions posed in our discussion, we urge the undertaking of additional, longitudinal research about the sites of professional learning and development and communities of practice (such as conferences and symposia) within science communication. These sites, when intentionally designed to be intercultural and culturally sustaining, provide unique, potentially rich opportunities for diverse science communication "stakeholders" to engage in critical dialogue — itself a tool for capacity building and understanding.

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How to cite

Menezes, S., Murray-Johnson, K., Smith, H., Trautmann, H. and Azizi, M. (2022). 'Making science communication inclusive: an exploratory study of choices, challenges and change mechanisms in the United States from an emerging movement'. *JCOM* 21 (05), A03. https://doi.org/10.22323/2.21050203.

ISSN 1824-2049. Published by SISSA Medialab. jcom.sissa.it