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Science Communication Demands a Critical Approach That Centers Inclusion, Equity, and Intersectionality

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We live in an era of abundant scientific information, yet access to information and to opportunities for substantive public engagement with the processes and outcomes of science are still inequitably distributed. Even with increasing interest in science communication and public engagement with science, historically marginalized and minoritized individuals and communities are largely overlooked and undervalued in these efforts. To address this gap, this paper aims to define inclusive science communication and clarify and amplify the field. We present inclusive science communication as one path forward to redress the systemic problems of inequitable access to and engagement with STEMM (science, technology, engineering, mathematics, and medicine). We describe the first national Inclusive Science Communication (InclusiveSciComm) Symposium held in the U.S. Based on the experience of organizing the symposium, we discuss recommendations for other convenings to help build a community of practice for inclusive science communication. In both research and practice, we advocate for more experimentation to help make inclusive science communication the future of science communication writ large, in order to engage diverse publics in their multiple ways of knowing and expand a sense of belonging in STEMM.

Keywords: science communication, inclusion, public engagement, critical dialogue, equity, inclusive science communication, informal science learning, journalism

INTRODUCTION

We live in an era of abundant scientific information, yet access to information and to opportunities for substantive public engagement with the processes and outcomes of science are still inequitably distributed. Even as interest in science communication[1] has grown (Chilvers, 2012; Dudo and Besley, 2016), marginalized individuals and communities remain largely undervalued in these efforts (Dawson, 2014b; Feinstein and Meshoulam, 2014; Streicher et al., 2014). This paper aims to advance the field of inclusive science communication (ISC) with a definition and rationale, examples, priorities for integrating research and practice across relevant disciplines, and a symposium-based model for building an ISC community of practice.

We envision a fundamental shift in science communication whereby inclusion, equity, and intersectionality ground all research and practice. Eventually, we hope the term "inclusive science communication" will be redundant. For now, however, the "inclusive" descriptor is a valuable framing device to clarify objectives and speed this transition. To this end, we define ISC as an intentional and reflexive practice and research approach that:

- Recognizes historical oppressions, discrimination, and inequities and centers the voices, knowledge, and experiences of marginalized individuals and communities in STEMM dialogue.
- Acknowledges that each person's individual characteristics (e.g., gender, race, physical ability) overlap with one another (defined as "intersectionality" by Crenshaw, 1989) and that these intersectional identities affect their status in the world (Shimmin et al., 2017).
- Further acknowledges that explicit and implicit biases (historical, cultural, experiential) of science communication practitioners and scholars influence the design and implementation of their work (Reich et al., 2010; Dawson, 2014c).
- Rejects the oversimplifications of the deficit model (Trench, 2008; Simis et al., 2016), in which science communicators treat public audiences as lacking relevant knowledge or experience.
- Incorporates asset-based methods that respect and value the ideas, experiences, questions, and criticisms that diverse publics bring to conversations about STEMM (Banks et al., 2007).
- Aims to cultivate belonging and engagement of audience and collaborator perspectives (Wynne, 1992; Cheryan et al., 2013; Haywood and Besley, 2014; Leggett-Robinson et al., 2018).
- Offers a multi-scaled approach to shift organizational cultures and structures and redress the systemic problems of inequitable access to and engagement with STEMM (Anila, 2017; Bevan et al., 2018).
- Is relevant across formal and informal learning and engagement settings.

[1]We define "science communication" in the broadest sense, encompassing any information exchange designed to engage targeted audiences in conversations or activities related to STEMM topics.

In summary, we urge a paradigmatic shift in science communication toward an overarching objective of expanding a sense of belonging in STEMM and approaches that embrace varied forms of expertise and ways of knowing.

Why Do We Need Inclusive Science Communication?

