CITIZEN SCIENCE:
THEORY AND PRACTICE

Learning from the First Citizen Science Association Virtual Conference

MEETING REPORT

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ABSTRACT

The Citizen Science Association (CSA) is a member-driven organization that connects people with interest in community/citizen science (c*science) from a wide range of backgrounds, disciplines, and experiences. In response to the COVID-19 pandemic, the bi-annual CSA conference pivoted away from an in-person format to a virtual format. *CitSciVirtual: Local, Global, Connected* occurred throughout May 2021 and brought together more than 700 attendees from 36 countries. The conference prioritized interactive experiences for attendees, including 16 collaborative poster sessions featuring 240 virtual posters, 55 workshops to learn and practice new skills, and 7 social events. This paper summarizes the impacts of the rapid transition to a virtual format on the conference goals, planning and decision-making processes, practices, outcomes, and attendee experiences. Both the strengths and weaknesses of this first virtual conference are featured to outline opportunities for growth for the CSA, c*science at large, and science conferences in general.

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INTRODUCTION

The Citizen Science Association (CSA), founded in 2013 in recognition of the growing citizen science movement, is young, open-minded, and nimble relative to some other science associations that have decades of history (Sarabipour et al. 2021). It is a member-driven organization that connects people from a wide range of backgrounds, disciplines, and experiences around one shared purpose: advancing knowledge through research and monitoring done by, for, and with members of the public (CSA 2019a). CSA is different from many scientific societies in that its membership spans far more than just academics and includes everyone needed for community/citizen science projects to be successful, including volunteers, educators, practitioners, and community leaders.

CSA provides inclusive forums to broaden the roots of science beyond research conducted by science graduates and institutions. Community/citizen science is referred to collectively as c*science for the remainder of this paper, although this vocabulary was not formally used as part of the CitSciVirtual 2021 conference. C*science transforms many elements of how science is carried out and what science can achieve when groups with diverse skills and various kinds of knowledge come together. In many ways, c*science has grown as a movement through person-to-person connections that enable shared learning and problem solving. CSA's bi-annual, in-person conferences act as a catalyst for progress and a connector of c*science researchers and practitioners.

With the rapid rise of COVID-19 health risks starting in early 2020, many in-person events were canceled and/or postponed. The original 2021 CSA conference was scheduled for May on the campus of Arizona State University. In summer 2020, Arizona State University and CSA staff determined that safety concerns made hosting a 2021 in-person conference impossible. So, CSA quickly pivoted and re-envisioned how to bring the c*science community together remotely in ways that elevate and support the many disciplines and communities within c*science (Figure 1). This paper, written by authors who were involved with the virtual adaptation, illustrates how this rapid transition enabled CSA to reflect on the goals of in-person conferences and the extent to which they can be achieved through an online platform.

Reflections on the conference goals, planning and decision-making processes, practices, and outcomes provide tangible takeaways that other programs or conference planning teams could apply. Both the strengths and weaknesses of this first virtual conference are featured to outline opportunities for growth for the conference itself, for CSA, and for c*science at large.

CITSCIVIRTUAL 2021

CSA's conferences provide an opportunity for members of the c*science community to share evidence-based practices from many contexts, to highlight innovation and insights, and to forge stronger relationships within the field and across disciplines. CitSciVirtual 2021 was CSA's first virtual conference, aimed at all affiliates in the field of c*science: scientists, practitioners, activists, funders, policymakers, nongovernmental organizations, artists, and

