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REVIEWS

Scientific Life

Broadening Participation in Scientific Conferences during the Era of Social Distancing

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Virtual conferences can offer significant benefits but require considerable planning and creativity to be successful. Here we describe the successes and failures of a hybrid in-person/virtual conference model. The COVID-19 epidemic presents the scientific community with an opportunity to pioneer novel models that effectively engage virtual participants to advance conference goals.

The COVID-19 outbreak has accelerated the use of virtual communication. Once optional and infrequent, virtual meetings have rapidly become a necessity for keeping scientific endeavors active during near shut-down conditions. Numerous scientific meetings have been cancelled, including those held annually for over 100 years. It is well past time for scientists to revise conference paradigms and embrace virtual participation to decrease travel and enrich conference experiences. Virtual attendance can lower carbon footprints [1], save time and money, and allow participants to balance work–life conflicts. By removing barriers, virtual participation dramatically expands accessibility, inclusivity, and equitability of participation in knowledge-sharing and networking opportunities. On-line conferences are especially significant in this moment since they accommodate restricted physical interaction while expanding the benefits of scientific conferences.

Scientific leaders must embrace creative models for virtual participation as a routine element of academic conferences. We report an organizational model and outcomes of a National Science Foundation-funded hybrid workshop (Deciphering the Microbiome, December 2019) that engaged in-person and virtual participants. While this meeting illustrates how virtual conferences can extend opportunities to early career researchers and those with limited access to in-person conferences, it also identifies limitations to virtual formats that demand creativity and experimentation to overcome.

Although step-by-step guides to planning a virtual conference have been proposed [2,3] and a number of models used [4], there is no consensus around which communication platforms or meeting structures are most effective in supporting diverse conference objectives. Conferences enable scientists to share their latest results; establish collaborations and generate ideas; engage in discussions that advance the field; and provide opportunities for career advancement and visibility, especially for early-career scientists. Organizers may seek additional outcomes, such as encouraging cross-disciplinary interactions or creating a diverse community. Virtual communication platforms differ substantially in their abilities to support these distinct goals. For example, webinar-style participation is the simplest to organize, and may be successful in disseminating new data, but is unlikely to build community or encourage networking. We argue that successful virtual meetings require thoughtful, strategic organization and planning beyond that of traditional conferences. We identified five factors underpinning successful virtual meeting organization (Figure 1):

(i) clear identification of goals;
(ii) deliberate design of structured interactions;
(iii) use of accessible, intuitive, and widely available technologies;
(iv) pre-event training with platform tools;
(v) postmeeting assessment of outcomes.

Building on these principles, we designed a workshop to provide traditional in-person outcomes, including opportunities to network and learn about new advances and techniques, and also to: (i) increase participation of early career researchers; (ii) extend access to scientists who infrequently attend meetings; and (iii) foster interaction between remote and in-person attendees. To accomplish these goals, we structured the meeting to engage attendees across multiple platforms (Figure 1). The program included short invited talks, small-group discussions, and large-group convenings. Importantly, we solicited information from all remote participants during registration as a basis for composing 14 virtual discussion groups ('virtual communities', VCs) that cut across disciplines, locations, and career stages. An additional 13 self-organized communities participated (often from a single physical location). Each VC was led by a trained moderator and was required to meet in advance of the workshop to practice using the meeting platforms. Finally, we allowed open streaming access on the day of the meeting regardless of preregistration. We used Zoom to broadcast audio and video from the meeting and within VCs, Twitter for outreach beyond our meeting, and Slack to support conference-wide questions and discussion, as well as 'private' engagement within

Going virtual

An effective model for broadening participation in scientific meetings

Foundation for organizing a successful virtual meeting

1. Clear identification of priorities and goals
2. Use of multiple accessible, and widely-available technologies
3. Design and incorporation of structured interactions (formal and informal)
4. Effective pre-event training with platform tools
5. Postmeeting assessment of outcomes