As a result of science communicators' cultural and epistemological tunnel vision, their efforts tend to benefit specific (e.g., affluent, college-educated, non-disabled) audiences (Ash and Lombana, 2013; Dawson, 2014c; Medin and Bang, 2014; Taylor, 2018). ISC aims to address the shortcomings in how researchers and communicators define and engage public audiences in STEMM topics, particularly tackling the deficit approach to science communication (Nisbet and Scheufele, 2009; Smallman, 2016). As Dawson (2019, p. 170) stated, "to continue with business as usual is to be complicit in practices that uphold and exacerbate racism, class discrimination, sexism, and other forms of oppression". In renouncing the status quo, we argue against science communication that singularly portrays science in the Western mold: that is, as objective and universal (Cobern and Loving, 2001; Medin and Bang, 2014; Bang et al., 2018) or as "governed by a rigid scientific method that produces incontestable facts" (Cunningham and Helms, 1998, p. 485). Because science communication is inherently contextual (Chilvers, 2012; Streicher et al., 2014; Bang et al., 2018), it is well-suited to counter assumptions of the Western model. ISC offers a critical approach that interrogates history, politics, and society, examining how people's multiple identities interact to affect their engagement with STEMM fields and issues of societal relevance (Feinstein and Meshoulam, 2014; Massarani and Merzagora, 2014; Schuldt and Pearson, 2016; Bevan et al., 2018; Calabrese Barton and Tan, 2019).

ISC can leverage society's intellectual assets (knowledge, experience, ways of knowing) to address the many wicked problems of our time (Rittel and Webber, 1973). These problems require STEMM-based solutions as well as community engagement and support (Wynne, 1992; Cohen et al., 2012; Perié et al., 2014; Mansyur et al., 2016). Such a massive effort requires a range of communication objectives, from sparking curiosity to building trust that drives behavioral change, and methods, from culturally-relevant exhibit design to community-engaged research (Reich et al., 2010; Dawson, 2012b; Haywood and Besley, 2014; Perié et al., 2014; Dudo and Besley, 2016; Berditchevskaia et al., 2017). This understanding of ISC leverages multiple science communication models (Lewenstein, 2003), including contextual (e.g., culturally-responsive design, per Calabrese Barton and Tan, 2010), lay expertise (e.g., multiple ways of knowing, per Delgado Bernal, 2002), and public participation (e.g., co-creation and collaborative design, per Shirk et al., 2012). Inclusive approaches can yield broad benefits including improved science learning (Johnson et al., 2014; Lemus et al., 2014), an increased sense of science identity (Carlone and Johnson, 2007; Ong et al., 2011) and science capital (Archer et al., 2015; Dewitt et al., 2016) for underrepresented communities, and greater empathy among technical experts (Casapulla et al., 2018).

ISC is a multi-scaled path toward systemic change (a paradigmatic shift, per Watson et al., 2008) that can redress inequities not only in science communication, but in STEMM education and practice. ISC practice, training, and research requires intentional—but not tokenized—involvement of underrepresented people in influential leadership positions (Pearson and Schuldt, 2014; Taylor, 2014). For example, the American Association for the Advancement of Science's If/Then Ambassadors program aims to highlight successful women in STEMM fields, showing girls different career pathways and how STEMM affects their lives (American Association for the Advancement of Science, 2019). Such representation provides "visual cues of belonging" (Pearson and Schuldt, 2014) needed to break down persistent stereotypes in the Western academic system (e.g., scientists as white males and environmentalists as white) and build trust in science communicators (Campbell et al., 2008; Davies et al., 2009; Mack et al., 2012; Cheryan et al., 2013; Taylor, 2014). While we view diverse representation and leadership as a critical early step toward systemic change, we note that it represents only one aspect of the shift needed to center inclusion (Hurtado et al., 2017).