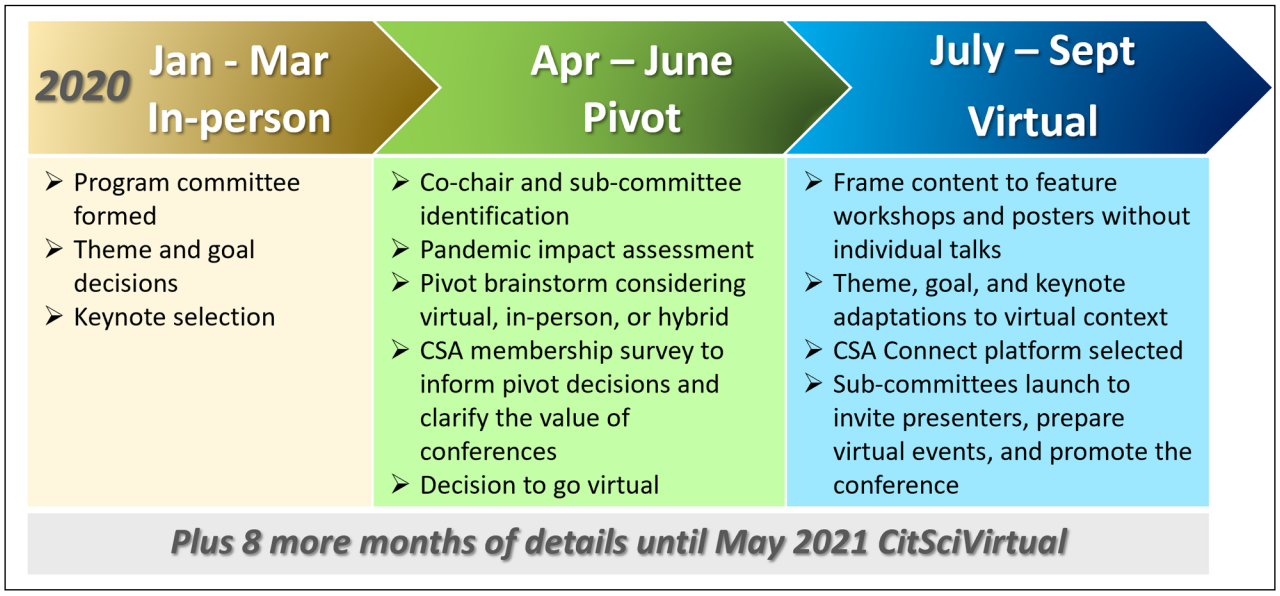

Figure 1 Timeline for conference planning, indicating the switch from planning for an in-person event to a virtual event.

other interested individuals. Throughout the month of May 2021, more than 700 participants came together from 36 different countries to share research findings, opinions, stories, and experiences. The breadth of work covered a wide range of topics from trustworthy data practices and public health to regional c*science networks and forest biodiversity. The program included 240 digital posters, 55 workshops, two keynote speakers, four plenary discussions, and seven social events (Supplemental File 1: Appendix A). It was an opportunity to listen and learn from others, hence the theme was *CitSciVirtual: Local, Global, Connected*.

PLANNING

CitSciVirtual 2021 was planned and organized by a volunteer-led conference program committee supported by two CSA staff members and a contracted conference coordinator. The program committee included 29 volunteers (including authors Hils and Silka), a conference program committee chair (author Cawood), and an emeritus conference program committee chair (author Hjarding). Within the broader program committee, there were four subcommittees responsible for making and implementing decisions related to keynote talks, posters, workshops, and special events. Additionally, three coordination committees provided guidance and support for the conference on topics related to 1) equity and development of Community Guidelines (including author Kelty), 2) communications, and 3) engagement technologies.

The decision to hold CitSciVirtual 2021 over the full month of May was based on committee members' experiences attending other virtual conferences during the pandemic. They reported finding it difficult to fully focus on the conference when professional and personal obligations were amplified by the pandemic. They often felt burnt out after sitting through up to eight hours of conference programming, especially on consecutive days. The program committee attempted to lower this barrier to participation by designing shorter daily blocks of content across a month in hopes that attendees might be able to spend one or two focused hours several times per week engaged in conference activities.

In the early stages of CitSciVirtual planning, the committee focused on establishing the conference goals and the value for attendees (Table 1). The six goals were driven not only by the desire to develop a program that would have direct benefits to the c*science community, but also to be responsive to the needs of the likely attendees, as expressed through surveys conducted by CSA in May and June 2020 (CSA 2020).