Virtual attendance captured a large global audience

388
Unique streaming connections from 25 countries

Australia, Austria, Belgium, Brazil, Canada, China, Colombia, Croatia, Czechia, France, Germany, India, Israel, Italy, Japan, Kenya, Latvia, Mexico, Netherlands, Norway, Portugal, South Africa, Switzerland, UK, USA

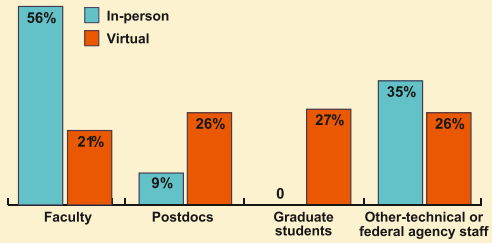
According to participant post meeting survey responses:

93% Had no prior virtual meeting experience

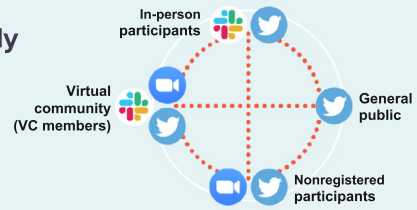
97% Would participate again in a virtual meeting

Virtual participation was accessed by all career stages

- Virtual participation equalized representation across career stages
- Early career participants were substantially increased through the virtual option



Hybrid meeting structure effectively supported broad participation



Communication platforms

- **ZOOM:** Streaming talks and individual VC discussion sessions
- **SLACK:** Conference-wide question/discussion platform; Discussion within individual VCs
- **TWITTER:** Communication beyond registered participants

The integrated, multiplatform structure was successful in facilitating broad communication and interactions among participants

zoom

388 Unique streaming connections[a]

178 Average connections per session[a]

[a] Including locations with multiple viewers

A structured platform of public and private Slack channels facilitated diverse participant interactions

slack

~1000 Public messages

~1000 Person-to-person, direct messages

Message threads supported interactive discussions

122 Threads engaged at least 2 participants, encompassing 98 unique users

72 Threads engaged at least 3 participants

>40 Messages within a single thread engaged 15 participants

Social media broadened the meeting footprint and engaged audiences beyond the event

1363 Total tweets

570 New followers gained over 48 hours

5 000 000 Estimated screens reached

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(See figure legend at the bottom of the next page.)

VCs (Figure 1). These platforms are well known in academic circles and are available to most users with a web-enabled device. Dedicated technical support was provided before and throughout the workshop. Incorporating multiple, overlapping participation modalities and communication technologies added a structural complexity to our conference absent from previous concepts of decentralized conferencing, which have ranged from text-only email chains [5] to immersive virtual reality [6]. Importantly, we identified no single platform that would fulfill all our needs. We expect that these platforms will, and should, vary according to conference objectives.

A postmeeting self-assessment included participant surveys, platform usage statistics, and informal attendee feedback. These data show that the workshop substantially met our core objectives but also raise significant challenges for conference organizers. (i) Virtual attendance increased participation from several dozen in-person invitees to over 300 remote participants. This enriched representation among early-career participants, in particular graduate students and postdoctoral scientists (Figure 1). (ii) Virtual participants were more likely than in-person participants to have attended one or no other conferences in 2019 (33.7% vs 4%), indicating an expansion of access. We estimate the costs of participation were reduced by 75–90% compared with in-person attendance, due to elimination of travel and lodging costs. (iii) Engagement was high across meeting platforms (Figure 1) but attempts to connect in-person and virtual attendees were only modestly successful. The average Slack user sent nearly seven messages (maximum 79), and the average Twitter user sent over four messages (maximum 187). Average virtual attendees watched 4.7 h of the proceedings through Zoom, remaining active for a median 50 min at a time. The majority of attendees stayed for the duration of sessions they viewed (45–82.3%, mean 58.43%), with low points corresponding to meals and summary remarks. However, only a third of surveyed in-person attendees reported communicating with virtual participants, and 28.8% of those in virtual groups communicated with in-person attendees while 91.4% communicated with other virtual participants. Virtual attendees not belonging to a VC reported even less interaction (18.2% with in-person attendees, 45.5% with virtual attendees), highlighting the importance of structured virtual activities.