EXISTING RESEARCH ON INCLUSIVE SCIENCE COMMUNICATION

Education scholars have studied inclusion for several decades (Cunningham and Helms, 1998; Aikenhead, 2001; Diangelo and Sensoy, 2010; Reich et al., 2010; Dewsbury, 2019), but research explicitly addressing ISC and its value is relatively new. A series of comments in the *Journal of Science Communication* discussed "socially inclusive science communication[2]," including an argument that "placing equity at the heart of science communication is crucial for developing more inclusive science communication practices," (Dawson, 2014b, p. 1). To our knowledge, this is the only peer-reviewed reference that uses ISC as we present it here.

Informal science learning (ISL) and science communication have similarities in practice and research but are based on different theories and rarely used in concert (Bevan et al., 2018; Dawson, 2019). In recognition of this overlap, we include research on inclusive approaches to ISL, particularly since this is the silo in which most ISC-relevant research is located (Dawson, 2019).

Reich et al. (2010, p. 10) described inclusive ISL as encompassing "physical, cognitive, and social dimensions", but efforts at inclusion often focus on access as the primary impediment to STEMM engagement (Rahm and Ash, 2008). Such oversimplifications fail to address assumptions about who belongs in STEMM spaces, forcing marginalized populations to participate in a space they have historically been excluded from, implicitly, explicitly, and/or intentionally (Dawson, 2014c, 2019; Massarani and Merzagora, 2014; Bevan et al., 2018). Framing access as the impediment assumes certain publics are uninterested in science or are not participating due to a failure to recognize the value of such engagement (Dawson, 2014b). This deficit mindset discounts the multiple ways of experiencing and practicing science, placing blame on marginalized groups rather than designer or institutional failures to create an inclusive space (Dawson, 2014b; Medin and Bang, 2014; Perié et al., 2014). When efforts at broadening participation fail to consider intersectional identities and the history that produced them, they are more likely to recreate the systems that marginalize people in the first place (Dawson, 2019; Torres-Gerald, 2019).

ISL also offers evidence for the value of inclusive public engagement from museum settings (Dawson, 2012a,b, 2014a,b,c, 2019; Feinstein and Meshoulam, 2014), gaming and design-based learning in afterschool primary and secondary school settings (Kafai et al., 2016; Hobbs et al., 2019), and community-engaged research (Haywood and Besley, 2014; Petersen et al., 2016; Soleri et al., 2016). Bevan et al. (2018) compiled many examples of effective ISC projects, emphasizing the importance of reflection, adaptation, and institutional change.

The existing research provides a foundation for ISC, albeit one that requires more blocks and cement. As we build on this foundation, related fields will benefit from an open floor plan with fewer walls. To this end, ISC should explore themes from ISL and formal education to learn from context-specific practice and research, and to develop common frameworks (National Research Council, 2009). Although significant research gaps remain in ISL, especially regarding methods for systematizing inclusion within institutions and organizations (Reich et al., 2010), a transdisciplinary approach to ISC will help dismantle research and practice silos and achieve the systemic change we seek (Fischhoff, 2013).

A MODEL FOR BUILDING COMMUNITY TO ADVANCE INCLUSIVE SCIENCE COMMUNICATION

A growing number of practitioners are experimenting with inclusive approaches that have not yet reached the peer-reviewed literature. ISC practice ranges from public engagement approaches such as Dr. Danielle N. Lee's use of hip hop themes and lyrics to launch conversations about animal behavior (Johnson, 2019) to journalists and science writers intentionally featuring diverse sources in their reporting (Yong, 2018). Asset-based practices—those that value the knowledge and experiences of participants, vs. viewing differences as shortcomings—offer rich ideas for expanding and codifying ISC, but only if they are shared and normalized (Jensen and Holliman, 2015).

Some of these practitioners have found community online, especially via Twitter. Online communities can support learning and identity formation (Hall, 2009; Reed, 2013), but they do not foster the substantive interdisciplinary conversations needed to advance ISC as a cohesive intellectual framework. Conferences can generate awareness, ideas, collaborations, and dialogue (Hatcher et al., 2006; Oester et al., 2017), yet, there are few in-person opportunities for ISC researchers or practitioners to network.