The conference was designed to prioritize interactions and dialogue among participants and to help participants build new skills. This priority was established in response to insights from Metimeter check-in polls during the 2021 conference, from 2021 CSA Connect comments during and post-conference, and from 2019 and 2021 post-conference surveys (CSA 2019b; Fischer and Cho 2021). These goals were major drivers in the decision not to have individual talks. Instead, the program committee focused on more interactive experiences for attendees such as discussion-based poster sessions and hands-on workshops (Supplemental File 1: Appendix A). They also moved away from the traditional conference abstract submission format which is not familiar to those outside of academic spaces, by opting for simple user-friendly Google Forms (Supplemental File 2: CitSciVirtual 2021 poster proposal submission form and Supplemental File 3: CitSciVirtual 2021 workshop proposal submission form) and clear guidelines for submission and specific questions (Supplemental File 4: CitSciVirtual 2021 poster submission guidelines and Supplemental File 5: CitSciVirtual 2021 workshop submission guidelines).

PLATFORM

In tandem with conference planning, CSA was also in the process of implementing a new membership platform, CSA Connect (www.connect.citizenscience.org), that would allow members to connect more easily and could host a variety of content like short courses and live events. CSA Connect became the conference's primary platform for schedules and event reminders, asynchronous material, including posters and workshop content, and social interactions. Within the platform, participants were able to upload and comment on posters, develop courses and workshops, chat with other participants, connect to live events, and watch/replay recorded events. To prepare attendees for the new interface and to help presenters construct interactive content, the program committee provided orientations to the space in the month before CitSciVirtual as well as a live help desk available throughout the conference. However, both attendees and organizers faced challenges navigating the new platform and implementing all available features. The project evaluation results indicated that frustrations with the platform were a major drawback to the conference, with more than 30% of evaluation respondents mentioning challenges connecting with others on the platform (Fischer and Cho 2021).

PROGRAM

The CitSciVirtual program was a mix of keynotes, interactive poster sessions, workshops, and social events. All virtual content was available through the conference platform to paid CitSciVirtual 2021 attendees. Keynotes were streamed live, posted publicly, and did not require conference registration to view.

TIMELINE	SPEAKERS AND PANELISTS	SESSION TITLE	GOALS AND INSPIRATION
Opening Keynote	**Dr. Mustafa Santiago Ali** Vice President of Environmental Justice, Climate and Community Revitalization at the National Wildlife Federation	*Power of Policy, Science, Race, and Community*	Promote environmental justice discussions and framing for conference
Week 2 Plenary	**Dr. Joseph Kerski** Education Manager at Esri	*Mapping, analyzing, and communicating citizen science information using field tools, web GIS, dashboards, and StoryMaps*	Conference sponsor and practical skill-building opportunity
Week 3 Plenary	**Dr. Valerie Ann Johnson** Dean of Arts, Sciences, and Humanities at Shaw University **Dr. Na'Taki Osborn Jelks** Assistant Professor of environmental science and health at Spelman College **Dr. Mark Barns** Associate Professor of History and Geography at Morgan State University **Dr. Russell Smith** Professor of Geography at Winston-Salem State University **Dr. David Padgett** Associate Professor of Geography at Tennessee State University	*Still on the Frontlines: Historically Black Colleges and Universities Engaging in Citizen Science and Community Science*	Led by CSA's Environmental Justice Practitioners Working Group to highlight c*science work being done at HBCUs
CitSciCon (Friday of Week 3)	**Hilde Fålun Strøm and Sunniva Sorby** Volunteers and polar explorers	*Leading Discovery: Volunteers in their Own Voices*	Cosponsored with SciStarter and NASA as part of CitSciCon. Opportunity to highlight volunteers
CitSciCon (Saturday of Week 3)	**Dr. Chris Lintott** Professor of Astrophysics at the University of Oxford and Principal Investigator of the Zooniverse	*Celebrating the Science of Millions*	Cosponsored with SciStarter and NASA as part of CitSciCon. Featured questions submitted by Zooniverse volunteers
Closing Keynote	**Dr. Sylvia Acevedo** Former CEO of Girl Scouts of the USA	*Science Confidence and Competence: Impact at Scale*	Promote K-12 education discussions

Table 1 CitSciVirtual 2021 panels and keynote speakers. Videos of all panels and keynotes are available on the CSA YouTube Channel.