Deficiencies became apparent through postmeeting analysis and serve as a reminder of how important critical assessment will be to improving virtual conference experiences. Though direct comparison of virtual and in-person conferences is difficult [7], our workshop offered an opportunity for some limited contrasts. While all attendees reported gaining similar insight into the field and new resources, there was a split in their perceptions of networking. In-person attendees more often agreed that they had made connections with potential collaborators than did remote attendees ($P < 0.001$). The median in-person attendee strongly felt that they had networked across disciplines at the conference, while virtual participants agreed with this less often ($P < 0.001$). Lack of informal networking opportunities is a familiar critique of virtual meetings, but a marginal increase in perceptions of networking success was found for virtual participants who belonged to a structured community compared with those participating individually ($P = 0.040$), suggesting structured interactions improved the experience.

Our workshop did not provide asynchronous attendance options (i.e., recorded proceedings). While we deliberately chose to avoid this, intending to promote active engagement during the meeting, it also prevented scientists in distant time zones or with significant time restraints from participating fully. Disappointment with time limits on structured interactions and a lack of dedicated time to interact with in-person attendees were common critiques from the VC members. No conference can serve every need, and it may be prudent to weigh the effort required to replicate in-person experiences against the inherent strengths of virtual platforms.

Our self-evaluation also raised questions about approaches to conference assessment. A postmeeting survey captured immediate perceptions, though some conference benefits appear only after longer periods of time (e.g., professional visibility or coauthorship on grant applications and manuscripts). Adequate self-evaluation and assessment of outcomes is nontrivial. We have presented some simple analytics from our digital tools, which clearly represent volume of communication, but determining the quality of interactions requires deeper consideration. While virtual academic conference assessment is not well researched, there is a rich literature on how to assess remote learning outcomes in virtual educational settings [8,9]. Incorporating this work into improved conference evaluations may challenge meeting organizers but is essential for furthering the dialogue around best practices. Several aspects of virtual conferencing are especially in need of more critical evaluation. The potential for biases in use of digital communication is particularly salient to the role virtual conferences can play in broadening participation. Remote platforms have promised to equalize gender

Figure 1. Thoughtfully Planned Virtual Conferences Can Produce Wide-Ranging Benefits for the Scientific Community. An analysis of participant surveys, app-usage statistics, and informal feedback following a hybrid virtual workshop (Deciphering the Microbiome, December 2019) suggests that strong, foundational organization, coupled with the use of flexible communication platforms, increases attendance, broadens participation, and facilitates discussion.

disparities in communication before, though biases persist in online formats [10]. And despite the difficulty of comparing virtual and in-person conferences, we must reach a clear understanding of the unique benefits provided by face-to-face and virtual interaction so that these can be appropriately balanced at future conferences.

Assuredly, the coming months will see continued experimentation with virtual conference structures, and new challenges will surface. Already, the scientific community is recognizing how easily cyber security and enhanced accessibility options are overlooked. Many digital platforms now provide enhanced security options, but it remains incumbent on organizers to ensure adequate accessibility, for instance including captioning and/or sign language interpretation for all audiences, which our workshop failed to provide.

New technology and the challenges of the SARS-Cov-2 pandemic have changed the landscape in which we work and communicate as scientists. Our survey found 97% of respondents would participate in another virtual meeting, suggesting that the community is ready to embrace new forms of attendance. Meeting organizers must similarly adopt new conference models, commit resources to enhancing the virtual experience, share effective strategies, and accelerate science communication while broadening participation through innovative uses of technology. Our experience shows that virtual conference models should be tailored to specific meeting objectives and continuously refined following careful examination, but also suggests that investment in creative virtual meeting delivery has significant payoffs for the scientific community.

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