[2]In Europe, "socially inclusive science communication" has been used to refer to inclusion of minoritized social identities, distinct from "inclusive communication," which generally references accessibility of communications for people with disabilities (Shiose et al., 2010; Scottish Government, 2011). This distinction has not taken root in the U.S.

One previous conference, the 2014 International Public Communication of Science and Technology conference (PCST), brought together science communication researchers and practitioners around the central theme of "science communication for social inclusion[3] and political engagement" (Featherstone, 2014; Treffry-Goatley, 2014). The PCST conference demonstrated a key tension in ISC; many ISC practitioners are not publishing their work but researchers look to the published literature to inform their research questions and seek funding. There remains a significant shortage of research/practice collaborations that could ameliorate these challenges (Featherstone, 2014).

To address these gaps, the University of Rhode Island's (URI) Metcalf Institute organized the United States' first national conference about ISC: #InclusiveSciComm: A Symposium on Advancing Inclusive Public Engagement with Science. The co-authors of this paper include the inaugural planning committee for the InclusiveSciComm Symposium.

InclusiveSciComm Symposium organizers created the 2018 program to:

- Identify needs and opportunities for inclusive, intersectional, and asset-based science communication approaches;
- Highlight practitioners and researchers whose work can serve as cross-sectoral models;
- Discuss structural problems that hinder inclusive approaches and how these problems can be addressed; and
- Inspire new collaborations among attendees and provide practical information that attendees could implement in their work to prioritize inclusion.

Registrants included 150 science communication practitioners, trainers, educators and researchers at various career stages. The agenda was designed to foster conversations and develop networks that transcend disciplinary expertise and sectoral employment, offer examples of ISC approaches applied in diverse settings, and help participants center inclusion in their own work, with a concluding discussion on the next steps for advancing ISC (see Smith et al., 2020, for a detailed analysis of pre/post symposium survey data). Anecdotal responses on Twitter and conversations with organizers revealed diverse outcomes including new collaborations, changes in program design, and especially among graduate students, greater interest in ISC careers.

We acknowledge the limitations of drawing broad conclusions from a single event. As described above, this emerging field of study demands much more attention and rigorous assessment. We share our experience of trying to foster an ISC community of practice via the symposium as a model for supporting learning and change-making across science communication modalities and settings. We provide these recommendations to help others advance the field by launching intentional and rigorous ISC conversations in their respective communities.

Plan for a Range of Experiences and Perspectives

This began with the planning committee, which sought diverse perspectives, and encouraged open communication about how to model inclusion. Organizers carefully selected a diverse range of speakers from varied disciplines whose work centered inclusion from the beginning of their science communication efforts (e.g., the Broad Science podcast, the American Geophysical Union's Thriving Earth Exchange, Two Photon Art). Symposium attendees had wide-ranging experience related to advancing diversity, equity, and inclusion (DEI). This mixture enriched the symposium, helping those who were less experienced in discussing DEI to identify gaps in inclusive practice and specific actions to address them, without frustrating the more experienced attendees.

Given the diverse perspectives needed to inform ISC, participants and speakers should represent a wide range of sectors, disciplines, geographies, and marginalized identities. For example, while ISC related to people with disabilities was addressed in several symposium panels, participants noted that they would like this to be a greater focus in future events, along with sexuality, gender, nationality, and age.

Embrace Varied Approaches to Inclusive Science Communication

This was a fundamental tenet of the InclusiveSciComm Symposium, and survey comments indicate that many attendees had not previously appreciated the wide variety of methods for ISC research and practice. One participant noted, "this conference helped me realize that there are far more people playing different roles who care deeply about inclusive scicomm than just practitioners who are trained in science." This heightened awareness of how ISC can be integrated across disciplines and sectors is a valuable outcome of in-person meetings.