CSA Connect synched with Zoom, the video conference software popularized in the months before this conference. Each conference session could host up to 100 participants and system-generated, simultaneous closed captions were available. Live sessions, video recordings, and alternate audio/visual files provided personalized options for presenters to convey their message, and most sessions were recorded using Zoom. Keynote and workshop sessions wove together pre-recorded and live content to allow smooth viewing for participants. Additionally, poster presenters shared recorded audio and video to guide attendees through their projects as though they were in-person. A benefit of the pre-recorded elements, especially for posters, was that presenters could pre-record in multiple languages; about 10% of posters were recorded in languages other than English, including recordings in French, Spanish, Portuguese, and Italian.

Keynotes and panelists

CitSciVirtual featured two keynote speakers and four plenary sessions (Table 2). One of the best attended and most engaging events of the conference was the Historically Black Colleges and Universities (HBCU) panel. This panel brought forth enthusiasm for potential collaborations and inspired the forthcoming HBCU Fellowship program offered by CSA to support the advancement of HBCU faculty and students in c*science. Additionally, in partnership with SciStarter and NASA, there was a public weekend event called CitSciCon. This event was designed to engage volunteers and educators, and featured NASA citizen science projects.

Posters and collaborative sessions

A conference centerpiece was the virtual posters and collaborative poster sessions. Topics representing the diversity of the c*science community were covered by 240

EVENT GOALS	EVENT ACTIONS	OUTCOMES
Goal 1: Opportunities for networking, connection, and gathering for: a. specific interest groups (e.g., libraries), b. disparate groups (e.g., libraries and environmental justice), and c. the entire c*science community.	Program and informal events include synchronous and asynchronous elements across a broad range of subjects.	Most of the respondents to the survey strongly agreed and agreed that they engaged with people from different disciplines (74%) and different intellectual spaces (72%).
Goal 2: Opportunities to learn new skills.	Accepted most poster and workshop submissions if they had a connection to c*science.	The discussion-focused poster sessions allowed presenters to share insights with each other and the session attendees. 80% of survey respondents indicated that participating in CitSciVirtual helped them gain insights into innovations and lessons learned, as well as share their own insights about c*science. The workshop sessions provided a space for more in-depth discussions. The challenges participants had with the conference platform likely hindered information sharing, especially with asynchronous content.
Goal 3: Opportunities to share and receive feedback on work.	Conversations took place both in private and in public and on and off the conference platform.	Though the platform was a hurdle for some, survey respondents agreed (68%) that they could engage with others on the platform and use the platform to access poster and workshop materials. Furthermore, 87% of survey respondents said they attended live sessions, whereas 13% said they registered but did not participate in live sessions. Of those respondents, some indicated that they did not think they would watch any recorded sessions.
Goal 4: Expand reach to include audiences who likely would not have attended an in-person conference in Arizona (including non-specialist audiences or the simply curious), including: a. ways to connect that require low bandwidth, b. ways to connect with people across a wide range of time zones, and c. ways to connect with non-English speaking audiences Pricing structure accounts for multiple audiences.	Adhered to CSA Environmental Justice and Integrity, Diversity, and Equity working group suggestions to make this conference more accessible, equitable, and inclusive. Updated code of conduct and community guidelines to better address the broader audience present in a virtual space. Allowed for posters to be presented in both English and preferred languages.	Almost 90% of survey respondents felt welcome and that they were able to engage in the event. Only 1% of attendees were new to c*science. There were some issues, one of which was that international participants were unable to join some live events because of time-zone conflicts.
Goal 5: Delivery of programming should be as simple and straightforward as possible, for attendees, presenters, and organizers.	Guidelines for presenters and organizers recommended materials be presented at high school level, with consideration for accessibility.	The platform was an issue for 30% of survey respondents, and they found it hard to navigate and find the event schedule or links to live events on zoom. There is a learning curve with the platform, and attendees need more guidance, including recorded videos on how to navigate the space.
Goal 6: Digital events in 2021 should feed into and support in-person conference in 2022.	2021 and 2022 events can serve as a test case for future conferences and integration of digital and in-person events.	Survey respondents wanted the 2022 event to be a hybrid-style event (52% strongly agree, 28% agree); 47% of respondents said they would attend in person, whereas 41% said they would attend virtually.

Table 2 CitSciVirtual 2021 conference goals with associated conference activities and outcomes. Statistics came from a Post *Evaluation Report* (Fischer and Cho 2021).

posters and 16 collaborative sessions (Supplemental File 6: CitSciVirtual 2021 poster session topics and schedule). Standard PDF-style posters were welcome, along with more creative formats such as ArcGIS StoryMaps or Prezi presentations. Presenters could also prepare a three-minute oral presentation in audio or video format to guide

viewers through their project. Additionally, presenters could participate in a moderated live collaborative poster session with a group of 8 to 12 other presenters on similar topics (e.g., youth engagement, project structure and design, environmental justice). Though collaborative sessions were open to all poster presenters, approximately 10% of poster presenters chose not to attend. Each collaborative session began with a pre-recorded 30-second video introduction of each poster presenter. Then a trained moderator facilitated the conversation among presenters, and a chat coordinator integrated audience comments and questions into the discussion. The sessions were designed to improve collaboration and encourage meaningful conversations within the conference community. About 80% of respondents to conference evaluation surveys expressed a desire to see similarly styled interactive poster sessions going forward (Fischer and Cho 2021).

Because the conference was virtual, there were few constraints on the number of posters that could fit into the program, so only 1% of submissions were rejected. All submissions were reviewed by program committee volunteers with selection rubrics (Supplemental File 7: CitSciVirtual 2021 poster submission review criteria) designed to accept as many submissions as possible. Prior CSA conferences included abstract submitters as reviewers for other abstract submissions, allowing an element of community voice in shaping the program. But because the acceptance criteria were broad and inclusive, for CitSciVirtual, reviews and acceptance decisions were made by the members of the poster sub-committee. Finally, the conference program committee chair and CSA staff organized the submissions into sections based on topic with consideration to the time-zone of the presenter(s).

Workshops

Workshops used a similar planning and implementation structure as was followed for the posters. The primary goal of the workshops was to provide opportunities to learn and practice new skills. All 55 workshops had both asynchronous content for engagement at any time, and synchronous live sessions focused on interactive activities. Workshops were included as part of the registration cost, and attendees were asked to select from a set of curated workshop bundles. Each bundle included four, 90-minute workshop sessions. Workshop organizers and presenters had flexibility about how to structure workshops and what elements (e.g., breakout groups, message boards) to incorporate. Workshop topics ranged from participatory research and indigenous knowledge to data collection and management, and communication and policy (Supplemental File 8: CitSciVirtual 2021 workshop descriptions). On CSA Connect, workshop leaders could share a variety of resources with participants to support the workshop content, including overview materials, embedded video recordings, and text documents.

Social events

CSA working groups and c*science collaborations are often grassroots efforts fueled by volunteers, so networking within the annual meeting is essential for CSA to serve its membership throughout the year. Program committee members, CSA board members, and shared interest groups hosted seven different social events to provide networking opportunities. They were informal, flexible, and open to anyone. Social events included trivia, weekly meet-and-greets with the CSA Board and CSA Working Groups, a student mixer, speed networking, and coffee breaks/happy hours.

REFLECTIONS

Overall, we found CitSciVirtual met most of the goals set out for the conference (Table 2). This conference did provide participants multiple opportunities for networking, connecting, learning new skills, and receiving feedback on their work in c*science. While well-intentioned, the month-long event was too long, and attendance dropped considerably after the first week. This was particularly problematic for workshops scheduled during the second half of the month. Although a huge amount of material could be viewed asynchronously, many event attendees only engaged during synchronous events. Based on formative and summative evaluations, attendees felt that they gained valuable insights and were generally able to connect with other members of the c*science community. People found some of the sessions that focused on underrepresented groups, such as the panel of representatives from HBCUs, to be particularly impactful. They also appreciated the focus on interactive, discussion-based sessions rather than an extended series of individual talks.