Dialogue and Practice Are Essential

While symposium participants left with new knowledge, perspectives, and tools, there was a clear desire for more opportunities to practice the application of their new insights. Future ISC meetings and trainings should address practitioners' lack of language, skills, and confidence for facilitating difficult conversations across difference. Discussions about potentially uncomfortable topics such as privilege, power, or marginalization are essential for inclusive practice and pedagogy (Miller et al., 2004). To advance ISC, practitioners and researchers need more opportunities to practice this "critical dialogue" (Laman et al., 2012).

Discuss Opportunities for Systemic and Structural Change at Different Scales

Symposium attendees sought ways to address the structural problems that hinder ISC, from inconsistent institutional support

[3]Science communication for social inclusion addresses the role of science communication in society. Socially inclusive science communication refers to an approach to science communication. We do not favor one priority over the other. Rather, we believe ISC should concern itself with both approach and the societal role of science communication.

for science communication activities to underrepresentation of marginalized identities in science journalism and community-engaged research. Systemic change takes place at different scales. It could focus on influence or agency in relationships (Calabrese Barton and Tan, 2010; Anila, 2017), such that community collaborators are truly engaged in science communication efforts and their knowledge assets are recognized and valued (Yosso, 2005; Philip and Azevedo, 2017). Alternately, systemic change could happen at the institutional scale, e.g., a newsroom makes hiring or editorial decisions based on inclusive priorities (Arana, 2018; Columbia Journalism Review, 2018) or a university changes the promotion and tenure review process to value science communication (Jacobson et al., 2004; Scheufele, 2013).

DISCUSSION: FUTURE DIRECTIONS

ISC is a rich area for study. Based on literature and our symposium experience, we propose several key issues that require integrated research and practice, and, especially, interdisciplinary discussion (Trench and Bucchi, 2010). Case studies of intentionally inclusive public engagement with science (PES) and ISL efforts will clarify how program objectives and settings might influence outcomes. Longitudinal studies of programs and institutions could identify effective strategies to address the systemic failures that have excluded marginalized peoples from STEMM and, instead, promote "life-long, life-wide, and life-deep" STEMM learning (Banks et al., 2007). Few studies have explored how cultural processes (Manzini, 2003) and epistemological orientations (Medin and Bang, 2014; Philip and Azevedo, 2017) inform effective science communication. Finally, practitioner and researcher uncertainty about how to approach critical dialogue has important implications for the ways individuals and communities relate to and perceive science (National Research Council, 2009; Dawson, 2014a,b), public participation in STEMM research (Haywood and Besley, 2014), and the degree to which public discourse about contentious scientific topics is fully representative and valued (Wynne, 1992; Biegelbauer and Hansen, 2011). Meetings such as the InclusiveSciComm Symposium offer a venue for clarifying the priorities for ISC and connecting siloed disciplines and sectors to advance the field.

CONCLUSION

Science communication practitioners and scholars need to consider how identities operate not only interpersonally, but also systemically (Choo and Ferree, 2010; Falcón, 2016). ISC requires intentional design based on a goal of including the diverse experiences and identities participants bring to their learning environments. Science communication can and must become a field that supports our pluralistic societies. Without actively reframing our approach, researchers, and practitioners are perpetuating inequities by default (Dawson, 2019). We advocate for ISC as a critical approach that embodies an intentional investment in supporting and recognizing inclusion, equity, and intersectionality from ideation to implementation and evaluation. More transdisciplinary, cross-sectoral convenings like the InclusiveSciComm Symposium are needed to build an ISC community of practice. We hope this growing community will seed changes in how science communication is envisioned, practiced, and perceived.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Oregon Institutional Review Board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

KC was the lead author. SMe provided substantive edits throughout the process. AM, SMa, ANM, MF-M, BD, and CT contributed important ideas and edits for the final version. All authors contributed as thought partners in conceiving the paper.

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