GOAL 1: NETWORKING AND CONNECTION OPPORTUNITIES

CitSciVirtual 2021 attracted a variety of participants. Over half (52%) identified their primary field as ecology or conservation, 35% percent identified as members of the environmental justice community, and 33% as part of the education community. Many participants were affiliated with higher education institutions (51%), although there was significant participation from people who work in nonprofits (26%), nature centers (25%), and informal learning spaces (25%). Most of the attendees (84%) are not

new to the field, and noted their engagement in c*science for three or more years. Despite efforts to focus on justice, equity, diversity, and inclusion (JEDI) in the design of the event, CitSciVirtual was diverse only in some respects. Attendees did not represent a wide range of racial, gender, or educational diversity. The vast majority of attendees were white (74%), identified as women (77%), and had a graduate degree (80%).

Though the conference was homogenous in some respects, the majority of attendees (74%) reported that they had opportunities to engage with people from other disciplines. Additionally, most (60%) said that they had opportunities to engage with people from diverse racial and ethnic backgrounds during the conference. While interacting with like-minded colleagues is beneficial, conference attendees also value opportunities to explore beyond their educational, geographic, discipline, and institutional silos of knowledge (Rich et al. 2020). Breaking these barriers increases the quality and consistency of best practices in the realm of c*science.

The interactive and collaborative sessions were successful, with more than 80% of survey respondents saying that they would like to see more discussion-focused sessions at conferences going forward. Presenters in the collaborative poster sessions reported enjoying the opportunity to connect with others working on similar topics. Feedback shared with program committee members and CSA staff indicated that overall, individual talk sessions were not missed, and there is a strong preference for interactive and collaborative sessions. It was noted that the dedicated facilitator was an integral element to the success of these sessions. However, some reported missing the opportunity to engage deeply with a specific poster and presenter. Although these opportunities were available through the CSA Connect platform, these functions (finding event links, liking, sharing, and messaging) and were not well utilized.

One area of improvement is the desire for more informal opportunities to meet with and connect with other attendees. Although the program committee tried to address this, not everyone was aware of or able to participate in the live events or able to utilize the available CSA Connect functions. In retrospect, the conference could have focused more on networking opportunities that wove the diverse CSA community together and allowed for critical and exploratory discussions beyond the bounds of our own echo chambers.

GOAL 2: SKILL-BUILDING OPPORTUNITIES

While the conference planning committee attempted to ensure ample opportunities for skill building with the focus on workshops during CitSciVirtual, this did not always work as intended. While there was inspiring content created and presented by workshop organizers, overall, this often did not translate into meaningful experiences for workshop attendees or presenters. Several factors may have contributed to this shortfall such as how asynchronous material was presented, expectations that attendees would prepare in advance, and the ways that attendees were expected to engage in the live workshops. To highlight some of the rich content created for the workshops, CSA staff assisted presenters that reworked workshop content into a stand-alone webinar or mini-course offered through CSA.

One area for improvement is providing additional support to emerging researchers in the c*sciences. Our conference attempted peer connection sessions specifically for students, but generally these events were poorly attended. Potentially transitioning to a peer-organized model for these interactive events could better meet the needs of emerging researchers in virtual spaces and help improve attendance (Newman et al. 2021; Sarabipour et al. 2021). Specific support could include allocating a proportion of presentations for emerging researchers alongside senior researchers and within primetime slots (Rich et al. 2020; Sarabipour et al. 2021) while guaranteeing feedback for all interested presenters through a poster competition or interactive poster discussions. Other options could be to encourage teams of presenters to highlight emerging researchers, which may free up more time for established researchers to provide feedback, mentorship, and guidance for other attendees' research and career development (Sarabipour et al. 2021).

GOAL 3: FEEDBACK OPPORTUNITIES

Virtual posters did provide a unique opportunity for participants to give and receive feedback on their work before, during, and after the conference. Conversations appeared on poster discussion threads before the conference officially opened, and some conversations continued after the official end of the conference. Asynchronous commenting on posters or private messaging enabled engagement with other participants that was agnostic of time zones. This format also supported engagement in a variety of languages other than English.

However, feedback experiences were mixed in terms of opportunities for participants to share and receive feedback on their work. On one hand, virtual spaces reduce thresholds for participation for some individuals by increasing time to craft communications and control over interactions with other participants (Vervoort et al. 2020; Sarabipour 2020; Sarabipour et al. 2021). On the other hand, the visibility and permanence of communication in virtual spaces with unknown sizes of audiences of unfamiliar others may lead some presenters to be more

reserved in their communication to avoid risk of plagiarism or embarrassment (noted as the Hawthorne Effect by Stein et al. 2021). Instituting more options for blinding and anonymity may help reduce this barrier with a potential sacrifice in transparency. Special protections can be instituted to protect unpublished/preliminary data by abstaining from posting presentation materials from social media platforms or providing options for non-recorded sessions that are not uploaded to CSA Connect (e.g., Spencer, Doran, and Burcham 2021).

One main area of improvement is to increase the chances for feedback even though the platform can be challenging. On the basis of results from CitSciVirtual 2021, during the 2022 conference, the Conference Program Committee planned pre-conference sessions for poster presenters to share their virtual poster, in which they could get feedback on their poster while also giving feedback to others or gaining new ideas for their work. More importantly, the CSA Connect algorithm shows the most recent comments at the top of the platform. To increase poster topic visibility, certain people created "playlists" of a group of posters around a specific topic. Finally, content should remain up for attendees to view in their own time after the conference ends, including keynote speeches and workshop sessions, as well as all virtual posters.

GOALS 4 AND 5: INCLUSION AND ACCESSIBILITY

Virtual conferences can provide a venue for participation that has the potential to expand the reach of an in-person conference, and we saw some of this in CitSciVirtual. Presenters and attendees came from all over the world, and the number of countries represented nearly doubled from previous years of in-person conferences. There were also presenters from nontraditional backgrounds, including high school students and individuals researching medical issues of personal significance, that are not typical of traditional academic conferences. The vast majority of attendees (more than 90% for workshops and more than 80% for poster collaborative sessions) reported feeling welcome and included in live sessions.

Despite this, the new platform resulted in a significant accessibility barrier for some. Many users struggled to find information and engage effectively through CSA Connect. There was a help desk and informational articles available throughout the event and CSA staff held tutorials on how to navigate the site. Even with these aids available, many attendees found the platform frustrating and had difficulty finding the links to the live Zoom sessions or the event schedule, as well as difficulty trying to download and/or watch the asynchronous materials. The CSA Connect platform, Mighty Networks, was also not compatible with screen readers, and most individual presenters did not include closed captions despite encouragement from event organizers. These shortfalls were felt by some attendees and presenters who prefer languages other than English or rely more heavily on either audio or visual content. Furthermore, the internet connections were not reliable for all attendees and presenters, leading to exclusion from synchronous content. The digital gap specifically affected our rural or international attendees, and we expect internet connectivity issues disproportionately impacted other underrepresented and minoritized populations as noted by other pandemic-era conference organizers (Spencer et al. 2021). The availability of prerecorded presentations and recorded live sessions helped to overcome connectivity challenges and language barriers. But most hosts during live sessions forgot to turn on the closed captions, and much of the richness of discussion occurred in simultaneous sessions without as much activity in asynchronous chat features.

The intention to provide a supportive and productive virtual environment for all attendees was not fulfilled in transition to the virtual conference space, which was a common experience for research conferences even before the pandemic (De Saá-Pérez et al. 2015; Nielsen, Bloch, and Schiebinger 2018). Accessibility concerns persisted after the transition to a virtual conference even though we reduced the safety and physical accessibility concerns about travel options and venues where conferences are usually held (Shirk, Cooper, and Bowser 2018; Sarabipour et al. 2021). Additionally, there was a reduced registration fee scaled to reduce the financial barrier to participation for those of specific identity-groups defined by CSA (Supplemental File 1: Appendix B). CSA continues to update their registration fee scales to be more inclusive of its audience. For example, CSA has reduced rates for students, retirees, K–12 educators, environmental justice and Indigenous practitioners, and project volunteers. But we must acknowledge that these fees are only one part of the cost to fully participate in a conference, and diverse participants benefit from a conference that transcends traditional meeting formats.

After summing the accessibility and inclusivity challenges faced during the transition to virtual conferences and more generally in academic conferences (reviewed by Sarabipour et al. 2021), we conclude that one area of improvement is to acknowledge the limited voices that could participate in this conference and think about steps that would allow them to participate in the future. The conference did incorporate Black voices in the HBCU session and with the kick-off keynote speaker, and some Indigenous voices with the workshop bundle, "Participatory Research and Indigenous Knowledge." However, anecdotal evidence collected during sessions and social events identified shortcomings in conference elements that were intended to embrace disabled, student and early-career,

and international communities. For the 2022 conference, CSA intentionally targeted student and early-career people with a mentorship program to guide them through the conference. Furthermore, for the 2023 hybrid conference, CSA should invite the local and regional high schools and colleges to include more Latinx and Indigenous voices.

GOAL 6: VIRTUAL AND IN-PERSON CONFERENCE SYNERGY

CitSciVirtual 2021 significantly impacted the planning process for all CSA future events, as well as CSA operations and policies. One outcome of the event was the Code of Conduct, which has been shared with several different communities and supported by the CSA community (Supplemental File 9: CitSciVirtual 2021 community guidelines). Building on lessons learned from CitSciVirtual, the 2022 CSA conference included a virtual core program accessible to attendees around the world, as well as regional (in-person or virtual) events to help participants connect to their local c*science community. The major themes that emerged from submissions and discussions during CitSciVirtual, including increasing diversity and inclusion in c*science, forming partnerships, and sustaining projects through time, formed the basis for the 2022 conference core program.

CONCLUSION

Hosting conferences is a major role that CSA plays within the global c*science community of practice, providing opportunities to network, share, and learn from one another. While many lessons were learned in the planning and implementation of CitSciVirtual, and we hope to see continued improvement in structure and delivery, we found many benefits to hosting a virtual conference. Although we did not fully meet our goals related to access and engaging new audiences, we were able to engage with participants from around the world, and some participants in the United States who likely would not have attended our in-person conferences. Overall, CitSciVirtual 2021 was an important learning experience and will provide a valuable starting point for future CSA events and conferences going forward.

While we expect CSA to return to in-person conferencing as the barriers to entry for virtual conferences fall over time, CSA must find a place on the leading edge of accessibility, power-sharing, democratization, and inclusivity to honor our memberships' high valuation of these ideals. We believe that virtual events and the lessons learned during CitSciVirtual 2021 can help move towards that goal.

DATA ACCESSIBILITY STATEMENTS

The data that support the findings of this study from the CSA Evaluation Report are available from the corresponding author, A. Hils, upon reasonable request.

SUPPLEMENTARY FILES

The supplementary Files for this article can be found as follows:

- **Supplemental File 1.** Appendices A and B, Information related to conference schedule and fee structure. DOI: https://doi.org/10.5334/cstp.559.s1
- **Supplemental File 2.** CitSciVirtual 2021 poster proposal submission form. DOI: https://doi.org/10.5334/cstp.559.s2
- **Supplemental File 3.** CitSciVirtual2021 workshop proposal submission form. DOI: https://doi.org/10.5334/cstp.559.s3
- **Supplemental File 4.** CitSciVirtual 2021 poster submission guidelines. DOI: https://doi.org/10.5334/cstp.559.s4
- **Supplemental File 5.** CitSciVirutal2021 workshop submission guidelines. DOI: https://doi.org/10.5334/cstp.559.s5
- **Supplemental File 6.** CitSciVirtual 2021 poster session topics and schedule. DOI: https://doi.org/10.5334/cstp.559.s6
- **Supplemental File 7.** CitSciVirtual 2021 poster submission review criteria. DOI: https://doi.org/10.5334/cstp.559.s7
- **Supplemental File 8.** CitSciVirtual 2021 workshop descriptions. DOI: https://doi.org/10.5334/cstp.559.s8
- **Supplemental File 9.** CitSciVirtual 2021 community guidelines. DOI: https://doi.org/10.5334/cstp.559.s9

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTION

All authors participated in the planning of CitSciVirtual 2021. All also participated in the planning, writing, and editing of this manuscript.

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